CALCULATION INDEX

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered As Promised

ISO 9001:2008 CERTIFIED

PROJECT: **HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
Norfolk Southern RR over SR 562
DATE: **5/18/16 10:15 AM**

ODOT PID NO: *77889*
GF JOB NO: **54682**
UPDATED BY: CTM
UPDATED DATE: May 18, 2016

CALCULATION NUMBER	CALCULATION SUBJECT (Root Folder #)	Current REV #	DATE	Calc	Check	Update	Verify	Scanned Check	NOTES	Overall Pg. No.
HAM562_0026_01	(10) Geometry: Top of Rail EL, Bottom of Beam EL, Vertical Clearances	04	01/17/16	EFD	VDT	VDT	CTM	Digital	*Alignments from PAVR*	3
HAM562_0026_02	(35) Girder: Section Properties	03	01/14/16	EFD	VDT	EFD	VDT	Digital	*Includes Proportion Check & Stiffener Requirements*	16
HAM562_0026_03	(35) Girder: Girder Loads, Stresses, and Deflections	05	01/14/16	CTM	VDT	EFD	VDT	Digital	*Spreadsheet Linked to 0026_02, Single design for both spans*	23
HAM562_0026_04	(15) Loads: Abutment Design Loads	02	01/14/16	VDT	VDK	VDT	EFD	Digital	*Spreadsheet Linked to 0026_03*	45
HAM562_0026_05	(25) Abutments: Abutment Analysis (Abut5)	01	01/20/16	VDT	VDK	VDT	EFD	Digital	*Abut5 Analysis*	50
HAM562_0026_06	(15) Loads: Pier Design Loads	00	07/16/14	VDT	VDK	VDT	CTM	Digital		60
HAM562_0026_07	(30) Pier Analysis (RCPier)	01	01/18/16	VDT	VDK	VDT	CTM	Digital		64
HAM562_0026_07SR	(30) Pier Analysis (Footing Shear Reinforcing)	01	01/18/16	VDT	VDK	VDT	CTM	Digital		256
HAM562_0026_08	(15) Loads: Retaining Wall Design Loads	00	07/30/14	VDT	VDK	VDT	EFD	Digital	*Lateral Earth Pressures from Train Surcharge*	258
HAM562_0026_09	(25) Abutments: Retaining Wall Analysis (Abut5)	00	07/30/14	VDT	VDK	VDT	EFD	Digital	*Abut5 Analysis*	263
HAM562_0026_10	(40) Bearings: Bearing Design	02	01/14/16	CTM	VDT	VDT	CTM	Digital		271
HAM562_0026_11	(45) Connection Details: Girder Connection Details	01	01/18/16	VDT	VDK	VDT	CTM	Digital		284
HAM562_0026_12	(45) Connection Details: Shear Studs	01	01/18/16	VDT	VDK	VDT	CTM	Digital		313
HAM562_0026_13R	(23) Shoring: Sheeting, Phase A&B Rear	02	01/18/16	SNH	VDT	VDT	CTM	Digital	*Prosheet Analysis*	321

CALCULATION INDEX

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PROJECT: **HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
Norfolk Southern RR over SR 562
DATE: **5/18/16 10:15 AM**

ODOT PID NO: *77889*
GF JOB NO: **54682**
UPDATED BY: CTM
UPDATED DATE: May 18, 2016

CALCULATION NUMBER	CALCULATION SUBJECT (Root Folder #)	Current REV #	DATE	Calc	Check	Update	Verify	Scanned Check	NOTES	Overall Pg. No.
HAM562_0026_13F	(23) Shoring: Sheeting, Phase A&B Forward	00	09/12/14	SNH	CTM	SNH	CTM	Digital	*Prosheet Analysis*	381
HAM562_0026_14R	(23) Shoring: Sheeting, Phase C&D Rear	01	06/03/15	SNH	VDT	SNH	VDT	Digital	*Prosheet Analysis*	405
HAM562_0026_14F	(23) Shoring: Sheeting, Phase C&D Forward	00	09/12/14	SNH	CTM	SNH	CTM	Digital	*Prosheet Analysis*	425
HAM562_0026_15	(25) Abutments: Pile and Lagging Wall Analysis	00	11/06/14	EFD	CTM	EFD	VDT	Digital		449
HAM562_0026_16	(60) Quantities: Estimated Project Quantities	02	04/28/16	CTM	SNH	VDT	CTM	Digital		460
HAM075_PROS_12	(50) Deck: Concrete Deck Design	01	01/14/16	VDK	CTM	EFD	VDK	Digital	*Since bridge geometry is similar to prosser, the same design is applied*	475
HAM562_0026_PP	Pipe Pile Calculation	00	07/17/14	EFD	VDT	N/A	N/A	Digital		488

DESIGN CALCULATION COVER SHEET

Gannett Fleming
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PROJECT:	**HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***NSRR Elevations***	**GF JOB NO:**	**54682**
	PGL, Bottom of Beam	CALC NO.:	**HAM562_0026_01**
	and Under-Clearances	REV NO.:	**04**
FILE NAME(s):	*HAM562_0026_01.xlsx*	**SHEET:**	**1 OF 13**

SUPERSEDES CALC NO: 02 (Stage 2 Interim)

CALCULATION DESCRIPTION:

This will calculate points along the vertical profile of the alignment based upon standard geometric calculations.

This will calculate bottom of beam and bottom of bearing elevations. **This assumes that the bottom of beam elevations are equal across the skew.**

This will calculate vertical clearances under the structure; including to the existing roadway surface (from the TIN file)

DESIGN BASIS OR REFERENCES:

EMH&T Suppllied Survey & Roadway Basemaps
Stage 1 Railroad Profiles
Stage 1 Bridge Layout

MISCELLANEOUS NOTES:

PGL is assumed to be the top of low rail

Bridge Layout is updated to Stage 2 bridge construction sequencing as well as a new superstructure with a composite concrete deck.

Stage 3: Updated Deck Thickness and Bearing Heights

RECORD OF ISSUES:

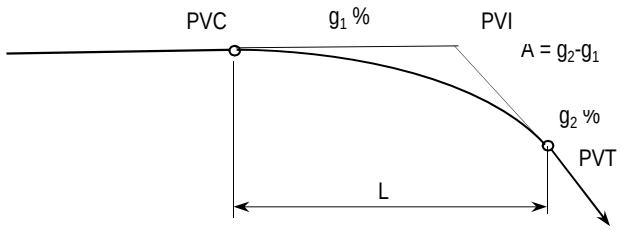
REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
N/A	Pre-Stage 1 Calculation	EFD	02/13/12		
00	Stage 1 Calculation	CTM	11/01/13		
01	Update for Existing Road & PD Track & Skew	EFD	12/17/13		
02	Stage 2 Update to Composite Deck	EFD	04/09/14		
03	Stage 2 Update to Current RR Sta.	JEA	07/24/14		
04	Stage 3 Update to Deck and Bearings	VDT	01/17/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
EFD	09/19/14	VDT	09/23/14	VDT	09/23/14	SNH	11/19/14

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
		PROJECT: **HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR Maiinline Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
Under Mainline Profile		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (Main NS Track)

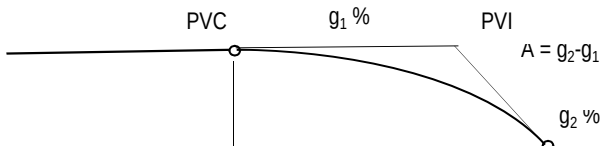


1: SYMMETRICAL PARABOLIC CURVE			2: STRAIGHT GRADE	
L =	**100**		L =	**81.94**
g1 =	**-0.3368%**		g =	**0.5100%**
g2 =	**0.5100%**			
PVI Station	**128+72.67**			
PVI Elev =	**550.7421**			
PVC Station =	128+22.67		PVC Station =	**129+22.67**
PVC Elev =	550.91		PVC Elev =	**551.00**
PVT Station =	129+22.67		PVT Station =	**130+04.61**
PVT Elev =	551.00		PVT Elev =	**551.41**
Location & El of High Point=	128+62.44	550.844		
Chord elev @ PVI =	550.95			
Tangent offset at PVI (e) =	0.4234			

3: SYMMETRICAL PARABOLIC CURVE			4: STRAIGHT GRADE	
L =	**100**		L =	**632.24**
g1 =	**0.5100%**		g =	**-0.2428%**
g2 =	**-0.2428%**			
PVI Station	**130+54.61**			
PVI Elev =	**551.67**			
PVC Station =	130+04.61		PVC Station =	**131+04.61**
PVC Elev =	551.42		PVC Elev =	**551.55**
PVT Station =	131+04.61		PVT Station =	**137+36.85**
PVT Elev =	551.55		PVT Elev =	**550.01**
Location & El of High Point=	130+72.36	551.588		
Chord elev @ PVI =	551.48			
Tangent offset at PVI (e) =	-0.3764			

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
		PROJECT: **HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR Maiinline Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
Under Mainline Profile		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (Main NS Track)



Vertical Clearance Point Entry

Station	Location Description	PGL Elevation	Station	Location Description	PGL Elevation
129+88.09	SP1 Rear: Toe Barrier @ LT Girder	551.33	130+47.37	SP2 Rear: Toe/Barr @ LT Girder	551.56
129+95.72	SP1 Rear: EOP @ LT Girder	551.37	130+51.22	SP2 Rear: PG/Crown/EOP @ LT Girder	551.57
130+36.77	SP1: SR562 PG/Crown/EOP @ LT Girder	551.54	130+81.30	SP2 FWD: EOP @ LT Girder	551.58
130+40.63	SP1 FWD: Toe/Barr @ LT Girder	551.55	130+93.26	SP2 FWD: Toe/Barr @ LT Girder	551.57
129+64.82	SP1 Rear: Toe Barrier @ RT Girder	551.21	130+29.35	SP2 Rear: Toe/Barr @ RT Girder	551.52
129+73.28	SP1 Rear: EOP @ RT Girder	551.26	130+33.66	SP2 Rear: PG/Crown/EOP @ RT Girder	551.53
130+17.52	SP1: SR562 PG/Crown/EOP @ RT Girder	551.47	130+64.61	SP2 FWD: EOP @ RT Girder	551.59
130+21.82	SP1 FWD: Toe/Barr @ RT Girder	551.49	130+77.61	SP2 FWD: Toe/Barr @ RT Girder	551.59
130+31.57	SP1: FWD @ PCB @ LT Gird (2' from sheetng)	551.53	130+56.41	SP2 Rear @ PCB @ LT Gird (2' from sheetng)	551.58
130+11.72	SP1: FWD @ PCB @ RT Gird (2' from sheetng)	551.45	130+39.47	SP2: Rear @ PCB @ RT Gird (2' from sheetng)	551.55

Skew

Substructure units are skewed in relation to the horizontal curvature of the track alignment. As such; the actual station of C/L bearing for each fascia beam will be entered; as to allow for an exact PGL calculation for each bearing. The deck joint and caps will be made level, making the bottom of girder elevations equal

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
		PROJECT: **HAM-75-7.85**	

ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR Maiinline Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
Under Mainline Profile		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (Main NS Track)

Note: PGL = Top of low rail. Back of Backwall excludes any backwall haunch.

WP = Working Point = Intersection of PGL Alignment

Station	Element (at PGL, U.N.O.)	PGL Elevation	Main Track Data			Alt. Track Data		
			Super Elevation	High Rail Elev.	Low Rail Elev.	Super Elevation	High Rail Elev.	Low Rail Elev.
128+52.22	Begin 100' Approach	550.85	0.000 in	550.85	550.85			
128+62.22	0.1	550.84	0.000 in	550.84	550.84			
128+72.22	0.2	550.85	0.000 in	550.85	550.85			
128+82.22	0.3	550.86	0.000 in	550.86	550.86			
128+92.22	0.4	550.88	0.000 in	550.88	550.88			
129+02.22	0.5	550.91	0.000 in	550.91	550.91			
129+12.22	0.6	550.95	0.000 in	550.95	550.95			
129+22.22	0.7	550.99	0.000 in	550.99	550.99			
129+32.22	0.8	551.05	0.000 in	551.05	551.05			
129+42.22	0.9	551.10	0.000 in	551.10	551.10			
129+52.22	Rear Backwall (Rear Face)	551.15	0.000 in	551.15	551.15			
129+56.14	Rear Bckwll @ WP (Front Face)	551.17	0.000 in	551.17	551.17			
129+78.20	Rear Abut, LT Girder CL Brg	551.28	0.000 in	551.28	551.28			
129+58.33	Rear Abut C/L Brg @ NSRR	551.18	0.000 in	551.18	551.18			
129+53.15	Rear Abut, RT Girder CL Brg	551.15	0.000 in	551.15	551.15			
129+61.88	0.05 * Span 1 Deck	551.20	0.000 in	551.20	551.20			
129+65.42	0.10 * Span 1 Deck	551.22	0.000 in	551.22	551.22			
129+68.97	0.15 * Span 1 Deck	551.23	0.000 in	551.23	551.23			
129+72.51	0.20 * Span 1 Deck	551.25	0.000 in	551.25	551.25			
129+76.06	0.25 * Span 1 Deck	551.27	0.000 in	551.27	551.27			
129+79.60	0.30 * Span 1 Deck	551.29	0.000 in	551.29	551.29			
129+83.15	0.35 * Span 1 Deck	551.31	0.000 in	551.31	551.31			
129+86.69	0.40 * Span 1 Deck	551.32	0.000 in	551.32	551.32			
129+90.24	0.45 * Span 1 Deck	551.34	0.000 in	551.34	551.34			
129+93.79	0.50 * Span 1 Deck	551.36	0.000 in	551.36	551.36			
129+97.33	0.55 * Span 1 Deck	551.38	0.000 in	551.38	551.38			
130+00.88	0.60 * Span 1 Deck	551.40	0.000 in	551.40	551.40			
130+04.42	0.65 * Span 1 Deck	551.41	0.000 in	551.41	551.41			
130+07.97	0.70 * Span 1 Deck	551.43	0.000 in	551.43	551.43			
130+11.51	0.75 * Span 1 Deck	551.45	0.000 in	551.45	551.45			
130+15.06	0.80 * Span 1 Deck	551.46	0.000 in	551.46	551.46			
130+18.60	0.85 * Span 1 Deck	551.48	0.000 in	551.48	551.48			
130+22.15	0.90 * Span 1 Deck	551.49	0.000 in	551.49	551.49			
130+25.69	0.95 * Span 1 Deck	551.51	0.000 in	551.51	551.51			
130+42.26	Pier #1 LT Girder CL Brg	551.55	0.000 in	551.55	551.55			
130+29.24	Pier #1 C/L Brg @ NSRR	551.52	0.000 in	551.52	551.52			
130+24.15	Pier #1 RT Girder CL Brg	551.50	0.000 in	551.50	551.50			

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
		PROJECT: **HAM-75-7.85**	

ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR Maiinline Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
Under Mainline Profile		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (Main NS Track)

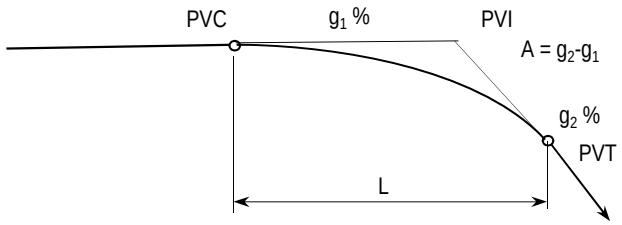
Note: PGL = Top of low rail. Back of Backwall excludes any backwall haunch.

WP = Working Point = Intersection of PGL Alignment

Station	Element (at PGL, U.N.O.)	PGL Elevation	Main Track Data			Alt. Track Data		
			Super Elevation	High Rail Elev.	Low Rail Elev.	Super Elevation	High Rail Elev.	Low Rail Elev.
130+30.89	Pier #1 C/L	551.52	0.000 in	551.52	551.52			
130+45.31	Pier #1, LT Girder CL Brg	551.56	0.000 in	551.56	551.56			
130+32.54	Pier #1 C/L Brg @ NSRR	551.53	0.000 in	551.53	551.53			
130+27.55	Pier #1, RT Girder CL Brg	551.51	0.000 in	551.51	551.51			
130+35.95	0.05 * Span 2 Deck	551.54	0.000 in	551.54	551.54			
130+39.37	0.10 * Span 2 Deck	551.55	0.000 in	551.55	551.55			
130+42.78	0.15 * Span 2 Deck	551.55	0.000 in	551.55	551.55			
130+46.20	0.20 * Span 2 Deck	551.56	0.000 in	551.56	551.56			
130+49.61	0.25 * Span 2 Deck	551.57	0.000 in	551.57	551.57			
130+53.02	0.30 * Span 2 Deck	551.57	0.000 in	551.57	551.57			
130+56.44	0.35 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+59.85	0.40 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+63.27	0.45 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+66.68	0.50 * Span 2 Deck	551.59	0.000 in	551.59	551.59			
130+70.09	0.55 * Span 2 Deck	551.59	0.000 in	551.59	551.59			
130+73.51	0.60 * Span 2 Deck	551.59	0.000 in	551.59	551.59			
130+76.92	0.65 * Span 2 Deck	551.59	0.000 in	551.59	551.59			
130+80.34	0.70 * Span 2 Deck	551.59	0.000 in	551.59	551.59			
130+83.75	0.75 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+87.16	0.80 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+90.58	0.85 * Span 2 Deck	551.58	0.000 in	551.58	551.58			
130+93.99	0.90 * Span 2 Deck	551.57	0.000 in	551.57	551.57			
130+97.41	0.95 * Span 2 Deck	551.56	0.000 in	551.56	551.56			
131+10.83	FWD Abut, LT Girder CL Brg	551.53	0.000 in	551.53	551.53			
131+00.82	FWD Abut C/L Brg @ NSRR	551.56	0.000 in	551.56	551.56			
130+98.47	FWD Abut, RT Girder CL Brg	551.56	0.000 in	551.56	551.56			
131+02.86	FWD Bckwll @ WP (Front Face)	551.55	0.000 in	551.55	551.55			
131+05.34	FWD Backwall (Rear Face)	551.55	0.000 in	551.55	551.55			
131+15.34	0.1	551.52	0.000 in	551.52	551.52			
131+25.34	0.2	551.50	0.000 in	551.50	551.50			
131+35.34	0.3	551.47	0.000 in	551.47	551.47			
131+45.34	0.4	551.45	0.000 in	551.45	551.45			
131+55.34	0.5	551.43	0.000 in	551.43	551.43			
131+65.34	0.6	551.40	0.000 in	551.40	551.40			
131+75.34	0.7	551.38	0.000 in	551.38	551.38			
131+85.34	0.8	551.35	0.000 in	551.35	551.35			
131+95.34	0.9	551.33	0.000 in	551.33	551.33			
132+05.34	End 100' Depart	551.30	0.000 in	551.30	551.30			

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
		PROJECT: **HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *EFD*	DATE: *12/16/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR PD Track Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (PD Yard Track over Structure)



1: SYMMETRICAL PARABOLIC CURVE			2: STRAIGHT GRADE	
L =	**100**		L =	**104.06**
g1 =	**-0.3375%**		g =	**0.5254%**
g2 =	**0.5254%**			
PVI Station	**5+69.09**			
PVI Elev =	**550.74**			
PVC Station =	5+19.09		PVC Station =	**6+19.09**
PVC Elev =	550.91		PVC Elev =	**551.00**
PVT Station =	6+19.09		PVT Station =	**7+23.15**
PVT Elev =	551.00		PVT Elev =	**551.5487**
Location & El of High Point=	5+58.20	550.84		
Chord elev @ PVI =	550.96			
Tangent offset at PVI (e) =	0.4315			

3: SYMMETRICAL PARABOLIC CURVE			4: STRAIGHT GRADE	
L =	**100**		L =	**679.76**
g1 =	**0.5254%**		g =	**-0.6793%**
g2 =	**-0.6793%**			
PVI Station	**7+73.15**			
PVI Elev =	**551.81**			
PVC Station =	7+23.15		PVC Station =	**8+23.15**
PVC Elev =	551.55		PVC Elev =	**551.47**
PVT Station =	8+23.15		PVT Station =	**15+02.91**
PVT Elev =	551.47		PVT Elev =	**546.85**
Location & El of High Point=	7+66.76	551.66		
Chord elev @ PVI =	551.51			
Tangent offset at PVI (e) =	-0.6024			

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **02**
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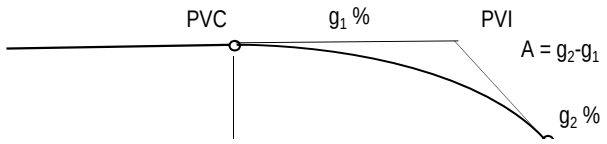
BRIDGE NO: *HAM-562-0026*		UPDATED: *JEA*	DATE: *07/24/14*
SUBJECT: *NSRR PD Track Elevations*		CHECKED:	DATE:
PGL Data		UPDATED:	DATE:
		VERIFIED:	DATE:

PGL Vertical Curve & Profile Data (PD Yard Track over Structure)



Vertical Clearance Point Entry

Station	Location Description	PGL Elevation	Station	Location Description	PGL Elevation
6+94.40	SP1 Rear: Toe Barrier @ LT Girder	551.40	7+56.54	SP2 Rear: Toe/Barr @ LT Girder	551.66
7+02.32	SP1 Rear: EOP @ LT Girder	551.44	7+60.63	SP2 Rear: PG/Crown/EOP @ LT Girder	551.66
7+45.32	SP1: SR562 PG/Crown/EOP @ LT Girder	551.64	7+92.76	SP2 FWD: EOP @ LT Girder	551.62
7+49.40	SP1 FWD: Toe/Barr @ LT Girder	551.65	8+05.28	SP2 FWD: Toe/Barr @ LT Girder	551.57
6+73.05	SP1 Rear: CL Abut Brg.	551.29	7+50.27	SP2 Rear: CL Pier Brg.	551.65
7+46.86	SP1 FWD: CL Pier Brg.	551.64	8+20.25	SP2 FWD: CL Abut Brg.	551.49
7+39.83	SP1: FWD @ Proposed Shoring @ LT Girder	551.62	7+66.15	SP2: FWD @ Proposed Shoring @ LT Girder	551.66
Diff. From ML SP1 Rear: Toe Barrier @ LT Girder		-0.803 in	Diff. From ML SP2 Rear: Toe/Barr @ LT Girder		-1.111 in
Diff. From ML SP1 Rear: EOP @ LT Girder		-0.836 in	Diff. From ML SP2 Rear: PG/Crown/EOP @ LT Girder		-1.080 in
Diff. From ML SP1: SR562 PG/Crown/EOP @ LT Girder		-1.145 in	Diff. From ML SP2 FWD: EOP @ LT Girder		-0.453 in
Diff. From ML SP1 FWD: Toe/Barr @ LT Girder		-1.142 in	Diff. From ML SP2 FWD: Toe/Barr @ LT Girder		-0.030 in
Diff. From ML SP1 Rear: CL Abut Brg.		-0.062 in	Diff. From ML SP2 Rear: CL Pier Brg.		-1.039 in
Diff. From ML SP1 FWD: CL Pier Brg.		-1.028 in	Diff. From ML SP2 FWD: CL Abut Brg.		0.512 in
Diff. From ML SP1: FWD @ Proposed Shoring @ LT Girder		-1.132 in	Diff. From ML SP2: FWD @ Proposed Shoring @ LT Girder		-1.020 in

The "Diff. from" values above is the difference between the elevation of the mainline and the Track D elevations at the point in question. The left girder elevations are used to approximate the station of the track D alignment.

6+66.14	Rear face of Rear Abutment	551.25	8+25.14	Rear face of Forward Abutment	551.46
7+48.56	CL of Pier	551.64			

7+10.53	mid span	551.48	7+85.61	mid span	551.64

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_01	REV. NO.: 03
ODOT PID NO.: 77889		PROJECT: HAM-75-7.85	
BRIDGE NO: HAM-562-0026		DESIGNED: CTM	DATE: 11/01/13
SUBJECT: NSRR Mainline Elevations		UPDATED: CTM	DATE: 07/11/14
Bottom of Beam and Bearing		CHECKED:	DATE:
Set by Mainline Profile		UPDATED: VDT	DATE: 01/17/16
		VERIFIED:	DATE:

NOTE 1:
There is no expected superelevation on the tracks across this structure due to yard switching. However, given that there are two tracks across this structure that enter the yard; the adjustment value listed is for the siding track (PD). The value will be used when the siding elevation, at a point normal to the chord station of the mainline, is lower than the mainline elevation. This will ensure that the ballast depth calculated in pink is for the lowest point of either track. This only applies to the values on the left girder (nearest girder to the PD-1 track).

Substructure Elevation Data

Calculation assumes that all girders are at the same elevation along the span (along the skew). The cap and expansion joints in the steel plate deck will be level.

Design Span Length (Span Chord Length)	69.500 ft	Minimum Deck Cross-Slope	0.0100	Deck Extension past Brg	1.5889ft

Live Load Deflection Allowance

L/800 LL deflection will be assumed in a straight line approximation to account for cars parked atop the structure. It is assumed that girders will be cambered for DL deflection — *d=1.043 in*

Element/ Location	Span 1: Rear Abutment			Span 1: Pier #1			Span 1: Vertical Clearance Locations									
	Rear Abut, LT Girder CL Brg	Rear Abut C/L Brg @ NSRR	Rear Abut, RT Girder CL Brg	Pier #1 LT Girder CL Brg	Pier #1 C/L Brg @ NSRR	Pier #1 RT Girder CL Brg	SP1 Rear: Toe Barrier @ LT Girder	SP1 Rear: EOP @ LT Girder	SP1: SR562 PG/Crown/EOP @ LT Girder	SP1 FWD: Toe/Barr @ LT Girder	SP1 Rear: Toe Barrier @ RT Girder	SP1 Rear: EOP @ RT Girder	SP1: SR562 PG/Crown/EOP @ RT Girder	SP1 FWD: Toe/Barr @ RT Girder	SP1: FWD @ PCB @ LT Gird (2' from sheetng)	SP1: FWD @ PCB @ RT Gird (2' from sheetng)
Dist. Along C/L Girder (From C/L Brg.)	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	10.4815 ft	18.7909 ft	63.3186 ft	67.4976 ft	10.4815 ft	18.7909 ft	63.3186 ft	67.4976 ft	59.7490 ft	59.7490 ft
Station	129+78.20	129+58.33	129+53.15	130+42.26	130+29.24	130+24.15	129+88.09	129+95.72	130+36.77	130+40.63	129+64.82	129+73.28	130+17.52	130+21.82	130+31.57	130+11.72
Mainline PGL Elevation	551.280	551.179	551.153	551.554	551.518	551.500	551.331	551.370	551.540	551.550	551.212	551.255	551.475	551.492	551.525	551.449
C/L to Chord (+ = Right)																
141 RE Rail Height	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in
Assumed Tie Plate Thickness	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in
Tie Thickness	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in
Siding Adjustment (See Note 1)	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in
Ballast (9" min under non-supered tie)	10.326 in	9.110 in	8.793 in	9.431 in	9.000 in	8.790 in	10.302 in	10.269 in	9.639 in	9.505 in	8.877 in	8.896 in	8.853 in	8.806 in	9.674 in	8.765 in
Waterproofing Thickness	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in
Deck Crown Height	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in
Min Concrete Thickness	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in
Top Flange Thickness	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in
Web Depth	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in
Bottom Flange Thickness	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in
PGL to Bottom of Steel (Feet)	6.532 ft	6.431 ft	6.405 ft	6.458 ft	6.422 ft	6.404 ft	6.530 ft	6.528 ft	6.475 ft	6.464 ft	6.412 ft	6.413 ft	6.410 ft	6.406 ft	6.478 ft	6.402 ft
Min. Bottom of Steel Elevation	544.748	544.748	544.748	545.096	545.096	545.096	544.800	544.842	545.065	545.086	544.800	544.842	545.065	545.086	545.047	545.047
Distance Along C/L Girder	0.000 ft	0.000 ft	0.000 ft	69.500 ft	69.500 ft	69.500 ft	10.482 ft	18.791 ft	63.319 ft	67.498 ft	10.482 ft	18.791 ft	63.319 ft	67.498 ft	59.749 ft	59.749 ft
Max Allowable LL Deflection	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.314 in	0.564 in	0.185 in	0.060 in	0.314 in	0.564 in	0.185 in	0.060 in	0.293 in	0.293 in
Min. Bottom of Steel & Deflection	544.748	544.748	544.748	545.096	545.096	545.096	544.774	544.795	545.050	545.081	544.774	544.795	545.050	545.081	545.023	545.023
Sole Plate Thickness	1.500 in	1.500 in	1.500 in	2.000 in	2.000 in	2.000 in										
Bearing Thickness	3.398 in	3.398 in	3.398 in	3.692 in	3.692 in	3.692 in										
Masonry Plate Thickness	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in										
Total Bearing Thickness	0.41 ft	0.41 ft	0.41 ft	0.47 ft	0.47 ft	0.47 ft										
Max. Top of Cap Elevation	544.34	544.34	544.34	544.62	544.62	544.62										

	Rear Abutment	Pier #1, Span 1
Top of Cap Elevation	544.34	544.62
Total Differential (Fascia Girders)	0.000 in	0.000 in
No. of Girder Spaces	18	18
Individual Bearing Thickness Step	0.000 in	0.000 in

Left Girder Slope: 0.5007%

Deck Crown Long. Slope: 0.5007%

Mainline PGL Chord Slope: 0.4875%

Right Girder Slope: 0.5007%

Beam Differential: 2/32

Deck extends past bearing CL 1.742 (along CL Girder)

Rear Abut. Deck Low Point = 548.91

Rear Abut. Deck Crown Point: = 549.03

Deck extends past bearing CL 1.437 (along CL Girder)

Pier Deck Low Point = 549.27

Pier Deck Crown Point: = 549.39

0.12361701

Rear Top/Curb (24" Standard) = 551.03

Rear Top/End Dam = 549.11

Pier Top/Curb (24" Standard) = 551.39

Pier Top/End Dam = 549.48

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_01	REV. NO.: 03
ODOT PID NO.: 77889		PROJECT: HAM-75-7.85	
BRIDGE NO: HAM-562-0026		DESIGNED: CTM	DATE: 11/01/13
SUBJECT: NSRR Mainline Elevations		UPDATED: CTM	DATE: 07/11/14
Bottom of Beam and Bearing		CHECKED:	DATE:
Set by Mainline Profile		UPDATED: VDT	DATE: 01/17/16
		VERIFIED:	DATE:

NOTE 1:
There is no expected superelevation on the tracks across this structure due to yard switching. However, given that there are two tracks across this structure that enter the yard; the adjustment value listed is for the siding track (PD). The value will be used when the siding elevation, at a point normal to the chord station of the mainline, is lower than the mainline elevation. This will ensure that the ballast depth calculated in pink is for the lowest point of either track. This only applies to the values on the left girder (nearest girder to the PD-1 track).

Substructure Elevation Data

Calculation assumes that all girders are at the same elevation along the span (along the skew). The cap and expansion joints in the steel plate deck will be level.

Design Span Length (Span Chord Length)	69.500 ft	Minimum Deck Cross-Slope	0.0100	Deck Extension past Brg	1.5889ft

Live Load Deflection Allowance

L/800 LL deflection will be assumed in a straight line approximation to account for cars parked atop the structure. It is assumed that girders will be cambered for DL deflection. — *d=1.043 in*

Element/ Location	Span 2: Pier #1			Span 2: Forward Abutment			Span 2: Vertical Clearance Locations									
	Pier #1, LT Girder CL Brg	Pier #1 C/L Brg @ NSRR	Pier #1, RT Girder CL Brg	FWD Abut, LT Girder CL Brg	FWD Abut C/L Brg @ NSRR	FWD Abut, RT Girder CL Brg	SP2 Rear: Toe/Barr @ LT Girder	SP2 Rear: PG/Crown/EOP @ LT Girder	SP2 FWD: EOP @ LT Girder	SP2 FWD: Toe/Barr @ LT Girder	SP2 Rear: Toe/Barr @ RT Girder	SP2 Rear: PG/Crown/EOP @ RT Girder	SP2 FWD: EOP @ RT Girder	SP2 FWD: Toe/Barr @ RT Girder	SP2 Rear @ PCB @ LT Gird (2' from sheetng)	SP2: Rear @ PCB @ RT Gird (2' from sheetng)
Dist. Along C/L Girder (From C/L Brg.)	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	0.0000 ft	2.0024 ft	6.1814 ft	38.9006 ft	51.6368 ft	2.0024 ft	6.1814 ft	36.3206 ft	49.0180 ft	9.7510 ft	9.7510 ft
Station	130+45.31	130+32.54	130+27.55	131+10.83	131+00.82	130+98.47	130+47.37	130+51.22	130+81.30	130+93.26	130+29.35	130+33.66	130+64.61	130+77.61	130+56.41	130+39.47
Mainline PGL Elevation	551.56	551.53	551.51	551.53	551.56	551.56	551.56	551.57	551.58	551.57	551.52	551.53	551.59	551.59	551.58	551.55
C/L to Chord (+ = Right)																
141 RE Rail Height	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in	7.438 in
Assumed Tie Plate Thickness	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in	1.000 in
Tie Thickness	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in	7.000 in
Siding Adjustment (See Note 1)	0.000 in	0.000 in	0.000 in	0.512 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in
Ballast	9.386 in	9.000 in	8.809 in	9.803 in	10.600 in	10.658 in	9.470 in	9.625 in	10.380 in	10.447 in	8.917 in	9.151 in	10.342 in	10.585 in	9.777 in	9.403 in
Waterproofing Thickness	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in	1.125 in
Deck Crown Height	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in	1.500 in
Min Concrete Thickness	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in	9.000 in
Top Flange Thickness	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in
Web Depth	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in	35.000 in
Bottom Flange Thickness	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in	3.000 in
PGL to Bottom of Steel (Feet)	6.454 ft	6.422 ft	6.406 ft	6.531 ft	6.555 ft	6.560 ft	6.461 ft	6.474 ft	6.537 ft	6.542 ft	6.415 ft	6.434 ft	6.534 ft	6.554 ft	6.487 ft	6.455 ft
Min. Bottom of Steel Elevation	545.106	545.106	545.106	545.002	545.002	545.002	545.103	545.097	545.048	545.029	545.103	545.097	545.052	545.033	545.092	545.092
Distance Along C/L Girder	0.000 ft	0.000 ft	0.000 ft	69.500 ft	69.500 ft	69.500 ft	2.002 ft	6.181 ft	38.901 ft	51.637 ft	2.002 ft	6.181 ft	36.321 ft	49.018 ft	9.751 ft	9.751 ft
Max Allowable LL Deflection	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.060 in	0.185 in	0.918 in	0.536 in	0.060 in	0.185 in	0.995 in	0.614 in	0.293 in	0.293 in
Min. Bottom of Steel & Deflection	545.106	545.106	545.106	545.002	545.002	545.002	545.098	545.081	544.971	544.984	545.098	545.081	544.969	544.982	545.067	545.067
Sole Plate Thickness	2.000 in	2.000 in	2.000 in	1.500 in	1.500 in	1.500 in										
Bearing Thickness	3.692 in	3.692 in	3.692 in	3.448 in	3.448 in	3.448 in										
Masonry Plate Thickness	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in	0.000 in										
Total Bearing Thickness	0.47 ft	0.47 ft	0.47 ft	0.41 ft	0.41 ft	0.41 ft										
Max. Top of Cap Elevation	544.63	544.63	544.63	544.59	544.59	544.59										

	Pier #1, Span 2	Forward Abutment
Top of Cap Elevation	544.63	544.59
Total Differential (Fascia Girders)	0.000 in	0.000 in
No. of Girder Spaces	18	18
Individual Bearing Thickness Step	0.000 in	0.000 in

Left Girder Slope: -0.1499%

Deck Crown Long. Slope: -0.1499%

Mainline PGL Chord Slope: 0.0420%

Right Girder Slope: -0.1499%

Beam Differential: - 1/32

Deck extends past bearing CL 1.437 (along CL Girder)

Pier Deck Low Point = 549.28

Pier Deck Crown Point: = 549.40

Deck extends past bearing CL 1.742 (along CL Girder)

FWD Abut. Deck Low Point = 549.17

FWD Abut. Deck Crown Point: = 549.29

Pier Top/Curb (24" Standard) = 551.40

Pier Top/End Dam = 549.48

FWD Top/Curb (24" Standard) = 551.29

FWD Top/End Dam = 549.37

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **01**
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *EFD*	DATE: *12/16/13*
SUBJECT: *Elevations*		CHECKED: *CTM*	DATE: *12/17/13*
Vertical Clearance Under		UPDATED: *CTM*	DATE: *12/17/13*
Structure		VERIFIED: *MTO*	DATE: *02/12/14*
		PROJECT: **HAM-75-7.85**	

EMHT VC Data (Ramp J - BF002 File)		EMHT VC Data (Ramp M - BF002 File)	
G1 =	-0.0380	G1 =	-0.0504
G2 =	0.0183	G2 =	0.0380
VC =	350.00 ft.	VC =	540.00 ft.
PVC Sta. =	405 + 08.830	PVC Sta. =	425 + 45.080
PVT Sta. =	408 + 58.830	PVT Sta. =	430 + 85.078
PVC Elev. =	532.083	PVC Elev.	535.498
PVT Elev. =	528.640	PVT Elev.	532.142

Proposed Mainline Location Under **NSRR Bridge, SPAN #1**	NSRR Station	Mainline Profile Grade Elev.	Mainline Bottom of Beam Elevation (inc. LL Δ)		Ramp J Station	Crossroad PGL Elevation	Offset To EOP From PGL (ft)	Slope to EOP From PGL	Offset From EOP to Location (ft)	Slope From EOP to Location	Crossroad Pavement Elevation	Vertical Clearance (ft)
SP1 Rear: Toe Barrier @ LT Girder	129 + 88.090	551.331	544.774		407 + 08.750	527.704	50.950	-0.0213	8.000	-0.0400	526.299	18.48
SP1 Rear: EOP @ LT Girder	129 + 95.720	551.370	544.795		407 + 11.160	527.691	42.637	-0.0213			526.783	18.01
SP1: SR562 PG/Crown/EOP @ LT Girder	130 + 36.770	551.540	545.050		407 + 24.050	527.634					527.634	17.42
SP1 FWD: Toe/Barr @ LT Girder	130 + 40.630	551.550	545.081		407 + 25.260	527.630			4.000	-0.0400	527.470	17.61
SP1 Rear: Toe Barrier @ RT Girder	129 + 64.820	551.212	544.774		406 + 41.590	528.458	49.247	-0.0161	8.000	-0.0400	527.346	17.43
SP1 Rear: EOP @ RT Girder	129 + 73.280	551.255	544.795		406 + 44.000	528.419	41.294	-0.0161			527.754	17.04
SP1: SR562 PG/Crown/EOP @ RT Girder	130 + 17.520	551.475	545.050		406 + 56.490	528.229					528.229	**16.82**
SP1 FWD: Toe/Barr @ RT Girder	130 + 21.820	551.492	545.081		406 + 57.700	528.211			4.000	-0.0400	528.051	17.03
SP1: FWD @ PCB @ LT Gird (2' from sheetng)	130 + 31.570	551.525	545.023									
SP1: FWD @ PCB @ RT Gird (2' from sheetng)	130 + 11.720	551.449	545.023									

MVC = 16 ft 9.9 in

Proposed Mainline Location Under **NSRR Bridge, SPAN #2**	NSRR Station	Mainline Profile Grade Elev.	Mainline Bottom of Beam Elevation (inc. LL Δ)		Ramp M Station	Crossroad PGL Elevation	Offset To EOP From PGL (ft)	Slope to EOP From PGL	Offset From EOP to Location (ft)	Slope From EOP to Location	Crossroad Pavement Elevation	Vertical Clearance (ft)
SP2 Rear: Toe/Barr @ LT Girder	130 + 47.370	551.564	545.098		428 + 64.940	527.749			4.000	-0.0400	527.589	17.51
SP2 Rear: PG/Crown/EOP @ LT Girder	130 + 51.220	551.571	545.081		428 + 63.730	527.746					527.746	17.34
SP2 FWD: EOP @ LT Girder	130 + 81.300	551.585	544.971		428 + 54.250	527.737	31.352	-0.0138			527.304	17.67
SP2 FWD: Toe/Barr @ LT Girder	130 + 93.260	551.571	544.984		428 + 50.560	527.737	43.543	-0.0138	0.002	-0.0400	527.136	17.85
SP2 Rear: Toe/Barr @ RT Girder	130 + 29.350	551.518	545.098		429 + 32.510	528.254			4.000	-0.0400	528.094	17.00
SP2 Rear: PG/Crown/EOP @ RT Girder	130 + 33.660	551.531	545.081		429 + 31.290	528.238					528.238	**16.84**
SP2 FWD: EOP @ RT Girder	130 + 64.610	551.585	544.969		429 + 22.580	528.133	28.817	-0.0157			527.680	17.29
SP2 FWD: Toe/Barr @ RT Girder	130 + 77.610	551.587	544.982		429 + 18.900	528.092	40.970	-0.0157	0.002	-0.0400	527.448	17.53
SP2 Rear @ PCB @ LT Gird (2' from sheetng)	130 + 56.410	551.578	545.067									
SP2: Rear @ PCB @ RT Gird (2' from sheetng)	130 + 39.470	551.547	545.067									

MVC = 16 ft 10.1 in

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **01**
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		UPDATED: *EFD*	DATE: *12/16/13*
SUBJECT: *Elevations*		CHECKED: *CTM*	DATE: *12/17/13*
Vertical Clearance Under		UPDATED: *CTM*	DATE: *12/17/13*
Structure		VERIFIED: *MTO*	DATE: *02/12/14*

PROJECT: **HAM-75-7.85**

EMHT VC Data (Ramp J - BF002 File)		EMHT VC Data (Ramp M - BF002 File)	
G1 =	-0.0380	G1 =	-0.0504
G2 =	0.0183	G2 =	0.0380
VC =	350.00 ft.	VC =	540.00 ft.
PVC Sta. =	405 + 08.830	PVC Sta. =	425 + 45.080
PVT Sta. =	408 + 58.830	PVT Sta. =	430 + 85.078
PVC Elev. =	532.083	PVC Elev.	535.498
PVT Elev. =	528.640	PVT Elev.	532.142

Existing Roadway Elevation Under **NSRR Bridge, SPAN #1**	Mainline Bottom of Beam Elevation (inc. LL Δ)	Existing Roadway Elevation (From TIN File)	Vertical Clearance (ft) (If Applicable)	**Existing Roadway Elevation** Under **NSRR Bridge, SPAN #2**	Mainline Bottom of Beam Elevation (inc. LL Δ)	Existing Roadway Elevation (From TIN File)	Vertical Clearance (ft) (If Applicable)
SP1 Rear: Toe Barrier @ LT Girder	544.774	-		SP2 Rear: Toe/Barr @ LT Girder	545.098	-	
SP1 Rear: EOP @ LT Girder	544.795	-		SP2 Rear: PG/Crown/EOP @ LT Girder	545.081	529.964	15.12
SP1: SR562 PG/Crown/EOP @ LT Girder	545.050	529.932	15.12	SP2 FWD: EOP @ LT Girder	544.971	529.545	15.43
SP1 FWD: Toe/Barr @ LT Girder	545.081	-		SP2 FWD: Toe/Barr @ LT Girder	544.984	-	
SP1 Rear: Toe Barrier @ RT Girder	544.774	-		SP2 Rear: Toe/Barr @ RT Girder	545.098	-	
SP1 Rear: EOP @ RT Girder	544.795	-		SP2 Rear: PG/Crown/EOP @ RT Girder	545.081	530.135	**14.95**
SP1: SR562 PG/Crown/EOP @ RT Girder	545.050	530.164	**14.89**	SP2 FWD: EOP @ RT Girder	544.969	529.620	15.35
SP1 FWD: Toe/Barr @ RT Girder	545.081	-		SP2 FWD: Toe/Barr @ RT Girder	544.982	-	
SP1: FWD @ PCB @ LT Gird (2' from sheetng)	545.023	529.871	15.15	SP2 Rear @ PCB @ LT Gird (2' from sheetng)	545.067	529.908	15.16
SP1: FWD @ PCB @ RT Gird (2' from sheetng)	545.023	530.109	14.91	SP2: Rear @ PCB @ RT Gird (2' from sheetng)	545.067	530.075	14.99
	MVC =	14 ft	10.6 in		MVC =	14 ft	11.4 in

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **00**
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *07/09/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *07/10/14*
SUBJECT: *Elevations*		UPDATED: *VDT*	DATE: *07/10/14*
SCREED AND FINAL		VERIFIED: *CTM*	DATE: *07/14/14*
DECK ELEVATIONS		PROJECT: **HAM-75-7.85**	

SPAN 1 TABLES

Typical Deck Crown Height: 1.50 in
Span Length: 69.50 ft
Rear Low Point Elevation: 548.915
Forward Low Point Elevation: 549.263
Girder Slope: 0.501%

FINAL DECK ELEVATION TABLE (Quarter Points)

LINE NO.	LOCATION	Rear Abut. 0.000 L (0.00 ft)	0.125 L (8.69 ft)	0.250 L (17.38 ft)	0.375 L (26.06 ft)	Mid Span 0.500 L (34.75 ft)	0.625 L (43.44 ft)	0.750 L (52.13 ft)	0.875 L (60.81 ft)	Pier 1.000 L (69.50 ft)
LINE 1	LEFT CURB LINE	549.04	549.08	549.13	549.17	549.21	549.26	549.30	549.34	549.39
LINE 2	LEFT LOW POINT #1	548.91	548.96	549.00	549.05	549.09	549.13	549.18	549.22	549.26
LINE 3	DECK CROWN #1	549.04	549.08	549.13	549.17	549.21	549.26	549.30	549.34	549.39
LINE 4	LEFT LOW POINT #2	548.91	548.96	549.00	549.05	549.09	549.13	549.18	549.22	549.26
LINE 5	DECK CROWN #2	549.04	549.08	549.13	549.17	549.21	549.26	549.30	549.34	549.39
LINE 6	RIGHT LOW POINT #1	548.91	548.96	549.00	549.05	549.09	549.13	549.18	549.22	549.26
LINE 7	DECK CROWN #3	549.04	549.08	549.13	549.17	549.21	549.26	549.30	549.34	549.39
LINE 8	RIGHT LOW POINT #2	548.91	548.96	549.00	549.05	549.09	549.13	549.18	549.22	549.26
LINE 9	RIGHT CURB LINE	549.04	549.08	549.13	549.17	549.21	549.26	549.30	549.34	549.39

SCREED ELEVATION TABLE (Quarter Points)

LINE NO.	LOCATION	Rear Abut. 0.000 L (0.00 ft)	0.125 L (8.69 ft)	0.250 L (17.38 ft)	0.375 L (26.06 ft)	Mid Span 0.500 L (34.75 ft)	0.625 L (43.44 ft)	0.750 L (52.13 ft)	0.875 L (60.81 ft)	Pier 1.000 L (69.50 ft)
LINE 1	LEFT CURB LINE	549.04	549.09	549.15	549.20	549.24	549.28	549.32	549.36	549.39
LINE 2	LEFT LOW POINT #1	548.91	548.97	549.02	549.07	549.12	549.16	549.20	549.23	549.26
LINE 3	DECK CROWN #1	549.04	549.09	549.15	549.20	549.24	549.28	549.32	549.36	549.39
LINE 4	LEFT LOW POINT #2	548.91	548.97	549.02	549.07	549.12	549.16	549.20	549.23	549.26
LINE 5	DECK CROWN #2	549.04	549.09	549.15	549.20	549.24	549.28	549.32	549.36	549.39
LINE 6	RIGHT LOW POINT #1	548.91	548.97	549.02	549.07	549.12	549.16	549.20	549.23	549.26
LINE 7	DECK CROWN #3	549.04	549.09	549.15	549.20	549.24	549.28	549.32	549.36	549.39
LINE 8	RIGHT LOW POINT #2	548.91	548.97	549.02	549.07	549.12	549.16	549.20	549.23	549.26
LINE 9	RIGHT CURB LINE	549.04	549.09	549.15	549.20	549.24	549.28	549.32	549.36	549.39

DL1 + DL2 Deflections (Excludes Steel Self Weight)	0.00	0.14	0.25	0.33	0.36	0.33	0.25	0.14	0.00

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_01**	REV. NO.: **00**
		PROJECT: **HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *CTM*	DATE: *07/09/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *07/10/14*
SUBJECT: *Elevations*		UPDATED: *VDT*	DATE: *07/10/14*
SCREED AND FINAL		VERIFIED: *CTM*	DATE: *07/14/14*
DECK ELEVATIONS			

SPAN 2 TABLES

Typical Deck Crown Height: 1.50 in
Span Length: 69.50 ft

Rear Low Point Elevation: 549.273
Forward Low Point Elevation: 549.169

Girder Slope: -0.150%

FINAL DECK ELEVATION TABLE (Quarter Points)

LINE NO.	LOCATION	Pier 0.000 L (0.00 ft)	0.125 L (8.69 ft)	0.250 L (17.38 ft)	0.375 L (26.06 ft)	Mid Span 0.500 L (34.75 ft)	0.625 L (43.44 ft)	0.750 L (52.13 ft)	0.875 L (60.81 ft)	Fwd Abut 1.000 L (69.50 ft)
LINE 1	LEFT CURB LINE	549.40	549.38	549.37	549.36	549.35	549.33	549.32	549.31	549.29
LINE 2	LEFT LOW POINT #1	549.27	549.26	549.25	549.23	549.22	549.21	549.19	549.18	549.17
LINE 3	DECK CROWN #1	549.40	549.38	549.37	549.36	549.35	549.33	549.32	549.31	549.29
LINE 4	LEFT LOW POINT #2	549.27	549.26	549.25	549.23	549.22	549.21	549.19	549.18	549.17
LINE 5	DECK CROWN #2	549.40	549.38	549.37	549.36	549.35	549.33	549.32	549.31	549.29
LINE 6	RIGHT LOW POINT #1	549.27	549.26	549.25	549.23	549.22	549.21	549.19	549.18	549.17
LINE 7	DECK CROWN #3	549.40	549.38	549.37	549.36	549.35	549.33	549.32	549.31	549.29
LINE 8	RIGHT LOW POINT #2	549.27	549.26	549.25	549.23	549.22	549.21	549.19	549.18	549.17
LINE 9	RIGHT CURB LINE	549.40	549.38	549.37	549.36	549.35	549.33	549.32	549.31	549.29

SCREED ELEVATION TABLE (Quarter Points)

LINE NO.	LOCATION	Pier 0.000 L (0.00 ft)	0.125 L (8.69 ft)	0.250 L (17.38 ft)	0.375 L (26.06 ft)	Mid Span 0.500 L (34.75 ft)	0.625 L (43.44 ft)	0.750 L (52.13 ft)	0.875 L (60.81 ft)	Fwd Abut 1.000 L (69.50 ft)
LINE 1	LEFT CURB LINE	549.40	549.40	549.39	549.39	549.38	549.36	549.34	549.32	549.29
LINE 2	LEFT LOW POINT #1	549.27	549.27	549.27	549.26	549.25	549.24	549.22	549.19	549.17
LINE 3	DECK CROWN #1	549.40	549.40	549.39	549.39	549.38	549.36	549.34	549.32	549.29
LINE 4	LEFT LOW POINT #2	549.27	549.27	549.27	549.26	549.25	549.24	549.22	549.19	549.17
LINE 5	DECK CROWN #2	549.40	549.40	549.39	549.39	549.38	549.36	549.34	549.32	549.29
LINE 6	RIGHT LOW POINT #1	549.27	549.27	549.27	549.26	549.25	549.24	549.22	549.19	549.17
LINE 7	DECK CROWN #3	549.40	549.40	549.39	549.39	549.38	549.36	549.34	549.32	549.29
LINE 8	RIGHT LOW POINT #2	549.27	549.27	549.27	549.26	549.25	549.24	549.22	549.19	549.17
LINE 9	RIGHT CURB LINE	549.40	549.40	549.39	549.39	549.38	549.36	549.34	549.32	549.29

DL1 + DL2 Deflections (Excludes Steel Self Weight)	0.00	0.14	0.25	0.33	0.36	0.33	0.25	0.14	0.00

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Girder***	**GF JOB NO:**	**54682**
	Built-Up Section Properties	CALC NO.:	**HAM562_0026_02**
		REV NO.:	**03**
FILE NAME(s):	*HAM562_0026_02.xlsx*	**SHEET: 1 OF 7**	

SUPERSEDES CALC NO: 01 (Stage 2 Design)

CALCULATION DESCRIPTION:

This will calculate the section properties of the plate girder and check stiffener requirements.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 15
Bridge Layout per 075_0834SBS003

MISCELLANEOUS NOTES:

Modified at Stage 2 to include the composite properties

Modified at Stage 3 to reduce the non-composite section to reflect the net section

Modified After Stage 3 comments to accommodate increased LL distribution

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 1 Calculation	CTM	09/27/13		
01	Stage 2 Calculation	EFD	04/08/14		
02	Stage 3: Net Section Modulus	EFD	05/27/15	VDT	06/02/15
03	Stage 3: Increased Flange Length				

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	01/14/16						

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_02	REV. NO.: 03
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: *EFD*	DATE: *04/08/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *11/05/14*
SUBJECT: *Girder*		BACK CHECKED:	DATE:
Built-Up Section Properties		UPDATED: *VDT*	DATE: *01/14/16*
Span 1 - Composite		VERIFIED:	DATE:

Indicates user input

Yield Strength of Steel (Fy): 50.0 ksi
TOTAL Girder Depth: 41.000 in

Assumed Fillet Weld Size: 0.3750 in
Assumed Unit Weight: 490.0 pcf

SECTION PROPERTIES ABOUT PRIMARY AXIS - NON-COMPOSITE - NET

Note: the "y" C.G. dimension is input from the bottom of the bottom fiber (all values positive)

Description	Element No.	Width (in.)	Height (in.)	Area (A) (in^2)	y (C.G.) (in.)	Ay (in^3)	Ay^2 (in^4)	I_{xo} (in^4)	Ay^2+I_{xo} (in^4)
Top Flange	1	21.000	3.000	63.000	39.5000	2488.50	98295.8	47.3	98343
Web Plate	2	0.750	35.000	26.250	20.5000	538.13	11031.6	2679.7	13711
Bottom Flange	3	19.000	3.000	57.000	1.5000	85.50	128.3	42.8	171
Total		21.000	41.000	146.250		3112.13			112225.3

Cross Sectional Area:	A =	146.250	in^2
Basic Section Weight:	Steel =	497.7	plf
Weld Weight:	Weld =	1.503	plf (includes four fillet welds)
Design Dead Load:	W =	500	plf (Rounded up to nearest pound)

Distance from Bottom Edge to N.A.:	d_y =	21.279	in.
Moment of Inertia:	I_x =	46000.8	in^4
Radius of Gyration:	R_x =	17.74	in.
Section Modulus:	Bot S_x =	2161.75	in^3

Top S_x = 2332.64 in^3

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_02	REV. NO.: 03
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: *EFD*	DATE: *04/08/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *11/05/14*
SUBJECT: *Girder*		BACK CHECKED:	DATE:
Built-Up Section Properties		UPDATED: *VDT*	DATE: *01/14/16*
Span 1 - Composite		VERIFIED:	DATE:

Indicates user input

SECTION PROPERTIES ABOUT PRIMARY AXIS - COMPOSITE (n=8)

Note: The deck thickness is taken as 7", to allow for construction variation (0.5") as well as a top sacrificial layer (0.5")

Description	Element No.	Width (in.)	Height (in.)	Area (A) (in^2)	y (C.G.) (in.)	Ay (in^3)	Ay^2 (in^4)	I_{xo} (in^4)	Ay^2+I_{xo} (in^4)
Top Flange	1	21.000	3.000	63.000	39.5000	2488.50	98295.8	47.3	98343
Web Plate	2	0.750	35.000	26.250	20.5000	538.13	11031.6	2679.7	13711
Bottom Flange	3	21.000	3.000	63.000	1.5000	94.50	141.8	47.3	189
Deck *(3'-6" spa, n=8)*	4	5.250	8.000	42.000	45.0000	1890.00	85050.0	224.0	85274
Total		21.000	49.000	194.250		5011.13			197517.3

Distance from Bottom Edge to N.A.:	d_y =	25.797	in.		
Moment of Inertia:	I_x =	68243.8	in^4		
Radius of Gyration:	R_x =	18.74	in.		
Section Modulus:	Bot S_x =	2645.38	in^3	Top S_x =	2941.20 in^3

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_02	REV. NO.: 03
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: *EFD*	DATE: *04/08/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *11/05/14*
SUBJECT: *Girder*		BACK CHECKED:	DATE:
Built-Up Section Properties		UPDATED: *VDT*	DATE: *01/14/16*
Span 1 - Composite		VERIFIED:	DATE:

Indicates user input

SECTION PROPERTIES ABOUT SECONDARY AXIS

Note: the "x" C.G. dimension is input about the centerline of web. Negative = Left, Positive = Right

Description	Element No.	Width (in.)	Height (in.)	Area (A) (in^2)	x (C.G.) (in.)	Ax (in^3)	Ax^2 (in^4)	I_{yo} (in^4)	Ax^2+I_{yo} (in^4)
Top Flange	1	21.000	3.000	63.000	0.0000	661.50	6945.8	2315.3	9261
Web Plate	2	0.750	35.000	26.250	0.0000	275.63	2894.1	1.2	2895
Bottom Flange	3	21.000	3.000	63.000	0.0000	661.50	6945.8	2315.3	9261
Total		21.000	41.000	152.250		1598.63			21417.3

Total Surface Perimeter:	P.tot =	164.500	in
Reduced Perimeter:	P.red	143.5	in (does not include top of top flange)
Total Surface Area:	SA.tot	1.142	ft^2/ft
Reduced Surface Area:	SA.red	0.997	ft^2/ft

Distance from Left Edge to N.A.:	d_x =	10.500	in.
Moment of Inertia:	I_y =	4631.7	in^4
Radius of Gyration:	R_y =	5.52	in.
Section Modulus:	Left S_y =	441.12	in^3

Right S_y = 441.12 in^3

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_02	REV. NO.: 03
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: *EFD*	DATE: *04/08/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDT*	DATE: *11/05/14*
SUBJECT: *Girder*		BACK CHECKED:	DATE:
Built-Up Section Properties		UPDATED: *VDT*	DATE: *01/14/16*
Span 1 - Composite		VERIFIED:	DATE:

Indicates user input

AREMA 15-1.7 Cross-Sectional Checks

AREMA 15-1.7.1 Compression Flange Bracing

Distance between bracing points:	D.b=	0.000	in	*Continously laterally braced*
Allowable distance between bracing points:	D.b-a =	133.662	in	*AREMA 15-1.7.1.b*
Check compliance:	**BRACING OK**			*Continously laterally braced*

AREMA 15-1.6.2 Outstanding Compression Flange

Thickness of Flange:	T.f=	3.000	in	
Outstanding Width:	W.comp =	10.125	in	
Allowable Outstanding Width:	W.cmp.a =	31.067	in	*AREMA 15-1.6.2.a.(1)*
Check compliance:	**FLANGE OK**			*^^Ties are not directly upon the flange ^^*

AREMA 15-1.7.3 Web Plate Thickness (Without Longitudinal Stiffeners)

Clear distance between flanges:	D.fl=	35.000	in	
Thickness ratio of allowable clear distance between flanges:	D.fl.r=	0.007		*AREMA 15-1.7.3.a* *(Assumes fully stressed top flange)*
Minimum allowable web ratio thickness:	t.w-a1=	0.262	in	
1/6 of flange thickness check:	t.w-a1=	0.500	in	*AREMA 15-1.7.3.c*
Actual web thickness:	t.w=	0.750	in	*NS Requires 1/2" Minimum*
Check compliance:	**WEB OK**			

AREMA 15-1.7.7 Minimum Bearing and Jacking Stiffener Thickness - Preliminary Size

Outstanding Leg:	ℓ.s=	10.125	in	
Minimum Thickness:	t.s=	0.841	in	*AREMA 15-1.6.2.a(1)* *(Bracing and secondary members)* *^^ Equation re-arranged to solve for "t" ^^*
Minimum Bearing Stiffener Thickness:	**0.875 in**			

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_02	REV. NO.: 03
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: EFD	DATE: 04/08/14
BRIDGE NO: HAM-562-0026		CHECKED: VDT	DATE: 11/05/14
SUBJECT: Girder		BACK CHECKED:	DATE:
Built-Up Section Properties		UPDATED: VDT	DATE: 01/14/16
Span 1 - Composite		VERIFIED:	DATE:

Indicates user input

AREMA 15-1.7.8.a-c Intermediate Transverse Web Stiffeners - Preliminary Size

Preliminary stiffener thickness:	T.st	0.500	in	*Enter Data (3/8" minimum per AREMA)*
Web depth limit of required stiffeners:	D.fl-ns=	38.292	in	*AREMA 15-1.7.8.a (equation in paragraph)*
Maximum Spacing Equation:	d.st.eq	52.505	in	*AREMA 15-1.7.8.a ("d" equation, assumes S=0.20*Fy)*
				*0.20 * Fy is based upon prelim analysis, past the jacking stiffener*
Requirement Check:	**Unstiffened**			*^^ Preliminary Design... Update for Final Design ^^*
Maximum Spacing from paragraph:	d.st.text	35.000	in	*AREMA 15-1.7.8.a (text in paragraph)*
Minimum Spacing Considered:	d.prelim	30.000	in	*Rounded down to the nearest 6"*
Minimum Moment of Inertia:	I.st.min	20.918	in^3	*AREMA 15-1.7.8.a ("I" equation)*
Preliminary stiffener width:	W.st	5.000	in	*Enter Data*
Minimum allowable stiffener width:	W.min	3.367	in	*AREMA 15-1.7.8.b*
Maximum allowable stiffener width:	W.max	8.000	in	*AREMA 15-1.7.8.b*
Single Plate Moment of Inertia:	I.st-plt	5.208	in^4	
Distance, Plate centroid to web centroid:	R.st-plt	2.875	in	
Area of single stiffener plate:	A.st-plt	2.500	in^2	
Moment of Inertia of Stiffeners:	I.st	25.872	in^4	*Moment of I about CL web, using Parallel Axis Theorem*
Moment of Inertia Check:	**Stiff. Size OK**			

Intermediate Stiffener Details: **NO INTERMEDIATE STIFFENERS REQUIRED**

AREMA 15-1.7.8.f Longitudinal Web Stiffeners - Check that they are not required

NOTE: It is desireable to not include longitudinal web stiffeners. Re-proportion girder if longitudinal stiffers are required

Web depth limit of required stiffeners:	D.ls-max	101.805	in	*AREMA 15-1.7.8.f (assumes f = 0.55 *Fy)*
Actual web depth between flanges:	D.fl=	35.000	in	
Requirement Check:	**Long. Unstiffened**			

SECTION PROPERTIES ABOUT PRIMARY AXIS - GROSS

Note: the "y" C.G. dimension is input from the bottom of the bottom fiber (all values positive)

Description	Element No.	Width (in.)	Height (in.)	Area (A) (in^2)	y (C.G.) (in.)	Ay (in^3)	Ay^2 (in^4)	I_{xo} (in^4)	Ay^2+I_{xo} (in^4)
Top Flange	1	21.000	3.000	63.000	39.5000	2488.50	98295.8	47.3	98343
Web Plate	2	0.750	35.000	26.250	20.5000	538.13	11031.6	2679.7	13711
Bottom Flange (2 holes)	3	21.000	3.000	63.000	1.5000	94.50	141.8	47.3	189
Total		21.000	41.000	152.250		3121.13			112243.3

Cross Sectional Area:	A =	152.250	in^2
Basic Section Weight:	Steel =	518.1	plf
Weld Weight:	Weld =	1.503	plf (includes four fillet welds)
Design Dead Load:	W =	520	plf (Rounded up to nearest pound)

Distance from Bottom Edge to N.A.:	d_y =	20.500	in.
Moment of Inertia:	I_x =	48260.2	in^4
Radius of Gyration:	R_x =	17.80	in.
Section Modulus:	Bot S_x =	2354.16	in^3

Top S_x = 2354.16 in^3

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Loads***	**GF JOB NO:**	**54682**
	Girders	CALC NO.:	**HAM-562-0026_03**
	Stresses and Deflection Checks	REV NO.:	**05**
FILE NAME(s):	*HAM562_0026_03.xlsx*	**SHEET: 1 OF 22**	

SUPERSEDES CALC NO: 04 (Stage 3)

CALCULATION DESCRIPTION:

This will calculate all loads applied to the superstructure.
Vertical beam stresses and deflections will be calculated and checked.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2013) Chapter 15
Calculation: HAM562_0026_02 (Beam Properties)
Bridge Layout per 562_0026SBS001/2.dgn

MISCELLANEOUS NOTES:

EFD Updates made per CTM Comments; VDK re-check to ensure that this master template follows the current AREMA code and is fully functional before it is used repeatedly on all 3 HAM-75 bridges (4 unique spans)

EFD Stage 2 Updates are to include the composite section properties when calculating DL2 & Live Load deflections.

Stage 3: Tie length updated to 10', Span Stress Check tables are updated to show the 16ksi allowable fatigue stress in the bottom flange due to the bolted stiffener connection.

Stage 3: percent of max rail load applied to single girder increased

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 1 Calculation	CTM	11/01/13		
01	Stage 1 Update to Steel Plate Deck	EFD	12/11/13		
02	Stage 2 Update to Composite Concrete Deck	EFD	04/08/14		
03	Stage 2 Alignment Update	CTM	07/09/14		
04	Stage 3	EFD	05/27/15	VDT	06/02/15
05	Stage 3 Update to LL Distribution	VDT	01/14/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	01/14/16						

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM-562-0026_03**	REV. NO.: **05**
		PROJECT: **ODOT/EMH&T: HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: CTM	DATE: *11/01/13*
BRIDGE NO: *HAM-562-0026*		CHECKED:	DATE:
SUBJECT: *Loads*		BACK CHECKED:	DATE:
Girders		UPDATED:	DATE:
Load Combinations		VERIFIED:	DATE:

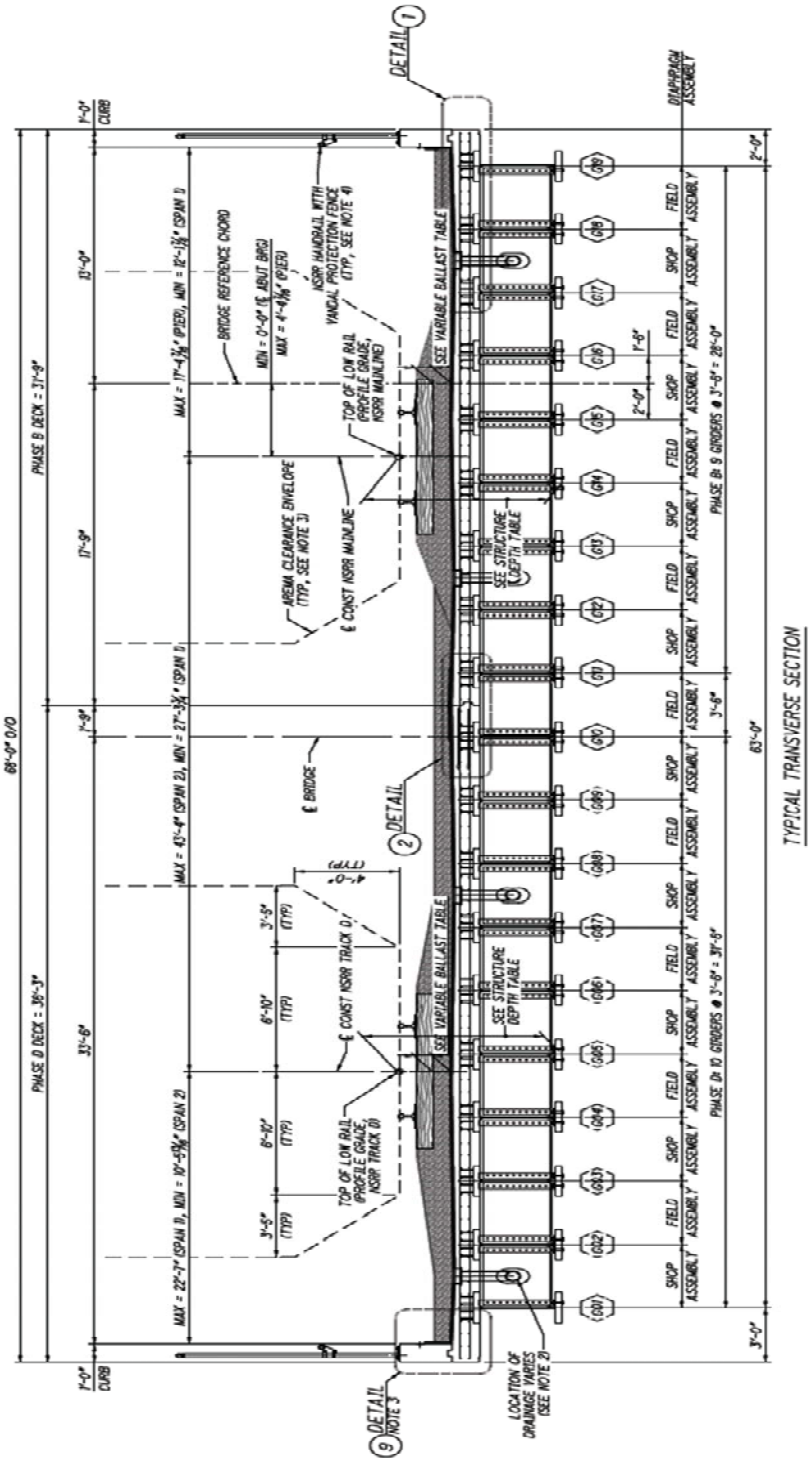
Load Combinations Considered (NSRR Factors included)

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg	Qb	EQ	CWR	DF	O.Stress Allowed
A1	1	1	1	1											100%
B1	1	1	1		1	1	1						1		125%
B1A	1	1	1		1	1	1						1		100%
C		1	1												f_{fat}
D1	1			1		1	1		1						150%
D2	**1**									**1**					**170%**
E1	1											1			150%
F	1							1							100%
G											1			1	150%
H1	1														150%
H2	*1*														*125%*

Comb.	Description of Use
A1	All members
B1	All members, except floorbeam hangers and high strength bolts
B1A	Floorbeam hangers and high strength bolts
C	All members with Fatigue Details
D1	Members resisting overall instability
D2	**Members resisting overall instability (NSRR)**
E1	All members - Earthquake
F	Members loaded by wind only (Bracing)
G	Cross frames, diaphragms, anchor rods
H1	Members stressed during lifting or jacking
H2	*Members stressed during erection*

DL	Dead loads (self weight,superimposed dead loads, erection loads)
LL	Live loads
I	Impact (dynamic amplification)
CF	Centrifugal force
LF	Longitudinal forces from equipment (braking and locomotive traction)
N	Lateral forces from equipment (nosing)
W	Wind forces loaded bridge
WU	Wind forces on unloaded bridge
SL	Live load on leeward track of 1200 lb/ft without impact
Qg	Derailment load for girder design
Qb	Derailment load for lateral bracing design
EQ	Forces from earthquake (combined transverse and longitudinal)
CWR	Forces from CWR (lateral and longitudinal)
DF	Lateral forces from out-of-plane bending and from load distribution effects (Differential Deflection due to derailment)
f_{fat}	Allowable stress based on member loaded length and fatigue detail category

Typical Section



Gannett Fleming	GF JOB # 54682	CALC NO.: HAM-562-0026_03	REV. NO.: 05
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: CTM	DATE: 07/09/14
BRIDGE NO: HAM-562-0026		CHECKED: VDT	DATE: 07/10/14
SUBJECT: Loads		UPDATED: VDT	DATE: 07/10/14
Girders		UPDATED: VDT	DATE: 01/14/16
Span 1 & 2 Girders		VERIFIED:	DATE:

General Layout Data - Spans are Identical

Span Length Data

C/C Bearings (Max):	69.500 ft	
Front Face/Face of Abut. Backwall:	73.500 ft	
Min. Clearance from Backwall:	4.000 in	0.333 ft
Maximum Beam Length:	72.000 ft	
Beam Extension past C/L Brg.	1.250 ft	

Track Alignment

Degree of Curvature:	10.00 deg	
Radius of Curvature:	573.69 ft	
Superelevation:	0.000 in	0.000 ft
Maximum Design Speed:	15.0 mph	

Superstructure Cross Section Data

Out/Out Deck	68.500 ft
Standard Track Gage:	4.708 ft
C/C Rail Heads	4.932 ft
Number of Beams:	19
Standard Beam Spacing:	3.500 ft
Standard Overhang:	2.750 ft
Max Eccentricity,	
CL Deck/CL Alignment:	21.000 in
Deck Cross-Slope:	1.000%
Maximum Cross-Slope Width	8.750 ft
Tie Length:	8.500 ft
Curb Thickness	1.000 ft
Crossframe Spacing	12.000 ft
Stiffener Spacing	12.000 ft
Bridge Deck Length:	72.670 ft

Will be used to calculate total longitudinal forces

Vertical Tie-In to Top of Top Flange

Rail Height:	7.438 in
Tie Plate:	1.000 in
Tie Thickness:	7.000 in
TYPICAL Ballast:	10.500 in
Min Waterproofing (Inc. Protection)	1.125 in
Min. Deck Thickness	9.000 in
Max Additional Cross-Slope:	1.050 in
Rail Head to Top of Beam:	d_{top} = 37.113 in
Height of Curb:	H_{curb} = 27.000 in
Bottom of Tie to Top of Beam:	d_b = 21.675 in
Beam Lateral Distribution Length:	DB_{Lat}= 12.11 ft
AREMA: 15-1.3.4.2.4.a	
Deck Lateral Distribution Length:	DDk_{Lat}= 10.31 ft
Deck Long. Distribution Length:	DDK_{Long}= 4.81 ft
AREMA: 15-1.3.4.2.2	

Tie Length reduced back to 8.5' per NSSR Comments

Number of beam spaces in lateral distribution length: 3.461 — *Straight multiplication, if within 0.15 it will be rounded up.*

3.000 — *Assumes beam layout centered on alignment*

Assumes maximum eccentricity in one direction

Number of beams to distribute live load to: 4 — *Standard live load and track/rail dead load will be equally divided amongst this many beams*

Material & Girder Data

Reference Calculation: HAM075_0834C for beam properties

Basic Girder Data

XS Area:	152.250	in^2
Dead Load:	520	*plf*
Total Depth:	41.000	*in*
Web Depth:	35.000	*in*
Web Thickness:	0.750	*in*
Flange Width:	21.000	*in*
Flange Thickness:	3.000	*in*
Diaphragm Weight:	226.1	*lb*
Diapragm (6" x1/2" flanges with 1/2" web plate)		
Stiffener Weight:	24.2	*lb*
Intermediate Only		
Extra Steel Weight:	5%	
Bolts, Gusset Plates, LLB		
Diaphragm Flanges	61.3	*lb*
Diaphragm Web	164.8	*lb*

Material Densities and Unit Loads

Track (Rails and fastenings):	200.0	*plf*
Steel:	490.0	*pcf*
Reinforced and Prestressed concrete:	150.0	*pcf*
Plain (unreinforced) concrete:	145.0	*pcf*
Timber:	60.0	*pcf*
Sand and Gravel, Compacted (ballast):	120.0	*pcf*
Sand and Gravel, Loose:	100.0	*pcf*
SIP Formwork (including flute concrete):	15.0	*psf*
Deck Waterproofing:	10.0	*psf*
Handrail Weight:	15.0	*plf*

Steel Properties (ASTM A588, Grade 50)

Yeild Stress:	50.0	*ksi*
Ultimate Stress:	70.0	*ksi*
Modulus of Elasticity:	29000.0	*ksi*

Girder Properties

Non-Composite is based on net section, composite is based on gross section

Primary Axis (non-composite)				n=8 Composite
Distance from Bottom Edge to N.A.:	d_y =	21.279	in.	25.8
Moment of Inertia:	I_x =	46000.8	in^4	68243.8
Radius of Gyration:	R_x =	17.74	in.	18.7
Section Modulus:	Bot S_x =	2161.75	in^3	2645.4
	Top S_x =	2332.64	in^3	2941.2

Secondary Axis			
Distance from LEFT Edge to N.A.:	d_x =	10.500	in.
Moment of Inertia:	I_y =	4631.7	in^4
Radius of Gyration:	R_y =	5.52	in.
Section Modulus:	Left S_y =	441.12	in^3
	Right S_y =	441.12	in^3

ODOT PID NO.:	77889	DESIGNED: CTM	DATE: 07/09/14
BRIDGE NO:	HAM-562-0026	CHECKED: VDT	DATE: 07/10/14
SUBJECT:	Loads	UPDATED: VDT	DATE: 07/10/14
	Girders	UPDATED: VDT	DATE: 01/14/16
	Span 1 & 2 Girders	VERIFIED:	DATE:

Basic Live Load Data

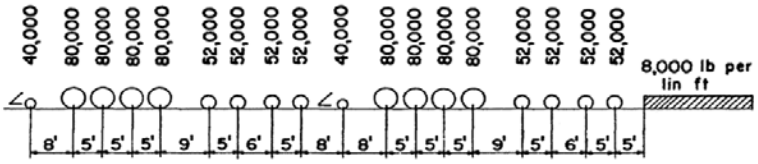


Figure 15-1-2. Cooper E 80 Load

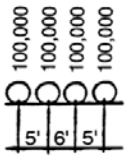


Figure 15-1-3. Alternate Live Load on 4 Axles

Unloaded Leeward Train:

SL= 1.200 klf

AREMA 1.3.10.a

Interpolated Data from AREMA Table 15-1-15 (Single Rail Loads)

Span Length (ft)	Maximum Moment (ft*kips)	Maximum Moment Quarter Point (ft*kips)	Maximum Shears (Kips)			Maximum Pier Reaction (Kips)	
			At End	At Quarter Point	At Center		
70	3415.00	2608.20	221.04	131.89	77.14	354.08	
69.50	3369.8	2573.7	219.7	131.3	77.0	351.9	-5.0%
80	4318.90	3298.00	248.40	143.41	80.00	397.70	
69.50	724.54	543.40	41.70	20.85	0.00	41.70	**Unloaded Train (SL=1200 plf)**

Live Load Due to Load Eccentricity

AREMA 15-1.3.4.2.4.a states axle loads may be equally distributed to all girders within the lateral width prescribed above.

AREMA 15-1.3.4.2.1.d states that the effects of eccentricity and centrifugal load shall be included for ballasted decks.

Eccentricity due to Horizontal Curvature of Alignment

Eccentricity of load will apply a greater percentage of total load to a pair of girders if 4 are in the zone of influence.

Eccentricity load increase will be applied to a single girder if only 2-3 beams are in the zone of influence.

Standard number of beams to distribute live load to: 4

% increase on an individual girder due to eccentricity: 25.0%

Un-Eccentric % of **rail** load to each beam: 50.0%

Eccentric % of rail load to girders on outside of curve: 60.00%

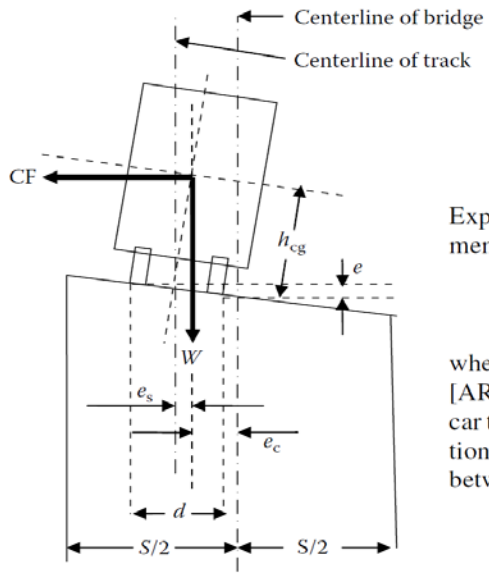
Note: 1/2 of the increase is taken even though as little as 1/3 could be assumed due to parabolically varying eccentricity. This is conservative.

Eccentricity is calculated by {ECCENTRICITY OF LOAD } / {BEAM SPACING}

A maximum value of 50% is allowed. An eccentricity larger than 50% will begin to distribute load to the next equally space girder.

The eccentric % of rail load to girders on outside of curve was based on the max possible load any girder could see. Using the 12.11 feet of lateral distribution length calculated above, girder spacing (3.5') divided by the lateral distribution length gives us 3.5 / 12.11 = 28.9% of the total load, or 57.8% of any rail load. To be conservative, 60% of a rail load will be applied.

Eccentricity due to Superelevation



$$e_s = \frac{h_{cg} e}{d}$$

Expressed as a percentage, this will affect the magnitude of forces to supporting members each side of the track in the following proportion:

$$\frac{2e_s}{s}(100), \qquad (3.29)$$

where h_{cg} is the distance from the center of gravity of the rail car to the base of the track [AREMA (2008) recommends 8 ft for the distance from the center of gravity of the car to the top of the rail]; e is the superelevation of the track; d is the horizontal projection of track gage distance (generally taken as 4.9 ft); s is the width of the span (distance between the center of gravity of longitudinal members supporting the curved track).

Known Variables & Calculations

Deg. of curve, D =	10.00 *deg*		
Train Center of gravity, h_{cg} =	8.00 *ft*	Superelevation Eccentricity, e_s =	0.000 *in*
Superelevation, SE =	0.000 *in*		
Track c/c, d =	4.932 *ft*	Superelevation Load +/-, SE =	0.00%
C/C of resisting force couple:	7.000 *ft*	*Increases inside of curve, decreases outside of curve*	

Note: Resisting force couple distance is the centroid of the supporting girder pairs for a 4-girder support system. 3 or 2 girder systems will have rocking applied to the outer most supporting girder.

SE Applied Inside of Curve (per Beam) = 0.00%

SE Applied Outside of Curve (per Beam) = 0.00%

Outside of Curve Ecentricity		Inside of Curve Eccentricity	
Vertical Cent. Factor, CF_v =	**60.00%**	**Vertical Cent. Factor, CF_v =**	**40.00%**

Applied Loads (Beams Outside of Curve)

	Span Length (ft)	Maximum Moment (ft*kips)	Maximum Moment Quarter Point (ft*kips)	Maximum Shears (Kips)			Maximum Pier Reaction (Kips)
				At End	At Quarter Point	At Center	
Standard Live Load	69.50	2021.88	1544.23	131.80	78.79	46.20	211.14
Unloaded Train (SL)	69.50	434.72	326.04	25.02	12.51	0.00	25.02

Applied Loads (Beams Inside of Curve)

	Span Length (ft)	Maximum Moment (ft*kips)	Maximum Moment Quarter Point (ft*kips)	Maximum Shears (Kips)			Maximum Pier Reaction (Kips)
				At End	At Quarter Point	At Center	
Standard Live Load	69.50	1347.92	1029.48	87.87	52.53	30.80	140.76
Unloaded Train (SL)	69.50	289.82	217.36	16.68	8.34	0.00	16.68

Dead Load Geometry

Note: All dead loads are to be uniformly distributed

Concrete & Integral Ballast Mat Sectional Area

Curb	4.50	sq. ft.
Min. Deck	51.38	sq. ft.
Cross Slope	3.00	sq. ft.
Between Top Flanges:	8.38	sq. ft.
Total Concrete:	**67.25**	**sq. ft.**

Deck Waterproofing

Total Length Across:	**68.75**	**ft**

Total Steel Weight (Interior Beam)

This will also be used for exterior beam DL

Beam:	520	plf
Cross Frame:	18.84	plf
Stiffeners:	2.02	plf
Miscellaneous:	27.04	plf
Total Interior Beam:	**568**	**plf**

Ballast Area

Thick, Max (top of tie):	1.46	ft
Thick, Min (at curb):	0.75	ft
NS Criteria, Future Ballast:	0.50	ft
Width, Ballast:	66.50	ft
Area, Max Ballast:	12.40	sq. ft.
Area, Side Ballast:	64.04	sq. ft.
Area, Future Ballast:	**33.25**	**sq. ft.**
Total Placed Ballast:	**76.44**	**sq. ft.**

DL - Dead Load

Moments, Forces, and Stresses (All Beams)

Load	W (klf)	V_{DL} (kip)	M_{DL} (kip-in)	σ_{DL} (ksi)	Δ_{DL} (inches)	Notes
Steel	0.57	20.45	4115.37	1.90	0.22351	Erection Load
NON-COMPOSITE Concrete	0.50	17.83	3589.14	1.66	0.19493	Deck Pouring
COMPOSITE Concrete	0.04	1.28	257.40	0.12	0.00942	Composite
Waterproofing	0.04	1.30	262.17	0.12	0.00960	Composite
Placed Ballast	0.48	17.38	3497.80	1.62	0.12805	
Future Ballast	0.21	7.56	1521.53	0.70		NO CAMBER
Handrail	0.002	0.06	11.44	0.01	0.00042	
Rail/Ties/Clips	0.05	1.80	362.27	0.17	0.01326	Divided by live load # of beams
Total Unfactored Dead Load	**1.88**	**67.66**	**13617.12**	**6.30**	**0.57921**	Track Supporting Beams
Total Unfactored Dead Load	**1.83**	**65.86**	**13254.85**	**6.13**	**0.56594**	Exterior Beams Only

Calculated Natural Frequency

Unloaded Natural Frequency				Loaded Natural Frequency			
Mass per linial foot:	m=	90.55805422	slug/in	Loading (Alt. Load):	P	400000	pounds
First Mode:	ω_1	34.18418335	rad/s	First Mode:	ωL_1	29.64964	rad/s
	ω_1	5.440581756	hertz		ωL_1	4.718886	hertz
	t_1	0.1838	seconds		tL_1	0.2119	seconds

TABLE 4.2
Undamped Natural Frequencies of Various Beams

Beam	ω_{ni} (rad/s)
	$\frac{i^2\pi^2}{L^2}\sqrt{\frac{EI}{m}}$
	$\frac{(4i^2+4i+1)\pi^2}{4L^2}\sqrt{\frac{EI}{m}}$
	$\frac{(4i^2-4i+1)\pi^2}{4L^2}\sqrt{\frac{EI}{m}}$
	$\frac{(16i^2+8i+1)\pi^2}{16L^2}\sqrt{\frac{EI}{m}}$

for the span of Example 4.3, $\omega_1 = 66.58$ rad/s = 10.6 Hz, is slightly greater than the estimate of 9.4 Hz for railway ballasted girder spans in Figure 4.8.

Due to the inertial effects of the relatively large railway live load on steel spans, the loaded simply supported beam natural frequencies are required in the dynamic analysis of steel railway superstructures. Approximate equations for the loaded simply supported beam fundamental frequency, ω_{L1}, have been proposed (Fryba, 1972) as

$$\omega_{L1} = \omega_1\sqrt{\frac{1}{1+(2P/mgL)+(m_w/2mg)}} \quad \text{for moving uniform continuous loads} \tag{4.16}$$

and

$$\omega_{L1} = \omega_1\sqrt{\frac{1}{1+(2P/mgL)}} \quad \text{for moving constant concentrated loads.} \tag{4.17}$$

A similar equation for the loaded simply supported beam fundamental frequency, ω_{L1}, was proposed for a moving harmonically varying concentrated force

TABLE 4.3
Unloaded Fundamental Frequencies of Steel Railway Bridges (Empirical Equations from Fryba, 1996)

Superstructure	Unloaded Fundamental Frequency, f_1 (Hz)
Steel truss spans	$1135(L)^{-1.1}$
Ballasted girder spans	$135(L)^{-0.7}$
Open deck girder spans	$680/L$

Note: L = length in feet.

LL - Max Live Load

Moments, Forces, and Stresses

Beams Outside of Curve

Load	Equiv. W (klf)	V_{LL} (kip)	M_{LL} (kip-in)	σ_{LL} (ksi)	Δ_{LL} (inches)	Notes
Standard AREMA Live Load	3.35	131.80	24262.60	11.22	0.88825	Inc. For Deflection
Unloaded Train (SL)	0.72	25.02	5216.67	2.41	0.19098	Composite

Beams Inside of Curve

Load	Equiv. W (klf)	V_{LL} (kip)	M_{LL} (kip-in)	σ_{LL} (ksi)	Δ_{LL} (inches)	Notes
Standard AREMA Live Load	2.23	87.87	16175.06	7.48	0.59217	Inc. For Deflection
Unloaded Train (SL)	0.48	16.68	3477.78	1.61	0.12732	Composite

I - Vertical Live Load Impact

Moments, Forces, and Stresses

Impact Factor

AREMA 15-1.3.5.c (1)

Impact Factor Equation Used: (a)

Impact Factor Applied: 30.94%

Rocking Effect

AREMA 15-1.3.5.d

Rocking Effect Loading 20.0%

C/C Tracks of applied force couple: 4.932 ft

Number of beams resisting force couple: 4

C/C of resisting force couple: 7.000 ft

Additional Rocking Impact Applied: 14.1%

Note: Resisting force couple distance is the centroid of the supporting girder pairs for a 4-girder support system. 3 or 2 girder systems will have rocking applied to the outer most supporting girder.

Total Impact Factor

Total Calculated Impact Factor: 45.0%

Impact Factor Considered: 90.0% *AREMA 15-1.3.5(b) allows reduction for ballasted deck.*

Total Applied Impact Factor: 40.5%

Beams Outside of Curve

Load	Equiv. W (klf)	V_I (kip)	M_I (kip-in)	σ_I (ksi)	Δ_I (inches)	Notes
Standard AREMA Live Load	1.36	53.42	9834.11	4.55	0.36003	Inc. for Deflection
Unloaded Train (SL)	0.29	10.14	2114.42	0.98	0.07741	Composite

Beams Inside of Curve

Load	Equiv. W (klf)	V_I (kip)	M_I (kip-in)	σ_I (ksi)	Δ_I (inches)	Notes
Standard AREMA Live Load	0.90	35.61	6556.08	3.03	0.24002	Inc. for Deflection
Unloaded Train (SL)	0.19	6.76	1409.61	0.65	0.05161	Composite

Δ_v - Vertical Deflection Check

(Live Load + Impact)

AREMA 15-1.2.5.b

AREMA Allowable		MAX Live Load and Impact Deflections	
L/640	1.303 *in*	Max Live Load Deflection:	0.888 *in*
		Corresponding Impact Deflection:	0.360 *in*
		Total Live Load + Impact Deflection:	1.248 *in*

	Actual		Allowable	
Deflection Check:	1.248	≤	1.303	**OK**
Deflection Ratio:	L / 668	≤	L / 640	

CF - Centrifugal Force

Moments, Forces, and Stresses

AREMA 15-1.3.6

Known Variables & Calculations

Deg. of curve, D =	10.00 *deg*	Speed, S =	15.0 *mph*
Train Center of gravity, h_{cg} =	8.00 *ft*	Track c/c, d =	4.932 *ft*
Cent. Factor, CF =	2.63%		
Horizontal Cent. Factor, CF_h =	2.63%	Vertical Cent. Factor, CF_v =	4.27%
Applied to each rail head		*Increases outside of curve, decreases inside of curve*	

Outside of Curve (per beam)		Inside of Curve (per beam)	
Vertical Cent. Factor, CF_v =	**2.13%**	**Vertical Cent. Factor, CF_v =**	**-2.13%**

Beams Outside of Curve

Load	Equiv. W (klf)	V_{CF} (kip)	M_{CF} (kip-in)	σ_{CF} (ksi)	Δ_{CF} (inches)	Notes
Standard AREMA Live Load	0.071	2.81	517.98	0.24	0.01896	Composite
Unloaded Train (SL)	0.015	0.53	111.37	0.05	0.00408	

Horizontal Cent. Load = 3.47 kip / Girder

Beams Inside of Curve

Load	Equiv. W (klf)	V_{CF} (kip)	M_{CF} (kip-in)	σ_{CF} (ksi)	Δ_{CF} (inches)	Notes
Standard AREMA Live Load	-0.048	-1.88	-345.32	-0.16	-0.01264	Will reduce stresses
Unloaded Train (SL)	-0.010	-0.36	-74.25	-0.03	-0.00272	Will reduce stresses

Horizontal Cent. Load = 2.31 kip / Girder

LF - Longitudinal Force

Moments, Forces, and Stresses

AREMA 15-1.3.12

The relative stiffness of substructures and related fixity will play a large role in longitudinal force distribution throughout a long structure.

LF herein will be for the worst case for this span.

The force for this individual span will be used to design individual items on this span.

Longitudinal force for the entire bridge length should be calculated and investigated seperately for substructure design and analysis.

Average Carriage Length = 40.0 ft

$$LF_B = 45 + 1.2L$$

Braking - Fully Loaded Bridge

Loaded Length:	72.670	*ft*
Full LF_{B_All}	132.20	*kips*
This Spans Portion of Full $LF_{B_All_Span}$	126.44	*kips*

Braking - This Span Only

LF_{B_Span}	128.40	*kips*
Center of Action	8.00	*ft*
Vertical LF_{BV_Span}	25.68	*kips*

Front axle to rear axle

$$LF_T = 25\sqrt{L}$$

Traction - Fully Loaded Bridge

Loaded Length:	72.670	*ft*
Full LF_{T_All}	213.12	*kips*
This Spans Portion of Full $LF_{T_All_Span}$	203.82	*kips*

Traction - This Span Only

LF_{T_Span}	208.42	*kips*
Center of Action	3.00	*ft*
Vertical LF_{TV_Span}	15.63	*kips*

Controling Load - Total

Maximum Longitudinal Force:	LF_{Max}	208.42	*kips*
Max Shear from LF:	LF_V	25.68	*kips*
Equally distributed shear:	w_{LF}	0.37	*klf*
Moment created from LF_v:	LF_M	2677.14	*kip-in*

Applied Load - Per Rail

Max Shear:	LF_V	12.84	*kips*
Moment created from LF_v:	LF_M	1338.57	*kip-in*

Beams Outside of Curve

Load	Equiv. W (klf)	V_{LF} (kip)	M_{LF} (kip-in)	σ_{LF} (ksi)	Δ_{LF} (inches)	Notes
Standard AREMA Live Load	0.11	7.70	803.14	0.37	0.02940	Composite
Unloaded Train (SL)	0.02	1.46	172.68	0.08	0.00632	Composite

Beams Inside of Curve

Load	Equiv. W (klf)	V_{LF} (kip)	M_{LF} (kip-in)	σ_{LF} (ksi)	Δ_{LF} (inches)	Notes
Standard AREMA Live Load	0.07	5.14	535.43	0.25	0.01960	Composite
Unloaded Train (SL)	0.02	0.97	115.12	0.05	0.00421	Composite

N - Lateral Forces (Nosing)

Moments, Forces, and Stresses

AREMA 15-1.3.9

Not used for girder design. *Will be used for bracing system design.*

a. A single moving concentrated lateral force equal to one-quarter of the weight of the heaviest axle of the specified live load, without impact, shall be applied at the base of rail in either direction and at any point along the span in addition to the other lateral forces specified (Reference 20). On spans supporting multiple tracks, the force shall be applied on one track only.

b. The only resulting stresses to be considered are axial stresses in members bracing the flanges of stringer, beam and girder spans, axial stresses in the chords of truss spans and in members of cross frames of such spans, and stresses from lateral bending of flanges of longitudinal flexural members having no bracing system. The effects of lateral bending between braced points of flanges, axial forces in flanges, vertical forces and forces transmitted to bearings shall be disregarded.

Heaviest Axle: Alt. Load = 100 kip

Notional Lateral Design Load, N = 25.0 kip

W - Wind on Loaded Bridge

Moments, Forces, and Stresses

AREMA 15-1.3.7

In general, the wind force shall be considered as a moving load acting in any horizontal direction. As a minimum, the bridge shall be designed for laterally and longitudinally applied wind forces acting independently as follows:

a. On the train, the lateral wind force shall be taken at 300 lb. per linear foot applied normal to the train on one track at a distance of 8 feet above top of rail.

b. On the bridge, lateral wind pressure shall be taken at 30 lb. per square foot normal to the following surfaces:

(1) For girder spans, 1.5 times the vertical projection of the span.

c. The lateral wind force on girder and truss spans, however, shall not be taken as less than 200 lb. per foot for the loaded chord or flange and 150 lb. per foot for the unloaded chord or flange, neglecting the wind force on the floor system.

d. The longitudinal wind force on spans shall be taken as:

(1) For girder spans, 25 percent of the lateral wind force.

Loaded Length: 72.000 *ft*

Wind on Superstructure

Girder Height:	41.000	*in*
Deck Thickness:	9.00	*in*
Curb Height:	27.00	*in*
Total Height:	6.42	*ft*
1.5 x Total Height:	9.63	*ft*
Wind Pressure:	30.00	*psf*
Wind Load:	288.75	*plf*

Not less than 200 plf, will be used for lateral bracing

Total Wind Force:	20.79	*kip*
Force Centroid:	4.81	*ft*
Resisting Couple	63.00	*ft*
Resisting Force:	1.59	*kip*
Resisting Load/Girder:	11.03	*plf* (up/down)

50% is assumed to be resisted by a single beam

OUTER MOST (windward = up, leeward = down)

Girder Moment from Vertical Component 6.66 *kip*ft*

(Worst Beam)

Wind on Live Load

Lateral Load Applied:	300.000	*plf*
Load Centroid:	8.00	*ft*
Vertical Component:	486.59	*plf*

*Assumed to act down on rail at the **outside of curve***

*Assumed to act up on rail at the **inside of curve***

Total Wind Force: 21.60 *kip*

Girder Moment from Vertical Component 293.79 *kip*ft*

(Total)

NOTE: Lateral Loads will also be used for lateral bracing system design and stability analysis of substructures.

Total Girder Moment and shears are multiplied by eccentricity factors above.

Beams Outside of Curve

Load	Equiv. W (klf)	V_W (kip)	M_W (kip-in)	σ_W (ksi)	Δ_W (inches)	Notes
Standard AREMA Live Load	0.30	10.91	2195.22	1.02	0.11923	
Unloaded Train (SL)	0.30	10.91	2195.22	1.02	0.11923	

Beams Inside of Curve

Load	Equiv. W (klf)	V_W (kip)	M_W (kip-in)	σ_W (ksi)	Δ_W (inches)	Notes
Standard AREMA Live Load	-0.21	-7.40	-1490.12	-0.69	-0.08093	Will reduce stress
Unloaded Train (SL)	-0.21	-7.40	-1490.12	-0.69	-0.08093	Will reduce stress

WU - Wind on Unloaded Bridge

Moments, Forces, and Stresses

AREMA 15-1.3.8

a. The lateral wind force on the unloaded bridge shall be taken as 50 lb per square foot of surface as defined in Article 1.3.7b.

b. The longitudinal wind force on the unloaded spans shall be taken as:

(1) For girder spans, 25 percent of the lateral wind force.

Loaded Length: 72.000 *ft*

Lateral on Superstructure

1.5 x Total Height:	9.63 *ft*
Wind Pressure:	50.00 *psf*
Wind Load:	481.25 *plf*

Not less than 200 plf, will be used for lateral bracing

Total Wind Force:	34.65 *kip*

Vertical on Superstructure

Force Centroid:	4.81 *ft*
Resisting Couple	63.00 *ft*
Resisting Force:	2.65 *kip*
Resisting Load/Girder:	18.38 *plf*

OUTER MOST (windward = up, leeward = down)

Girder Moment from Vertical Component	11.10 *kip*ft*

(Worst Beam)

NOTE: Lateral Loads will also be used for lateral bracing system design and stability analysis of substructures.

Total Girder Moment and shears are multiplied by eccentricity factors above

Beams Outside of Curve

Load	Equiv. W (klf)	V_{WU} (kip)	M_{WU} (kip-in)	σ_{WU} (ksi)	Δ_{WU} (inches)	Notes
Standard AREMA Live Load	0.02	0.66	133.18	0.06	0.00723	
Unloaded Train (SL)	0.02	0.66	133.18	0.06	0.00723	

Beams Inside of Curve

Load	Equiv. W (klf)	V_{WU} (kip)	M_{WU} (kip-in)	σ_{WU} (ksi)	Δ_{WU} (inches)	Notes
Standard AREMA Live Load	-0.02	-0.66	-133.18	-0.06	-0.00723	Will reduce stress
Unloaded Train (SL)	-0.02	-0.66	-133.18	-0.06	-0.00723	Will reduce stress

Qg - Derailment Load on Girders

Moments, Forces, and Stresses

NFS_UP2 V.C.2 (Beams - Used for D2 Loadcase)

C. **Design of Superstructure for Derailment:**

2. The supporting steel members, whose centerlines measure not more than 11′-0″ from the outside face of curb shall be considered as carrying the derailed load. An impact load, equal to 0.8x live load, shall be provided. Allowable unit stresses in steel shall be not more than 70 percent greater than the normal allowable unit stresses.

Total Impact Factor

Total Applied Impact Factor: 80.0%

Note: AREMA Rail load will be applied to an individual girder (derail directly atop girder) and multiplied by the impact factor listed above)

Girder Forces below are the total LL+I for the derailed condition - Used for Load Case D2

Derailed Beam

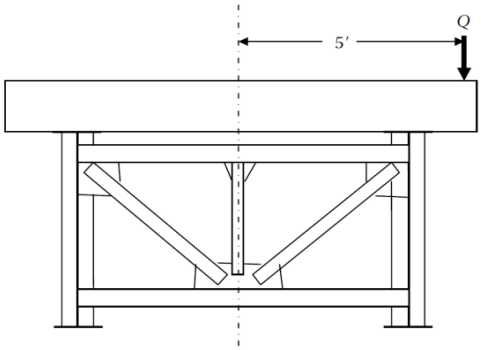
Load	Equiv. W (klf)	V_Q (kip)	M_Q (kip-in)	σ_Q (ksi)	Δ_Q (inches)	Notes
Standard AREMA Live Load	10.05	395.41	72787.79	33.67	2.66476	Stress Check
Unloaded Train (SL)	2.16	75.06	15650.01	7.24	0.57295	Composite

Qb - Derailment Load on lateral bracing

Moments, Forces, and Stresses

AREMA 15-1.3.10 .b (Cross Frames Only - Used for G Loadcase) - Max Differential Deflections Considered in Connection Calculations

.... "A single line of wheel loads (Q) equal to the design load per rail (Article 1.3.3) including full design impact is to be applied at an eccentricity of 5 feet from the centerline of track as shown in Figure 15-1-4, but no further than the edge of the deck or, for open decks, the bridge ties."



Geometry Considered

The entire load will be applied to a single girder and the vertical force will need to be transmitted to the adjacent girder through the cross frame or diaphragm within the allowable stress (150%).

Total Impact Factor

Total Applied Impact Factor: 40.5%

Cooper E-80 Impact Load for Design

Vertical Point Load: 56.2 kip

Will be applied to cross bracing in lieu of differential deflection analysis.
Overstress allowance applies.

CWR - Continously Welded Rail

Not Required on Ballasted Deck

128 Design of Modern Steel Railway Bridges

4.4.3 Forces From the CWR on Steel Railway Bridges

The magnitude of the CWR–bridge thermal interaction is governed by the following conditions:

- The type of bridge (open deck, ballasted‡) and bridge materials.

‡ For ordinary ballast deck bridges, the differential thermal movements are generally accommodated by the ballast section.

EQ - Earthquake Loads

Not explicity required for a single span bridge

AREMA Chapter 9. *Multi-Span bridges should utilize the ELF Procedure.*

Table 9-1-7. Analysis Procedure Selection

Bridge Configuration	Analysis Procedure[1]
Single-span	No analysis required
Two-span	ELF or MA Procedure
Multi-span regular[2]	ELF or MA Procedure
Multi-span irregular[2]	MA Procedure

Note:
1. ELF denotes Equivalent Lateral Force Procedure, MA denotes Modal Analysis Procedure.
2. Irregular bridges are those structures with significantly irregular configuration or support stiffness.

1.4.5.3 Equivalent Lateral Force Procedure[1]

The Equivalent Lateral Force Procedure may be used for two-span bridges or multi-span regular bridges as described in Paragraph 1.4.5.2. The procedure is described below.

1.4.4.3 Seismic Response Coefficient[1]

The Seismic Response Coefficient (C_m) to be used in the methods of analysis recommended in Paragraph 1.4.5, shall be calculated from the following formula. For areas with soft soil conditions and high seismicity, or close proximity to known faults, use of a site-specific response spectrum is preferred.

$$C_m = \frac{1.2ASD}{T_m^{2/3}} \leq 2.5AD$$

C_m= Seismic Response Coefficient for the mth mode

A= Base Acceleration Coefficient determined in accordance with Paragraph 1.3.3.3 — A = 6% 475 Year Return

S= Site Coefficient determined in accordance with Paragraph 1.4.4.1 — S = 1.2 Rock > 200'

D= Damping Adjustment Factor determined in accordance with Paragraph 1.4.4.2 — D = 1.000 **AREMA 9-1.4.4.2** *(Assumes 5% damping)*

T_m= Period of vibration of the mth mode in seconds

Lateral Period of Vibration, $T_m = 2\pi*(W/gK)^{1/2}$ — Per AASHTO LRFD 4.7.4.3.2c

W =	2540473	lbs	
g =	32.17	ft/sec^2	
I =	416559186	in^4	*(Deck)*
E =	3604997	lbs/in^2	
$v_{s,MAX}$ =	0.000005	in	
K=	173913609		
T_m =	0.133889	sec	

Seismic Response Coefficient for the First Mode

Calculated C_m =	33.0%	
Maximum C_m =	15.0%	
Used C_m =	15.0%	Note: For reference, ODOT assumes 20% across the state.

Horizontal Seismic Load

Distributed Weight of Bridge:	34959.03	*plf*	
Distributed horizontal Load, p(x):	5243.85	*plf*	
Total horizontal Load:	377.56	*kip*	
Total Longitudinal Load at each end:	377.56	*kip*	(Use for anchor bolt and foundation analysis)
Total Lateral Load at each end:	188.78	*kip*	(Use for end diaphragms)

Δ_L - Lateral Deflection Check

AREMA 15-1.2.5.c

Allowable Chord Deflection =	0.250	*in*	*0.25" = Curved, 0.375 "= Tangent*
Chord Length =	31	*feet*	*31' = Curved, 62' = Tangent*
Allowable Span Deflection =	1.25657	*in*	*Squared Proportional to Span Length*

Lateral Centrifugal Force on Fully Loaded Bridge

Horizontal Cent. Factor, CF_h = 5.27%

Total (Applied to both rail heads)

Horizontal Cent. Moment = 2129.04 *kip-in*

(Ratio of vertical moment - load on the total track is considered)

W - Wind Forces On fully loaded bridge

Total Lateral Load: 0.04906 *kips/inch*

Total (Applied to both rail heads)

Total Lateral Moment: 4265.715 *kip-in*

Section Properties Used

"D" of the outer most beams	63.00	*in*
"D" of the inner most beams	21.00	*in*
Girder Sectional Area:	152.25	in^2
Girder Secondary Mom. Of Inertia:	4631.73	in^4
Moment of Inertia of outer pair:	1217823.96	in^4
Moment of Inertia of remaining:	143547.96	in^4
Total Lateral Mom. Of I Considered:	680685.96	in^4

N - Notional Load

Lateral Point Load: 25.0 *kips*

Total Lateral Moment: 5212.5 *kip-in*

Note: The entire bridge will not be assumed for lateral deflection (to be conservative). Only the girders supporting one track will be used and 50% of the the section properties combined using the parallel axis theorem. This assumes a largely rigid lateral system, which is required by AREMA.

Factored Moments Applied

Load Combination A1 =	2129.04	*kip-in*	with	100%	*Allowable*
Load Combination B1 =	9478.21	*kip-in*	with	125%	*Allowable*
Load Combination B1A =	9478.21	*kip-in*	with	100%	*Allowable*
Load Combination D1 =	11607.26	*kip-in*	with	150%	*Allowable*

Calculated Conservative Lateral Deflections

Load Combination A1 =	0.00781	*in*	with	1.257 in	*Allowable*	**OK**
Load Combination B1 =	0.03479	*in*	with	1.571 in	*Allowable*	**OK**
Load Combination B1A =	0.03479	*in*	with	1.257 in	*Allowable*	**OK**
Load Combination D1 =	0.04260	*in*	with	1.885 in	*Allowable*	**OK**

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM-562-0026_03	REV. NO.: 05
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: CTM	DATE: 11/01/13
BRIDGE NO: HAM-562-0026		UPDATED: EFD	DATE: 12/11/13
SUBJECT: Loads		CHECKED:	DATE:
Girders		UPDATED: EFD	DATE: 05/27/15
Span 1 Stresses		VERIFIED: VDT	DATE: 06/02/15

Unfactored Girder Bending Stresses

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg
Beams Outside of Curve										
Standard AREMA Live Load	6.30 ksi	11.22 ksi	4.55 ksi	0.24 ksi	0.37 ksi		1.02 ksi	0.06 ksi	0.00 ksi	33.67 ksi
Unloaded Train (SL)	6.30 ksi	0.00 ksi	0.98 ksi	0.05 ksi	0.08 ksi		1.02 ksi	0.06 ksi	2.41 ksi	7.24 ksi
Beams Inside of Curve										
Standard AREMA Live Load	6.30 ksi	7.48 ksi	3.03 ksi	-0.16 ksi	0.25 ksi		-0.69 ksi	-0.06 ksi	0.00 ksi	33.67 ksi
Unloaded Train (SL)	6.30 ksi	0.00 ksi	0.65 ksi	-0.03 ksi	0.05 ksi		-0.69 ksi	-0.06 ksi	1.61 ksi	7.24 ksi

Bending Stresses from Girder Load Cases - Outside of Curve

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg	Qb	EQ	CWR	DF	Total	Allowable	Check
A1	6.30 ksi	11.22 ksi	4.55 ksi	0.24 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	22.31 ksi	27.50 ksi	OK
B1	6.30 ksi	11.22 ksi	4.55 ksi	0.00 ksi	0.37 ksi	0.00 ksi	1.02 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	23.46 ksi	34.38 ksi	OK
B1A	6.30 ksi	11.22 ksi	4.55 ksi	0.00 ksi	0.37 ksi	0.00 ksi	1.02 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	23.46 ksi	27.50 ksi	OK
C - FATIGUE	0.00 ksi	11.22 ksi	4.55 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	15.77 ksi	16.00 ksi	OK
D1	6.30 ksi	0.00 ksi	0.00 ksi	0.24 ksi	0.00 ksi	0.00 ksi	1.02 ksi	0.00 ksi	2.41 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	9.97 ksi	41.25 ksi	OK
D2	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	33.67 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	39.97 ksi	46.75 ksi	OK
E1	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	41.25 ksi	OK
F	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.06 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.36 ksi	27.50 ksi	OK
G	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	41.25 ksi	OK
H1	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	41.25 ksi	OK
H2	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	34.38 ksi	OK

Bending Stresses from Girder Load Cases - Inside of Curve

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg	Qb	EQ	CWR	DF	Total	Allowable	Check
A1	6.30 ksi	7.48 ksi	3.03 ksi	-0.16 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	16.65 ksi	27.50 ksi	OK
B1	6.30 ksi	7.48 ksi	3.03 ksi	0.00 ksi	0.25 ksi	0.00 ksi	-0.69 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	16.37 ksi	34.38 ksi	OK
B1A	6.30 ksi	7.48 ksi	3.03 ksi	0.00 ksi	0.25 ksi	0.00 ksi	-0.69 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	16.37 ksi	27.50 ksi	OK
C - FATIGUE	0.00 ksi	7.48 ksi	3.03 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	10.52 ksi	16.00 ksi	OK
D1	6.30 ksi	0.00 ksi	0.00 ksi	-0.16 ksi	0.00 ksi	0.00 ksi	-0.69 ksi	0.00 ksi	1.61 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	7.06 ksi	41.25 ksi	OK
D2	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	33.67 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	39.97 ksi	46.75 ksi	OK
E1	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	41.25 ksi	OK
F	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	-0.06 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.24 ksi	27.50 ksi	OK
G	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	41.25 ksi	OK
H1	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	41.25 ksi	OK
H2	6.30 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.30 ksi	34.38 ksi	OK

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM-562-0026_03	REV. NO.: 05
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: CTM	DATE: 11/01/13
BRIDGE NO: HAM-562-0026		UPDATED: EFD	DATE: 12/11/13
SUBJECT: Loads		CHECKED:	DATE:
Girders		UPDATED: EFD	DATE: 05/27/15
Span 1 Stresses		VERIFIED: VDT	DATE: 06/02/15

Unfactored Girder Shear Loads (At Supports)

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg
Beams Outside of Curve										
Standard AREMA Live Load	67.66 kip	131.80 kip	53.42 kip	2.81 kip	7.70 kip		10.91 kip	0.66 kip	0.00 ksi	395.41 kip
Unloaded Train (SL)	67.66 kip	0.00 ksi	10.14 kip	0.53 kip	1.46 kip		10.91 kip	0.66 kip	25.02 kip	75.06 kip
Beams Inside of Curve										
Standard AREMA Live Load	67.66 kip	87.87 kip	35.61 kip	-1.88 kip	5.14 kip		-7.40 kip	-0.66 kip	0.00 ksi	395.41 kip
Unloaded Train (SL)	67.66 kip	0.00 ksi	6.76 kip	-0.36 kip	0.97 kip		-7.40 kip	-0.66 kip	16.68 kip	75.06 kip

Shear Area
30.75 in^2

Shear Stresses from Girder Load Cases - Outside of Curve

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg	Qb	EQ	CWR	DF	Total	Allowable	Check
A1	2.20 ksi	4.29 ksi	1.74 ksi	0.09 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	8.32 ksi	17.50 ksi	OK
B1	2.20 ksi	4.29 ksi	1.74 ksi	0.00 ksi	0.25 ksi	0.00 ksi	0.35 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	8.83 ksi	21.88 ksi	OK
B1A	2.20 ksi	4.29 ksi	1.74 ksi	0.00 ksi	0.25 ksi	0.00 ksi	0.35 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	8.83 ksi	17.50 ksi	OK
C - FATIGUE	0.00 ksi	4.29 ksi	1.74 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.02 ksi		
D1	2.20 ksi	0.00 ksi	0.00 ksi	0.09 ksi	0.00 ksi	0.00 ksi	0.35 ksi	0.00 ksi	0.81 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	3.46 ksi	26.25 ksi	OK
D2	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	12.86 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	15.06 ksi		
E1	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	26.25 ksi	OK
F	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.02 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.22 ksi	17.50 ksi	OK
G	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	26.25 ksi	OK
H1	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	26.25 ksi	OK
H2	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	21.88 ksi	OK

Shear Stresses from Girder Load Cases - Inside of Curve

Comb.	DL	LL	I	CF	LF	N	W	WU	SL	Qg	Qb	EQ	CWR	DF	Total	Allowable	Check
A1	2.20 ksi	2.86 ksi	1.16 ksi	-0.06 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.16 ksi	17.50 ksi	OK
B1	2.20 ksi	2.86 ksi	1.16 ksi	0.00 ksi	0.17 ksi	0.00 ksi	-0.24 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.14 ksi	21.88 ksi	OK
B1A	2.20 ksi	2.86 ksi	1.16 ksi	0.00 ksi	0.17 ksi	0.00 ksi	-0.24 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	6.14 ksi	17.50 ksi	OK
C - FATIGUE	0.00 ksi	2.86 ksi	1.16 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	4.02 ksi		
D1	2.20 ksi	0.00 ksi	0.00 ksi	-0.06 ksi	0.00 ksi	0.00 ksi	-0.24 ksi	0.00 ksi	0.54 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.44 ksi	26.25 ksi	OK
D2	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	12.86 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	15.06 ksi		
E1	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	26.25 ksi	OK
F	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	-0.02 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.18 ksi	17.50 ksi	OK
G	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	26.25 ksi	OK
H1	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	26.25 ksi	OK
H2	2.20 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	0.00 ksi	2.20 ksi	21.88 ksi	OK

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Loads***	**GF JOB NO:**	**54682**
	Abutment Loads for	CALC NO.:	**HAM562_0026_04**
	Abut5 Program	REV NO.:	**02**
FILE NAME(s):	*HAM562_0026_04.xlsx*	**SHEET: 1 OF 5**	

SUPERSEDES CALC NO: 01 (Stage 2 Design)

CALCULATION DESCRIPTION:

This will calculate all loads applied to the abutment on a per-foot basis for use in the Abut5 program.

Vertical Loads: The max girder reaction will be divided by the girder spacing to produce the worst loading scenario on an abutment.
Horizontal Loads: The horizontal girder reactions are divided by the a width equal to 66% of the substructure and 33% of the total out-out of the beams. This recognizes the fact that the deck diaphragm action will distribute the loads to all of teh girders, and that the entire stem will resist bending by the time the force is distributed to the foundation. The vertical/longitudinal components will be used as input into Abut5. A single fixed abutment design will be completed.

The forward abutment will be fixed, but the taller rear abutment dimensions will be analyzed to ensure the analysis is conservative and is applicable for both abutments.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2013) Chapter 8, Section 5
AREMA (2014) Chapter 15, Section 5
Calculation: HAM562_0026C_10 (Bearing Design)
Calculation: HAM562_0026C_03 (Girder Loads and Reactions)
Calculation: HAM562_0026C_01 (Elevation Data)
Revised Stage 1 Plans
(top-down construction after addresssing ODOT and NSRR comments)

MISCELLANEOUS NOTES:

Abut5 Calculates the abutment self-weight and earth loads automatically. This calculation will determine earth loads based upon rankine.

Bearing stiffnesses asssume conservative values from prelimnary elastomeric design

Loads input into Abut5 will be grouped according to AASHTO.

Stage 3: Updated loads per updated girder section/deck section

RECORD OF ISSUES:

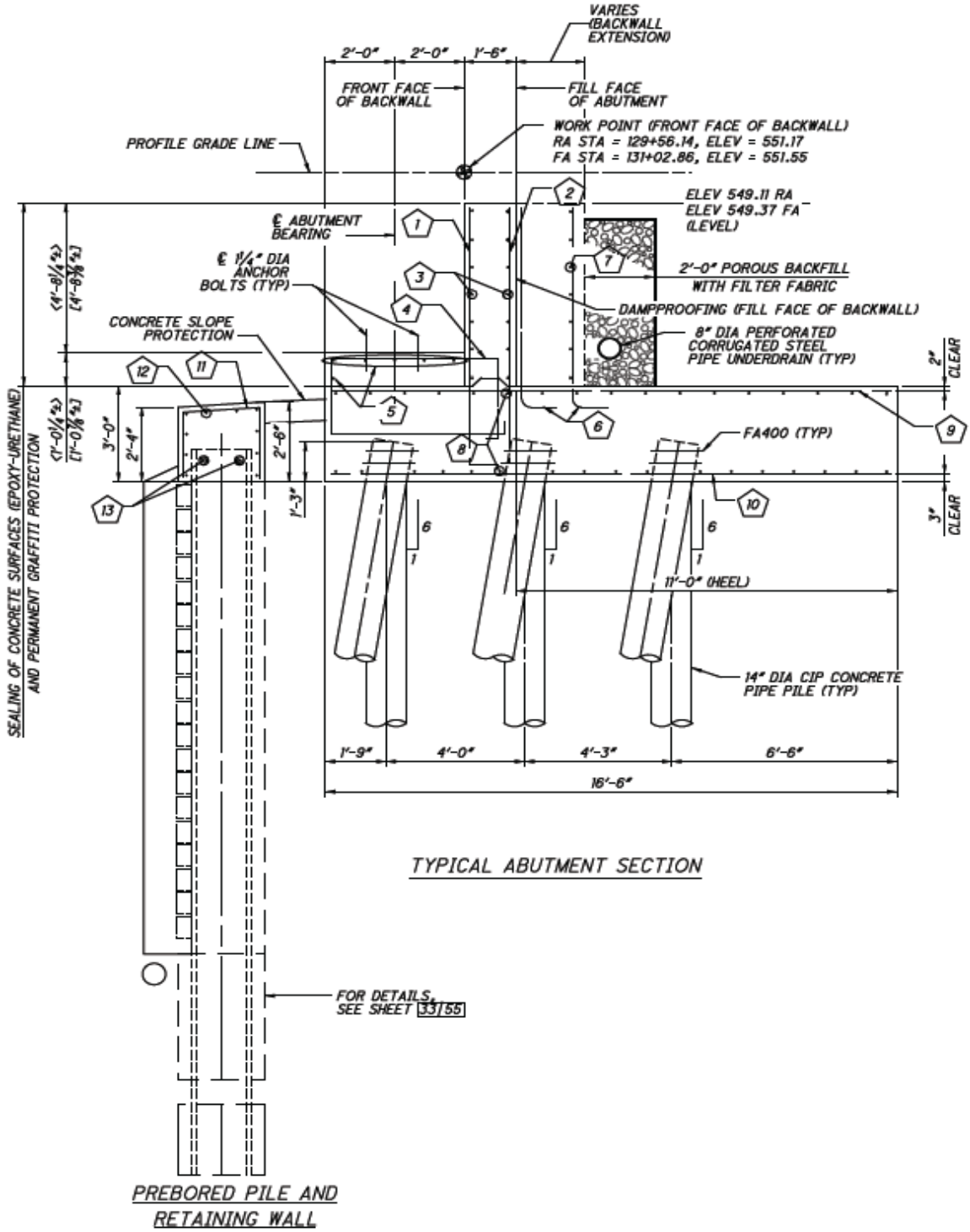
REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 1 Calculation	CTM	11/13/13		
01	Stage 2 Calculation	VDT	07/17/14	EFD	07/30/14
02	Stage 3 Update	VDT	01/14/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/17/14	VDK	07/18/14	VDT	07/18/14	EFD	07/30/14

Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_04**	REV. NO.: **02**
		PROJECT: **ODOT/EMH&T: HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *VDT*	DATE: *07/17/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDK*	DATE: *07/18/14*
SUBJECT: *Loads*		UPDATED: *VDT*	DATE: *07/18/14*
Abutment Loads for		VERIFIED: *EFD*	DATE: *07/30/14*
Rear Abutment (Worst Case)		VERIFY @ BRG FINALIZED: *VDT*	DATE: *11/05/14*

Typical Section (Stage 2 Details)



Gannett Fleming	GF JOB # 54682	CALC NO.: **HAM562_0026_04**	REV. NO.: **02**
		PROJECT: **ODOT/EMH&T: HAM-75-7.85**	
ODOT PID NO.: 77889		DESIGNED: *VDT*	DATE: *07/17/14*
BRIDGE NO: *HAM-562-0026*		CHECKED: *VDK*	DATE: *07/18/14*
SUBJECT: *Loads*		UPDATED: *VDT*	DATE: *07/18/14*
Abutment Loads for		VERIFIED: *EFD*	DATE: *07/30/14*
Rear Abutment (Worst Case)		VERIFY @ BRG FINALIZED: *VDT*	DATE: *11/05/14*

General Layout Data (Stage 1 Dimension used)

Girder Layout (For Distribution)

Typical Girder Spacing:	3.500 ft	
^^ Normal to the C/L of the deck ^^		
Girder Spacing Used:	3.657 ft	
		Along Skew
C/C Track Supporting Girders:	10.500 ft	10.970 ft
C/C Lateral Girders:	28.000 ft	29.253 ft
Abutment Stem Length:	34.000 ft	
Number of LL Girders:	4	*Vertical Load Distribution*
Girder	4	

Trigonometry multipliers to make loads and dimensions normal/parallel to abutment face

Skew Angle:	16.830 deg	0.29 rad
^^ Normal to the C/L of the girder ^^		
Girder Spacing (1/cos):	1.045	
Lateral Loads (sin):	0.290	
Longitudinal Loads (cos):	0.957	
Considered Lateral Girders:	9	*Horiz. Load Distrib.*
Bottom/Ftg. ELEV:	540.30	*Elevations At Back of Backwall of rear abutment*
PGL ELEV:	551.25	

Reaction Data from calculation HAM562_0026C_03

Girder Reactions Considered - Span 2

Worst Case Reactions - Standard AREMA Live Load (Girder Outside of Curve)

DL Vert	LL Vert	CF Lat	LF Long	WL Lat	WS Lat	EQ Normal	Qg Vert	Impact Load *(Used to Check Bearing Size)*	Thermal Load *(From Bearing Design)*
67.66 kip	131.80 kip	13.88 kip	208.42 kip	10.80 kip	10.40 kip	377.56 kip	395.41 kip	53.42 kip	3.02 kip
		(2)	**(2)**	**(2)**	**(2)**	(1)	(4)		

(1) The total earthquake load is assumed to be in any direction. Normal to the face of abutment is considered herein. (parallel to the face of abutment will not control by inspection)

(2)** The horizontal loads (lateral and longitudinal) are the **total force PER abutment.

(4) This derail load includes impact for substructure design (pier stability)

Abut 5 Load Inputs from Girder Reactions

Abutment Reactions / LF of Abutment

Worst Case Reactions - Standard AREMA Live Load (Girders Outside of Curve)

DL Vert	LL Vert	CF Lat	LF Long	WL Lat	WS Lat	EQ Normal	Qg Vert	Upward Wind	Bearing LF
18.50 kip/ft	36.05 kip/ft	0.14 kip/ft	6.22 kip/ft	0.11 kip/ft	0.10 kip/ft	11.69 kip/ft	108.14 kip/ft	0.18 kip/ft	0.79 kip/ft
			(1)	(3)	(2)	(4)			

(1) AREMA Commentary 9.1.3.12 explains that there is only a negligible reduction in longitudinal force on a ballasted deck bridge. As such, all of the longitudinal force will be transferred to the fixed abutment. The width that the longitudinal force is distributed across is 66% of the stem width plus 33% of the superstructure width. This recongnizes that stem outside of the superstructure bearing width will resist the bending moment (worst bending moment at the bottom of the stem = more room to dissipate across stem height).

(2) The total reaction given above is per abutment; this load is over the C/C exterior girder width

(3) The total reaction given above is due to a live load per abutment; this load is over the C/C track supporting girders

(4) The earthquake load is reduced by thermal load (calculated below) which allows for the bearing to absorb and transfer some of the ground motion to the expansion abutment. The dynami coefficient of friction is assumed to be 33% of static (conservative per bronze/steel published values). The EQ load is distributed laterally in the same manner as the longitudinal loads

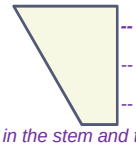
Train Surcharge Loading

Cooper E-80 Linear Load:	8000 plf	Bottom/Tie to Bottom/Footing:	9.700 ft	Use
Assumed Soil Density:	110 pcf	Abut5 TOP FTG TO TOP EMBANK -->	6.700 ft	6.90
^^ Type 2 Soil, per AREMA Table 8-5-2		Bottom of Tie to Top of Backwall:	0.833 ft	
Typical Tie Width:	8.500 ft	Footing Thickness	3.000 ft	
		Stem Height (to top of backwall) -->	5.867 ft	6.10

Lateral distribution of surcharge at top of backwall:	9.33 ft	*AREMA 8-5.3.1.b*	
Lateral distribution of surcharge at bottom of footing:	18.20 ft	*AREMA 8-5.3.1.b*	*18.2*
Equivalent surcharge at the top of backwall:	7.79 ft	*Per foot of abutment width*	
Equivalent surcharge at the bottom of footing:	4.00 ft	*Per foot of abutment width*	

Soil surcharge below is per foot of abutment width, rounded up to the nearest 0.1'

Soil surcharge at a point 1/3 Down from ties	**6.60 ft**	***-- Worst case for overturning & Bending***
Soil surcharge at a point 1/2 Down from ties	5.90 ft	*-- Average Eq. Surcharge (Sliding)*
Soil surcharge at a point 2/3 Down from ties	5.30 ft	*-- Equivilant at the base of the footing*



The worst case surcharge (1/3 down) is used for the Abut5 Analysis because it will give the worst case bending in the stem and the worst case overturning (vertical force on piles as well as bending in the foundation). However, ***this will overestimate the required sliding resistance.*** *Due to that, there is no need to be overly conservative on the sliding resistance of the Abut5 output.*

Additional Longitudinal Backwall Forces

Ref: AREMA 8-5.3.1.c - Increase backwall loads by 100% for earth and surcharge pressures.

No additional loading will be added to Abut5; the required reinforcing will be increased by the factor below:

Multiplier due to increased surcharge on backwall: ***2.20***

*^^ Includes a 100% increase to satisfy AREMA 8-5.3.1.c and a ratio of (top of backall)/(applied surcharge)^^*

Granular Backfill

A select granular backfill will be used behind the abutment.

For the design of the abutment, Backfill Type 2 or 1 of AREMA Table 8-5-1 (Section 8-5.2.5) is assumed.

Using Rankine theory (to match ABUT5 Routine) for a vertical wall, the equivilant fluid pressure is as follows:

Friction btwn backfill and stem concrete δ:	15.0 deg	0.2618	*Half of backfill angle*
Angle of backfill β:	1.4 deg	0.0250	*Assumes a 2.5% profile grade behind the abutment*
Conservative Angle of Internal Friction ϕ:	30.0 deg	0.5236	*AREMA Table 8-5-2 (Type 1), Project Geotech Report uses 33*
Angle of Stem (Fill-Face) θ:	90.0 deg	1.5708	*Angle from horizontal (90 degrees… less than 90 for a batter*

	Coulomb	***Rankine***
K_a Numerator:	**0.750**	**0.750**
K_a denominator Sqrt Term:	0.592	2.217
K_a denominator Outside Term:	0.966	1.000
K_a Denominator:	**2.447**	**2.217**
Coefficient of Active Earth Pressure K_a:	**0.306**	**0.338**

NOTE: Coulomb is calculated simply for reference should it ever be needed.

Rankine formulast are per "All-In-One Civil Engineering PE Exam Guide, Goswami"

Equivalent Fluid Pressure Dry: 37.2 psi

(AREMA Chart C-8-5-6 is conservative and for walls less than 20'. It approximates 31.0 psi for type 1 soil)

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Abutment	CALC NO.:	**HAM562_0026_05**
	Abut5 Program	REV NO.:	**01**
FILE NAME(s):	*AB5_HAM_562.dat &*	**SHEET: 1 OF 10**	
	AB5_HAM_562.out		

SUPERSEDES CALC NO: 00 (Stage 2)

CALCULATION DESCRIPTION:

This will analyze the proposed abutment utilizing previously calculated load, geometric, and soil input within the Abut5 program. The rear abutment will be analyzed, and the same design will be used for both abutments.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
Calculation: HAM562_0026_04 (Abutment Loads)
Calculation: HAM562_0026_01 (Elevation Data)
Abut5 Users Manual (PennDOT)

MISCELLANEOUS NOTES:

Abut5 calculates the abutment self-weight and earth loads automatically. Loads input into Abut5 are to be grouped according to AASHTO but are very similar to AREMA Load Cases. No tension is allowed in piles while vertical surcharge load is applied. Minimum tension will be alowed in piles withour vertical surcharge load applied, since the lateral component is still applied. Minimum tension will be allowed for seismic.

Stage 3: Re-ran analysis with updated increased loads to ensure conservative design

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/17/14	EFD	07/30/14
01	Stage 3 Update	VDT	01/20/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/17/14	VDK	07/18/14	VDT	07/18/14	EFD	07/30/14

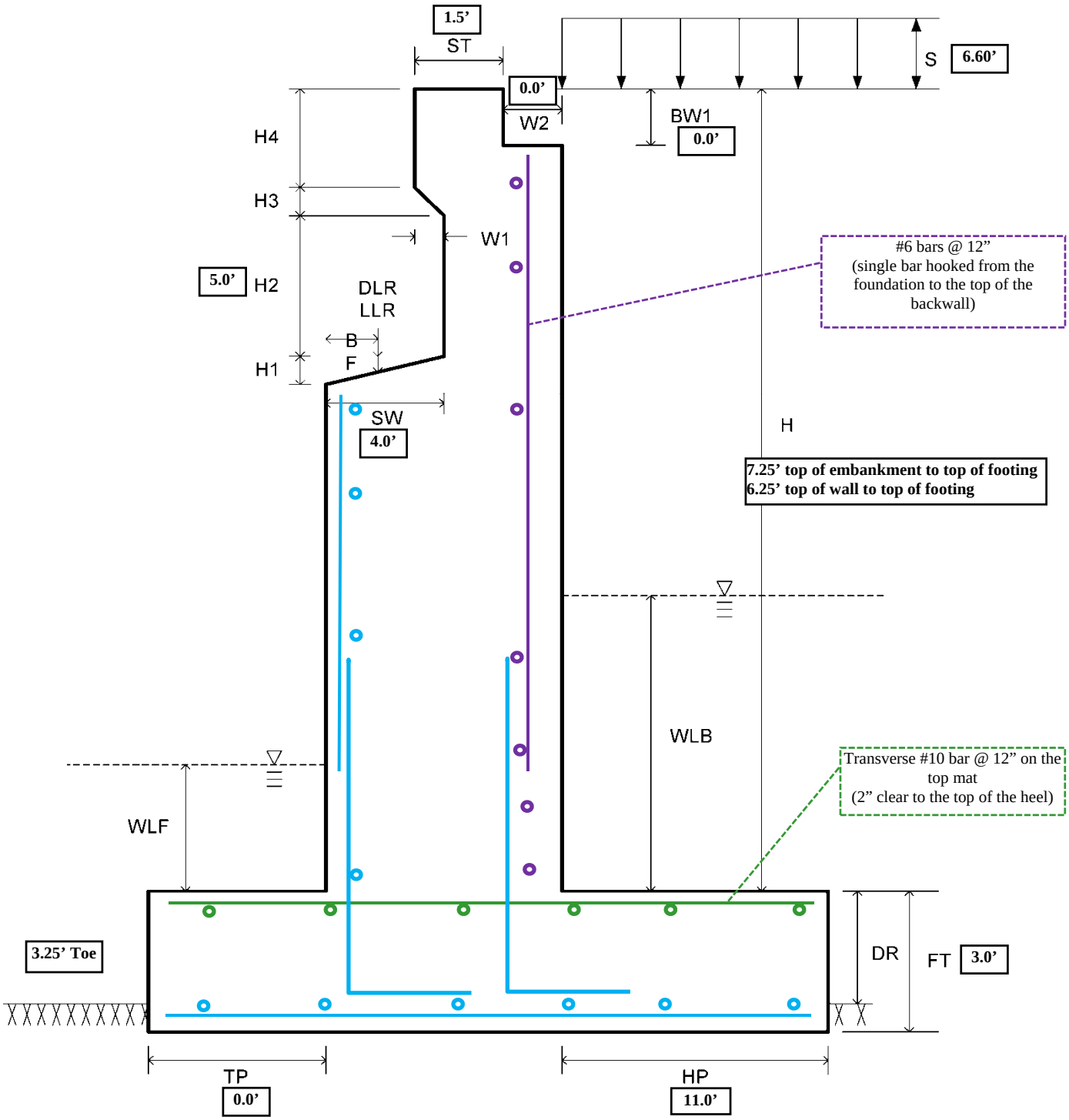


Figure 5.2.1 Input Dimensions - Abutment Type I

NOTE: Heights "H" are rounded up (approximately 6") in this analysis to ensure conservative design will still apply subject to any potential minor elevation changes during final detailing.

Reinforcing Note: All other bars shall be #5's at 12". 3" Clear to bottom of footing. 2" clear to all other surfaces. Vertical stem rebar should be outside of horizontal rebar. Transverse footing rebar should be on the top/bottom of longitudinal rebar.

```
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   ---------------------------------------------------------------------------
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*Rear abutment design (fixed)
*NSSR over OH-562
* ** Created by EngAsst **
* EngAsst Information: [Program=ABUT5] [Version=5.4.0.0]
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022000400004000500                                                              ! Pile
032000425004000500                                                              ! Pile
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                    LFD Abutment and Retaining Wall                333067

PROGRAM P4354040                                          01/14/2016 11:54
VERSION 5.4.0.0          LAST UPDATED 05/05/2005        DOCUMENTATION 05/2005

INPUT: ... nt Analysis\Abut5\1-14-2016 AB5_HAM_562-vF.dat

ABUTMENT DESIGN FOR HAM-562-0026
REAR ABUTMENT DESIGN (FIXED)
NSSR OVER OH-562


                            ANALYSIS OF
                     ABUTMENT WITH BACKWALL TYPE I

                      TYPE OF FOOTING : ON PILES

                                                                EQUIV FLUID
DESIGN                   FTG    PILE            PILE             PRESSURE
METHOD   A OR D   TYPE   TYPE     D   EMBEDDED  ROWS   R OR S     DRY   SAT
  SL       A       1      2     14.0             3               37.2

                      ALLOW SOIL   WATER  TOP FTG   WATER    TOP WALL   LIVE
COEFF OF  BACKFILL  PRESS OR AXIAL LEVEL  TO TOP    LEVEL     TO TOP    LOAD
FRICTION    SLOPE     PILE CAPAC    BACK  EMBANK    FRONT    BACKFILL   SURCH
             2.5        207.00              7.25                        6.60

TOP FTG  F'C                                  LATERAL                     PILE
TO ROCK  BACK   F'C    F'C  REBAR   PILE  PILE  PILE      REBAR  OVR  80%   ROW
SURFACE  WALL   STEM   FTG  GRADE  BATTER  OPT  CAPAC  Kv  DES   STR  RULE  OPT
        4000.  4000.  4000.   60.                0.0        Y     Y

  TOP OF
(BACK)WALL                                          MAX
TO TOP OF     TOP      PROJECTION          MAX    FTG
 FOOTING   THICKNESS   TOE   HEEL  T OR H  PROJ  WIDTH   H1     H2    H3    H4
   6.25      1.50      0.00 11.00                       0.00   5.00  0.00  0.00

                           FRONT           HEIGHT
                           FACE   BRIDGE     OF
                           TO DL   SEAT   BACKWALL  BACK   FOOTING  PILE  FTG
 W1   W2   W3   BW1   BW2   REACT   WIDTH   BATTER  BATTER THICKNESS COST  COST
0.00 0.00       0.00         2.00    4.00                    3.00

     TRIAL
 REBAR SPACING  BAR   BW    STEM    FTG    MIN
 1  2  3  4  5  LOC  EXPOS  EXPOS  EXPOS   As
 3  6  8  9 12   Y

     STEM REBAR COVER           FOOTING REBAR COVER
 VERT  HORIZ   VERT  HORIZ    LONG  TRANS   LONG  TRANS
 2.00   3.00   2.00   2.50    2.00   3.00   4.00   3.00

                                          LONG
                      WIND   WIND         FORCE
 DL     LL    WIND    ON     ON   UPWARD  FROM   CENTR  TEMP
REACT  REACT  ON LL  SUPER   SUB   WIND    LL    FORCE  FORCE
18.50  36.05   0.11   0.10          0.18   6.22   0.14   0.79

                            BACKWALL            ALLOW
    PARAPET OR EXTERNAL     LIVE LOAD  SEISMIC   PILE
 HORZ   DIST   VERT   DIST   VERT   HORZ   LOAD   UPLIFT
                                          11.30    7.00
```

ROW NO	PILE BATTER	DISTANCE BETWEEN ROWS	PILE SPACING	PERCENT ROW BATTERED
1	2.0	1.75	4.90	50.0
2	2.0	4.00	4.00	50.0
3	2.0	4.25	4.90	50.0

14" OD x 7/16" wall thickness cast in place pipe piles with structural allowable of 207 Kips (after accounting for future degradation of 0.05")

```
                    REINFORCEMENT SUMMARY
                    ---------------------
                     REBAR SPACINGS (in):
                              3.
                              6.
                              8.
                              9.
                             12.

          REBAR COVERS (in):   (C.G. OF BAR TO OUTER FACE)
                  STEM                      FOOTING
          BACK          FRONT          TOP         BOTTOM
       VERT  HORIZ   VERT  HORIZ  LONG   TRANS  LONG   TRANS
       2.00   3.00   2.00   2.50  2.00    3.00  4.00    3.00

                     BACK WALL -- SEVERE
       EXPOSURES:    STEM ------- SEVERE
                     FOOTING ---- NORMAL

       MINIMUM AREA OF STEEL PER FOOT: 0.125 SQUARE INCHES


***  NOTE  ***
 - THE REBARS IN THE BOTTOM OF THE FOOTING ARE BELOW THE TOP OF THE PILES.
```

NOTE: Minor uplift is present in several situation that are not applicable to this design. The "T" load cases includes the full freight surcharge on the large toe, creating uplift in the front row (not possible when girder dead load is not present). The other load cases "Without Vertical Component of Live Load Surcharge" are meant for situations such as retaining walls, where there may be lateral live load thrust, but not vertical surcharge on the heel… that is not possible in this abutment scenario.

```
                         PILE FOOTING ANALYSIS
                         ---------------------

***  WARNING  ***
 - THERE IS UPLIFT IN THE FIRST OR LAST PILE ROW.


***  NOTE  ***
 - SINCE Kv WAS NOT ENTERED,  0.0 WAS COMPUTED AND USED.

 - FOR THE TEMPORARY CONSTRUCTION LOADING CONDITION (GROUP T) - FILL HEIGHT
   TO ABUTMENT SEAT, LIVE LOAD SURCHARGE, BUOYANCY AND WIND ON SUBSTRUCTURE
   (IF APPLICABLE):
    > PILE CAPACITY HAS BEEN INCREASED BY A FACTOR OF 1.25.
    > MIN FACTOR OF SAFETY FOR OVERTURNING ABOUT THE FRONT ROW OF PILES = 1.5.

 - FOR PILE ROWS WITH BOTH VERTICAL AND BATTERED PILES, PILE LOADS ARE
   FOR THE MAXIMUM CONDITION (AXIAL LOAD IN BATTERED PILES).


***  SEISMIC DESIGN - DESIGNER NOTES  ***
 1. BRIDGE BEARING SEAT LENGTH MUST BE CHECKED VERSUS THE MINIMUM REQUIRED
    BEARING SUPPORT LENGTHS AS DETERMINED BY SECTION 4.8, APPENDIX A, DM-4.
 2. VERTICAL REINFORCEMENT ON BACK FACE OF STEM MUST BE HOOKED INTO THE
    FOOTING.
 3. TOP REINFORCEMENT IN THE FOOTING, BOTH LONGITUDINAL AND TRANSVERSE,
    SHALL BE A MINIMUM OF #5's @ 12" SPACING.
 4. VERTICAL REINFORCEMENT, #4's @ 4' SPACING, ARE REQUIRED TO TIE THE
    TOP AND BOTTOM MATS OF REINFORCING IN THE FOOTING TOGETHER.
```

STABILITY ANALYSIS (SERVICE LOADS) - WITH VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	BAL. SUM V	BAL. MOMENT	O.T. SUM H	O.T. MOMENT	FRONT ROW TO RESULT	PILE LOAD FRONT	PILE LOAD BACK	PILE LOAD ALLOW	LAT. RESIST	F.S. O.T.
1	81.09	223.20	4.61	20.17	2.50	200.85	47.21	207.00	11.20	11.07
2	36.15	133.56	2.05	7.10	3.50	68.15	42.93	258.75	14.00	18.81
3	81.04	223.19	10.97	47.20	2.17	216.72	30.79	258.75	14.00	4.73
4	81.09	223.20	5.40	23.53	2.46	202.84	45.16	258.75	14.00	9.49
5	36.15	133.56	2.84	10.46	3.41	70.15	40.89	289.80	15.68	12.77
6	81.04	223.19	11.76	50.56	2.13	218.72	28.75	289.80	15.68	4.41
7	36.33	133.61	13.25	54.70	2.17	97.16	13.81	477.69	25.84	2.44
T	18.82	145.14	1.80	4.28	7.49	-9.17	68.03	258.75	14.00	33.91

NOTE: Max Pile Reaction under Primary Loads is 201 Kips. It is 217 kips when longitudinal live load is added. Allowable Increased to 239 kips de to 0.5" thick wall (ncreased from 7/16")

STABILITY ANALYSIS (SERVICE LOADS) - WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	BAL. SUM V	BAL. MOMENT	O.T. SUM H	O.T. MOMENT	FRONT ROW TO RESULT	PILE LOAD FRONT	PILE LOAD BACK	PILE LOAD ALLOW	LAT. RESIST	F.S. O.T.
1	72.38	142.62	4.61	20.17	1.69	214.24*	6.35	207.00	11.20	7.07
2	36.15	133.56	2.05	7.10	3.50	68.15	42.93	258.75	14.00	18.81
3	72.33	142.61	10.97	47.20	1.32	230.12	-10.06	258.75	14.00	3.02
4	72.38	142.62	5.40	23.53	1.65	216.24	4.31	258.75	14.00	6.06
5	36.15	133.56	2.84	10.46	3.41	70.15	40.89	289.80	15.68	12.77
6	72.33	142.61	11.76	50.56	1.27	232.11	-12.11	289.80	15.68	2.82
7	36.33	133.61	13.25	54.70	2.17	97.16	13.81	477.69	25.84	2.44
T	10.11	64.56	1.80	4.28	5.96	4.22	27.18	258.75	14.00	15.08

* - PILE LOAD EXCEEDS AXIAL PILE CAPACITY

FOOTING ANALYSIS (SERVICE LOADS) - WITH VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	TOE MOMENT	TOE SHEAR @	HEEL MOMENT	HEEL SHEAR @
1	0.00	0.00 D	77.22	-8.53 F
2	0.00	0.00 D	37.52	-3.97 F
3	0.00	0.00 D	92.08	-5.26 F
4	0.00	0.00 D	79.07	-8.12 F
5	0.00	0.00 D	39.37	-3.57 F
6	0.00	0.00 D	93.93	-4.86 F
7	0.00	0.00 D	63.85	1.75 F
T	0.00	0.00 D	20.85	-3.36 F

FOOTING ANALYSIS (SERVICE LOADS) - WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	TOE MOMENT	TOE SHEAR @	HEEL MOMENT	HEEL SHEAR @
1	0.00	0.00 D	67.11	-6.74 F
2	0.00	0.00 D	37.52	-3.97 F
3	0.00	0.00 D	81.97	-3.48 F
4	0.00	0.00 D	68.96	-6.34 F
5	0.00	0.00 D	39.37	-3.57 F
6	0.00	0.00 D	83.82	-3.07 F
7	0.00	0.00 D	63.85	1.75 F
T	0.00	0.00 D	10.74	-1.57 F

FOOTING DESIGN - WITH AND WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

FOOTING WIDTH	FOOTING THICKNESS	TOE PROJ	HEEL PROJ	EFFECTIVE DEPTH TOE	EFFECTIVE DEPTH HEEL
16.50	3.00	0.00	11.00	2.750	2.750

SHEAR STR TOE	ALLOWABLE SHEAR TOE	SHEAR STR HEEL	ALLOWABLE SHEAR HEEL	TRANS REINFORCEMENT TOE-BOT	TRANS REINFORCEMENT HEEL-TOP	LONGITUDINAL REINFORCEMENT
0.000	0.060	0.004	0.060	0.12	1.25	0.13

LONGITUDINAL MOMENT CALCULATIONS - WITH VERTICAL COMPONENT OF LL SURCHARGE
GROUP 1 GOVERNS

MAX UNIFORM LOAD (w) = 4.915 K/FT
MAX UNIFORM SERVICE LOAD (w) = 4.915 K/FT
MAX PILE SPACING = 4.90 FEET
MAX LONGITUDINAL MOMENT = 5.90 K-FT
MAX LONG. MOMENT (SERVICE) = 5.90 K-FT

NOTE: 4#10 bars at 12" = 1.27 sq.in.

PILE PATTERN

ROW	BATTER	DISTANCE	SPACING	% BATTERED
1	2.0 ON 12	1.75	4.90	50.0
2	2.0 ON 12	5.75	4.00	50.0
3	2.0 ON 12	10.00	4.90	50.0

C.G. OF PILES 5.83 FT. FROM TOE I OF PILES PER FOOT 6.948
PILE DENSITY 0.6582 PILES PER FOOT

STEM ANALYSIS

DESIGN OF STEM SECTION AT 2.50 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7
MOMENT	0.86	0.10	0.86	0.86	0.10	0.86	0.10
AXIAL FORCE	0.56	0.56	0.56	0.56	0.56	0.56	0.56
SHEAR	0.73	0.12	0.73	0.73	0.12	0.73	0.12

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
1.500	0.004	0.060	0.125

DESIGN OF STEM SECTION AT 5.00 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7
MOMENT	3.84	0.78	3.84	3.84	0.78	3.84	0.78
AXIAL FORCE	1.12	1.12	1.12	1.12	1.12	1.12	1.12
SHEAR	1.69	0.47	1.69	1.69	0.47	1.69	0.47

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
1.500	0.009	0.060	**0.132**

NOTE: 2.20 x the backwall reinforcing per AREMA 8-5.3.1.c and to account for higher effective surcharge at the top of the backwall
REQUIRED: 0.132 in^2/ft * 2.20 = 0.29 in^2/ft
AREMA Minimum is 0.250 in^2/ft

Required: #5's @ 12" = 0.31 in^2/ft
USE: #6 bars @ 12" = 0.44 in^2/ft to match wingwalls

DESIGN OF STEM SECTION AT 5.31 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7	T
MOMENT	52.19	15.50	54.13	52.44	15.75	54.38	17.40	0.01
AXIAL FORCE	55.93	19.70	55.88	55.93	19.70	55.88	19.88	0.26
SHEAR	1.97	0.62	8.33	2.76	1.41	9.12	6.17	0.08

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
5.500	0.012	0.060	0.125

DESIGN OF STEM SECTION AT 5.62 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7	T
MOMENT	52.83	15.71	56.75	53.32	16.20	57.25	19.34	0.05
AXIAL FORCE	56.19	19.96	56.14	56.19	19.96	56.14	20.14	0.52
SHEAR	2.11	0.69	8.47	2.90	1.48	9.26	6.24	0.16

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
5.500	0.012	0.060	0.125

DESIGN OF STEM SECTION AT 5.94 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7	T
MOMENT	53.51	15.93	59.42	54.25	16.68	60.16	21.30	0.11
AXIAL FORCE	56.45	20.22	56.39	56.45	20.22	56.39	20.40	0.77
SHEAR	2.25	0.76	8.61	3.04	1.55	9.40	6.31	0.25

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
5.500	0.012	0.060	0.125

DESIGN OF STEM SECTION AT 6.25 FT FROM TOP

AASHTO GROUP (SERVICE)	1	2	3	4	5	6	7	T
MOMENT	54.24	16.18	62.14	55.23	17.17	63.13	23.28	0.20
AXIAL FORCE	56.71	20.48	56.65	56.71	20.48	56.65	20.66	1.03
SHEAR	2.40	0.83	8.76	3.19	1.62	9.55	6.38	0.34

SECTION THICKNESS	SHEAR STRESS	ALLOWABLE SHEAR	BACK FACE REINF
5.500	0.012	0.060	0.125

SUMMARY OF STEEL DESIGN

FOOTING DESIGN

Top longitudinal reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

Bottom longitudinal reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

Top transverse reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240 *
6	8	1.580
8	9	1.500
9	9	1.333
12	10	1.270

Bottom transverse reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

* - INDICATES THAT AREA SELECTED IS LESS THAN REQUIRED BUT WITHIN TOLERANCE

STEM DESIGN

Vertical reinforcement on back face:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
At Section #1, 2.50 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #2, 5.00 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #3, 5.31 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #4, 5.62 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #5, 5.94 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #6, 6.25 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200

NOTE: 2.20 x the backwall reinforcing per AREMA 8-5.3.1.c and to account for higher effective surcharge at the top of the backwall
REQUIRED: 0.132 in^2/ft * 2.20 = 0.29 in^2/ft
AREMA Minimum is 0.250 in^2/ft

Required: #5's @ 12" = 0.31 in^2/ft
USE: #6 bars @ 12" = 0.44 in^2/ft to match wingwalls

```
          OPTIMUM REBAR DESIGN
          --------------------


FOOTING:


 Top longitudinal reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
Bottom longitudinal reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
  Top transverse reinforcement:
     Spacing       Rebar

       12.            10
        9.             9
        3.             5
        6.             8
        8.             9
 Bottom transverse reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
```

Proposed Footing Reinforcing

Top Mat:
#5's @ 12" Longitudinally
#10's @ 12" Laterally (2" clear to top)
Bottom Mat:
#5's @ 12" Longitudinally
#5's # 12" Laterally

```
STEM:


  Here is the design of the vertical reinforcement
  in the back face of the stem.   For this design,
  the  spacing and rebar size are the same for the
  entire height of the wall.

  Vertical reinforcement on back of stem:
     Spacing       Rebar

       12.             4

STEEL DESIGNS LISTED FROM MOST DESIRABLE TO LEAST
OPTIMAL
```

Proposed Primary Backwall Reinforcing

Rear Mat Vertical Bars:
#5's @12" (hooked directly into the footing)

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Loads***	**GF JOB NO:**	**54682**
	Pier Loads for	CALC NO.:	**HAM562_0026_06**
	RCPier Program	REV NO.:	**00**
FILE NAME(s):	*HAM562_0026_06.xlsx*	**SHEET:**	**1 OF 4**

SUPERSEDES CALC NO: 00 (Stage 2)

CALCULATION DESCRIPTION:

This will calculate all loads applied to the pier for use in RC-PIER.

All horizontal loads will be broken into XZ directions for input into RCPier. Wind load calculations will be automated by RCPIer to allow correct overturning values to be recognized (uplift per AASHTO).

RCPier load cases and design factors will be modfied AASHTO Standard (ASD).

As per NS/STV comments, the abutments will be fixed, with the pier being expansion.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
AREMA (2014) Chapter 15, Section 10
Calculation: HAM562_0026_03

MISCELLANEOUS NOTES:

RCPier Calculates the pier self-weight, thermal loads & wind loads (super and sub) automatically.

Bearing stiffness calculations are completed with Abutment load calculations.

Stage 3: Loads updated per girder section and deck thickness update; Calcs remained the same

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/11/14		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/11/14	VDK	07/15/14	VDT	07/16/14		

Notes

- *RCPier will be used to auto-calculate wind loads (super & sub), thermal friction loads & seismic loads on bearings*
- *LL interpolated from AREMA Table 15-1-15 (Single Rail Loads)*
- *CF and LF loads (X & Z directions) are modified for skew.*
- *AREMA 8-5.3.1.f states that impact need not be considered for a wall-type pier or abutment.*
- *Wind and Long. Force calculations are different in the concrete portion of the code. However, since the girders were designed to the chapter 15 loads, the substructure will be designed to support those loads.*

AREMA Load Cases (AREMA Table 8-2-4)

Loads Considered

D = Dead Load
L = Live Load
I = Impact
CF = Centrifugal Force
E = Earth Pressure
W = Wind on Structure (45psf)
WL = Wind on Live (300 plf)
LF = Long. Force
F = Bearing Friction *(T in RCPier)*
EQ = Earthquake Load
OF = Other Forces *(R,S,T in RCPier)*
B = Buoyancy
SF = Stream Flow Pressure

AREMA Service Load Groups

Group	Items	O.S. Allowance
I	D + L + CF + E + B + SF + I	100%
II	D + E + B + SF + W	125%
III	D + L + CF + E+B+SF + 0.5W + WL + LF + F + I	125%
IV	D + L + CF + E + B + SF + OF + I	125%
V	D + E + B + SF + W + OF	140%
VI	D+L+CF+E+B+SF+ 0.5W + WL + LF + F+OF + I	140%
VII	D + L + CF + E + B + SF + ICE + I	140%
VIII	D + E + B + SF + W + ICE	150%

Interpolated Data from AREMA Table 15-1-15 (Single Rail Loads)

Span 1 and Span 2							
Span Length (ft)	Maximum Moment (ft*kips)	Maximum Moment Quarter Point (ft*kips)	Maximum Shears (Kips)			Maximum Pier Reaction (Kips)	
			At End	At Quarter Point	At Center		
70	3415.00	2608.20	221.04	131.89	77.14	354.08	
70.000	3415.0	2608.2	221.0	131.9	77.1	354.08	0.0%

- *Single Rail Loads are distributed to 2 girders (Two rails on 4 girders)*
- *Since both spans are 70 ft, one will be analyzed then applied to both*

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_06	REV. NO.: 00
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: VDT	DATE: 07/11/14
BRIDGE NO: HAM-562-0026		CHECKED VDK	DATE: 07/15/14
SUBJECT: Loads		UPDATED: VDT	DATE: 07/16/14
Pier Loads for		VERIFIED:	DATE:
RCPier Program			

Pertinent Layout Data - Span 1 of 2

Trigonometry multipliers to make resolve loads into X & Z components

Skew Angle: 16.83 deg 0.29 rad

^^ Normal to the C/L of the girder ^^

Multiplier for Lateral Load (CF)

"X" Value (cos): 0.957

"Z" Value (sin): 0.290

Multiplier for Longitudinal Load (LF)

"X" Value (sin): 0.290

"Z" Value (cos): 0.957

Pertinent Reaction Data from calculation HAM075_0834_Span1_03 & RCP AutoCalculation

Span 1 Load Distribution 50.00%

^^ Span 1 Max Pier Reaction / Total Max Pier Reaction ^^

Max Factor 1.602

^^ Average Max Pier Reaction / Span 1 Max End Shear ^^

- Loads are imported from HAM562_0026_03 (Both spans same)

Horizontal loads are divided among all the girders instead of LL girders

Misc. Reactions - Span 1

Worst Case Reactions - Standard AREMA Live Load

Girder Location	DL (-Y)	LL - Balanced (-Y)	LL - Unbalanced (-Y)	Derail - Balanced (-Y)	Derail - Unbalanced (-Y)
Bearing 9	65.86 kip				
Bearing 8	67.66 kip				
Bearing 7	67.66 kip				
Bearing 6	67.66 kip	70.38 kip	87.87 kip		
Bearing 5	67.66 kip	70.38 kip	87.87 kip	105.57 kip	131.80 kip
Bearing 4	67.66 kip	105.57 kip	131.80 kip	105.57 kip	131.80 kip
Bearing 3	67.66 kip	105.57 kip	131.80 kip	105.57 kip	131.80 kip
Bearing 2	67.66 kip			316.70 kip	395.41 kip
Bearing 1	67.66 kip				

Total = 351.89 kip

exterior girder

Centrifugal Reactions - Span 1

Worst Case Reactions - Standard AREMA Live Load

Girder Location	CF - Balanced (-X)	CF - Balanced (-Y)	CF - Balanced (-Z)	CF - Unbalanced (-X)	CF - Unbalanced (-Y)	CF - Unbalanced (-Z)
Bearing 9	0.79 kip		0.24 kip	0.98 kip		0.30 kip
Bearing 8	0.79 kip		0.24 kip	0.98 kip		0.30 kip
Bearing 7	0.79 kip		0.24 kip	0.98 kip		0.30 kip
Bearing 6	0.79 kip	-1.50 kip	0.24 kip	0.98 kip	-1.88 kip	0.30 kip
Bearing 5	0.79 kip	-1.50 kip	0.24 kip	0.98 kip	-1.88 kip	0.30 kip
Bearing 4	1.18 kip	2.25 kip	0.36 kip	1.48 kip	2.81 kip	0.45 kip
Bearing 3	1.18 kip	2.25 kip	0.36 kip	1.48 kip	2.81 kip	0.45 kip
Bearing 2	1.18 kip		0.36 kip	1.48 kip		0.45 kip
Bearing 1	1.18 kip		0.36 kip	1.48 kip		0.45 kip

Braking/Traction Reactions - Span 1

Worst Case Reactions - Standard AREMA Live Load

Girder Location	LF - Balanced (-X)	LF - Balanced (-Y)	LF - Balanced (-Z)	LF - Unbalanced (-X)	LF - Unbalanced (-Y)	LF - Unbalanced (-Z)
Bearing 9	1.60 kip		5.30 kip	2.00 kip		6.62 kip
Bearing 8	1.60 kip		5.30 kip	2.00 kip		6.62 kip
Bearing 7	1.60 kip		5.30 kip	2.00 kip		6.62 kip
Bearing 6	1.60 kip	4.11 kip	5.30 kip	2.00 kip	5.14 kip	6.62 kip
Bearing 5	1.60 kip	4.11 kip	5.30 kip	2.00 kip	5.14 kip	6.62 kip
Bearing 4	2.06 kip	6.17 kip	6.80 kip	2.57 kip	7.70 kip	8.49 kip
Bearing 3	2.06 kip	6.17 kip	6.80 kip	2.57 kip	7.70 kip	8.49 kip
Bearing 2	2.06 kip		6.80 kip	2.57 kip		8.49 kip
Bearing 1	2.06 kip		6.80 kip	2.57 kip		8.49 kip

Gannett Fleming	GF JOB # 54682	CALC NO.: HAM562_0026_06	REV. NO.: 00
		PROJECT: ODOT/EMH&T: HAM-75-7.85	
ODOT PID NO.: 77889		DESIGNED: VDT	DATE: 07/11/14
BRIDGE NO: HAM-562-0026		CHECKED VDK	DATE: 07/15/14
SUBJECT: Loads		UPDATED: VDT	DATE: 07/16/14
Pier Loads for		VERIFIED:	DATE:
RCPier Program			

Pertinent Layout Data - Span 2 of 2

Trigonometry multipliers to make resolve loads into X & Z components

Skew Angle: 16.83 deg 0.29 rad

^^ Normal to the C/L of the girder ^^

Multiplier for Lateral Load (CF)

"X" Value (cos): 0.957

"Z" Value (sin): 0.290

Multiplier for Longitudinal Load (LF)

"X" Value (sin): 0.290

"Z" Value (cos): 0.957

Pertinent Reaction Data from calculation HAM075_0834_Span1_03 & RCP AutoCalculation

Span 2 Load Distribution 50.00%

^^ Span 2 End Shear / Total End Shear ^^

- Loads are imported from HAM562_0026_03 (Both Spans same)

Misc. Reactions - Span 2

Worst Case Reactions - Standard AREMA Live Load

Girder Location	DL (-Y)	LL - Balanced (-Y)	LL - Unbalanced (-Y)	Derail - Balanced (-Y)	Derail - Unbalanced (-Y)
Bearing 9	65.86 kip				
Bearing 8	67.66 kip				
Bearing 7	67.66 kip				
Bearing 6	67.66 kip	70.38 kip			
Bearing 5	67.66 kip	70.38 kip		105.57 kip	
Bearing 4	67.66 kip	105.57 kip		105.57 kip	
Bearing 3	67.66 kip	105.57 kip		105.57 kip	
Bearing 2	67.66 kip			316.70 kip	
Bearing 1	67.66 kip				
	Total =	351.89 kip			

exterior girder

Centrifugal Reactions - Span 2

Worst Case Reactions - Standard AREMA Live Load

Girder Location	CF - Balanced (-X)	CF - Balanced (-Y)	CF - Balanced (-Z)	CF - Unbalanced (-X)	CF - Unbalanced (-Y)	CF - Unbalanced (-Z)
Bearing 9	0.79 kip		0.24 kip			
Bearing 8	0.79 kip		0.24 kip			
Bearing 7	0.79 kip		0.24 kip			
Bearing 6	0.79 kip	-1.50 kip	0.24 kip			
Bearing 5	0.79 kip	-1.50 kip	0.24 kip			
Bearing 4	1.18 kip	2.25 kip	0.36 kip			
Bearing 3	1.18 kip	2.25 kip	0.36 kip			
Bearing 2	1.18 kip		0.36 kip			
Bearing 1	1.18 kip		0.36 kip			

Braking/Traction Reactions - Span 2

Worst Case Reactions - Standard AREMA Live Load

Girder Location	LF - Balanced (-X)	LF - Balanced (-Y)	LF - Balanced (-Z)	LF - Unbalanced (-X)	LF - Unbalanced (-Y)	LF - Unbalanced (-Z)
Bearing 9	1.60 kip		5.30 kip			
Bearing 8	1.60 kip		5.30 kip			
Bearing 7	1.60 kip		5.30 kip			
Bearing 6	1.60 kip	4.11 kip	5.30 kip			
Bearing 5	1.60 kip	4.11 kip	5.30 kip			
Bearing 4	2.06 kip	6.17 kip	6.80 kip			
Bearing 3	2.06 kip	6.17 kip	6.80 kip			
Bearing 2	2.06 kip		6.80 kip			
Bearing 1	2.06 kip		6.80 kip			

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT: **ODOT/EMH&T: HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
SUBJECT: ***Analysis***
Pier
FILE NAME(s): *HAM562_0026 Pier.rcp*

ODOT PID NO: *77889*
EMH&T JOB NO:
GF JOB NO: 54682
CALC NO.: **HAM562_0026_07**
REV NO.: **01**
SHEET: 1 OF 192

SUPERSEDES CALC NO: 00 (Stage 1)

CALCULATION DESCRIPTION:

This will analyze the proposed expansion pier utilizing loads calculated in HAM562_0026_06. Analysis will be per AREMA Working Stress Design.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2013) Chapter 8, Section 5
Calculation: HAM562_0026_06 (Pier Loads)
Calculation: HAM562_0026_01 (Elevation Data)
RCPier Users Manual

MISCELLANEOUS NOTES:

RCPier Calculates the abutment self-weight, Wind, and Thermal Loads.

Stage 3: Analysis re-ran with increased loading to ensure conservative design through LL distribution and deck updates

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 1 Calculation	VDT	07/15/14		
01	Stage 3 Update	VDT	01/18/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/15/14	VDK	07/15/14	VDT	07/16/14		

PROJECT DATA

PROJECT DATA

Project:	HAM562_0026 Railroad Bridge Pier
User Job No.:	054682
Designer:	VDT
Date:	Jul/11/2014
Checker:	
Checked date:	
State:	OH
State Job No.:	PID: 77889
Structure type:	Pier.
Pier View:	Upstation.
Code:	AASHTO STANDARD (17th Edition 2002)
Comments:	Center, expansion pier of a two span deck girder bridge carrying NSSR ove r OH-562. No impact load designed for wall type piers per AREMA 8-5.3.1.f Longitudinal Forces (z-direction) cannot exceed 0.1*(DL+LL) because once the load reaches that limit the bearing plabegins to slide. Derail Load applied to Girder 8 of 9, second rail load divided among next 3 closest girders (5, 6, and 7 of 9). Wind and Seismic Loads are auto-calculated, Thermal Loads not included. S nce both bearings on the pier are

PIER GEOMETRY

Pier Info:

Pier View:	Upstation.
Pier Type:	Multi Column

Cap Shape

Cap Shape: Straight
Top Elevations: start = 544.50 ft end = 544.50 ft
Depth(Z) = 84.00 in Skew angle = 16.83 Reduction of I = 1.000
Length(X) = 34.75 ft Height(Y) = 60.00 in

Column Shape : Rectangular

Number of columns: 7

Column number 1

Location from the left edge of the cap(X): 2.38 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 57.00 in Depth(Z) = 48.00 in

Column number 2

Location from the left edge of the cap(X): 7.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

Column number 3

Location from the left edge of the cap(X): 12.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

Column number 4

Location from the left edge of the cap(X): 17.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

Column number 5

Location from the left edge of the cap(X): 22.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

Column number 6

Location from the left edge of the cap(X): 27.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

Column number 7

Location from the left edge of the cap(X): 32.25 ft
Elevations: bottom = 526.00 ft top = 542.00 ft Reduction of I = 1.000
Column Bottom is Fixed

Column Section Dimensions

Width(X) = 60.00 in Depth(Z) = 48.00 in

SUPERSTRUCTURE INFO

Superstructure info:

Total number of spans:	2
Span number rear to current pier:	1
Number of traffic lanes:	1
Barrier height :	56.50 in
Depth of slab :	12.00 in
Curb to curb distance:	31.500 ft

Beam info:

Height in	Section area in^2	Inertia (Ixx) in^4	Inertia (Iyy) in^4	Beam CG in
41.00	183.00	63156.80	4001.20	20.50

Span #	Span length ft	Bridge Width ft
1	70.000	32.500
2	70.000	32.500
		32.500

BEARING POINTS

Number of bearing lines: 2

First bearing line **Eccentricity = 1.58 ft**

Point	Distance ft
1	3.26
2	6.92
3	10.58
4	14.23
5	17.89
6	21.55
7	25.20
8	28.86
9	32.52

Second bearing line **Eccentricity = -1.58 ft**

Point	Distance ft
1	2.30
2	5.96
3	9.62
4	13.27
5	16.93
6	20.59
7	24.24
8	27.90
9	31.56

MATERIAL PROPERTIES

MATERIAL PROPERTIES

	Cap	Column	Footing
Concrete Type	normal	normal	normal
Concrete Strength (psi)	4000.00	4000.00	4000.00
Concrete Density (lb/ft3)	150.00	150.00	150.00
Concrete Modulus Ec (ksi)	3834.30	3834.30	3834.30
Steel Strength Fy (ksi)	60.00	60.00	60.00

DESIGN PARAMETERS

DESIGN PARAMETERS

AASHTO STANDARD Code

Strength Reduction factors for reinf. concrete

Flexure and tension	0.90
Shear and torsion (normal)	0.85
Shear and torsion (lightweight)	0.85
Axial compression (ties)	0.70
Axial compression (spiral)	0.75

Multi presence factors for live load

1 Lane	1.00
2 Lanes	1.00
3 Lanes	0.90
4 Lanes	0.75
5 Lanes	0.75
6 Lanes	0.75

	Crack control factor kip/ft	Clear cover in	Clear side cover in	Impact factors (auto calculation)
Cap	170.00	2.00	2.00	1.26
Column	170.00	2.00		1.26
Footing	130.00	3.00	3.00	1.00

Degree of fixity in foundations for Moment Magnify Method: Ga = 5.00

SEISMIC DESIGN PARAMETERS

Strength Reduction factors for reinf. Concrete Seismic Design

Flexure and tension	0.90
Shear and torsion (normal)	0.85
Shear and torsion (lightweight)	0.85
Axial compression (ties)	0.70
Axial compression (spiral)	0.75

Seismic Overstrength

Flexure and tension	1.30
Axial compression (ties)	1.30
Axial compression (spiral)	1.30

Response Modification Factor	1.00

Use core area for plastic hinging calculations.

Design Factors

Cap Design Factor	1.20
Footing Design Factor	1.20

Plastic Hinge Moment

Use actual computed Plastic Hinging Moment for each column in all combinations.

LOADS

Pier Info:

Pier View:	Upstation.

Load Cases: 36

Loadcase ID: D1 Name:

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	Y	-67.66
1	2	Y	-67.66
1	3	Y	-67.66
1	4	Y	-67.66
1	5	Y	-67.66
1	6	Y	-67.66
1	7	Y	-67.66
1	8	Y	-67.66
1	9	Y	-65.86
2	1	Y	-67.66
2	2	Y	-67.66
2	3	Y	-67.66
2	4	Y	-67.66
2	5	Y	-67.66
2	6	Y	-67.66
2	7	Y	-67.66
2	8	Y	-67.66
2	9	Y	-65.86

Loadcase ID: (L+In)1 Name: (no impact) Balanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	6	Y	-70.38
1	5	Y	-70.38
1	4	Y	-105.57
1	3	Y	-105.57
2	6	Y	-70.38
2	5	Y	-70.38
2	4	Y	-105.57
2	3	Y	-105.57

Loadcase ID: (L+In)2 Name: (no impact) Unbalanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	6	Y	-87.87
1	5	Y	-87.87
1	4	Y	-131.80
1	3	Y	-131.80

Loadcase ID: CF1 Name: Balanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-1.18
1	1	Z	-0.36
1	2	X	-1.18
1	2	Z	-0.36
1	3	Y	-2.25
1	3	Z	-0.36
1	3	X	-1.18
1	4	X	-1.18
1	4	Y	-2.25
1	4	Z	-0.36
1	5	X	-0.79
1	5	Y	1.50
1	5	Z	-0.24
1	6	X	-0.79
1	6	Y	1.50
1	6	Z	-0.24
1	7	X	-0.79
1	7	Z	-0.24
1	8	X	-0.79
1	8	Z	-0.24
1	9	X	-0.79
1	9	Z	-0.24
2	1	X	-1.18
2	1	Z	-0.36
2	2	Z	-0.36
2	2	X	-1.18
2	3	Z	-0.36
2	3	Y	-2.25
2	3	X	-1.18
2	4	Z	-0.36
2	4	Y	-2.25
2	4	X	-1.18
2	5	Z	-0.24
2	5	Y	1.50
2	5	X	-0.79
2	6	Z	-0.24
2	6	Y	1.50
2	6	X	-0.79
2	7	Z	-0.24
2	7	X	-0.79
2	8	Z	-0.24
2	8	X	-0.79
2	9	Z	-0.24
2	9	X	-0.79

Loadcase ID: CF2 Name: Unbalanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	Z	-0.45
1	1	X	-1.48
1	2	Z	-0.45
1	2	X	-1.48
1	3	Z	-0.45
1	3	Y	-2.81
1	3	X	-1.48
1	4	Z	-0.45
1	4	Y	-2.81
1	4	X	-1.48
1	5	Z	-0.30
1	5	Y	1.88
1	5	X	-0.98
1	6	Z	-0.30
1	6	Y	1.88
1	6	X	-0.98
1	7	Z	-0.30
1	7	X	-0.98
1	8	Z	-0.30
1	8	X	-0.98
1	9	X	-0.98
1	9	Z	-0.30

Loadcase ID: LF1 Name: Balanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	Z	-6.80
1	1	X	-2.06
1	2	Z	-6.80
1	2	X	-2.06
1	3	Z	-6.80
1	3	Y	-6.17
1	3	X	-2.06
1	4	Z	-6.80
1	4	Y	-6.17
1	4	X	-2.06
1	5	Z	-5.30
1	5	Y	-4.11
1	5	X	-1.60
1	6	Z	-5.30
1	6	Y	-4.11
1	6	X	-1.60
1	7	Z	-5.30
1	7	X	-1.60
1	8	Z	-5.30
1	8	X	-1.60
1	9	Z	-5.30
1	9	X	-1.60
2	1	Z	-6.80
2	1	X	-2.06
2	2	Z	-6.80
2	2	X	-2.06
2	3	Z	-6.80
2	3	Y	-6.17
2	3	X	-2.06
2	4	Z	-6.80
2	4	Y	-6.17
2	4	X	-2.06
2	5	Z	-5.30
2	5	Y	-4.11
2	5	X	-1.60
2	6	X	-1.60
2	6	Z	-5.30
2	6	Y	-4.11
2	7	X	-1.60
2	7	Z	-5.30
2	8	X	-1.60
2	8	Z	-5.30
2	9	Z	-5.30
2	9	X	-1.60

Loadcase ID: LF2 Name: Unbalanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	Z	-8.49
1	1	X	-2.57
1	2	Z	-8.49
1	2	X	-2.57
1	3	Z	-8.49
1	3	Y	-7.70
1	3	X	-2.57
1	4	Z	-8.49
1	4	Y	-7.70
1	4	X	-2.57
1	5	Z	-6.62
1	5	Y	-5.14
1	5	X	-2.00
1	6	Z	-6.62
1	6	Y	-5.14
1	6	X	-2.00
1	7	Z	-6.62
1	7	X	-2.00
1	8	Z	-6.62
1	8	X	-2.00
1	9	Z	-6.62
1	9	X	-2.00

Loadcase ID: (L+Ip)1 Name: Derail - Balanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	2	Y	-316.70
1	3	Y	-105.57
1	4	Y	-105.57
1	5	Y	-105.57
2	2	Y	-316.70
2	3	Y	-105.57
2	4	Y	-105.57
2	5	Y	-105.57

Loadcase ID: (L+Ip)2 Name: Derail - Unbalanced

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	2	Y	-395.41
1	3	Y	-131.80
1	4	Y	-131.80
1	5	Y	-131.80

Loadcase ID: E1 Name:

Multiplier = 1.000

Footing loads

Footing #	Type	Dir	Mag1	y1/L	Mag2	y2/L
1	UDL	Y	5.000 klf	0.00		1.00

Loadcase ID: W1 Name: Angle: 75

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-3.94 kips	0.50		
UDL	Z		0.18 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.151 klf	0.00		0.84
7	UDL	Z	0.243 klf	0.00		0.84
6	UDL	X	-0.151 klf	0.00		0.84
6	UDL	Z	0.243 klf	0.00		0.84
5	UDL	X	-0.151 klf	0.00		0.84
5	UDL	Z	0.243 klf	0.00		0.84
4	UDL	X	-0.151 klf	0.00		0.84
4	UDL	Z	0.243 klf	0.00		0.84
3	UDL	X	-0.151 klf	0.00		0.84
3	UDL	Z	0.243 klf	0.00		0.84
2	UDL	X	-0.151 klf	0.00		0.84
2	UDL	Z	0.243 klf	0.00		0.84
1	UDL	X	-0.146 klf	0.00		0.84
1	UDL	Z	0.235 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-0.84
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	-0.00
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	-0.00
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	-0.00
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	-0.00
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	-0.00
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	-0.00
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	-0.00
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	0.84
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-0.84
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	-0.00
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	-0.00
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	-0.00
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	-0.00
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	-0.00
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	-0.00
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	-0.00
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	0.84
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 75.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W2 Name: Angle: 60

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-4.74 kips	0.50		
UDL	Z		0.13 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.208 klf	0.00		0.84
7	UDL	Z	0.195 klf	0.00		0.84
6	UDL	X	-0.208 klf	0.00		0.84
6	UDL	Z	0.195 klf	0.00		0.84
5	UDL	X	-0.208 klf	0.00		0.84
5	UDL	Z	0.195 klf	0.00		0.84
4	UDL	X	-0.208 klf	0.00		0.84
4	UDL	Z	0.195 klf	0.00		0.84
3	UDL	X	-0.208 klf	0.00		0.84
3	UDL	Z	0.195 klf	0.00		0.84
2	UDL	X	-0.208 klf	0.00		0.84
2	UDL	Z	0.195 klf	0.00		0.84
1	UDL	X	-0.202 klf	0.00		0.84
1	UDL	Z	0.190 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-0.84
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	-0.00
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	-0.00
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	-0.00
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	-0.00
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	-0.00
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	-0.00
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	-0.00
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	0.84
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-0.84
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	-0.00
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	-0.00
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	-0.00
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	-0.00
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	-0.00
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	-0.00
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	-0.00
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	0.84
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 60.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W3 Name: Angle: 45

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-4.48 kips	0.50		
UDL	Z		0.07 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.234 klf	0.00		0.84
7	UDL	Z	0.125 klf	0.00		0.84
6	UDL	X	-0.234 klf	0.00		0.84
6	UDL	Z	0.125 klf	0.00		0.84
5	UDL	X	-0.234 klf	0.00		0.84
5	UDL	Z	0.125 klf	0.00		0.84
4	UDL	X	-0.234 klf	0.00		0.84
4	UDL	Z	0.125 klf	0.00		0.84
3	UDL	X	-0.234 klf	0.00		0.84
3	UDL	Z	0.125 klf	0.00		0.84
2	UDL	X	-0.234 klf	0.00		0.84
2	UDL	Z	0.125 klf	0.00		0.84
1	UDL	X	-0.229 klf	0.00		0.84
1	UDL	Z	0.123 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-0.84
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	-0.00
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	-0.00
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	-0.00
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	-0.00
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	-0.00
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	-0.00
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	-0.00
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	0.84
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-0.84
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	-0.00
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	-0.00
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	-0.00
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	-0.00
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	-0.00
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	-0.00
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	-0.00
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	0.84
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 45.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W4 Name: Angle: 30

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-3.23 kips	0.50		
UDL	Z		0.02 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.221 klf	0.00		0.84
7	UDL	Z	0.052 klf	0.00		0.84
6	UDL	X	-0.221 klf	0.00		0.84
6	UDL	Z	0.052 klf	0.00		0.84
5	UDL	X	-0.221 klf	0.00		0.84
5	UDL	Z	0.052 klf	0.00		0.84
4	UDL	X	-0.221 klf	0.00		0.84
4	UDL	Z	0.052 klf	0.00		0.84
3	UDL	X	-0.221 klf	0.00		0.84
3	UDL	Z	0.052 klf	0.00		0.84
2	UDL	X	-0.221 klf	0.00		0.84
2	UDL	Z	0.052 klf	0.00		0.84
1	UDL	X	-0.218 klf	0.00		0.84
1	UDL	Z	0.051 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-0.84
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	-0.00
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	-0.00
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	-0.00
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	-0.00
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	-0.00
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	-0.00
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	-0.00
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	0.84
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-0.84
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	-0.00
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	-0.00
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	-0.00
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	-0.00
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	-0.00
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	-0.00
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	-0.00
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	0.84
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 30.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W5 Name: Angle: 15

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-1.82 kips	0.50		
UDL	Z		-0.00 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.187 klf	0.00		0.84
7	UDL	Z	-0.006 klf	0.00		0.84
6	UDL	X	-0.187 klf	0.00		0.84
6	UDL	Z	-0.006 klf	0.00		0.84
5	UDL	X	-0.187 klf	0.00		0.84
5	UDL	Z	-0.006 klf	0.00		0.84
4	UDL	X	-0.187 klf	0.00		0.84
4	UDL	Z	-0.006 klf	0.00		0.84
3	UDL	X	-0.187 klf	0.00		0.84
3	UDL	Z	-0.006 klf	0.00		0.84
2	UDL	X	-0.187 klf	0.00		0.84
2	UDL	Z	-0.006 klf	0.00		0.84
1	UDL	X	-0.187 klf	0.00		0.84
1	UDL	Z	-0.006 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-0.84
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	-0.00
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	-0.00
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	-0.00
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	-0.00
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	-0.00
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	-0.00
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	-0.00
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	0.84
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-0.84
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	-0.00
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	-0.00
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	-0.00
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	-0.00
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	-0.00
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	-0.00
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	-0.00
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	0.84
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 15.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W6 Name: Angle: 0

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-3.61 kips	0.50		
UDL	Z		-0.03 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.227 klf	0.00		0.84
7	UDL	Z	-0.069 klf	0.00		0.84
6	UDL	X	-0.227 klf	0.00		0.84
6	UDL	Z	-0.069 klf	0.00		0.84
5	UDL	X	-0.227 klf	0.00		0.84
5	UDL	Z	-0.069 klf	0.00		0.84
4	UDL	X	-0.227 klf	0.00		0.84
4	UDL	Z	-0.069 klf	0.00		0.84
3	UDL	X	-0.227 klf	0.00		0.84
3	UDL	Z	-0.069 klf	0.00		0.84
2	UDL	X	-0.227 klf	0.00		0.84
2	UDL	Z	-0.069 klf	0.00		0.84
1	UDL	X	-0.224 klf	0.00		0.84
1	UDL	Z	-0.068 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.60
1	1	Y	-4.63
1	1	Z	0.63
1	2	X	-0.60
1	2	Y	2.53
1	2	Z	0.63
1	3	X	-0.60
1	3	Y	2.53
1	3	Z	0.63
1	4	X	-0.60
1	4	Y	2.53
1	4	Z	0.63
1	5	X	-0.60
1	5	Y	2.53
1	5	Z	0.63
1	6	X	-0.60
1	6	Y	2.53
1	6	Z	0.63
1	7	X	-0.60
1	7	Y	2.53
1	7	Z	0.63
1	8	X	-0.60
1	8	Y	2.53
1	8	Z	0.63
1	9	X	-0.60
1	9	Y	9.69
1	9	Z	0.63
2	1	X	-0.60
2	1	Y	-4.63
2	1	Z	0.63
2	2	X	-0.60
2	2	Y	2.53
2	2	Z	0.63
2	3	X	-0.60
2	3	Y	2.53
2	3	Z	0.63
2	4	X	-0.60
2	4	Y	2.53
2	4	Z	0.63
2	5	X	-0.60
2	5	Y	2.53
2	5	Z	0.63
2	6	X	-0.60
2	6	Y	2.53
2	6	Z	0.63
2	7	X	-0.60
2	7	Y	2.53
2	7	Z	0.63

Line #	Bearing #	Dir	Load kips
	8	X	-0.60
2	8	Y	2.53
2	8	Z	0.63
2	9	X	-0.60
2	9	Y	9.69
2	9	Z	0.63

Auto generation details:

Generated Wind Load on Structure

Angle of wind = 0.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning 20.000 psf

Loadcase ID: W7 Name: Angle: -15

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-4.64 kips	0.50		
UDL	Z		-0.08 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.231 klf	0.00		0.84
7	UDL	Z	-0.143 klf	0.00		0.84
6	UDL	X	-0.231 klf	0.00		0.84
6	UDL	Z	-0.143 klf	0.00		0.84
5	UDL	X	-0.231 klf	0.00		0.84
5	UDL	Z	-0.143 klf	0.00		0.84
4	UDL	X	-0.231 klf	0.00		0.84
4	UDL	Z	-0.143 klf	0.00		0.84
3	UDL	X	-0.231 klf	0.00		0.84
3	UDL	Z	-0.143 klf	0.00		0.84
2	UDL	X	-0.231 klf	0.00		0.84
2	UDL	Z	-0.143 klf	0.00		0.84
1	UDL	X	-0.226 klf	0.00		0.84
1	UDL	Z	-0.140 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.15
1	1	Y	-0.21
1	1	Z	-0.86
1	2	X	-0.15
1	2	Y	-0.00
1	2	Z	-0.86
1	3	X	-0.15
1	3	Y	-0.00
1	3	Z	-0.86
1	4	X	-0.15
1	4	Y	-0.00
1	4	Z	-0.86
1	5	X	-0.15
1	5	Y	-0.00
1	5	Z	-0.86
1	6	X	-0.15
1	6	Y	-0.00
1	6	Z	-0.86
1	7	X	-0.15
1	7	Y	-0.00
1	7	Z	-0.86
1	8	X	-0.15
1	8	Y	-0.00
1	8	Z	-0.86
1	9	X	-0.15
1	9	Y	0.21
1	9	Z	-0.86
2	1	X	-0.15
2	1	Y	-0.21
2	1	Z	-0.86
2	2	X	-0.15
2	2	Y	-0.00
2	2	Z	-0.86
2	3	X	-0.15
2	3	Y	-0.00
2	3	Z	-0.86
2	4	X	-0.15
2	4	Y	-0.00
2	4	Z	-0.86
2	5	X	-0.15
2	5	Y	-0.00
2	5	Z	-0.86
2	6	X	-0.15
2	6	Y	-0.00
2	6	Z	-0.86
2	7	X	-0.15
2	7	Y	-0.00
2	7	Z	-0.86

Line #	Bearing #	Dir	Load kips
	8	X	-0.15
2	8	Y	-0.00
2	8	Z	-0.86
2	9	X	-0.15
2	9	Y	0.21
2	9	Z	-0.86

Auto generation details:

Generated Wind Load on Structure

Angle of wind = -15.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W8 Name: Angle: -30

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-4.64 kips	0.50		
UDL	Z		-0.14 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.197 klf	0.00		0.84
7	UDL	Z	-0.209 klf	0.00		0.84
6	UDL	X	-0.197 klf	0.00		0.84
6	UDL	Z	-0.209 klf	0.00		0.84
5	UDL	X	-0.197 klf	0.00		0.84
5	UDL	Z	-0.209 klf	0.00		0.84
4	UDL	X	-0.197 klf	0.00		0.84
4	UDL	Z	-0.209 klf	0.00		0.84
3	UDL	X	-0.197 klf	0.00		0.84
3	UDL	Z	-0.209 klf	0.00		0.84
2	UDL	X	-0.197 klf	0.00		0.84
2	UDL	Z	-0.209 klf	0.00		0.84
1	UDL	X	-0.191 klf	0.00		0.84
1	UDL	Z	-0.204 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.15
1	1	Y	-0.21
1	1	Z	-0.86
1	2	X	-0.15
1	2	Y	-0.00
1	2	Z	-0.86
1	3	X	-0.15
1	3	Y	-0.00
1	3	Z	-0.86
1	4	X	-0.15
1	4	Y	-0.00
1	4	Z	-0.86
1	5	X	-0.15
1	5	Y	-0.00
1	5	Z	-0.86
1	6	X	-0.15
1	6	Y	-0.00
1	6	Z	-0.86
1	7	X	-0.15
1	7	Y	-0.00
1	7	Z	-0.86
1	8	X	-0.15
1	8	Y	-0.00
1	8	Z	-0.86
1	9	X	-0.15
1	9	Y	0.21
1	9	Z	-0.86
2	1	X	-0.15
2	1	Y	-0.21
2	1	Z	-0.86
2	2	X	-0.15
2	2	Y	-0.00
2	2	Z	-0.86
2	3	X	-0.15
2	3	Y	-0.00
2	3	Z	-0.86
2	4	X	-0.15
2	4	Y	-0.00
2	4	Z	-0.86
2	5	X	-0.15
2	5	Y	-0.00
2	5	Z	-0.86
2	6	X	-0.15
2	6	Y	-0.00
2	6	Z	-0.86
2	7	X	-0.15
2	7	Y	-0.00
2	7	Z	-0.86

Line #	Bearing #	Dir	Load kips
	8	X	-0.15
2	8	Y	-0.00
2	8	Z	-0.86
2	9	X	-0.15
2	9	Y	0.21
2	9	Z	-0.86

Auto generation details:

Generated Wind Load on Structure

Angle of wind = -30.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W9 Name: Angle: -45

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-3.60 kips	0.50		
UDL	Z		-0.19 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.134 klf	0.00		0.84
7	UDL	Z	-0.250 klf	0.00		0.84
6	UDL	X	-0.134 klf	0.00		0.84
6	UDL	Z	-0.250 klf	0.00		0.84
5	UDL	X	-0.134 klf	0.00		0.84
5	UDL	Z	-0.250 klf	0.00		0.84
4	UDL	X	-0.134 klf	0.00		0.84
4	UDL	Z	-0.250 klf	0.00		0.84
3	UDL	X	-0.134 klf	0.00		0.84
3	UDL	Z	-0.250 klf	0.00		0.84
2	UDL	X	-0.134 klf	0.00		0.84
2	UDL	Z	-0.250 klf	0.00		0.84
1	UDL	X	-0.129 klf	0.00		0.84
1	UDL	Z	-0.241 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.15
1	1	Y	-0.21
1	1	Z	-0.86
1	2	X	-0.15
1	2	Y	-0.00
1	2	Z	-0.86
1	3	X	-0.15
1	3	Y	-0.00
1	3	Z	-0.86
1	4	X	-0.15
1	4	Y	-0.00
1	4	Z	-0.86
1	5	X	-0.15
1	5	Y	-0.00
1	5	Z	-0.86
1	6	X	-0.15
1	6	Y	-0.00
1	6	Z	-0.86
1	7	X	-0.15
1	7	Y	-0.00
1	7	Z	-0.86
1	8	X	-0.15
1	8	Y	-0.00
1	8	Z	-0.86
1	9	X	-0.15
1	9	Y	0.21
1	9	Z	-0.86
2	1	X	-0.15
2	1	Y	-0.21
2	1	Z	-0.86
2	2	X	-0.15
2	2	Y	-0.00
2	2	Z	-0.86
2	3	X	-0.15
2	3	Y	-0.00
2	3	Z	-0.86
2	4	X	-0.15
2	4	Y	-0.00
2	4	Z	-0.86
2	5	X	-0.15
2	5	Y	-0.00
2	5	Z	-0.86
2	6	X	-0.15
2	6	Y	-0.00
2	6	Z	-0.86
2	7	X	-0.15
2	7	Y	-0.00
2	7	Z	-0.86

Line #	Bearing #	Dir	Load kips
	8	X	-0.15
2	8	Y	-0.00
2	8	Z	-0.86
2	9	X	-0.15
2	9	Y	0.21
2	9	Z	-0.86

Auto generation details:

Generated Wind Load on Structure

Angle of wind = -45.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W10 Name: Angle: -60

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	-1.82 kips	0.50		
UDL	Z		-0.22 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	-0.059 klf	0.00		0.84
7	UDL	Z	-0.253 klf	0.00		0.84
6	UDL	X	-0.059 klf	0.00		0.84
6	UDL	Z	-0.253 klf	0.00		0.84
5	UDL	X	-0.059 klf	0.00		0.84
5	UDL	Z	-0.253 klf	0.00		0.84
4	UDL	X	-0.059 klf	0.00		0.84
4	UDL	Z	-0.253 klf	0.00		0.84
3	UDL	X	-0.059 klf	0.00		0.84
3	UDL	Z	-0.253 klf	0.00		0.84
2	UDL	X	-0.059 klf	0.00		0.84
2	UDL	Z	-0.253 klf	0.00		0.84
1	UDL	X	-0.057 klf	0.00		0.84
1	UDL	Z	-0.243 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.15
1	1	Y	-0.21
1	1	Z	-0.86
1	2	X	-0.15
1	2	Y	-0.00
1	2	Z	-0.86
1	3	X	-0.15
1	3	Y	-0.00
1	3	Z	-0.86
1	4	X	-0.15
1	4	Y	-0.00
1	4	Z	-0.86
1	5	X	-0.15
1	5	Y	-0.00
1	5	Z	-0.86
1	6	X	-0.15
1	6	Y	-0.00
1	6	Z	-0.86
1	7	X	-0.15
1	7	Y	-0.00
1	7	Z	-0.86
1	8	X	-0.15
1	8	Y	-0.00
1	8	Z	-0.86
1	9	X	-0.15
1	9	Y	0.21
1	9	Z	-0.86
2	1	X	-0.15
2	1	Y	-0.21
2	1	Z	-0.86
2	2	X	-0.15
2	2	Y	-0.00
2	2	Z	-0.86
2	3	X	-0.15
2	3	Y	-0.00
2	3	Z	-0.86
2	4	X	-0.15
2	4	Y	-0.00
2	4	Z	-0.86
2	5	X	-0.15
2	5	Y	-0.00
2	5	Z	-0.86
2	6	X	-0.15
2	6	Y	-0.00
2	6	Z	-0.86
2	7	X	-0.15
2	7	Y	-0.00
2	7	Z	-0.86

Line #	Bearing #	Dir	Load kips
	8	X	-0.15
2	8	Y	-0.00
2	8	Z	-0.86
2	9	X	-0.15
2	9	Y	0.21
2	9	Z	-0.86

Auto generation details:

Generated Wind Load on Structure

Angle of wind = -60.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: W11 Name: Angle: -75

Multiplier = 1.000

Cap loads

Type	Dir	Arm ft	Mag1	x1/L	Mag2	x2/L
Force	X	0.00	0.25 kips	0.50		
UDL	Z		-0.23 klf	0.00		1.00

Column loads

Col #	Type	Dir	Mag1	y1/L	Mag2	y2/L
7	UDL	X	0.007 klf	0.00		0.84
7	UDL	Z	-0.231 klf	0.00		0.84
6	UDL	X	0.007 klf	0.00		0.84
6	UDL	Z	-0.231 klf	0.00		0.84
5	UDL	X	0.007 klf	0.00		0.84
5	UDL	Z	-0.231 klf	0.00		0.84
4	UDL	X	0.007 klf	0.00		0.84
4	UDL	Z	-0.231 klf	0.00		0.84
3	UDL	X	0.007 klf	0.00		0.84
3	UDL	Z	-0.231 klf	0.00		0.84
2	UDL	X	0.007 klf	0.00		0.84
2	UDL	Z	-0.231 klf	0.00		0.84
1	UDL	X	0.007 klf	0.00		0.84
1	UDL	Z	-0.219 klf	0.00		0.84

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.15
1	1	Y	-0.21
1	1	Z	-0.86
1	2	X	-0.15
1	2	Y	-0.00
1	2	Z	-0.86
1	3	X	-0.15
1	3	Y	-0.00
1	3	Z	-0.86
1	4	X	-0.15
1	4	Y	-0.00
1	4	Z	-0.86
1	5	X	-0.15
1	5	Y	-0.00
1	5	Z	-0.86
1	6	X	-0.15
1	6	Y	-0.00
1	6	Z	-0.86
1	7	X	-0.15
1	7	Y	-0.00
1	7	Z	-0.86
1	8	X	-0.15
1	8	Y	-0.00
1	8	Z	-0.86
1	9	X	-0.15
1	9	Y	0.21
1	9	Z	-0.86
2	1	X	-0.15
2	1	Y	-0.21
2	1	Z	-0.86
2	2	X	-0.15
2	2	Y	-0.00
2	2	Z	-0.86
2	3	X	-0.15
2	3	Y	-0.00
2	3	Z	-0.86
2	4	X	-0.15
2	4	Y	-0.00
2	4	Z	-0.86
2	5	X	-0.15
2	5	Y	-0.00
2	5	Z	-0.86
2	6	X	-0.15
2	6	Y	-0.00
2	6	Z	-0.86
2	7	X	-0.15
2	7	Y	-0.00
2	7	Z	-0.86

Line #	Bearing #	Dir	Load kips
	8	X	-0.15
2	8	Y	-0.00
2	8	Z	-0.86
2	9	X	-0.15
2	9	Y	0.21
2	9	Z	-0.86

Auto generation details:

Generated Wind Load on Structure

Angle of wind = -75.00 deg Elevation above which wind load acts = 526.00 ft
User defined wind pressure:

Wind pressure for superstructure: Wind pressure for substructure:
Transverse 11.000 psf Cap 45.000 psf
Longitudinal 22.000 psf Column 45.000 psf
Overturning not considered

Loadcase ID: WL1 Name: Angle: 75

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.10
1	1	Y	-0.32
1	1	Z	0.14
1	2	X	-0.10
1	2	Y	-0.00
1	2	Z	0.14
1	3	X	-0.10
1	3	Y	-0.00
1	3	Z	0.14
1	4	X	-0.10
1	4	Y	-0.00
1	4	Z	0.14
1	5	X	-0.10
1	5	Y	-0.00
1	5	Z	0.14
1	6	X	-0.10
1	6	Y	-0.00
1	6	Z	0.14
1	7	X	-0.10
1	7	Y	-0.00
1	7	Z	0.14
1	8	X	-0.10
1	8	Y	-0.00
1	8	Z	0.14
1	9	X	-0.10
1	9	Y	0.32
1	9	Z	0.14
2	1	X	-0.10
2	1	Y	-0.32
2	1	Z	0.14
2	2	X	-0.10
2	2	Y	-0.00
2	2	Z	0.14
2	3	X	-0.10
2	3	Y	-0.00
2	3	Z	0.14
2	4	X	-0.10
2	4	Y	-0.00
2	4	Z	0.14
2	5	X	-0.10
2	5	Y	-0.00
2	5	Z	0.14
2	6	X	-0.10
2	6	Y	-0.00
2	6	Z	0.14
2	7	X	-0.10
2	7	Y	-0.00
2	7	Z	0.14

Line #	Bearing #	Dir	Load kips
	8	X	-0.10
2	8	Y	-0.00
2	8	Z	0.14
2	9	X	-0.10
2	9	Y	0.32
2	9	Z	0.14

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 75.00 deg Live load length = 70.00 ft

Loadcase ID: WL2 Name: Angle: 60

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.17
1	1	Y	-0.54
1	1	Z	0.10
1	2	X	-0.17
1	2	Y	-0.00
1	2	Z	0.10
1	3	X	-0.17
1	3	Y	-0.00
1	3	Z	0.10
1	4	X	-0.17
1	4	Y	-0.00
1	4	Z	0.10
1	5	X	-0.17
1	5	Y	-0.00
1	5	Z	0.10
1	6	X	-0.17
1	6	Y	-0.00
1	6	Z	0.10
1	7	X	-0.17
1	7	Y	-0.00
1	7	Z	0.10
1	8	X	-0.17
1	8	Y	-0.00
1	8	Z	0.10
1	9	X	-0.17
1	9	Y	0.54
1	9	Z	0.10
2	1	X	-0.17
2	1	Y	-0.54
2	1	Z	0.10
2	2	X	-0.17
2	2	Y	-0.00
2	2	Z	0.10
2	3	X	-0.17
2	3	Y	-0.00
2	3	Z	0.10
2	4	X	-0.17
2	4	Y	-0.00
2	4	Z	0.10
2	5	X	-0.17
2	5	Y	-0.00
2	5	Z	0.10
2	6	X	-0.17
2	6	Y	-0.00
2	6	Z	0.10
2	7	X	-0.17
2	7	Y	-0.00
2	7	Z	0.10

Line #	Bearing #	Dir	Load kips
	8	X	-0.17
2	8	Y	-0.00
2	8	Z	0.10
2	9	X	-0.17
2	9	Y	0.54
2	9	Z	0.10

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 60.00 deg Live load length = 70.00 ft

Loadcase ID: WL3 Name: Angle: 45

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.28
1	1	Y	-0.90
1	1	Z	0.04
1	2	X	-0.28
1	2	Y	-0.00
1	2	Z	0.04
1	3	X	-0.28
1	3	Y	-0.00
1	3	Z	0.04
1	4	X	-0.28
1	4	Y	-0.00
1	4	Z	0.04
1	5	X	-0.28
1	5	Y	-0.00
1	5	Z	0.04
1	6	X	-0.28
1	6	Y	-0.00
1	6	Z	0.04
1	7	X	-0.28
1	7	Y	-0.00
1	7	Z	0.04
1	8	X	-0.28
1	8	Y	-0.00
1	8	Z	0.04
1	9	X	-0.28
1	9	Y	0.90
1	9	Z	0.04
2	1	X	-0.28
2	1	Y	-0.90
2	1	Z	0.04
2	2	X	-0.28
2	2	Y	-0.00
2	2	Z	0.04
2	3	X	-0.28
2	3	Y	-0.00
2	3	Z	0.04
2	4	X	-0.28
2	4	Y	-0.00
2	4	Z	0.04
2	5	X	-0.28
2	5	Y	-0.00
2	5	Z	0.04
2	6	X	-0.28
2	6	Y	-0.00
2	6	Z	0.04
2	7	X	-0.28
2	7	Y	-0.00
2	7	Z	0.04

Line #	Bearing #	Dir	Load kips
	8	X	-0.28
2	8	Y	-0.00
2	8	Z	0.04
2	9	X	-0.28
2	9	Y	0.90
2	9	Z	0.04

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 45.00 deg Live load length = 70.00 ft

Loadcase ID: WL4 Name: Angle: 30

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.33
1	1	Y	-1.06
1	1	Z	-0.00
1	2	X	-0.33
1	2	Y	-0.00
1	2	Z	-0.00
1	3	X	-0.33
1	3	Y	-0.00
1	3	Z	-0.00
1	4	X	-0.33
1	4	Y	-0.00
1	4	Z	-0.00
1	5	X	-0.33
1	5	Y	-0.00
1	5	Z	-0.00
1	6	X	-0.33
1	6	Y	-0.00
1	6	Z	-0.00
1	7	X	-0.33
1	7	Y	-0.00
1	7	Z	-0.00
1	8	X	-0.33
1	8	Y	-0.00
1	8	Z	-0.00
1	9	X	-0.33
1	9	Y	1.06
1	9	Z	-0.00
2	1	X	-0.33
2	1	Y	-1.06
2	1	Z	-0.00
2	2	X	-0.33
2	2	Y	-0.00
2	2	Z	-0.00
2	3	X	-0.33
2	3	Y	-0.00
2	3	Z	-0.00
2	4	X	-0.33
2	4	Y	-0.00
2	4	Z	-0.00
2	5	X	-0.33
2	5	Y	-0.00
2	5	Z	-0.00
2	6	X	-0.33
2	6	Y	-0.00
2	6	Z	-0.00
2	7	X	-0.33
2	7	Y	-0.00
2	7	Z	-0.00

Line #	Bearing #	Dir	Load kips
	8	X	-0.33
2	8	Y	-0.00
2	8	Z	-0.00
2	9	X	-0.33
2	9	Y	1.06
2	9	Z	-0.00

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 30.00 deg Live load length = 70.00 ft

Loadcase ID: WL5 Name: Angle: 15

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.34
1	1	Y	-1.09
1	1	Z	-0.05
1	2	X	-0.34
1	2	Y	-0.00
1	2	Z	-0.05
1	3	X	-0.34
1	3	Y	-0.00
1	3	Z	-0.05
1	4	X	-0.34
1	4	Y	-0.00
1	4	Z	-0.05
1	5	X	-0.34
1	5	Y	-0.00
1	5	Z	-0.05
1	6	X	-0.34
1	6	Y	-0.00
1	6	Z	-0.05
1	7	X	-0.34
1	7	Y	-0.00
1	7	Z	-0.05
1	8	X	-0.34
1	8	Y	-0.00
1	8	Z	-0.05
1	9	X	-0.34
1	9	Y	1.09
1	9	Z	-0.05
2	1	X	-0.34
2	1	Y	-1.09
2	1	Z	-0.05
2	2	X	-0.34
2	2	Y	-0.00
2	2	Z	-0.05
2	3	X	-0.34
2	3	Y	-0.00
2	3	Z	-0.05
2	4	X	-0.34
2	4	Y	-0.00
2	4	Z	-0.05
2	5	X	-0.34
2	5	Y	-0.00
2	5	Z	-0.05
2	6	X	-0.34
2	6	Y	-0.00
2	6	Z	-0.05
2	7	X	-0.34
2	7	Y	-0.00
2	7	Z	-0.05

Line #	Bearing #	Dir	Load kips
	8	X	-0.34
2	8	Y	-0.00
2	8	Z	-0.05
2	9	X	-0.34
2	9	Y	1.09
2	9	Z	-0.05

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 15.00 deg Live load length = 70.00 ft

Loadcase ID: WL6 Name: Angle: 0

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.37
1	1	Y	-1.19
1	1	Z	-0.11
1	2	X	-0.37
1	2	Y	-0.00
1	2	Z	-0.11
1	3	X	-0.37
1	3	Y	-0.00
1	3	Z	-0.11
1	4	X	-0.37
1	4	Y	-0.00
1	4	Z	-0.11
1	5	X	-0.37
1	5	Y	-0.00
1	5	Z	-0.11
1	6	X	-0.37
1	6	Y	-0.00
1	6	Z	-0.11
1	7	X	-0.37
1	7	Y	-0.00
1	7	Z	-0.11
1	8	X	-0.37
1	8	Y	-0.00
1	8	Z	-0.11
1	9	X	-0.37
1	9	Y	1.19
1	9	Z	-0.11
2	1	X	-0.37
2	1	Y	-1.19
2	1	Z	-0.11
2	2	X	-0.37
2	2	Y	-0.00
2	2	Z	-0.11
2	3	X	-0.37
2	3	Y	-0.00
2	3	Z	-0.11
2	4	X	-0.37
2	4	Y	-0.00
2	4	Z	-0.11
2	5	X	-0.37
2	5	Y	-0.00
2	5	Z	-0.11
2	6	X	-0.37
2	6	Y	-0.00
2	6	Z	-0.11
2	7	X	-0.37
2	7	Y	-0.00
2	7	Z	-0.11

Line #	Bearing #	Dir	Load kips
	8	X	-0.37
2	8	Y	-0.00
2	8	Z	-0.11
2	9	X	-0.37
2	9	Y	1.19
2	9	Z	-0.11

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = 0.00 deg Live load length = 70.00 ft

Loadcase ID: WL7 Name: Angle: -15

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.31
1	1	Y	-1.01
1	1	Z	-0.14
1	2	X	-0.31
1	2	Y	-0.00
1	2	Z	-0.14
1	3	X	-0.31
1	3	Y	-0.00
1	3	Z	-0.14
1	4	X	-0.31
1	4	Y	-0.00
1	4	Z	-0.14
1	5	X	-0.31
1	5	Y	-0.00
1	5	Z	-0.14
1	6	X	-0.31
1	6	Y	-0.00
1	6	Z	-0.14
1	7	X	-0.31
1	7	Y	-0.00
1	7	Z	-0.14
1	8	X	-0.31
1	8	Y	-0.00
1	8	Z	-0.14
1	9	X	-0.31
1	9	Y	1.01
1	9	Z	-0.14
2	1	X	-0.31
2	1	Y	-1.01
2	1	Z	-0.14
2	2	X	-0.31
2	2	Y	-0.00
2	2	Z	-0.14
2	3	X	-0.31
2	3	Y	-0.00
2	3	Z	-0.14
2	4	X	-0.31
2	4	Y	-0.00
2	4	Z	-0.14
2	5	X	-0.31
2	5	Y	-0.00
2	5	Z	-0.14
2	6	X	-0.31
2	6	Y	-0.00
2	6	Z	-0.14
2	7	X	-0.31
2	7	Y	-0.00
2	7	Z	-0.14

Line #	Bearing #	Dir	Load kips
	8	X	-0.31
2	8	Y	-0.00
2	8	Z	-0.14
2	9	X	-0.31
2	9	Y	1.01
2	9	Z	-0.14

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = -15.00 deg Live load length = 70.00 ft

Loadcase ID: WL8 Name: Angle: -30

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.28
1	1	Y	-0.89
1	1	Z	-0.18
1	2	X	-0.28
1	2	Y	-0.00
1	2	Z	-0.18
1	3	X	-0.28
1	3	Y	-0.00
1	3	Z	-0.18
1	4	X	-0.28
1	4	Y	-0.00
1	4	Z	-0.18
1	5	X	-0.28
1	5	Y	-0.00
1	5	Z	-0.18
1	6	X	-0.28
1	6	Y	-0.00
1	6	Z	-0.18
1	7	X	-0.28
1	7	Y	-0.00
1	7	Z	-0.18
1	8	X	-0.28
1	8	Y	-0.00
1	8	Z	-0.18
1	9	X	-0.28
1	9	Y	0.89
1	9	Z	-0.18
2	1	X	-0.28
2	1	Y	-0.89
2	1	Z	-0.18
2	2	X	-0.28
2	2	Y	-0.00
2	2	Z	-0.18
2	3	X	-0.28
2	3	Y	-0.00
2	3	Z	-0.18
2	4	X	-0.28
2	4	Y	-0.00
2	4	Z	-0.18
2	5	X	-0.28
2	5	Y	-0.00
2	5	Z	-0.18
2	6	X	-0.28
2	6	Y	-0.00
2	6	Z	-0.18
2	7	X	-0.28
2	7	Y	-0.00
2	7	Z	-0.18

Line #	Bearing #	Dir	Load kips
	8	X	-0.28
2	8	Y	-0.00
2	8	Z	-0.18
2	9	X	-0.28
2	9	Y	0.89
2	9	Z	-0.18

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = -30.00 deg Live load length = 70.00 ft

Loadcase ID: WL9 Name: Angle: -45

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.21
1	1	Y	-0.67
1	1	Z	-0.19
1	2	X	-0.21
1	2	Y	-0.00
1	2	Z	-0.19
1	3	X	-0.21
1	3	Y	-0.00
1	3	Z	-0.19
1	4	X	-0.21
1	4	Y	-0.00
1	4	Z	-0.19
1	5	X	-0.21
1	5	Y	-0.00
1	5	Z	-0.19
1	6	X	-0.21
1	6	Y	-0.00
1	6	Z	-0.19
1	7	X	-0.21
1	7	Y	-0.00
1	7	Z	-0.19
1	8	X	-0.21
1	8	Y	-0.00
1	8	Z	-0.19
1	9	X	-0.21
1	9	Y	0.67
1	9	Z	-0.19
2	1	X	-0.21
2	1	Y	-0.67
2	1	Z	-0.19
2	2	X	-0.21
2	2	Y	-0.00
2	2	Z	-0.19
2	3	X	-0.21
2	3	Y	-0.00
2	3	Z	-0.19
2	4	X	-0.21
2	4	Y	-0.00
2	4	Z	-0.19
2	5	X	-0.21
2	5	Y	-0.00
2	5	Z	-0.19
2	6	X	-0.21
2	6	Y	-0.00
2	6	Z	-0.19
2	7	X	-0.21
2	7	Y	-0.00
2	7	Z	-0.19

Line #	Bearing #	Dir	Load kips
	8	X	-0.21
2	8	Y	-0.00
2	8	Z	-0.19
2	9	X	-0.21
2	9	Y	0.67
2	9	Z	-0.19

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = -45.00 deg Live load length = 70.00 ft

Loadcase ID: WL10 Name: Angle: -60

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.08
1	1	Y	-0.27
1	1	Z	-0.18
1	2	X	-0.08
1	2	Y	-0.00
1	2	Z	-0.18
1	3	X	-0.08
1	3	Y	-0.00
1	3	Z	-0.18
1	4	X	-0.08
1	4	Y	-0.00
1	4	Z	-0.18
1	5	X	-0.08
1	5	Y	-0.00
1	5	Z	-0.18
1	6	X	-0.08
1	6	Y	-0.00
1	6	Z	-0.18
1	7	X	-0.08
1	7	Y	-0.00
1	7	Z	-0.18
1	8	X	-0.08
1	8	Y	-0.00
1	8	Z	-0.18
1	9	X	-0.08
1	9	Y	0.27
1	9	Z	-0.18
2	1	X	-0.08
2	1	Y	-0.27
2	1	Z	-0.18
2	2	X	-0.08
2	2	Y	-0.00
2	2	Z	-0.18
2	3	X	-0.08
2	3	Y	-0.00
2	3	Z	-0.18
2	4	X	-0.08
2	4	Y	-0.00
2	4	Z	-0.18
2	5	X	-0.08
2	5	Y	-0.00
2	5	Z	-0.18
2	6	X	-0.08
2	6	Y	-0.00
2	6	Z	-0.18
2	7	X	-0.08
2	7	Y	-0.00
2	7	Z	-0.18

Line #	Bearing #	Dir	Load kips
	8	X	-0.08
2	8	Y	-0.00
2	8	Z	-0.18
2	9	X	-0.08
2	9	Y	0.27
2	9	Z	-0.18

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = -60.00 deg Live load length = 70.00 ft

Loadcase ID: WL11 Name: Angle: -75

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-0.00
1	1	Y	-0.02
1	1	Z	-0.17
1	2	X	-0.00
1	2	Y	-0.00
1	2	Z	-0.17
1	3	X	-0.00
1	3	Y	-0.00
1	3	Z	-0.17
1	4	X	-0.00
1	4	Y	-0.00
1	4	Z	-0.17
1	5	X	-0.00
1	5	Y	-0.00
1	5	Z	-0.17
1	6	X	-0.00
1	6	Y	-0.00
1	6	Z	-0.17
1	7	X	-0.00
1	7	Y	-0.00
1	7	Z	-0.17
1	8	X	-0.00
1	8	Y	-0.00
1	8	Z	-0.17
1	9	X	-0.00
1	9	Y	0.02
1	9	Z	-0.17
2	1	X	-0.00
2	1	Y	-0.02
2	1	Z	-0.17
2	2	X	-0.00
2	2	Y	-0.00
2	2	Z	-0.17
2	3	X	-0.00
2	3	Y	-0.00
2	3	Z	-0.17
2	4	X	-0.00
2	4	Y	-0.00
2	4	Z	-0.17
2	5	X	-0.00
2	5	Y	-0.00
2	5	Z	-0.17
2	6	X	-0.00
2	6	Y	-0.00
2	6	Z	-0.17
2	7	X	-0.00
2	7	Y	-0.00
2	7	Z	-0.17

Line #	Bearing #	Dir	Load kips
	8	X	-0.00
2	8	Y	-0.00
2	8	Z	-0.17
2	9	X	-0.00
2	9	Y	0.02
2	9	Z	-0.17

Auto generation details:

Generated Wind Load on Live Load

Angle of wind = -75.00 deg Live load length = 70.00 ft

Loadcase ID: EQ1 Name:

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	-8.04
1	1	Z	-1.35
1	2	X	-8.04
1	2	Z	-1.35
1	3	X	-8.04
1	3	Z	-1.35
1	4	X	-8.04
1	4	Z	-1.35
1	5	X	-8.04
1	5	Z	-1.35
1	6	X	-8.04
1	6	Z	-1.35
1	7	X	-8.04
1	7	Z	-1.35
1	8	X	-8.04
1	8	Z	-1.35
1	9	X	-8.04
1	9	Z	-1.35
2	1	X	-8.04
2	1	Z	-1.35
2	2	X	-8.04
2	2	Z	-1.35
2	3	X	-8.04
2	3	Z	-1.35
2	4	X	-8.04
2	4	Z	-1.35
2	5	X	-8.04
2	5	Z	-1.35
2	6	X	-8.04
2	6	Z	-1.35
2	7	X	-8.04
2	7	Z	-1.35
2	8	X	-8.04
2	8	Z	-1.35
2	9	X	-8.04
2	9	Z	-1.35

Auto generation details:

Generated Earthquake Load:

Bridge information

Importance classification: Essential Regular
Unit weight of superstructure = 11.58 kips/ft
Cross section area = 43.94 ft^2
Superstructure: Iy = 1907.12 ft^4 Ix = 27.41 ft^4
Total number of spans = 2 Span number rear to current pier = 1

Span data

Span number	Length ft
1	70.00
2	70.00

Pier - column data

Pier #	Ix ft^4	Iz ft^4	Area ft^2	Avg. height ft
1	185.33	285.72	139.00	16.00
2	185.33	285.72	139.00	16.00
3	185.33	285.72	139.00	16.00

Soil Profile Type:: II
Acceleration coeff. = 0.06
Seismic Zone: 4
Seismic forces - default

	X dir	Z dir
Case 1	1.00	0.30
Case 2	0.30	1.00

Loadcase ID: EQ2 Name:

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	8.04
1	1	Z	-1.35
1	2	X	8.04
1	2	Z	-1.35
1	3	X	8.04
1	3	Z	-1.35
1	4	X	8.04
1	4	Z	-1.35
1	5	X	8.04
1	5	Z	-1.35
1	6	X	8.04
1	6	Z	-1.35
1	7	X	8.04
1	7	Z	-1.35
1	8	X	8.04
1	8	Z	-1.35
1	9	X	8.04
1	9	Z	-1.35
2	1	X	8.04
2	1	Z	-1.35
2	2	X	8.04
2	2	Z	-1.35
2	3	X	8.04
2	3	Z	-1.35
2	4	X	8.04
2	4	Z	-1.35
2	5	X	8.04
2	5	Z	-1.35
2	6	X	8.04
2	6	Z	-1.35
2	7	X	8.04
2	7	Z	-1.35
2	8	X	8.04
2	8	Z	-1.35
2	9	X	8.04
2	9	Z	-1.35

Auto generation details:

Generated Earthquake Load:

Bridge information

Importance classification: Essential Regular
Unit weight of superstructure = 11.58 kips/ft
Cross section area = 43.94 ft^2
Superstructure: Iy = 1907.12 ft^4 Ix = 27.41 ft^4
Total number of spans = 2 Span number rear to current pier = 1

Span data

Span number	Length ft
1	70.00
2	70.00

Pier - column data

Pier #	Ix ft^4	Iz ft^4	Area ft^2	Avg. height ft
1	185.33	285.72	139.00	16.00
2	185.33	285.72	139.00	16.00
3	185.33	285.72	139.00	16.00

Soil Profile Type:: II
Acceleration coeff. = 0.06
Seismic Zone: 4
Seismic forces - default

	X dir	Z dir
Case 1	1.00	0.30
Case 2	0.30	1.00

Loadcase ID: EQ3 Name:

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	2.41
1	1	Z	4.50
1	2	X	2.41
1	2	Z	4.50
1	3	X	2.41
1	3	Z	4.50
1	4	X	2.41
1	4	Z	4.50
1	5	X	2.41
1	5	Z	4.50
1	6	X	2.41
1	6	Z	4.50
1	7	X	2.41
1	7	Z	4.50
1	8	X	2.41
1	8	Z	4.50
1	9	X	2.41
1	9	Z	4.50
2	1	X	2.41
2	1	Z	4.50
2	2	X	2.41
2	2	Z	4.50
2	3	X	2.41
2	3	Z	4.50
2	4	X	2.41
2	4	Z	4.50
2	5	X	2.41
2	5	Z	4.50
2	6	X	2.41
2	6	Z	4.50
2	7	X	2.41
2	7	Z	4.50
2	8	X	2.41
2	8	Z	4.50
2	9	X	2.41
2	9	Z	4.50

Auto generation details:

Generated Earthquake Load:

Bridge information

Importance classification: Essential Regular
Unit weight of superstructure = 11.58 kips/ft
Cross section area = 43.94 ft^2
Superstructure: Iy = 1907.12 ft^4 Ix = 27.41 ft^4
Total number of spans = 2 Span number rear to current pier = 1

Span data

Span number	Length ft
1	70.00
2	70.00

Pier - column data

Pier #	Ix ft^4	Iz ft^4	Area ft^2	Avg. height ft
1	185.33	285.72	139.00	16.00
2	185.33	285.72	139.00	16.00
3	185.33	285.72	139.00	16.00

Soil Profile Type:: II
Acceleration coeff. = 0.06
Seismic Zone: 4
Seismic forces - default

	X dir	Z dir
Case 1	1.00	0.30
Case 2	0.30	1.00

Loadcase ID: EQ4 Name:

Multiplier = 1.000

Bearing loads

Line #	Bearing #	Dir	Load kips
1	1	X	2.41
1	1	Z	-4.50
1	2	X	2.41
1	2	Z	-4.50
1	3	X	2.41
1	3	Z	-4.50
1	4	X	2.41
1	4	Z	-4.50
1	5	X	2.41
1	5	Z	-4.50
1	6	X	2.41
1	6	Z	-4.50
1	7	X	2.41
1	7	Z	-4.50
1	8	X	2.41
1	8	Z	-4.50
1	9	X	2.41
1	9	Z	-4.50
2	1	X	2.41
2	1	Z	-4.50
2	2	X	2.41
2	2	Z	-4.50
2	3	X	2.41
2	3	Z	-4.50
2	4	X	2.41
2	4	Z	-4.50
2	5	X	2.41
2	5	Z	-4.50
2	6	X	2.41
2	6	Z	-4.50
2	7	X	2.41
2	7	Z	-4.50
2	8	X	2.41
2	8	Z	-4.50
2	9	X	2.41
2	9	Z	-4.50

Auto generation details:

Generated Earthquake Load:

Bridge information

Importance classification: Essential Regular
Unit weight of superstructure = 11.58 kips/ft
Cross section area = 43.94 ft^2
Superstructure: Iy = 1907.12 ft^4 Ix = 27.41 ft^4
Total number of spans = 2 Span number rear to current pier = 1

Span data

Span number	Length ft
1	70.00
2	70.00

Pier - column data

Pier #	Ix ft^4	Iz ft^4	Area ft^2	Avg. height ft
1	185.33	285.72	139.00	16.00
2	185.33	285.72	139.00	16.00
3	185.33	285.72	139.00	16.00

Soil Profile Type:: II
Acceleration coeff. = 0.06
Seismic Zone: 4
Seismic forces - default

	X dir	Z dir
Case 1	1.00	0.30
Case 2	0.30	1.00

Selected load groups

AREMA Service I
AREMA Service II
AREMA Service III
AREMA Service IV
AREMA Service V
AREMA Service VI
AREMA Service VII
AREMA Service VIII
AREMA Svc VII EQ
AREMA Svc Derail
AREMA LFD 1
AREMA LFD 1A
AREMA LFD 2
AREMA LFD 3
AREMA LFD 4
AREMA LFD 5
AREMA LFD 6
AREMA LFD 7
AREMA LFD 8
AREMA LFD 9

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ANALYSIS RESULTS
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Global Coordinate System, Units: kip kft

LOAD CASES RESULTS FROM FRAME ANALYSIS:

Loadcase ID: SELF Name: Self Load of Structure

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-0.16	63.83	0.00	-0.00	0.00	0.84
1	2	0.16	-25.35	0.00	-0.00	0.00	1.72
2	3	-0.03	66.48	0.00	-0.00	0.00	0.14
2	4	0.03	-26.15	0.00	-0.00	0.00	0.30
3	5	0.01	66.52	0.00	-0.00	0.00	-0.07
3	6	-0.01	-26.02	0.00	-0.00	0.00	-0.15
4	7	-0.00	66.59	0.00	-0.00	0.00	0.02
4	8	0.00	-26.09	0.00	-0.00	0.00	-0.00
5	9	-0.02	66.56	0.00	-0.00	0.00	0.11
5	10	0.02	-26.06	0.00	-0.00	0.00	0.15
6	11	0.02	66.57	0.00	-0.00	0.00	-0.05
6	12	-0.02	-26.07	0.00	-0.00	0.00	-0.19
7	13	0.18	67.19	0.00	-0.00	0.00	-0.90
7	14	-0.18	-26.69	0.00	-0.00	0.00	-1.92
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	0.00	-12.10	0.00	0.00	0.00	13.94
9	2	0.00	12.47	0.00	0.00	0.00	-14.81
10	2	-0.16	12.88	0.00	0.00	0.00	13.09
10	17	0.16	-8.22	0.00	0.00	0.00	-3.72
11	17	-0.16	8.22	0.00	0.00	0.00	3.72
11	18	0.16	-0.41	0.00	0.00	0.00	2.70
12	18	-0.16	0.41	0.00	0.00	0.00	-2.70
12	19	0.16	5.94	0.00	0.00	0.00	-0.65
13	19	-0.16	-5.94	0.00	0.00	0.00	0.65
13	20	0.16	10.97	0.00	0.00	0.00	-8.75
14	20	-0.16	-10.97	0.00	0.00	0.00	8.75
14	4	0.16	12.71	0.00	0.00	0.00	-12.67
15	4	-0.19	13.44	0.00	0.00	0.00	12.37
15	21	0.19	-1.01	0.00	0.00	0.00	4.72
16	21	-0.19	1.01	0.00	0.00	0.00	-4.72
16	22	0.19	-0.31	0.00	0.00	0.00	4.81
17	22	-0.19	0.31	0.00	0.00	0.00	-4.81
17	23	0.19	4.02	0.00	0.00	0.00	3.28
18	23	-0.19	-4.02	0.00	0.00	0.00	-3.28
18	6	0.19	12.81	0.00	0.00	0.00	-10.82
19	6	-0.17	13.21	0.00	0.00	0.00	10.97
19	24	0.17	-7.83	0.00	0.00	0.00	-0.20
20	24	-0.17	7.83	0.00	0.00	0.00	0.20
20	25	0.17	-2.80	0.00	0.00	0.00	4.89
21	25	-0.17	2.80	0.00	0.00	0.00	-4.89
21	26	0.17	-0.08	0.00	0.00	0.00	5.64
22	26	-0.17	0.08	0.00	0.00	0.00	-5.64
22	27	0.17	11.37	0.00	0.00	0.00	-6.67
23	27	-0.17	-11.37	0.00	0.00	0.00	6.67
23	8	0.17	13.04	0.00	0.00	0.00	-10.57
24	8	-0.18	13.05	0.00	0.00	0.00	10.57

24	28	0.18	-9.70	0.00	0.00	0.00	-3.31
25	28	-0.18	9.70	0.00	0.00	0.00	3.31
25	29	0.18	0.08	0.00	0.00	0.00	5.65
26	29	-0.18	-0.08	0.00	0.00	0.00	-5.65
26	30	0.18	4.47	0.00	0.00	0.00	3.74
27	30	-0.18	-4.47	0.00	0.00	0.00	-3.74
27	31	0.18	9.50	0.00	0.00	0.00	-2.95
28	31	-0.18	-9.50	0.00	0.00	0.00	2.95
28	10	0.18	13.20	0.00	0.00	0.00	-10.95
29	10	-0.19	12.86	0.00	0.00	0.00	10.80
29	32	0.19	-2.39	0.00	0.00	0.00	4.41
30	32	-0.19	2.39	0.00	0.00	0.00	-4.41
30	33	0.19	0.26	0.00	0.00	0.00	4.95
31	33	-0.19	-0.26	0.00	0.00	0.00	-4.95
31	34	0.19	2.63	0.00	0.00	0.00	4.30
32	34	-0.19	-2.63	0.00	0.00	0.00	-4.30
32	12	0.19	13.39	0.00	0.00	0.00	-12.11
33	12	-0.18	12.69	0.00	0.00	0.00	12.30
33	35	0.18	-9.27	0.00	0.00	0.00	-5.15
34	35	-0.18	9.27	0.00	0.00	0.00	5.15
34	36	0.18	-4.24	0.00	0.00	0.00	1.32
35	36	-0.18	4.24	0.00	0.00	0.00	-1.32
35	37	0.18	0.44	0.00	0.00	0.00	3.01
36	37	-0.18	-0.44	0.00	0.00	0.00	-3.01
36	38	0.18	9.93	0.00	0.00	0.00	-6.35
37	38	-0.18	-9.93	0.00	0.00	0.00	6.35
37	14	0.18	13.56	0.00	0.00	0.00	-14.49
38	14	0.00	13.13	0.00	0.00	0.00	16.41
38	39	0.00	-11.73	0.00	0.00	0.00	-13.11
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: D1 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.37	148.12	-0.51	0.91	1.90	-17.45
1	2	-3.37	-148.12	0.51	-9.09	-1.90	-36.43
2	3	1.88	176.26	0.07	2.96	2.16	-9.58
2	4	-1.88	-176.26	-0.07	-1.88	-2.16	-20.48
3	5	0.66	185.06	-0.08	0.89	2.19	-3.30
3	6	-0.66	-185.06	0.08	-2.18	-2.19	-7.20
4	7	0.05	187.13	-0.07	-0.36	2.20	-0.32
4	8	-0.05	-187.13	0.07	-0.80	-2.20	-0.41
5	9	-0.64	185.05	0.15	-0.48	2.18	3.05
5	10	0.64	-185.05	-0.15	2.84	-2.18	7.16
6	11	-1.77	176.39	-0.00	-2.54	2.13	8.82
6	12	1.77	-176.39	0.00	2.52	-2.13	19.45
7	13	-3.54	156.27	0.45	-1.36	2.07	18.13
7	14	3.54	-156.27	-0.45	8.59	-2.07	38.56
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	-67.66	0.00	-107.13	0.00	0.00
9	2	0.00	67.66	0.00	107.13	0.00	-4.78
10	2	3.37	80.46	-0.51	-98.04	1.90	41.21
10	17	-3.37	-80.46	0.51	98.04	-1.44	30.17
11	17	3.37	12.80	-0.51	9.09	1.44	-30.17
11	18	-3.37	-12.80	0.51	-9.09	-0.68	49.22
12	18	3.37	12.80	-0.51	9.09	0.68	-49.22
12	19	-3.37	-12.80	0.51	-9.09	-0.06	64.72
13	19	3.37	-54.86	-0.51	-98.04	0.06	-64.72

13	20	-3.37	54.86	0.51	98.04	0.43	12.18
14	20	3.37	-122.52	-0.51	9.09	-0.43	-12.18
14	4	-3.37	122.52	0.51	-9.09	0.59	-28.40
15	4	5.25	53.74	-0.44	10.97	1.57	48.88
15	21	-5.25	-53.74	0.44	-10.97	-0.52	78.36
16	21	5.25	-13.92	-0.44	-96.16	0.52	-78.36
16	22	-5.25	13.92	0.44	96.16	-0.46	76.52
17	22	5.25	-13.92	-0.44	-96.16	0.46	-76.52
17	23	-5.25	13.92	0.44	96.16	-0.09	65.03
18	23	5.25	-81.58	-0.44	10.97	0.09	-65.03
18	6	-5.25	81.58	0.44	-10.97	0.65	-71.58
19	6	5.90	103.48	-0.52	13.15	1.54	78.78
19	24	-5.90	-103.48	0.52	-13.15	-1.00	27.21
20	24	5.90	35.82	-0.52	-93.98	1.00	-27.21
20	25	-5.90	-35.82	0.52	93.98	-0.50	61.52
21	25	5.90	-31.84	-0.52	13.15	0.50	-61.52
21	26	-5.90	31.84	0.52	-13.15	-0.22	45.03
22	26	5.90	-31.84	-0.52	13.15	0.22	-45.03
22	27	-5.90	31.84	0.52	-13.15	0.92	-24.39
23	27	5.90	-99.50	-0.52	-93.98	-0.92	24.39
23	8	-5.90	99.50	0.52	93.98	1.09	-56.16
24	8	5.95	87.63	-0.60	-93.18	1.12	56.56
24	28	-5.95	-87.63	0.60	93.18	-0.73	-0.60
25	28	5.95	19.97	-0.60	13.95	0.73	0.60
25	29	-5.95	-19.97	0.60	-13.95	0.38	36.58
26	29	5.95	19.97	-0.60	13.95	-0.38	-36.58
26	30	-5.95	-19.97	0.60	-13.95	0.88	53.30
27	30	5.95	-47.69	-0.60	-93.18	-0.88	-53.30
27	31	-5.95	47.69	0.60	93.18	1.45	7.63
28	31	5.95	-115.35	-0.60	13.95	-1.45	-7.63
28	10	-5.95	115.35	0.60	-13.95	1.87	-73.67
29	10	5.31	69.70	-0.45	11.11	0.31	66.51
29	32	-5.31	-69.70	0.45	-11.11	0.59	72.49
30	32	5.31	2.04	-0.45	-96.02	-0.59	-72.49
30	33	-5.31	-2.04	0.45	96.02	0.82	73.52
31	33	5.31	2.04	-0.45	-96.02	-0.82	-73.52
31	34	-5.31	-2.04	0.45	96.02	1.02	74.44
32	34	5.31	-65.62	-0.45	11.11	-1.02	-74.44
32	12	-5.31	65.62	0.45	-11.11	1.94	-59.95
33	12	3.54	110.77	-0.45	8.59	0.19	40.50
33	35	-3.54	-110.77	0.45	-8.59	0.11	31.57
34	35	3.54	43.11	-0.45	-98.54	-0.11	-31.57
34	36	-3.54	-43.11	0.45	98.54	0.54	72.86
35	36	3.54	-24.55	-0.45	8.59	-0.54	-72.86
35	37	-3.54	24.55	0.45	-8.59	0.94	50.98
36	37	3.54	-24.55	-0.45	8.59	-0.94	-50.98
36	38	-3.54	24.55	0.45	-8.59	1.76	6.62
37	38	3.54	-90.41	-0.45	-95.69	-1.76	-6.62
37	14	-3.54	90.41	0.45	95.69	2.07	-56.02
38	14	0.00	65.86	0.00	-104.28	0.00	17.46
38	39	0.00	-65.86	0.00	104.28	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: (L+In)1 Name: (no impact) Balanced

No impact factor is included in the individual live load.

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	10.29	28.63	-0.08	2.34	1.45	-53.52
1	2	-10.29	-28.63	0.08	-3.62	-1.45	-111.14
2	3	14.88	121.92	-0.56	-1.04	1.70	-78.22

2	4	-14.88	-121.92	0.56	-7.97	-1.70	-159.82
3	5	5.79	201.15	-0.24	-0.33	1.77	-30.94
3	6	-5.79	-201.15	0.24	-3.47	-1.77	-61.75
4	7	-6.56	192.70	0.21	1.03	1.72	33.52
4	8	6.56	-192.70	-0.21	2.35	-1.72	71.49
5	9	-12.23	120.95	0.65	2.40	1.53	62.60
5	10	12.23	-120.95	-0.65	7.95	-1.53	133.06
6	11	-8.03	42.29	0.17	-0.99	1.33	39.66
6	12	8.03	-42.29	-0.17	3.69	-1.33	88.87
7	13	-4.14	-3.84	-0.15	-3.42	1.23	18.69
7	14	4.14	3.84	0.15	1.06	-1.23	47.50
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	10.29	28.63	-0.08	3.62	1.45	111.14
10	17	-10.29	-28.63	0.08	-3.62	-1.38	-85.74
11	17	10.29	28.63	-0.08	3.62	1.38	85.74
11	18	-10.29	-28.63	0.08	-3.62	-1.26	-43.14
12	18	10.29	28.63	-0.08	3.62	1.26	43.14
12	19	-10.29	-28.63	0.08	-3.62	-1.16	-8.48
13	19	10.29	28.63	-0.08	3.62	1.16	8.48
13	20	-10.29	-28.63	0.08	-3.62	-1.09	18.94
14	20	10.29	28.63	-0.08	3.62	1.09	-18.94
14	4	-10.29	-28.63	0.08	-3.62	-1.06	28.43
15	4	25.17	150.55	-0.64	11.59	2.76	131.40
15	21	-25.17	-150.55	0.64	-11.59	-1.24	225.04
16	21	25.17	44.98	-0.64	-155.56	1.24	-225.04
16	22	-25.17	-44.98	0.64	155.56	-1.15	231.00
17	22	25.17	44.98	-0.64	-155.56	1.15	-231.00
17	23	-25.17	-44.98	0.64	155.56	-0.62	268.13
18	23	25.17	-60.59	-0.64	11.59	0.62	-268.13
18	6	-25.17	60.59	0.64	-11.59	0.45	166.67
19	6	30.96	140.57	-0.88	15.06	1.32	-104.92
19	24	-30.96	-140.57	0.88	-15.06	-0.42	248.88
20	24	30.96	35.00	-0.88	-152.09	0.42	-248.88
20	25	-30.96	-35.00	0.88	152.09	0.43	282.40
21	25	30.96	-70.57	-0.88	15.06	-0.43	-282.40
21	26	-30.96	70.57	0.88	-15.06	0.88	245.84
22	26	30.96	-70.57	-0.88	15.06	-0.88	-245.84
22	27	-30.96	70.57	0.88	-15.06	2.80	91.94
23	27	30.96	-140.95	-0.88	-96.38	-2.80	-91.94
23	8	-30.96	140.95	0.88	96.38	3.08	46.94
24	8	24.40	51.74	-0.67	-98.73	-1.37	-118.43
24	28	-24.40	-51.74	0.67	98.73	1.79	151.47
25	28	24.40	-18.64	-0.67	12.71	-1.79	-151.47
25	29	-24.40	18.64	0.67	-12.71	3.04	116.78
26	29	24.40	-18.64	-0.67	12.71	-3.04	-116.78
26	30	-24.40	18.64	0.67	-12.71	3.60	101.18
27	30	24.40	-89.02	-0.67	-98.73	-3.60	-101.18
27	31	-24.40	89.02	0.67	98.73	4.24	15.91
28	31	24.40	-159.40	-0.67	12.71	-4.24	-15.91
28	10	-24.40	159.40	0.67	-12.71	4.71	-96.43
29	10	12.17	-38.44	-0.02	4.75	-3.18	-36.63
29	32	-12.17	38.44	0.02	-4.75	3.22	-40.03
30	32	12.17	-38.44	-0.02	4.75	-3.22	40.03
30	33	-12.17	38.44	0.02	-4.75	3.24	-59.48
31	33	12.17	-38.44	-0.02	4.75	-3.24	59.48
31	34	-12.17	38.44	0.02	-4.75	3.24	-76.85
32	34	12.17	-38.44	-0.02	4.75	-3.24	76.85
32	12	-12.17	38.44	0.02	-4.75	3.29	-155.59
33	12	4.14	3.84	0.15	1.06	-1.96	66.72
33	35	-4.14	-3.84	-0.15	-1.06	1.87	-64.22

34	35	4.14	3.84	0.15	1.06	-1.87	64.22
34	36	-4.14	-3.84	-0.15	-1.06	1.73	-60.54
35	36	4.14	3.84	0.15	1.06	-1.73	60.54
35	37	-4.14	-3.84	-0.15	-1.06	1.59	-57.11
36	37	4.14	3.84	0.15	1.06	-1.59	57.11
36	38	-4.14	-3.84	-0.15	-1.06	1.33	-50.17
37	38	4.14	3.84	0.15	1.06	-1.33	50.17
37	14	-4.14	-3.84	-0.15	-1.06	1.23	-47.50
38	14	0.00	0.00	0.00	0.00	0.00	0.00
38	39	0.00	0.00	0.00	0.00	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: (L+In)2 Name: (no impact) Unbalanced

No impact factor is included in the individual live load.

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	6.02	13.88	-2.80	-115.15	-0.55	-31.14
1	2	-6.02	-13.88	2.80	70.39	0.55	-65.24
2	3	9.18	69.83	-0.40	-107.18	-1.07	-48.08
2	4	-9.18	-69.83	0.40	100.85	1.07	-98.77
3	5	4.35	123.17	3.50	-85.40	-2.51	-23.05
3	6	-4.35	-123.17	-3.50	141.41	2.51	-46.60
4	7	-3.52	123.19	3.51	-83.25	-4.56	18.01
4	8	3.52	-123.19	-3.51	139.48	4.56	38.26
5	9	-7.63	80.88	1.03	-93.26	-6.26	39.19
5	10	7.63	-80.88	-1.03	109.79	6.26	82.85
6	11	-5.47	29.85	-2.13	-106.18	-6.99	27.30
6	12	5.47	-29.85	2.13	72.08	6.99	60.24
7	13	-2.94	-1.47	-2.72	-105.21	-6.98	13.66
7	14	2.94	1.47	2.72	61.63	6.98	33.37
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	6.02	13.88	-2.80	-70.39	-0.55	65.24
10	17	-6.02	-13.88	2.80	70.39	3.03	-52.92
11	17	6.02	13.88	-2.80	-70.39	-3.03	52.92
11	18	-6.02	-13.88	2.80	70.39	7.20	-32.26
12	18	6.02	13.88	-2.80	-70.39	-7.20	32.26
12	19	-6.02	-13.88	2.80	70.39	10.59	-15.45
13	19	6.02	13.88	-2.80	-70.39	-10.59	15.45
13	20	-6.02	-13.88	2.80	70.39	13.27	-2.15
14	20	6.02	13.88	-2.80	-70.39	-13.27	2.15
14	4	-6.02	-13.88	2.80	70.39	14.19	2.45
15	4	15.20	83.72	-3.19	-171.23	-15.26	96.32
15	21	-15.20	-83.72	3.19	171.23	22.82	101.88
16	21	15.20	83.72	-3.19	-171.23	-22.82	-101.88
16	22	-15.20	-83.72	3.19	171.23	23.24	112.97
17	22	15.20	83.72	-3.19	-171.23	-23.24	-112.97
17	23	-15.20	-83.72	3.19	171.23	25.88	182.07
18	23	15.20	-48.08	-3.19	37.45	-25.88	-182.07
18	6	-15.20	48.08	3.19	-37.45	31.23	101.55
19	6	19.55	75.09	0.31	-103.96	-33.74	-54.95
19	24	-19.55	-75.09	-0.31	103.96	33.42	131.85
20	24	19.55	75.09	0.31	-103.96	-33.42	-131.85
20	25	-19.55	-75.09	-0.31	103.96	33.13	203.77
21	25	19.55	-56.71	0.31	104.73	-33.13	-203.77
21	26	-19.55	56.71	-0.31	-104.73	32.97	174.40
22	26	19.55	-56.71	0.31	104.73	-32.97	-174.40
22	27	-19.55	56.71	-0.31	-104.73	32.30	50.72

23	27	19.55	-56.71	0.31	104.73	-32.30	-50.72
23	8	-19.55	56.71	-0.31	-104.73	32.20	32.61
24	8	16.04	66.48	3.82	-34.75	-36.77	-70.87
24	28	-16.04	-66.48	-3.82	34.75	34.33	113.33
25	28	16.04	-21.39	3.82	104.37	-34.33	-113.33
25	29	-16.04	21.39	-3.82	-104.37	27.21	73.51
26	29	16.04	-21.39	3.82	104.37	-27.21	-73.51
26	30	-16.04	21.39	-3.82	-104.37	24.01	55.59
27	30	16.04	-21.39	3.82	104.37	-24.01	-55.59
27	31	-16.04	21.39	-3.82	-104.37	20.35	35.10
28	31	16.04	-109.26	3.82	243.50	-20.35	-35.10
28	10	-16.04	109.26	-3.82	-243.50	17.66	-41.91
29	10	8.41	-28.38	4.85	133.71	-23.92	-40.94
29	32	-8.41	28.38	-4.85	-133.71	14.24	-15.65
30	32	8.41	-28.38	4.85	133.71	-14.24	15.65
30	33	-8.41	28.38	-4.85	-133.71	11.78	-30.01
31	33	8.41	-28.38	4.85	133.71	-11.78	30.01
31	34	-8.41	28.38	-4.85	-133.71	9.59	-42.84
32	34	8.41	-28.38	4.85	133.71	-9.59	42.84
32	12	-8.41	28.38	-4.85	-133.71	-0.36	-100.97
33	12	2.94	1.47	2.72	61.63	-6.64	40.73
33	35	-2.94	-1.47	-2.72	-61.63	4.86	-39.77
34	35	2.94	1.47	2.72	61.63	-4.86	39.77
34	36	-2.94	-1.47	-2.72	-61.63	2.26	-38.36
35	36	2.94	1.47	2.72	61.63	-2.26	38.36
35	37	-2.94	-1.47	-2.72	-61.63	-0.17	-37.05
36	37	2.94	1.47	2.72	61.63	0.17	37.05
36	38	-2.94	-1.47	-2.72	-61.63	-5.09	-34.39
37	38	2.94	1.47	2.72	61.63	5.09	34.39
37	14	-2.94	-1.47	-2.72	-61.63	-6.98	-33.37
38	14	0.00	0.00	0.00	0.00	0.00	0.00
38	39	0.00	0.00	0.00	0.00	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: CF1 Name: Balanced

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	1.97	5.85	0.83	14.65	0.29	-17.45
1	2	-1.97	-5.85	-0.83	-1.32	-0.29	-14.04
2	3	2.69	3.47	0.82	14.95	0.37	-22.41
2	4	-2.69	-3.47	-0.82	-1.75	-0.37	-20.57
3	5	2.62	2.15	0.81	14.61	0.44	-22.02
3	6	-2.62	-2.15	-0.81	-1.73	-0.44	-19.92
4	7	2.54	-0.18	0.79	14.24	0.48	-21.52
4	8	-2.54	0.18	-0.79	-1.65	-0.48	-19.14
5	9	2.79	-1.35	0.73	13.64	0.49	-22.76
5	10	-2.79	1.35	-0.73	-1.99	-0.49	-21.82
6	11	2.61	-1.97	0.68	13.11	0.48	-21.76
6	12	-2.61	1.97	-0.68	-2.19	-0.48	-19.94
7	13	2.13	-4.97	0.62	12.49	0.47	-19.21
7	14	-2.13	4.97	-0.62	-2.58	-0.47	-14.88
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-1.18	0.00	-0.36	-0.90	0.00	2.95
9	2	1.18	0.00	0.36	0.90	0.03	-2.95
10	2	0.79	5.85	0.47	0.42	0.26	16.99
10	17	-0.79	-5.85	-0.47	-0.42	-0.68	-11.80
11	17	-0.39	5.85	0.11	-0.48	0.68	14.75
11	18	0.39	-5.85	-0.11	0.48	-0.85	-6.05

12	18	-0.39	5.85	0.11	-0.48	0.85	6.05
12	19	0.39	-5.85	-0.11	0.48	-0.99	1.04
13	19	-1.57	5.85	-0.25	-1.38	0.99	1.91
13	20	1.57	-5.85	0.25	1.38	-0.75	3.69
14	20	-2.75	5.85	-0.61	-2.28	0.75	-0.74
14	4	2.75	-5.85	0.61	2.28	-0.55	2.68
15	4	-0.07	9.32	0.22	-0.53	0.92	17.89
15	21	0.07	-9.32	-0.22	0.53	-1.43	4.18
16	21	-1.25	7.07	-0.14	-4.99	1.43	-1.23
16	22	1.25	-7.07	0.14	4.99	-1.42	2.17
17	22	-1.25	7.07	-0.14	-4.99	1.42	-2.17
17	23	1.25	-7.07	0.14	4.99	-1.30	8.01
18	23	-2.43	4.82	-0.50	-2.33	1.30	-5.06
18	6	2.43	-4.82	0.50	2.33	-0.46	13.13
19	6	0.20	6.97	0.30	-0.60	0.89	6.79
19	24	-0.20	-6.97	-0.30	0.60	-1.20	0.35
20	24	-0.98	4.72	-0.06	-5.06	1.20	2.60
20	25	0.98	-4.72	0.06	5.06	-1.15	1.93
21	25	-2.16	2.47	-0.42	-2.40	1.15	1.02
21	26	2.16	-2.47	0.42	2.40	-0.93	0.26
22	26	-2.16	2.47	-0.42	-2.40	0.93	-0.26
22	27	2.16	-2.47	0.42	2.40	-0.03	5.65
23	27	-2.95	3.97	-0.66	-0.63	0.03	-3.68
23	8	2.95	-3.97	0.66	0.63	0.18	4.95
24	8	-0.41	3.79	0.13	1.02	0.30	14.19
24	28	0.41	-3.79	-0.13	-1.02	-0.38	-11.77
25	28	-1.20	5.29	-0.11	-1.96	0.38	13.75
25	29	1.20	-5.29	0.11	1.96	-0.18	-3.90
26	29	-1.20	5.29	-0.11	-1.96	0.18	3.90
26	30	1.20	-5.29	0.11	1.96	-0.09	0.53
27	30	-1.99	6.79	-0.35	-0.18	0.09	1.44
27	31	1.99	-6.79	0.35	0.18	0.25	5.06
28	31	-2.78	8.29	-0.59	-3.16	-0.25	-3.09
28	10	2.78	-8.29	0.59	3.16	0.66	8.93
29	10	0.00	6.94	0.14	-1.17	-0.18	12.88
29	32	-0.00	-6.94	-0.14	1.17	-0.10	0.96
30	32	-0.79	6.94	-0.10	-1.77	0.10	1.02
30	33	0.79	-6.94	0.10	1.77	-0.05	2.49
31	33	-0.79	6.94	-0.10	-1.77	0.05	-2.49
31	34	0.79	-6.94	0.10	1.77	-0.00	5.63
32	34	-1.58	6.94	-0.34	-2.37	0.00	-3.66
32	12	1.58	-6.94	0.34	2.37	0.70	17.87
33	12	1.03	4.97	0.34	-0.18	-0.22	2.07
33	35	-1.03	-4.97	-0.34	0.18	-0.00	1.17
34	35	0.24	4.97	0.10	-0.78	0.00	0.81
34	36	-0.24	-4.97	-0.10	0.78	-0.10	3.95
35	36	-0.55	4.97	-0.14	-1.38	0.10	-1.98
35	37	0.55	-4.97	0.14	1.38	0.02	6.41
36	37	-0.55	4.97	-0.14	-1.38	-0.02	-6.41
36	38	0.55	-4.97	0.14	1.38	0.27	15.39
37	38	-1.34	4.97	-0.38	-1.98	-0.27	-13.41
37	14	1.34	-4.97	0.38	1.98	0.54	16.85
38	14	0.79	0.00	0.24	0.60	-0.06	-1.98
38	39	-0.79	0.00	-0.24	-0.60	0.00	1.98
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: CF2 Name: Unbalanced

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft

1	1	1.24	3.53	0.49	8.13	-0.05	-10.92
1	2	-1.24	-3.53	-0.49	-0.34	0.05	-8.90
2	3	1.68	2.11	0.55	8.77	-0.04	-13.97
2	4	-1.68	-2.11	-0.55	-0.03	0.04	-12.85
3	5	1.66	1.43	0.58	8.94	-0.00	-13.84
3	6	-1.66	-1.43	-0.58	0.29	0.00	-12.67
4	7	1.57	0.03	0.46	8.33	0.03	-13.34
4	8	-1.57	-0.03	-0.46	-0.91	-0.03	-11.77
5	9	1.72	-0.84	0.40	7.96	0.05	-14.12
5	10	-1.72	0.84	-0.40	-1.58	-0.05	-13.44
6	11	1.63	-1.26	0.41	8.01	0.06	-13.61
6	12	-1.63	1.26	-0.41	-1.38	-0.06	-12.48
7	13	1.32	-3.15	0.41	7.96	0.06	-11.98
7	14	-1.32	3.15	-0.41	-1.36	-0.06	-9.21
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	1.24	3.53	0.49	0.34	-0.05	8.90
10	17	-1.24	-3.53	-0.49	-0.34	-0.38	-5.77
11	17	-0.24	3.53	0.04	-0.79	0.38	9.47
11	18	0.24	-3.53	-0.04	0.79	-0.43	-4.21
12	18	-0.24	3.53	0.04	-0.79	0.43	4.21
12	19	0.24	-3.53	-0.04	0.79	-0.48	0.07
13	19	-0.24	3.53	0.04	-0.79	0.48	-0.07
13	20	0.24	-3.53	-0.04	0.79	-0.52	3.46
14	20	-1.72	3.53	-0.41	-1.91	0.52	0.24
14	4	1.72	-3.53	0.41	1.91	-0.38	0.93
15	4	-0.04	5.64	0.13	-1.88	0.34	11.92
15	21	0.04	-5.64	-0.13	1.88	-0.66	1.44
16	21	-0.04	5.64	0.13	-1.88	0.66	-1.44
16	22	0.04	-5.64	-0.13	1.88	-0.68	2.19
17	22	-0.04	5.64	0.13	-1.88	0.68	-2.19
17	23	0.04	-5.64	-0.13	1.88	-0.79	6.84
18	23	-1.52	2.83	-0.32	1.44	0.79	-3.14
18	6	1.52	-2.83	0.32	-1.44	-0.26	7.89
19	6	0.13	4.27	0.26	1.15	0.25	4.78
19	24	-0.13	-4.27	-0.26	-1.15	-0.52	-0.40
20	24	0.13	4.27	0.26	1.15	0.52	0.40
20	25	-0.13	-4.27	-0.26	-1.15	-0.77	3.68
21	25	-1.35	1.46	-0.19	4.48	0.77	0.02
21	26	1.35	-1.46	0.19	-4.48	-0.67	0.74
22	26	-1.35	1.46	-0.19	4.48	0.67	-0.74
22	27	1.35	-1.46	0.19	-4.48	-0.26	3.91
23	27	-1.35	1.46	-0.19	4.48	0.26	-3.91
23	8	1.35	-1.46	0.19	-4.48	-0.20	4.38
24	8	0.22	1.49	0.27	5.39	0.23	7.39
24	28	-0.22	-1.49	-0.27	-5.39	-0.40	-6.44
25	28	-0.76	3.37	-0.03	1.66	0.40	8.89
25	29	0.76	-3.37	0.03	-1.66	-0.35	-2.62
26	29	-0.76	3.37	-0.03	1.66	0.35	2.62
26	30	0.76	-3.37	0.03	-1.66	-0.33	0.20
27	30	-0.76	3.37	-0.03	1.66	0.33	-0.20
27	31	0.76	-3.37	0.03	-1.66	-0.31	3.42
28	31	-1.74	5.25	-0.33	-2.07	0.31	-0.97
28	10	1.74	-5.25	0.33	2.07	-0.08	4.67
29	10	-0.02	4.41	0.07	-0.49	0.13	8.77
29	32	0.02	-4.41	-0.07	0.49	-0.27	0.03
30	32	-0.02	4.41	0.07	-0.49	0.27	-0.03
30	33	0.02	-4.41	-0.07	0.49	-0.31	2.26
31	33	-0.02	4.41	0.07	-0.49	0.31	-2.26
31	34	0.02	-4.41	-0.07	0.49	-0.34	4.26
32	34	-1.00	4.41	-0.23	-1.24	0.34	-1.81

32	12	1.00	-4.41	0.23	1.24	0.12	10.84
33	12	0.64	3.15	0.19	0.14	-0.06	1.64
33	35	-0.64	-3.15	-0.19	-0.14	-0.06	0.41
34	35	0.64	3.15	0.19	0.14	0.06	-0.41
34	36	-0.64	-3.15	-0.19	-0.14	-0.24	3.43
35	36	-0.34	3.15	-0.11	-0.61	0.24	-0.98
35	37	0.34	-3.15	0.11	0.61	-0.14	3.79
36	37	-0.34	3.15	-0.11	-0.61	0.14	-3.79
36	38	0.34	-3.15	0.11	0.61	0.07	9.48
37	38	-0.34	3.15	-0.11	-0.61	-0.07	-9.48
37	14	0.34	-3.15	0.11	0.61	0.14	11.66
38	14	0.98	0.00	0.30	0.75	-0.08	-2.45
38	39	-0.98	0.00	-0.30	-0.75	0.00	2.45
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: LF1 Name: Balanced

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	4.00	10.97	16.02	286.97	2.73	-34.17
1	2	-4.00	-10.97	-16.02	-30.69	-2.73	-29.75
2	3	5.57	9.76	16.33	297.33	3.81	-44.71
2	4	-5.57	-9.76	-16.33	-35.98	-3.81	-44.45
3	5	5.56	11.75	15.99	292.90	5.00	-44.63
3	6	-5.56	-11.75	-15.99	-37.11	-5.00	-44.36
4	7	4.99	10.99	15.64	287.76	6.00	-41.54
4	8	-4.99	-10.99	-15.64	-37.58	-6.00	-38.22
5	9	4.52	6.81	15.22	281.85	6.48	-39.04
5	10	-4.52	-6.81	-15.22	-38.35	-6.48	-33.23
6	11	4.24	0.17	14.56	274.43	6.66	-37.57
6	12	-4.24	-0.17	-14.56	-41.55	-6.66	-30.27
7	13	3.61	-9.33	13.65	265.66	6.74	-34.21
7	14	-3.61	9.33	-13.65	-47.25	-6.74	-23.53
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-2.06	0.00	-6.80	-17.00	0.00	5.15
9	2	2.06	0.00	6.80	17.00	0.48	-5.15
10	2	1.94	10.97	9.22	13.69	2.25	34.90
10	17	-1.94	-10.97	-9.22	-13.69	-10.43	-25.17
11	17	-0.12	10.97	2.42	-3.31	10.43	30.32
11	18	0.12	-10.97	-2.42	3.31	-14.02	-14.00
12	18	-0.12	10.97	2.42	-3.31	14.02	14.00
12	19	0.12	-10.97	-2.42	3.31	-16.95	-0.73
13	19	-2.18	10.97	-4.38	-20.31	16.95	5.88
13	20	2.18	-10.97	4.38	20.31	-12.75	4.63
14	20	-4.24	10.97	-11.18	-37.31	12.75	0.52
14	4	4.24	-10.97	11.18	37.31	-9.05	3.11
15	4	1.33	20.73	5.15	-1.33	12.85	41.34
15	21	-1.33	-20.73	-5.15	1.33	-25.05	7.74
16	21	-0.73	14.56	-1.65	-28.10	25.05	-2.59
16	22	0.73	-14.56	1.65	28.10	-24.83	4.52
17	22	-0.73	14.56	-1.65	-28.10	24.83	-4.52
17	23	0.73	-14.56	1.65	28.10	-23.47	16.53
18	23	-2.79	8.39	-8.45	-35.33	23.47	-11.38
18	6	2.79	-8.39	8.45	35.33	-9.32	25.44
19	6	2.77	20.14	7.54	1.77	14.32	18.93
19	24	-2.77	-20.14	-7.54	-1.77	-22.04	1.70
20	24	0.71	13.97	0.74	-25.00	22.04	3.45
20	25	-0.71	-13.97	-0.74	25.00	-22.75	9.94
21	25	-1.35	7.80	-6.06	-32.23	22.75	-4.79

21	26	1.35	-7.80	6.06	32.23	-19.61	8.83
22	26	-1.35	7.80	-6.06	-32.23	19.61	-8.83
22	27	1.35	-7.80	6.06	32.23	-6.39	25.84
23	27	-2.95	3.69	-11.36	-51.99	6.39	-21.84
23	8	2.95	-3.69	11.36	51.99	-2.77	23.02
24	8	2.03	14.68	4.28	-14.40	8.77	15.20
24	28	-2.03	-14.68	-4.28	14.40	-11.50	-5.83
25	28	0.43	10.57	-1.02	-21.15	11.50	9.83
25	29	-0.43	-10.57	1.02	21.15	-9.59	9.85
26	29	0.43	10.57	-1.02	-21.15	9.59	-9.85
26	30	-0.43	-10.57	1.02	21.15	-8.73	18.70
27	30	-1.17	6.46	-6.32	-40.90	8.73	-14.70
27	31	1.17	-6.46	6.32	40.90	-2.67	20.89
28	31	-2.77	2.35	-11.62	-47.65	2.67	-16.89
28	10	2.77	-2.35	11.62	47.65	5.52	18.55
29	10	1.75	9.16	3.59	-9.30	0.96	14.69
29	32	-1.75	-9.16	-3.59	9.30	-8.13	3.58
30	32	0.15	9.16	-1.71	-22.55	8.13	0.42
30	33	-0.15	-9.16	1.71	22.55	-7.26	4.22
31	33	0.15	9.16	-1.71	-22.55	7.26	-4.22
31	34	-0.15	-9.16	1.71	22.55	-6.49	8.36
32	34	-1.45	9.16	-7.01	-35.80	6.49	-4.36
32	12	1.45	-9.16	7.01	35.80	7.86	23.13
33	12	2.79	9.33	7.55	5.75	-1.19	7.14
33	35	-2.79	-9.33	-7.55	-5.75	-3.72	-1.07
34	35	1.19	9.33	2.25	-7.50	3.72	5.07
34	36	-1.19	-9.33	-2.25	7.50	-5.87	3.87
35	36	-0.41	9.33	-3.05	-20.75	5.87	0.13
35	37	0.41	-9.33	3.05	20.75	-3.15	8.20
36	37	-0.41	9.33	-3.05	-20.75	3.15	-8.20
36	38	0.41	-9.33	3.05	20.75	2.36	25.06
37	38	-2.01	9.33	-8.35	-34.00	-2.36	-21.06
37	14	2.01	-9.33	8.35	34.00	8.15	27.53
38	14	1.60	0.00	5.30	13.25	-1.40	-4.00
38	39	-1.60	0.00	-5.30	-13.25	0.00	4.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: LF2 Name: Unbalanced

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	2.49	6.53	9.38	167.08	-0.07	-21.28
1	2	-2.49	-6.53	-9.38	-17.07	0.07	-18.62
2	3	3.46	5.76	9.89	175.91	0.46	-27.77
2	4	-3.46	-5.76	-9.89	-17.62	-0.46	-27.59
3	5	3.51	7.24	10.08	176.40	1.26	-28.04
3	6	-3.51	-7.24	-10.08	-15.13	-1.26	-28.14
4	7	3.15	7.06	9.97	174.90	1.87	-26.11
4	8	-3.15	-7.06	-9.97	-15.31	-1.87	-24.25
5	9	2.82	4.59	9.66	172.05	2.13	-24.39
5	10	-2.82	-4.59	-9.66	-17.43	-2.13	-20.76
6	11	2.63	0.33	9.24	168.54	2.17	-23.38
6	12	-2.63	-0.33	-9.24	-20.65	-2.17	-18.69
7	13	2.22	-5.84	8.83	165.07	2.16	-21.19
7	14	-2.22	5.84	-8.83	-23.77	-2.16	-14.26
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	2.49	6.53	9.38	17.07	-0.07	18.62

10	17	-2.49	-6.53	-9.38	-17.07	-8.25	-12.82
11	17	-0.08	6.53	0.89	-4.15	8.25	19.25
11	18	0.08	-6.53	-0.89	4.15	-9.57	-9.53
12	18	-0.08	6.53	0.89	-4.15	9.57	9.53
12	19	0.08	-6.53	-0.89	4.15	-10.64	-1.62
13	19	-0.08	6.53	0.89	-4.15	10.64	1.62
13	20	0.08	-6.53	-0.89	4.15	-11.49	4.64
14	20	-2.65	6.53	-7.60	-25.38	11.49	1.78
14	4	2.65	-6.53	7.60	25.38	-8.97	0.38
15	4	0.81	12.29	2.29	-7.76	9.43	27.21
15	21	-0.81	-12.29	-2.29	7.76	-14.85	1.90
16	21	0.81	12.29	2.29	-7.76	14.85	-1.90
16	22	-0.81	-12.29	-2.29	7.76	-15.15	3.53
17	22	0.81	12.29	2.29	-7.76	15.15	-3.53
17	23	-0.81	-12.29	-2.29	7.76	-17.04	13.68
18	23	-1.76	4.59	-6.20	-16.79	17.04	-7.25
18	6	1.76	-4.59	6.20	16.79	-6.66	14.94
19	6	1.76	11.83	3.88	-1.67	7.92	13.20
19	24	-1.76	-11.83	-3.88	1.67	-11.89	-1.08
20	24	1.76	11.83	3.88	-1.67	11.89	1.08
20	25	-1.76	-11.83	-3.88	1.67	-15.60	10.25
21	25	-0.81	4.13	-4.61	-10.70	15.60	-3.83
21	26	0.81	-4.13	4.61	10.70	-13.21	5.97
22	26	-0.81	4.13	-4.61	-10.70	13.21	-5.97
22	27	0.81	-4.13	4.61	10.70	-3.16	14.98
23	27	-0.81	4.13	-4.61	-10.70	3.16	-14.98
23	8	0.81	-4.13	4.61	10.70	-1.69	16.30
24	8	2.33	11.20	5.36	4.61	3.56	7.95
24	28	-2.33	-11.20	-5.36	-4.61	-6.98	-0.80
25	28	0.33	6.06	-1.26	-3.80	6.98	5.80
25	29	-0.33	-6.06	1.26	3.80	-4.64	5.48
26	29	0.33	6.06	-1.26	-3.80	4.64	-5.48
26	30	-0.33	-6.06	1.26	3.80	-3.59	10.55
27	30	0.33	6.06	-1.26	-3.80	3.59	-10.55
27	31	-0.33	-6.06	1.26	3.80	-2.38	16.35
28	31	-1.67	0.92	-7.88	-12.21	2.38	-11.35
28	10	1.67	-0.92	7.88	12.21	3.17	11.99
29	10	1.15	5.51	1.79	5.22	-1.04	8.76
29	32	-1.15	-5.51	-1.79	-5.22	-2.52	2.22
30	32	1.15	5.51	1.79	5.22	2.52	-2.22
30	33	-1.15	-5.51	-1.79	-5.22	-3.42	5.01
31	33	1.15	5.51	1.79	5.22	3.42	-5.01
31	34	-1.15	-5.51	-1.79	-5.22	-4.23	7.50
32	34	-0.85	5.51	-4.83	-11.33	4.23	-2.50
32	12	0.85	-5.51	4.83	11.33	5.67	13.78
33	12	1.78	5.84	4.41	9.33	-3.51	4.91
33	35	-1.78	-5.84	-4.41	-9.33	0.64	-1.12
34	35	1.78	5.84	4.41	9.33	-0.64	1.12
34	36	-1.78	-5.84	-4.41	-9.33	-3.59	4.47
35	36	-0.22	5.84	-2.21	-7.22	3.59	0.53
35	37	0.22	-5.84	2.21	7.22	-1.61	4.67
36	37	-0.22	5.84	-2.21	-7.22	1.61	-4.67
36	38	0.22	-5.84	2.21	7.22	2.38	15.22
37	38	-0.22	5.84	-2.21	-7.22	-2.38	-15.22
37	14	0.22	-5.84	2.21	7.22	3.91	19.26
38	14	2.00	0.00	6.62	16.55	-1.75	-5.00
38	39	-2.00	0.00	-6.62	-16.55	0.00	5.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: (L+Ip)1 Name: Derail - Balanced

Report

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	24.32	250.89	-1.51	-3.78	2.71	-139.71
1	2	-24.32	-250.89	1.51	-20.32	-2.71	-249.46
2	3	8.90	383.60	0.41	4.96	2.97	-60.21
2	4	-8.90	-383.60	-0.41	1.67	-2.97	-82.17
3	5	-9.15	335.42	0.25	2.41	2.70	34.53
3	6	9.15	-335.42	-0.25	1.60	-2.70	111.95
4	7	-14.78	216.22	0.59	2.75	2.29	63.42
4	8	14.78	-216.22	-0.59	6.69	-2.29	173.08
5	9	-9.95	86.00	0.52	1.14	1.85	37.21
5	10	9.95	-86.00	-0.52	7.12	-1.85	121.95
6	11	-1.12	13.54	0.03	-2.43	1.54	-9.84
6	12	1.12	-13.54	-0.03	2.95	-1.54	27.78
7	13	1.78	-18.84	-0.30	-5.05	1.40	-25.24
7	14	-1.78	18.84	0.30	0.28	-1.40	-3.28
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	24.32	250.89	-1.51	20.32	2.71	249.46
10	17	-24.32	-250.89	1.51	-20.32	-1.37	-26.88
11	17	24.32	250.89	-1.51	20.32	1.37	26.88
11	18	-24.32	-250.89	1.51	-20.32	0.87	346.40
12	18	24.32	250.89	-1.51	20.32	-0.87	-346.40
12	19	-24.32	-250.89	1.51	-20.32	2.70	650.21
13	19	24.32	-65.81	-1.51	-481.12	-2.70	-650.21
13	20	-24.32	65.81	1.51	481.12	4.14	587.17
14	20	24.32	-382.51	-1.51	20.32	-4.14	-587.17
14	4	-24.32	382.51	1.51	-20.32	4.64	460.48
15	4	33.22	1.09	-1.09	18.65	-1.67	-378.30
15	21	-33.22	-1.09	1.09	-18.65	4.25	380.88
16	21	33.22	-104.48	-1.09	-148.50	-4.25	-380.88
16	22	-33.22	104.48	1.09	148.50	4.40	367.04
17	22	33.22	-104.48	-1.09	-148.50	-4.40	-367.04
17	23	-33.22	104.48	1.09	148.50	5.30	280.80
18	23	33.22	-210.05	-1.09	18.65	-5.30	-280.80
18	6	-33.22	210.05	1.09	-18.65	7.13	-70.96
19	6	24.07	125.37	-0.84	17.05	-4.43	-40.99
19	24	-24.07	-125.37	0.84	-17.05	5.30	169.38
20	24	24.07	19.80	-0.84	-150.10	-5.30	-169.38
20	25	-24.07	-19.80	0.84	150.10	6.10	188.34
21	25	24.07	-85.77	-0.84	17.05	-6.10	-188.34
21	26	-24.07	85.77	0.84	-17.05	6.54	143.91
22	26	24.07	-85.77	-0.84	17.05	-6.54	-143.91
22	27	-24.07	85.77	0.84	-17.05	8.37	-43.14
23	27	24.07	-191.34	-0.84	-150.10	-8.37	43.14
23	8	-24.07	191.34	0.84	150.10	8.64	-104.22
24	8	9.29	24.87	-0.25	-156.80	-6.35	-68.86
24	28	-9.29	-24.87	0.25	156.80	6.51	84.75
25	28	9.29	-80.70	-0.25	10.36	-6.51	-84.75
25	29	-9.29	80.70	0.25	-10.36	6.98	-65.46
26	29	9.29	-80.70	-0.25	10.36	-6.98	65.46
26	30	-9.29	80.70	0.25	-10.36	7.19	-133.04
27	30	9.29	-80.70	-0.25	10.36	-7.19	133.04
27	31	-9.29	80.70	0.25	-10.36	7.43	-210.33
28	31	9.29	-80.70	-0.25	10.36	-7.43	210.33
28	10	-9.29	80.70	0.25	-10.36	7.61	-267.20
29	10	-0.66	5.31	0.26	3.24	-5.75	145.25
29	32	0.66	-5.31	-0.26	-3.24	5.23	-134.67
30	32	-0.66	5.31	0.26	3.24	-5.23	134.67
30	33	0.66	-5.31	-0.26	-3.24	5.09	-131.98

31	33	-0.66	5.31	0.26	3.24	-5.09	131.98
31	34	0.66	-5.31	-0.26	-3.24	4.97	-129.58
32	34	-0.66	5.31	0.26	3.24	-4.97	129.58
32	12	0.66	-5.31	-0.26	-3.24	4.43	-118.71
33	12	-1.78	18.84	0.30	0.28	-2.89	90.93
33	35	1.78	-18.84	-0.30	-0.28	2.70	-78.68
34	35	-1.78	18.84	0.30	0.28	-2.70	78.68
34	36	1.78	-18.84	-0.30	-0.28	2.41	-60.63
35	36	-1.78	18.84	0.30	0.28	-2.41	60.63
35	37	1.78	-18.84	-0.30	-0.28	2.15	-43.83
36	37	-1.78	18.84	0.30	0.28	-2.15	43.83
36	38	1.78	-18.84	-0.30	-0.28	1.61	-9.77
37	38	-1.78	18.84	0.30	0.28	-1.61	9.77
37	14	1.78	-18.84	-0.30	-0.28	1.40	3.28
38	14	0.00	0.00	0.00	0.00	0.00	0.00
38	39	0.00	0.00	0.00	0.00	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: (L+Ip)2 Name: Derail - Unbalanced

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	15.78	137.66	-2.24	-223.09	-18.36	-88.88
1	2	-15.78	-137.66	2.24	187.28	18.36	-163.60
2	3	7.74	234.67	7.09	-172.35	-21.99	-47.49
2	4	-7.74	-234.67	-7.09	285.77	21.99	-76.31
3	5	-5.62	214.92	4.47	-172.68	-24.43	22.65
3	6	5.62	-214.92	-4.47	244.13	24.43	67.26
4	7	-9.42	143.58	1.61	-172.95	-26.18	42.11
4	8	9.42	-143.58	-1.61	198.73	26.18	108.66
5	9	-7.36	60.19	-3.31	-183.63	-26.42	30.70
5	10	7.36	-60.19	3.31	130.68	26.42	87.03
6	11	-1.60	10.98	-4.72	-175.87	-25.41	-0.04
6	12	1.60	-10.98	4.72	100.35	25.41	25.71
7	13	0.49	-11.20	-2.90	-151.55	-24.34	-11.17
7	14	-0.49	11.20	2.90	105.18	24.34	3.38
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	15.78	137.66	-2.24	-187.28	-18.36	163.60
10	17	-15.78	-137.66	2.24	187.28	20.35	-41.47
11	17	15.78	137.66	-2.24	-187.28	-20.35	41.47
11	18	-15.78	-137.66	2.24	187.28	23.68	163.35
12	18	15.78	137.66	-2.24	-187.28	-23.68	-163.35
12	19	-15.78	-137.66	2.24	187.28	26.39	330.05
13	19	15.78	137.66	-2.24	-187.28	-26.39	-330.05
13	20	-15.78	-137.66	2.24	187.28	28.53	461.91
14	20	15.78	-257.75	-2.24	438.79	-28.53	-461.91
14	4	-15.78	257.75	2.24	-438.79	29.27	376.54
15	4	23.52	-23.08	4.85	153.02	-51.27	-300.24
15	21	-23.52	23.08	-4.85	-153.02	39.78	245.60
16	21	23.52	-23.08	4.85	153.02	-39.78	-245.60
16	22	-23.52	23.08	-4.85	-153.02	39.14	242.54
17	22	23.52	-23.08	4.85	153.02	-39.14	-242.54
17	23	-23.52	23.08	-4.85	-153.02	35.14	223.49
18	23	23.52	-154.88	4.85	361.70	-35.14	-223.49
18	6	-23.52	154.88	-4.85	-361.70	27.02	-35.86
19	6	17.90	60.05	9.32	117.57	-51.45	-31.39
19	24	-17.90	-60.05	-9.32	-117.57	41.91	92.89

20	24	17.90	60.05	9.32	117.57	-41.91	-92.89
20	25	-17.90	-60.05	-9.32	-117.57	32.98	150.41
21	25	17.90	-71.75	9.32	326.25	-32.98	-150.41
21	26	-17.90	71.75	-9.32	-326.25	28.16	113.24
22	26	17.90	-71.75	9.32	326.25	-28.16	-113.24
22	27	-17.90	71.75	-9.32	-326.25	7.84	-43.24
23	27	17.90	-71.75	9.32	326.25	-7.84	43.24
23	8	-17.90	71.75	-9.32	-326.25	4.87	-66.15
24	8	8.48	71.82	10.93	127.52	-31.05	-42.51
24	28	-8.48	-71.82	-10.93	-127.52	24.07	88.38
25	28	8.48	-59.98	10.93	336.21	-24.07	-88.38
25	29	-8.48	59.98	-10.93	-336.21	3.73	-23.25
26	29	8.48	-59.98	10.93	336.21	-3.73	23.25
26	30	-8.48	59.98	-10.93	-336.21	-5.42	-73.48
27	30	8.48	-59.98	10.93	336.21	5.42	73.48
27	31	-8.48	59.98	-10.93	-336.21	-15.88	-130.92
28	31	8.48	-59.98	10.93	336.21	15.88	130.92
28	10	-8.48	59.98	-10.93	-336.21	-23.59	-173.19
29	10	1.12	0.22	7.62	205.53	-2.83	86.16
29	32	-1.12	-0.22	-7.62	-205.53	-12.36	-85.73
30	32	1.12	0.22	7.62	205.53	12.36	85.73
30	33	-1.12	-0.22	-7.62	-205.53	-16.21	-85.62
31	33	1.12	0.22	7.62	205.53	16.21	85.62
31	34	-1.12	-0.22	-7.62	-205.53	-19.66	-85.52
32	34	1.12	0.22	7.62	205.53	19.66	85.52
32	12	-1.12	-0.22	-7.62	-205.53	-35.26	-85.08
33	12	-0.49	11.20	2.90	105.18	9.85	59.37
33	35	0.49	-11.20	-2.90	-105.18	-11.74	-52.08
34	35	-0.49	11.20	2.90	105.18	11.74	52.08
34	36	0.49	-11.20	-2.90	-105.18	-14.51	-41.35
35	36	-0.49	11.20	2.90	105.18	14.51	41.35
35	37	0.49	-11.20	-2.90	-105.18	-17.10	-31.37
36	37	-0.49	11.20	2.90	105.18	17.10	31.37
36	38	0.49	-11.20	-2.90	-105.18	-22.33	-11.13
37	38	-0.49	11.20	2.90	105.18	22.33	11.13
37	14	0.49	-11.20	-2.90	-105.18	-24.34	-3.38
38	14	0.00	0.00	0.00	0.00	0.00	0.00
38	39	0.00	0.00	0.00	0.00	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: E1 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-0.00	0.00	0.00	-0.00	0.00	0.00
1	2	-0.00	0.00	0.00	-0.00	0.00	0.00
2	3	-0.00	0.00	0.00	-0.00	0.00	0.00
2	4	-0.00	0.00	0.00	-0.00	0.00	0.00
3	5	-0.00	0.00	0.00	-0.00	0.00	0.00
3	6	-0.00	0.00	0.00	-0.00	0.00	0.00
4	7	-0.00	0.00	0.00	-0.00	0.00	0.00
4	8	-0.00	0.00	0.00	-0.00	0.00	0.00
5	9	-0.00	0.00	0.00	-0.00	0.00	0.00
5	10	-0.00	0.00	0.00	-0.00	0.00	0.00
6	11	-0.00	0.00	0.00	-0.00	0.00	0.00
6	12	-0.00	0.00	0.00	-0.00	0.00	0.00
7	13	-0.00	0.00	0.00	-0.00	0.00	0.00
7	14	-0.00	0.00	0.00	-0.00	0.00	0.00
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00

9	16	0.00	0.00	0.00	0.00	0.00	0.00
9	2	0.00	0.00	0.00	0.00	0.00	0.00
10	2	0.00	0.00	0.00	0.00	0.00	0.00
10	17	0.00	0.00	0.00	0.00	0.00	0.00
11	17	0.00	0.00	0.00	0.00	0.00	0.00
11	18	0.00	0.00	0.00	0.00	0.00	0.00
12	18	0.00	0.00	0.00	0.00	0.00	0.00
12	19	0.00	0.00	0.00	0.00	0.00	0.00
13	19	0.00	0.00	0.00	0.00	0.00	0.00
13	20	0.00	0.00	0.00	0.00	0.00	0.00
14	20	0.00	0.00	0.00	0.00	0.00	0.00
14	4	0.00	0.00	0.00	0.00	0.00	0.00
15	4	0.00	0.00	0.00	0.00	0.00	0.00
15	21	0.00	0.00	0.00	0.00	0.00	0.00
16	21	0.00	0.00	0.00	0.00	0.00	0.00
16	22	0.00	0.00	0.00	0.00	0.00	0.00
17	22	0.00	0.00	0.00	0.00	0.00	0.00
17	23	0.00	0.00	0.00	0.00	0.00	0.00
18	23	0.00	0.00	0.00	0.00	0.00	0.00
18	6	0.00	0.00	0.00	0.00	0.00	0.00
19	6	0.00	0.00	0.00	0.00	0.00	0.00
19	24	0.00	0.00	0.00	0.00	0.00	0.00
20	24	0.00	0.00	0.00	0.00	0.00	0.00
20	25	0.00	0.00	0.00	0.00	0.00	0.00
21	25	0.00	0.00	0.00	0.00	0.00	0.00
21	26	0.00	0.00	0.00	0.00	0.00	0.00
22	26	0.00	0.00	0.00	0.00	0.00	0.00
22	27	0.00	0.00	0.00	0.00	0.00	0.00
23	27	0.00	0.00	0.00	0.00	0.00	0.00
23	8	0.00	0.00	0.00	0.00	0.00	0.00
24	8	0.00	0.00	0.00	0.00	0.00	0.00
24	28	0.00	0.00	0.00	0.00	0.00	0.00
25	28	0.00	0.00	0.00	0.00	0.00	0.00
25	29	0.00	0.00	0.00	0.00	0.00	0.00
26	29	0.00	0.00	0.00	0.00	0.00	0.00
26	30	0.00	0.00	0.00	0.00	0.00	0.00
27	30	0.00	0.00	0.00	0.00	0.00	0.00
27	31	0.00	0.00	0.00	0.00	0.00	0.00
28	31	0.00	0.00	0.00	0.00	0.00	0.00
28	10	0.00	0.00	0.00	0.00	0.00	0.00
29	10	0.00	0.00	0.00	0.00	0.00	0.00
29	32	0.00	0.00	0.00	0.00	0.00	0.00
30	32	0.00	0.00	0.00	0.00	0.00	0.00
30	33	0.00	0.00	0.00	0.00	0.00	0.00
31	33	0.00	0.00	0.00	0.00	0.00	0.00
31	34	0.00	0.00	0.00	0.00	0.00	0.00
32	34	0.00	0.00	0.00	0.00	0.00	0.00
32	12	0.00	0.00	0.00	0.00	0.00	0.00
33	12	0.00	0.00	0.00	0.00	0.00	0.00
33	35	0.00	0.00	0.00	0.00	0.00	0.00
34	35	0.00	0.00	0.00	0.00	0.00	0.00
34	36	0.00	0.00	0.00	0.00	0.00	0.00
35	36	0.00	0.00	0.00	0.00	0.00	0.00
35	37	0.00	0.00	0.00	0.00	0.00	0.00
36	37	0.00	0.00	0.00	0.00	0.00	0.00
36	38	0.00	0.00	0.00	0.00	0.00	0.00
37	38	0.00	0.00	0.00	0.00	0.00	0.00
37	14	0.00	0.00	0.00	0.00	0.00	0.00
38	14	0.00	0.00	0.00	0.00	0.00	0.00
38	39	0.00	0.00	0.00	0.00	0.00	0.00
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W1 Name: Angle: 75

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.37	5.65	-5.56	-63.71	0.19	-22.84
1	2	-1.40	-5.65	2.39	4.02	-0.19	-12.80
2	3	4.15	1.89	-5.84	-67.16	0.17	-28.25
2	4	-2.11	-1.89	2.56	4.12	-0.17	-19.31
3	5	4.48	0.28	-5.85	-67.33	0.10	-30.02
3	6	-2.44	-0.28	2.57	4.03	-0.10	-22.76
4	7	4.59	0.02	-5.85	-67.37	0.01	-30.71
4	8	-2.56	-0.02	2.57	4.05	-0.01	-23.93
5	9	4.49	-0.19	-5.85	-67.34	-0.08	-30.07
5	10	-2.45	0.19	2.57	4.04	0.08	-22.88
6	11	4.16	-1.70	-5.84	-67.19	-0.15	-28.30
6	12	-2.12	1.70	2.56	4.12	0.15	-19.43
7	13	3.69	-5.97	-5.82	-67.01	-0.19	-25.79
7	14	-1.66	5.97	2.54	4.17	0.19	-14.46
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	-0.42	0.00	-0.49	0.00
9	16	-0.60	-0.84	1.06	0.25	0.49	1.50
9	2	0.60	0.84	-1.07	-0.25	-0.56	-1.56
10	2	0.80	4.81	-1.32	-3.76	0.75	14.36
10	17	-0.80	-4.81	1.16	3.76	0.36	-10.10
11	17	0.20	3.97	-0.53	-0.84	-0.36	11.59
11	18	-0.20	-3.97	0.26	0.84	0.94	-5.69
12	18	0.20	3.97	-0.26	-0.84	-0.94	5.69
12	19	-0.20	-3.97	0.04	0.84	1.12	-0.89
13	19	-0.40	3.97	0.60	0.74	-1.12	2.39
13	20	0.40	-3.97	-0.77	-0.74	0.46	1.41
14	20	-1.00	3.97	1.41	2.33	-0.46	0.09
14	4	1.00	-3.97	-1.47	-2.33	-0.02	1.23
15	4	1.11	5.86	-1.09	-1.79	0.19	18.08
15	21	-1.11	-5.86	0.65	1.79	1.87	-4.20
16	21	0.51	5.86	-0.02	-0.20	-1.87	5.70
16	22	-0.51	-5.86	-0.00	0.20	1.87	-4.92
17	22	0.51	5.86	0.00	-0.20	-1.87	4.92
17	23	-0.51	-5.86	-0.15	0.20	1.81	-0.08
18	23	-0.09	5.86	0.79	1.38	-1.81	1.58
18	6	0.09	-5.86	-1.10	-1.38	0.23	8.23
19	6	2.35	6.14	-1.48	-2.65	-0.13	14.52
19	24	-2.35	-6.14	1.29	2.65	1.54	-8.23
20	24	1.75	6.14	-0.66	-1.06	-1.54	9.73
20	25	-1.75	-6.14	0.48	1.06	2.09	-3.84
21	25	1.15	6.14	0.15	0.52	-2.09	5.34
21	26	-1.15	-6.14	-0.25	-0.52	1.98	-2.16
22	26	1.15	6.14	0.25	0.52	-1.98	2.16
22	27	-1.15	-6.14	-0.65	-0.52	1.01	11.24
23	27	0.55	6.14	1.28	2.11	-1.01	-9.74
23	8	-0.55	-6.14	-1.34	-2.11	0.59	11.70
24	8	3.11	6.17	-1.23	-1.94	-0.58	12.23
24	28	0.83	-6.17	1.12	1.94	1.33	-8.29
25	28	-1.43	6.17	-0.48	-0.35	-1.33	9.79
25	29	1.43	-6.17	0.14	0.35	1.91	1.69
26	29	-1.43	6.17	-0.14	-0.35	-1.91	-1.69
26	30	1.43	-6.17	-0.01	0.35	1.97	6.85
27	30	-2.03	6.17	0.65	1.23	-1.97	-5.36
27	31	2.03	-6.17	-0.82	-1.23	1.26	11.26
28	31	-2.63	6.17	1.45	2.82	-1.26	-9.76
28	10	2.63	-6.17	-1.58	-2.82	0.19	14.11
29	10	-0.18	5.98	-0.99	-1.23	-0.28	8.77

29	32	0.18	-5.98	0.62	1.23	1.88	3.15
30	32	-0.78	5.98	0.01	0.36	-1.88	-1.65
30	33	0.78	-5.98	-0.10	-0.36	1.86	4.68
31	33	-0.78	5.98	0.10	0.36	-1.86	-4.68
31	34	0.78	-5.98	-0.19	-0.36	1.79	7.38
32	34	-1.38	5.98	0.82	1.95	-1.79	-5.88
32	12	1.38	-5.98	-1.19	-1.95	-0.27	18.12
33	12	0.74	4.28	-1.36	-2.17	0.12	1.31
33	35	-0.74	-4.28	1.25	2.17	0.73	1.48
34	35	0.14	4.28	-0.61	-0.58	-0.73	0.02
34	36	-0.14	-4.28	0.44	0.58	1.23	4.08
35	36	-0.46	4.28	0.20	1.00	-1.23	-2.58
35	37	0.46	-4.28	-0.36	-1.00	0.98	6.40
36	37	-0.46	4.28	0.36	1.00	-0.98	-6.40
36	38	0.46	-4.28	-0.69	-1.00	0.03	14.14
37	38	-1.06	5.12	1.33	3.92	-0.03	-12.64
37	14	1.06	-5.12	-1.45	-3.92	-0.93	16.19
38	14	0.60	-0.84	-1.09	-0.25	0.74	-1.72
38	39	-0.60	0.84	1.04	0.25	-0.46	1.50
39	39	0.00	0.00	-0.41	0.00	0.46	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W2 Name: Angle: 60

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	4.16	6.08	-4.69	-55.41	0.19	-26.99
1	2	-1.43	-6.08	2.13	4.02	-0.19	-14.33
2	3	5.04	2.03	-4.92	-58.42	0.18	-33.07
2	4	-2.23	-2.03	2.28	4.11	-0.18	-21.61
3	5	5.39	0.30	-4.93	-58.59	0.10	-34.99
3	6	-2.59	-0.30	2.30	4.02	-0.10	-25.33
4	7	5.52	0.03	-4.93	-58.62	0.01	-35.76
4	8	-2.71	-0.03	2.30	4.04	-0.01	-26.62
5	9	5.41	-0.19	-4.93	-58.59	-0.09	-35.05
5	10	-2.60	0.19	2.30	4.04	0.09	-25.47
6	11	5.05	-1.81	-4.92	-58.44	-0.16	-33.11
6	12	-2.24	1.81	2.28	4.12	0.16	-21.73
7	13	4.54	-6.43	-4.90	-58.25	-0.20	-30.36
7	14	-1.73	6.43	2.27	4.18	0.20	-16.28
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	-0.29	0.00	-0.34	0.00
9	16	-0.60	-0.84	0.93	0.25	0.34	1.50
9	2	0.60	0.84	-0.94	-0.25	-0.41	-1.56
10	2	0.83	5.23	-1.19	-3.77	0.60	15.89
10	17	-0.83	-5.23	1.08	3.77	0.41	-11.25
11	17	0.23	4.39	-0.44	-0.85	-0.41	12.75
11	18	-0.23	-4.39	0.25	0.85	0.93	-6.21
12	18	0.23	4.39	-0.25	-0.85	-0.93	6.21
12	19	-0.23	-4.39	0.10	0.85	1.14	-0.89
13	19	-0.37	4.39	0.53	0.73	-1.14	2.39
13	20	0.37	-4.39	-0.66	-0.73	0.57	1.82
14	20	-0.97	4.39	1.29	2.32	-0.57	-0.32
14	4	0.97	-4.39	-1.33	-2.32	0.14	1.77
15	4	1.26	6.42	-0.95	-1.79	0.04	19.83
15	21	-1.26	-6.42	0.65	1.79	1.85	-4.63
16	21	0.66	6.42	-0.01	-0.21	-1.85	6.13
16	22	-0.66	-6.42	-0.01	0.21	1.85	-5.28
17	22	0.66	6.42	0.01	-0.21	-1.85	5.28
17	23	-0.66	-6.42	-0.11	0.21	1.80	0.02
18	23	0.06	6.42	0.75	1.38	-1.80	1.48

18	6	-0.06	-6.42	-0.96	-1.38	0.37	9.27
19	6	2.65	6.72	-1.34	-2.65	-0.27	16.06
19	24	-2.65	-6.72	1.21	2.65	1.58	-9.18
20	24	2.05	6.72	-0.57	-1.06	-1.58	10.68
20	25	-2.05	-6.72	0.45	1.06	2.07	-4.25
21	25	1.45	6.72	0.18	0.53	-2.07	5.75
21	26	-1.45	-6.72	-0.25	-0.53	1.95	-2.26
22	26	1.45	6.72	0.25	0.53	-1.95	2.26
22	27	-1.45	-6.72	-0.53	-0.53	1.11	12.39
23	27	0.85	6.72	1.16	2.11	-1.11	-10.89
23	8	-0.85	-6.72	-1.20	-2.11	0.73	13.03
24	8	3.57	6.75	-1.10	-1.93	-0.72	13.59
24	28	1.17	-6.75	1.01	1.93	1.40	-9.28
25	28	-1.77	6.75	-0.38	-0.35	-1.40	10.78
25	29	1.77	-6.75	0.14	0.35	1.88	1.77
26	29	-1.77	6.75	-0.14	-0.35	-1.88	-1.77
26	30	1.77	-6.75	0.04	0.35	1.96	7.42
27	30	-2.37	6.75	0.60	1.24	-1.96	-5.92
27	31	2.37	-6.75	-0.72	-1.24	1.32	12.39
28	31	-2.97	6.75	1.36	2.82	-1.32	-10.89
28	10	2.97	-6.75	-1.45	-2.82	0.34	15.64
29	10	-0.38	6.55	-0.85	-1.22	-0.42	9.83
29	32	0.38	-6.55	0.60	1.22	1.87	3.24
30	32	-0.98	6.55	0.04	0.37	-1.87	-1.74
30	33	0.98	-6.55	-0.10	-0.37	1.83	5.05
31	33	-0.98	6.55	0.10	0.37	-1.83	-5.05
31	34	0.98	-6.55	-0.16	-0.37	1.77	8.01
32	34	-1.57	6.55	0.79	1.95	-1.77	-6.51
32	12	1.57	-6.55	-1.06	-1.95	-0.12	19.93
33	12	0.67	4.74	-1.23	-2.16	-0.04	1.80
33	35	-0.67	-4.74	1.15	2.16	0.81	1.28
34	35	0.07	4.74	-0.51	-0.58	-0.81	0.21
34	36	-0.07	-4.74	0.39	0.58	1.24	4.33
35	36	-0.53	4.74	0.25	1.01	-1.24	-2.83
35	37	0.53	-4.74	-0.36	-1.01	0.97	7.06
36	37	-0.53	4.74	0.36	1.01	-0.97	-7.06
36	38	0.53	-4.74	-0.59	-1.01	0.11	15.63
37	38	-1.13	5.58	1.23	3.93	-0.11	-14.13
37	14	1.13	-5.58	-1.31	-3.93	-0.77	18.00
38	14	0.60	-0.84	-0.95	-0.25	0.57	-1.72
38	39	-0.60	0.84	0.92	0.25	-0.32	1.50
39	39	0.00	0.00	-0.29	0.00	0.32	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W3 Name: Angle: 45

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	4.46	6.14	-3.51	-44.82	0.20	-28.29
1	2	-1.37	-6.14	1.85	4.03	-0.20	-14.54
2	3	5.35	2.05	-3.68	-47.30	0.18	-34.49
2	4	-2.20	-2.05	1.99	4.12	-0.18	-21.97
3	5	5.71	0.30	-3.69	-47.48	0.11	-36.42
3	6	-2.55	-0.30	2.00	4.02	-0.11	-25.72
4	7	5.83	0.03	-3.69	-47.53	0.01	-37.18
4	8	-2.68	-0.03	2.01	4.04	-0.01	-27.01
5	9	5.72	-0.19	-3.69	-47.49	-0.09	-36.48
5	10	-2.57	0.19	2.00	4.03	0.09	-25.86
6	11	5.36	-1.82	-3.68	-47.34	-0.16	-34.53
6	12	-2.21	1.82	1.99	4.11	0.16	-22.09
7	13	4.84	-6.50	-3.66	-47.14	-0.20	-31.74

7	14	-1.69	6.50	1.97	4.19	0.20	-16.57
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	-0.16	0.00	-0.18	0.00
9	16	-0.60	-0.84	0.79	0.25	0.18	1.50
9	2	0.60	0.84	-0.80	-0.25	-0.24	-1.56
10	2	0.77	5.30	-1.05	-3.78	0.44	16.10
10	17	-0.77	-5.30	0.99	3.78	0.47	-11.40
11	17	0.17	4.46	-0.36	-0.86	-0.47	12.90
11	18	-0.17	-4.46	0.26	0.86	0.92	-6.27
12	18	0.17	4.46	-0.26	-0.86	-0.92	6.27
12	19	-0.17	-4.46	0.17	0.86	1.18	-0.87
13	19	-0.43	4.46	0.46	0.73	-1.18	2.37
13	20	0.43	-4.46	-0.53	-0.73	0.71	1.90
14	20	-1.03	4.46	1.16	2.31	-0.71	-0.40
14	4	1.03	-4.46	-1.19	-2.31	0.32	1.87
15	4	1.17	6.50	-0.80	-1.80	-0.13	20.10
15	21	-1.17	-6.50	0.64	1.80	1.84	-4.70
16	21	0.57	6.50	-0.00	-0.22	-1.84	6.20
16	22	-0.57	-6.50	-0.01	0.22	1.84	-5.34
17	22	0.57	6.50	0.01	-0.22	-1.84	5.34
17	23	-0.57	-6.50	-0.06	0.22	1.81	0.03
18	23	-0.03	6.50	0.70	1.37	-1.81	1.47
18	6	0.03	-6.50	-0.81	-1.37	0.55	9.42
19	6	2.53	6.80	-1.19	-2.65	-0.44	16.30
19	24	-2.53	-6.80	1.12	2.65	1.62	-9.33
20	24	1.93	6.80	-0.49	-1.07	-1.62	10.83
20	25	-1.93	-6.80	0.42	1.07	2.06	-4.31
21	25	1.33	6.80	0.21	0.52	-2.06	5.81
21	26	-1.33	-6.80	-0.25	-0.52	1.94	-2.29
22	26	1.33	6.80	0.25	0.52	-1.94	2.29
22	27	-1.33	-6.80	-0.40	-0.52	1.23	12.55
23	27	0.73	6.80	1.03	2.10	-1.23	-11.05
23	8	-0.73	-6.80	-1.06	-2.10	0.90	13.22
24	8	3.41	6.83	-0.95	-1.94	-0.89	13.79
24	28	1.07	-6.83	0.91	1.94	1.48	-9.43
25	28	-1.67	6.83	-0.27	-0.35	-1.48	10.93
25	29	1.67	-6.83	0.14	0.35	1.86	1.79
26	29	-1.67	6.83	-0.14	-0.35	-1.86	-1.79
26	30	1.67	-6.83	0.09	0.35	1.96	7.51
27	30	-2.27	6.83	0.55	1.23	-1.96	-6.01
27	31	2.27	-6.83	-0.62	-1.23	1.40	12.56
28	31	-2.87	6.83	1.25	2.82	-1.40	-11.06
28	10	2.87	-6.83	-1.30	-2.82	0.50	15.88
29	10	-0.30	6.64	-0.71	-1.21	-0.59	9.98
29	32	0.30	-6.64	0.57	1.21	1.86	3.26
30	32	-0.90	6.64	0.07	0.37	-1.86	-1.76
30	33	0.90	-6.64	-0.10	-0.37	1.82	5.12
31	33	-0.90	6.64	0.10	0.37	-1.82	-5.12
31	34	0.90	-6.64	-0.13	-0.37	1.77	8.12
32	34	-1.50	6.64	0.77	1.96	-1.77	-6.62
32	12	1.50	-6.64	-0.91	-1.96	0.05	20.21
33	12	0.71	4.82	-1.08	-2.16	-0.21	1.88
33	35	-0.71	-4.82	1.04	2.16	0.90	1.26
34	35	0.11	4.82	-0.40	-0.57	-0.90	0.24
34	36	-0.11	-4.82	0.34	0.57	1.26	4.37
35	36	-0.49	4.82	0.30	1.01	-1.26	-2.87
35	37	0.49	-4.82	-0.36	-1.01	0.96	7.16
36	37	-0.49	4.82	0.36	1.01	-0.96	-7.16
36	38	0.49	-4.82	-0.48	-1.01	0.20	15.87
37	38	-1.09	5.66	1.12	3.93	-0.20	-14.37
37	14	1.09	-5.66	-1.17	-3.93	-0.59	18.29
38	14	0.60	-0.84	-0.81	-0.25	0.38	-1.72
38	39	-0.60	0.84	0.79	0.25	-0.17	1.50

39	39	0.00	0.00	-0.15	0.00	0.17	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W4 Name: Angle: 30

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	4.19	5.82	-2.32	-34.78	0.21	-26.41
1	2	-1.24	-5.82	1.63	4.03	-0.21	-13.36
2	3	5.00	1.95	-2.44	-36.80	0.20	-32.13
2	4	-2.02	-1.95	1.75	4.13	-0.20	-20.30
3	5	5.33	0.29	-2.46	-36.99	0.12	-33.92
3	6	-2.35	-0.29	1.77	4.02	-0.12	-23.82
4	7	5.45	0.03	-2.47	-37.04	0.02	-34.58
4	8	-2.47	-0.03	1.77	4.04	-0.02	-25.00
5	9	5.34	-0.19	-2.46	-37.02	-0.08	-33.97
5	10	-2.36	0.19	1.77	4.03	0.08	-23.95
6	11	5.01	-1.74	-2.45	-36.86	-0.16	-32.16
6	12	-2.03	1.74	1.75	4.11	0.16	-20.41
7	13	4.52	-6.16	-2.43	-36.66	-0.21	-29.57
7	14	-1.54	6.16	1.74	4.18	0.21	-15.25
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	-0.05	0.00	-0.06	0.00
9	16	-0.60	-0.84	0.68	0.25	0.06	1.50
9	2	0.60	0.84	-0.69	-0.25	-0.11	-1.56
10	2	0.64	4.98	-0.95	-3.78	0.32	14.92
10	17	-0.64	-4.98	0.93	3.78	0.51	-10.50
11	17	0.04	4.14	-0.29	-0.86	-0.51	12.00
11	18	-0.04	-4.14	0.26	0.86	0.92	-5.84
12	18	0.04	4.14	-0.26	-0.86	-0.92	5.84
12	19	-0.04	-4.14	0.23	0.86	1.22	-0.83
13	19	-0.56	4.14	0.40	0.73	-1.22	2.33
13	20	0.56	-4.14	-0.42	-0.73	0.83	1.63
14	20	-1.16	4.14	1.06	2.31	-0.83	-0.13
14	4	1.16	-4.14	-1.06	-2.31	0.47	1.50
15	4	0.87	6.09	-0.68	-1.82	-0.28	18.80
15	21	-0.87	-6.09	0.63	1.82	1.84	-4.38
16	21	0.27	6.09	0.00	-0.23	-1.84	5.88
16	22	-0.27	-6.09	-0.00	0.23	1.84	-5.07
17	22	0.27	6.09	0.00	-0.23	-1.84	5.07
17	23	-0.27	-6.09	-0.02	0.23	1.83	-0.05
18	23	-0.33	6.09	0.66	1.35	-1.83	1.55
18	6	0.33	-6.09	-0.69	-1.35	0.70	8.65
19	6	2.02	6.38	-1.07	-2.67	-0.58	15.17
19	24	-2.02	-6.38	1.05	2.67	1.67	-8.64
20	24	1.42	6.38	-0.42	-1.08	-1.67	10.14
20	25	-1.42	-6.38	0.40	1.08	2.06	-4.03
21	25	0.82	6.38	0.24	0.50	-2.06	5.53
21	26	-0.82	-6.38	-0.25	-0.50	1.94	-2.22
22	26	0.82	6.38	0.25	0.50	-1.94	2.22
22	27	-0.82	-6.38	-0.30	-0.50	1.34	11.69
23	27	0.22	6.38	0.93	2.09	-1.34	-10.19
23	8	-0.22	-6.38	-0.94	-2.09	1.04	12.22
24	8	2.69	6.40	-0.83	-1.95	-1.03	12.77
24	28	0.54	-6.40	0.82	1.95	1.55	-8.68
25	28	-1.14	6.40	-0.18	-0.36	-1.55	10.18
25	29	1.14	-6.40	0.14	0.36	1.86	1.74
26	29	-1.14	6.40	-0.14	-0.36	-1.86	-1.74
26	30	1.14	-6.40	0.12	0.36	1.97	7.10
27	30	-1.74	6.40	0.51	1.22	-1.97	-5.60
27	31	1.74	-6.40	-0.53	-1.22	1.47	11.74

28	31	-2.34	6.40	1.16	2.81	-1.47	-10.24
28	10	2.34	-6.40	-1.18	-2.81	0.65	14.75
29	10	0.02	6.22	-0.59	-1.22	-0.73	9.20
29	32	-0.02	-6.22	0.54	1.22	1.86	3.20
30	32	-0.58	6.22	0.09	0.36	-1.86	-1.71
30	33	0.58	-6.22	-0.10	-0.36	1.81	4.85
31	33	-0.58	6.22	0.10	0.36	-1.81	-4.85
31	34	0.58	-6.22	-0.11	-0.36	1.76	7.66
32	34	-1.18	6.22	0.74	1.95	-1.76	-6.16
32	12	1.18	-6.22	-0.79	-1.95	0.19	18.90
33	12	0.85	4.48	-0.96	-2.16	-0.36	1.51
33	35	-0.85	-4.48	0.95	2.16	0.98	1.40
34	35	0.25	4.48	-0.32	-0.57	-0.98	0.10
34	36	-0.25	-4.48	0.29	0.57	1.27	4.19
35	36	-0.35	4.48	0.34	1.01	-1.27	-2.69
35	37	0.35	-4.48	-0.36	-1.01	0.96	6.69
36	37	-0.35	4.48	0.36	1.01	-0.96	-6.69
36	38	0.35	-4.48	-0.40	-1.01	0.28	14.78
37	38	-0.95	5.32	1.03	3.93	-0.28	-13.28
37	14	0.95	-5.32	-1.05	-3.93	-0.44	16.97
38	14	0.60	-0.84	-0.69	-0.25	0.24	-1.72
38	39	-0.60	0.84	0.68	0.25	-0.05	1.50
39	39	0.00	0.00	-0.05	0.00	0.05	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W5 Name: Angle: 15

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.64	5.38	-1.45	-27.93	0.23	-23.15
1	2	-1.12	-5.38	1.53	4.03	-0.23	-11.73
2	3	4.34	1.82	-1.55	-29.66	0.21	-28.18
2	4	-1.82	-1.82	1.63	4.15	-0.21	-17.94
3	5	4.64	0.27	-1.57	-29.87	0.12	-29.79
3	6	-2.12	-0.27	1.65	4.03	-0.12	-21.16
4	7	4.74	0.02	-1.57	-29.93	0.02	-30.34
4	8	-2.22	-0.02	1.65	4.03	-0.02	-22.18
5	9	4.65	-0.18	-1.57	-29.91	-0.08	-29.84
5	10	-2.13	0.18	1.65	4.02	0.08	-21.27
6	11	4.35	-1.62	-1.56	-29.76	-0.16	-28.21
6	12	-1.83	1.62	1.64	4.10	0.16	-18.05
7	13	3.91	-5.69	-1.54	-29.56	-0.21	-25.88
7	14	-1.39	5.69	1.62	4.18	0.21	-13.39
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.60	-0.84	0.63	0.25	-0.00	1.50
9	2	0.60	0.84	-0.63	-0.25	-0.04	-1.56
10	2	0.52	4.54	-0.90	-3.77	0.27	13.29
10	17	-0.52	-4.54	0.90	3.77	0.53	-9.26
11	17	-0.08	3.69	-0.26	-0.85	-0.53	10.76
11	18	0.08	-3.69	0.27	0.85	0.92	-5.27
12	18	-0.08	3.69	-0.27	-0.85	-0.92	5.27
12	19	0.08	-3.69	0.27	0.85	1.25	-0.79
13	19	-0.68	3.69	0.37	0.73	-1.25	2.29
13	20	0.68	-3.69	-0.36	-0.73	0.90	1.24
14	20	-1.28	3.69	1.00	2.32	-0.90	0.26
14	4	1.28	-3.69	-1.00	-2.32	0.57	0.97
15	4	0.54	5.51	-0.63	-1.83	-0.36	16.98
15	21	-0.54	-5.51	0.63	1.83	1.85	-3.93
16	21	-0.06	5.51	0.00	-0.25	-1.85	5.43
16	22	0.06	-5.51	-0.00	0.25	1.85	-4.70

17	22	-0.06	5.51	0.00	-0.25	-1.85	4.70
17	23	0.06	-5.51	0.00	0.25	1.85	-0.15
18	23	-0.66	5.51	0.63	1.34	-1.85	1.65
18	6	0.66	-5.51	-0.63	-1.34	0.79	7.57
19	6	1.46	5.78	-1.02	-2.69	-0.67	13.58
19	24	-1.46	-5.78	1.02	2.69	1.71	-7.66
20	24	0.86	5.78	-0.38	-1.10	-1.71	9.16
20	25	-0.86	-5.78	0.39	1.10	2.08	-3.62
21	25	0.26	5.78	0.25	0.48	-2.08	5.12
21	26	-0.26	-5.78	-0.25	-0.48	1.95	-2.13
22	26	0.26	5.78	0.25	0.48	-1.95	2.13
22	27	-0.26	-5.78	-0.24	-0.48	1.42	10.48
23	27	-0.34	5.78	0.88	2.07	-1.42	-8.98
23	8	0.34	-5.78	-0.88	-2.07	1.13	10.83
24	8	1.87	5.81	-0.77	-1.97	-1.11	11.35
24	28	-0.05	-5.81	0.77	1.97	1.61	-7.65
25	28	-0.55	5.81	-0.14	-0.38	-1.61	9.15
25	29	0.55	-5.81	0.14	0.38	1.87	1.66
26	29	-0.55	5.81	-0.14	-0.38	-1.87	-1.66
26	30	0.55	-5.81	0.14	0.38	1.99	6.52
27	30	-1.15	5.81	0.49	1.20	-1.99	-5.02
27	31	1.15	-5.81	-0.49	-1.20	1.52	10.58
28	31	-1.75	5.81	1.12	2.79	-1.52	-9.08
28	10	1.75	-5.81	-1.12	-2.79	0.73	13.18
29	10	0.38	5.63	-0.53	-1.23	-0.81	8.09
29	32	-0.38	-5.63	0.53	1.23	1.87	3.13
30	32	-0.22	5.63	0.10	0.35	-1.87	-1.63
30	33	0.22	-5.63	-0.10	-0.35	1.82	4.48
31	33	-0.22	5.63	0.10	0.35	-1.82	-4.48
31	34	0.22	-5.63	-0.10	-0.35	1.77	7.02
32	34	-0.82	5.63	0.73	1.94	-1.77	-5.52
32	12	0.82	-5.63	-0.73	-1.94	0.27	17.05
33	12	1.01	4.01	-0.91	-2.17	-0.43	1.00
33	35	-1.01	-4.01	0.91	2.17	1.02	1.60
34	35	0.41	4.01	-0.27	-0.58	-1.02	-0.10
34	36	-0.41	-4.01	0.27	0.58	1.28	3.94
35	36	-0.19	4.01	0.36	1.01	-1.28	-2.44
35	37	0.19	-4.01	-0.36	-1.01	0.96	6.01
36	37	-0.19	4.01	0.36	1.01	-0.96	-6.01
36	38	0.19	-4.01	-0.36	-1.01	0.32	13.25
37	38	-0.79	4.85	0.99	3.92	-0.32	-11.75
37	14	0.79	-4.85	-0.99	-3.92	-0.37	15.11
38	14	0.60	-0.84	-0.63	-0.25	0.16	-1.72
38	39	-0.60	0.84	0.63	0.25	0.00	1.50
39	39	0.00	0.00	0.00	0.00	-0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W6 Name: Angle: 0

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.97	9.20	-0.49	-20.28	0.19	-26.54
1	2	-0.94	-9.20	1.40	4.05	-0.19	-8.93
2	3	4.90	-0.42	-0.53	-21.51	0.16	-33.13
2	4	-1.83	0.42	1.46	4.41	-0.16	-16.89
3	5	5.68	-5.51	-0.56	-21.71	0.06	-37.27
3	6	-2.61	5.51	1.49	4.21	-0.06	-25.19
4	7	5.98	-6.94	-0.57	-21.76	-0.05	-38.92
4	8	-2.91	6.94	1.49	4.13	0.05	-28.36
5	9	5.75	-8.10	-0.57	-21.73	-0.16	-37.64
5	10	-2.68	8.10	1.50	4.00	0.16	-26.01

6	11	5.06	-12.33	-0.55	-21.47	-0.25	-33.92
6	12	-1.99	12.33	1.47	4.14	0.25	-18.62
7	13	4.51	-21.40	-0.58	-21.50	-0.30	-30.97
7	14	-1.44	21.40	1.51	3.59	0.30	-12.74
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.07	0.00	0.08	0.00
9	16	-0.60	-4.63	0.56	-5.75	-0.08	1.50
9	2	0.60	4.63	-0.56	5.75	0.04	-1.83
10	2	0.34	4.57	-0.84	-9.80	0.14	10.76
10	17	-0.34	-4.57	0.87	9.80	0.61	-6.70
11	17	-0.26	-0.06	-0.23	-0.88	-0.61	8.20
11	18	0.26	0.06	0.28	0.88	1.00	-8.30
12	18	-0.26	-0.06	-0.28	-0.88	-1.00	8.30
12	19	0.26	0.06	0.32	0.88	1.36	-8.37
13	19	-0.86	2.47	0.31	4.71	-1.36	9.87
13	20	0.86	-2.47	-0.28	-4.71	1.07	-7.51
14	20	-1.46	4.99	0.92	2.29	-1.07	9.01
14	4	1.46	-4.99	-0.91	-2.29	0.77	-7.35
15	4	0.37	4.57	-0.55	-2.12	-0.61	24.24
15	21	-0.37	-4.57	0.63	2.12	2.01	-13.42
16	21	-0.23	7.10	0.01	3.47	-2.01	14.92
16	22	0.23	-7.10	-0.00	-3.47	2.01	-13.98
17	22	-0.23	7.10	0.00	3.47	-2.01	13.98
17	23	0.23	-7.10	0.02	-3.47	2.02	-8.12
18	23	-0.83	9.63	0.61	1.05	-2.02	9.62
18	6	0.83	-9.63	-0.56	-1.05	1.03	6.51
19	6	1.78	4.11	-0.93	-3.16	-0.97	18.68
19	24	-1.78	-4.11	0.96	3.16	1.93	-14.47
20	24	1.18	6.64	-0.32	2.43	-1.93	15.97
20	25	-1.18	-6.64	0.35	-2.43	2.26	-9.61
21	25	0.58	9.17	0.28	0.01	-2.26	11.11
21	26	-0.58	-9.17	-0.26	-0.01	2.12	-6.36
22	26	0.58	9.17	0.26	0.01	-2.12	6.36
22	27	-0.58	-9.17	-0.20	-0.01	1.62	13.64
23	27	-0.01	11.70	0.83	5.60	-1.62	-12.14
23	8	0.01	-11.70	-0.82	-5.60	1.35	15.87
24	8	2.90	4.76	-0.67	1.47	-1.40	12.49
24	28	0.71	-4.76	0.69	-1.47	1.84	-9.45
25	28	-1.31	7.29	-0.06	-0.95	-1.84	10.95
25	29	1.31	-7.29	0.12	0.95	2.00	2.62
26	29	-1.31	7.29	-0.12	-0.95	-2.00	-2.62
26	30	1.31	-7.29	0.14	0.95	2.11	8.72
27	30	-1.91	9.82	0.49	4.64	-2.11	-7.22
27	31	1.91	-9.82	-0.46	-4.64	1.66	16.62
28	31	-2.51	12.34	1.09	2.22	-1.66	-15.12
28	10	2.51	-12.34	-1.07	-2.22	0.89	23.82
29	10	0.17	4.24	-0.43	-1.77	-1.06	2.18
29	32	-0.17	-4.24	0.49	1.77	1.97	6.28
30	32	-0.43	6.77	0.14	3.81	-1.97	-4.78
30	33	0.43	-6.77	-0.13	-3.81	1.90	8.20
31	33	-0.43	6.77	0.13	3.81	-1.90	-8.20
31	34	0.43	-6.77	-0.11	-3.81	1.85	11.26
32	34	-1.03	9.30	0.75	1.40	-1.85	-9.76
32	12	1.03	-9.30	-0.68	-1.40	0.38	28.80
33	12	0.96	-3.03	-0.79	-2.75	-0.63	-10.18
33	35	-0.96	3.03	0.81	2.75	1.15	8.21
34	35	0.36	-0.50	-0.18	2.84	-1.15	-6.71
34	36	-0.36	0.50	0.21	-2.84	1.34	6.23
35	36	-0.24	2.02	0.43	0.42	-1.34	-4.73
35	37	0.24	-2.02	-0.40	-0.42	0.97	6.53
36	37	-0.24	2.02	0.40	0.42	-0.97	-6.53
36	38	0.24	-2.02	-0.34	-0.42	0.30	10.19
37	38	-0.84	11.71	0.98	17.35	-0.30	-8.69

37	14	0.84	-11.71	-0.95	-17.35	-0.37	16.81
38	14	0.60	-9.69	-0.56	13.75	0.07	-4.07
38	39	-0.60	9.69	0.56	-13.75	0.08	1.50
39	39	0.00	0.00	0.07	0.00	-0.08	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W7 Name: Angle: -15

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.61	3.03	4.35	57.62	-0.28	-20.51
1	2	-0.56	-3.03	-2.46	-5.53	0.28	-9.09
2	3	4.18	0.98	4.58	60.90	-0.25	-24.44
2	4	-1.06	-0.98	-2.64	-5.56	0.25	-13.58
3	5	4.36	0.13	4.60	61.14	-0.15	-25.48
3	6	-1.25	-0.13	-2.67	-5.44	0.15	-15.53
4	7	4.44	0.02	4.60	61.20	-0.02	-25.99
4	8	-1.33	-0.02	-2.67	-5.46	0.02	-16.29
5	9	4.37	-0.07	4.60	61.16	0.11	-25.51
5	10	-1.26	0.07	-2.67	-5.45	-0.11	-15.60
6	11	4.18	-0.85	4.58	60.97	0.22	-24.44
6	12	-1.06	0.85	-2.65	-5.55	-0.22	-13.61
7	13	3.89	-3.24	4.55	60.65	0.27	-22.87
7	14	-0.77	3.24	-2.62	-5.73	-0.27	-10.53
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.19	0.00	0.22	0.00
9	16	-0.15	-0.21	-1.05	-2.48	-0.22	0.37
9	2	0.15	0.21	1.06	2.48	0.29	-0.38
10	2	0.42	2.83	1.40	3.05	-0.57	9.48
10	17	-0.42	-2.83	-1.33	-3.05	-0.64	-6.97
11	17	0.27	2.62	0.47	1.23	0.64	7.34
11	18	-0.27	-2.62	-0.34	-1.23	-1.24	-3.44
12	18	0.27	2.62	0.34	1.23	1.24	3.44
12	19	-0.27	-2.62	-0.24	-1.23	-1.60	-0.27
13	19	0.12	2.62	-0.62	-0.92	1.60	0.64
13	20	-0.12	-2.62	0.70	0.92	-0.97	1.87
14	20	-0.03	2.62	-1.56	-3.07	0.97	-1.50
14	4	0.03	-2.62	1.58	3.07	-0.45	2.37
15	4	1.04	3.59	1.06	2.48	0.20	11.21
15	21	-1.04	-3.59	-0.86	-2.48	-2.47	-2.70
16	21	0.89	3.59	0.00	0.33	2.47	3.07
16	22	-0.89	-3.59	0.01	-0.33	-2.47	-2.60
17	22	0.89	3.59	-0.01	0.33	2.47	2.60
17	23	-0.89	-3.59	0.08	-0.33	-2.44	0.37
18	23	0.74	3.59	-0.94	-1.82	2.44	-0.00
18	6	-0.74	-3.59	1.08	1.82	-0.75	6.02
19	6	1.99	3.73	1.59	3.62	0.60	9.51
19	24	-1.99	-3.73	-1.50	-3.62	-2.19	-5.69
20	24	1.84	3.73	0.64	1.47	2.19	6.06
20	25	-1.84	-3.73	-0.57	-1.47	-2.77	-2.49
21	25	1.70	3.73	-0.30	-0.68	2.77	2.85
21	26	-1.70	-3.73	0.34	0.68	-2.60	-0.92
22	26	1.70	3.73	-0.34	-0.68	2.60	0.92
22	27	-1.70	-3.73	0.52	0.68	-1.67	7.21
23	27	1.55	3.73	-1.38	-2.83	1.67	-6.84
23	8	-1.55	-3.73	1.41	2.83	-1.23	8.03
24	8	2.88	3.75	1.26	2.63	1.21	8.26
24	28	1.76	-3.75	-1.21	-2.63	-2.00	-5.87
25	28	-1.91	3.75	0.35	0.48	2.00	6.24
25	29	1.91	-3.75	-0.19	-0.48	-2.50	0.73
26	29	-1.91	3.75	0.19	0.48	2.50	-0.73

26	30	1.91	-3.75	-0.13	-0.48	-2.64	3.87
27	30	-2.06	3.75	-0.74	-1.67	2.64	-3.50
27	31	2.06	-3.75	0.81	1.67	-1.89	7.09
28	31	-2.21	3.75	-1.67	-3.82	1.89	-6.72
28	10	2.21	-3.75	1.73	3.82	-0.69	9.36
29	10	-0.95	3.68	0.93	1.63	0.81	6.25
29	32	0.95	-3.68	-0.77	-1.63	-2.50	1.09
30	32	-1.10	3.68	-0.09	-0.52	2.50	-0.72
30	33	1.10	-3.68	0.13	0.52	-2.44	2.58
31	33	-1.10	3.68	-0.13	-0.52	2.44	-2.58
31	34	1.10	-3.68	0.17	0.52	-2.37	4.24
32	34	-1.25	3.68	-1.03	-2.67	2.37	-3.87
32	12	1.25	-3.68	1.20	2.67	-0.09	11.40
33	12	-0.18	2.83	1.45	2.88	0.30	2.21
33	35	0.18	-2.83	-1.39	-2.88	-1.23	-0.38
34	35	-0.33	2.83	0.53	0.72	1.23	0.74
34	36	0.33	-2.83	-0.45	-0.72	-1.70	1.96
35	36	-0.48	2.83	-0.41	-1.43	1.70	-1.59
35	37	0.48	-2.83	0.48	1.43	-1.30	4.11
36	37	-0.48	2.83	-0.48	-1.43	1.30	-4.11
36	38	0.48	-2.83	0.63	1.43	-0.29	9.22
37	38	-0.63	3.03	-1.49	-3.25	0.29	-8.85
37	14	0.63	-3.03	1.55	3.25	0.76	10.95
38	14	0.15	-0.21	1.07	2.48	-0.49	-0.42
38	39	-0.15	0.21	-1.05	-2.48	0.21	0.37
39	39	0.00	0.00	0.19	0.00	-0.21	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W8 Name: Angle: -30

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	3.18	2.88	5.49	67.90	-0.27	-18.45
1	2	-0.60	-2.88	-2.74	-5.52	0.27	-8.55
2	3	3.71	0.93	5.77	71.70	-0.24	-22.12
2	4	-1.06	-0.93	-2.94	-5.55	0.24	-12.72
3	5	3.89	0.13	5.79	71.93	-0.14	-23.11
3	6	-1.24	-0.13	-2.96	-5.44	0.14	-14.57
4	7	3.97	0.02	5.79	71.99	-0.02	-23.61
4	8	-1.31	-0.02	-2.96	-5.47	0.02	-15.31
5	9	3.90	-0.07	5.79	71.95	0.11	-23.14
5	10	-1.24	0.07	-2.96	-5.46	-0.11	-14.64
6	11	3.71	-0.81	5.77	71.76	0.21	-22.12
6	12	-1.06	0.81	-2.94	-5.55	-0.21	-12.75
7	13	3.44	-3.07	5.74	71.45	0.27	-20.64
7	14	-0.79	3.07	-2.92	-5.72	-0.27	-9.84
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.33	0.00	0.38	0.00
9	16	-0.15	-0.21	-1.19	-2.48	-0.38	0.37
9	2	0.15	0.21	1.20	2.48	0.46	-0.38
10	2	0.45	2.67	1.54	3.04	-0.73	8.93
10	17	-0.45	-2.67	-1.42	-3.04	-0.58	-6.56
11	17	0.31	2.46	0.55	1.22	0.58	6.93
11	18	-0.31	-2.46	-0.34	-1.22	-1.25	-3.27
12	18	0.31	2.46	0.34	1.22	1.25	3.27
12	19	-0.31	-2.46	-0.17	-1.22	-1.56	-0.28
13	19	0.16	2.46	-0.69	-0.93	1.56	0.65
13	20	-0.16	-2.46	0.83	0.93	-0.84	1.71
14	20	0.01	2.46	-1.69	-3.08	0.84	-1.34
14	4	-0.01	-2.46	1.73	3.08	-0.27	2.15
15	4	1.07	3.39	1.21	2.47	0.03	10.56

15	21	-1.07	-3.39	-0.87	-2.47	-2.49	-2.54
16	21	0.92	3.39	0.01	0.32	2.49	2.91
16	22	-0.92	-3.39	0.01	-0.32	-2.49	-2.46
17	22	0.92	3.39	-0.01	0.32	2.49	2.46
17	23	-0.92	-3.39	0.13	-0.32	-2.43	0.33
18	23	0.77	3.39	-0.99	-1.83	2.43	0.03
18	6	-0.77	-3.39	1.22	1.83	-0.58	5.64
19	6	2.01	3.52	1.74	3.61	0.44	8.93
19	24	-2.01	-3.52	-1.59	-3.61	-2.14	-5.33
20	24	1.86	3.52	0.73	1.46	2.14	5.70
20	25	-1.86	-3.52	-0.60	-1.46	-2.78	-2.33
21	25	1.71	3.52	-0.26	-0.69	2.78	2.70
21	26	-1.71	-3.52	0.34	0.69	-2.62	-0.88
22	26	1.71	3.52	-0.34	-0.69	2.62	0.88
22	27	-1.71	-3.52	0.65	0.69	-1.55	6.79
23	27	1.57	3.52	-1.51	-2.84	1.55	-6.42
23	8	-1.57	-3.52	1.55	2.84	-1.06	7.54
24	8	2.88	3.53	1.41	2.63	1.04	7.76
24	28	1.76	-3.53	-1.32	-2.63	-1.92	-5.51
25	28	-1.91	3.53	0.46	0.48	1.92	5.88
25	29	1.91	-3.53	-0.19	-0.48	-2.52	0.70
26	29	-1.91	3.53	0.19	0.48	2.52	-0.70
26	30	1.91	-3.53	-0.08	-0.48	-2.64	3.65
27	30	-2.06	3.53	-0.79	-1.67	2.64	-3.28
27	31	2.06	-3.53	0.92	1.67	-1.82	6.67
28	31	-2.20	3.53	-1.78	-3.82	1.82	-6.30
28	10	2.20	-3.53	1.88	3.82	-0.53	8.79
29	10	-0.96	3.46	1.08	1.63	0.64	5.85
29	32	0.96	-3.46	-0.80	-1.63	-2.51	1.05
30	32	-1.11	3.46	-0.06	-0.52	2.51	-0.68
30	33	1.11	-3.46	0.14	0.52	-2.46	2.43
31	33	-1.11	3.46	-0.14	-0.52	2.46	-2.43
31	34	1.11	-3.46	0.20	0.52	-2.39	4.00
32	34	-1.26	3.46	-1.06	-2.67	2.39	-3.63
32	12	1.26	-3.46	1.35	2.67	0.08	10.72
33	12	-0.20	2.65	1.59	2.88	0.13	2.03
33	35	0.20	-2.65	-1.50	-2.88	-1.14	-0.31
34	35	-0.34	2.65	0.64	0.73	1.14	0.68
34	36	0.34	-2.65	-0.50	-0.73	-1.68	1.87
35	36	-0.49	2.65	-0.36	-1.42	1.68	-1.50
35	37	0.49	-2.65	0.48	1.42	-1.31	3.86
36	37	-0.49	2.65	-0.48	-1.42	1.31	-3.86
36	38	0.49	-2.65	0.74	1.42	-0.20	8.65
37	38	-0.64	2.86	-1.60	-3.24	0.20	-8.29
37	14	0.64	-2.86	1.70	3.24	0.94	10.27
38	14	0.15	-0.21	1.22	2.48	-0.67	-0.42
38	39	-0.15	0.21	-1.18	-2.48	0.36	0.37
39	39	0.00	0.00	0.32	0.00	-0.36	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W9 Name: Angle: -45

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	2.29	2.38	6.24	75.27	-0.26	-13.76
1	2	-0.55	-2.38	-2.99	-5.51	0.26	-6.74
2	3	2.71	0.77	6.57	79.47	-0.24	-16.64
2	4	-0.90	-0.77	-3.20	-5.56	0.24	-10.02
3	5	2.86	0.11	6.59	79.70	-0.14	-17.45
3	6	-1.05	-0.11	-3.22	-5.44	0.14	-11.54
4	7	2.92	0.01	6.59	79.76	-0.02	-17.84

4	8	-1.11	-0.01	-3.22	-5.47	0.02	-12.14
5	9	2.86	-0.06	6.59	79.72	0.11	-17.47
5	10	-1.06	0.06	-3.22	-5.46	-0.11	-11.60
6	11	2.71	-0.68	6.57	79.54	0.21	-16.64
6	12	-0.91	0.68	-3.20	-5.55	-0.21	-10.06
7	13	2.49	-2.53	6.55	79.24	0.26	-15.45
7	14	-0.69	2.53	-3.17	-5.71	-0.26	-7.72
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.45	0.00	0.51	0.00
9	16	-0.15	-0.21	-1.31	-2.48	-0.51	0.37
9	2	0.15	0.21	1.32	2.48	0.61	-0.38
10	2	0.40	2.17	1.67	3.04	-0.87	7.13
10	17	-0.40	-2.17	-1.49	-3.04	-0.53	-5.20
11	17	0.25	1.96	0.63	1.21	0.53	5.57
11	18	-0.25	-1.96	-0.35	-1.21	-1.26	-2.65
12	18	0.25	1.96	0.35	1.21	1.26	2.65
12	19	-0.25	-1.96	-0.11	-1.21	-1.54	-0.27
13	19	0.10	1.96	-0.75	-0.94	1.54	0.64
13	20	-0.10	-1.96	0.93	0.94	-0.73	1.24
14	20	-0.04	1.96	-1.79	-3.09	0.73	-0.87
14	4	0.04	-1.96	1.86	3.09	-0.13	1.52
15	4	0.86	2.73	1.34	2.47	-0.11	8.50
15	21	-0.86	-2.73	-0.88	-2.47	-2.51	-2.03
16	21	0.71	2.73	0.02	0.32	2.51	2.40
16	22	-0.71	-2.73	0.01	-0.32	-2.51	-2.04
17	22	0.71	2.73	-0.01	0.32	2.51	2.04
17	23	-0.71	-2.73	0.17	-0.32	-2.44	0.22
18	23	0.57	2.73	-1.03	-1.83	2.44	0.15
18	6	-0.57	-2.73	1.35	1.83	-0.45	4.42
19	6	1.62	2.84	1.87	3.61	0.31	7.12
19	24	-1.62	-2.84	-1.67	-3.61	-2.12	-4.21
20	24	1.47	2.84	0.81	1.46	2.12	4.58
20	25	-1.47	-2.84	-0.62	-1.46	-2.80	-1.86
21	25	1.32	2.84	-0.24	-0.69	2.80	2.23
21	26	-1.32	-2.84	0.34	0.69	-2.65	-0.76
22	26	1.32	2.84	-0.34	-0.69	2.65	0.76
22	27	-1.32	-2.84	0.76	0.69	-1.46	5.44
23	27	1.17	2.84	-1.62	-2.84	1.46	-5.07
23	8	-1.17	-2.84	1.68	2.84	-0.93	5.97
24	8	2.28	2.85	1.54	2.64	0.91	6.16
24	28	1.32	-2.85	-1.41	-2.64	-1.86	-4.34
25	28	-1.47	2.85	0.55	0.49	1.86	4.71
25	29	1.47	-2.85	-0.19	-0.49	-2.55	0.60
26	29	-1.47	2.85	0.19	0.49	2.55	-0.60
26	30	1.47	-2.85	-0.03	-0.49	-2.65	2.99
27	30	-1.62	2.85	-0.83	-1.66	2.65	-2.62
27	31	1.62	-2.85	1.01	1.66	-1.76	5.35
28	31	-1.76	2.85	-1.87	-3.82	1.76	-4.98
28	10	1.76	-2.85	2.01	3.82	-0.40	6.99
29	10	-0.71	2.79	1.21	1.64	0.50	4.61
29	32	0.71	-2.79	-0.82	-1.64	-2.53	0.95
30	32	-0.86	2.79	-0.04	-0.51	2.53	-0.59
30	33	0.86	-2.79	0.14	0.51	-2.48	2.00
31	33	-0.86	2.79	-0.14	-0.51	2.48	-2.00
31	34	0.86	-2.79	0.22	0.51	-2.40	3.26
32	34	-1.00	2.79	-1.08	-2.66	2.40	-2.89
32	12	1.00	-2.79	1.48	2.66	0.23	8.60
33	12	-0.10	2.11	1.72	2.89	-0.02	1.46
33	35	0.10	-2.11	-1.59	-2.89	-1.06	-0.08
34	35	-0.24	2.11	0.73	0.74	1.06	0.45
34	36	0.24	-2.11	-0.55	-0.74	-1.67	1.57
35	36	-0.39	2.11	-0.31	-1.41	1.67	-1.20
35	37	0.39	-2.11	0.48	1.41	-1.32	3.09

36	37	-0.39	2.11	-0.48	-1.41	1.32	-3.09
36	38	0.39	-2.11	0.83	1.41	-0.13	6.90
37	38	-0.54	2.32	-1.69	-3.23	0.13	-6.53
37	14	0.54	-2.32	1.83	3.23	1.09	8.14
38	14	0.15	-0.21	1.34	2.48	-0.83	-0.42
38	39	-0.15	0.21	-1.29	-2.48	0.48	0.37
39	39	0.00	0.00	0.43	0.00	-0.48	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W10 Name: Angle: -60

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	1.18	1.67	6.41	77.75	-0.27	-7.70
1	2	-0.42	-1.67	-3.13	-5.51	0.27	-4.16
2	3	1.44	0.55	6.76	82.13	-0.25	-9.46
2	4	-0.64	-0.55	-3.34	-5.57	0.25	-6.22
3	5	1.54	0.08	6.78	82.37	-0.15	-10.00
3	6	-0.74	-0.08	-3.36	-5.45	0.15	-7.26
4	7	1.58	0.01	6.79	82.43	-0.02	-10.24
4	8	-0.78	-0.01	-3.37	-5.48	0.02	-7.64
5	9	1.54	-0.05	6.79	82.40	0.10	-10.02
5	10	-0.74	0.05	-3.37	-5.46	-0.10	-7.30
6	11	1.45	-0.49	6.77	82.22	0.20	-9.47
6	12	-0.65	0.49	-3.35	-5.54	-0.20	-6.25
7	13	1.30	-1.76	6.74	81.94	0.25	-8.69
7	14	-0.50	1.76	-3.32	-5.70	-0.25	-4.72
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.51	0.00	0.59	0.00
9	16	-0.15	-0.21	-1.37	-2.48	-0.59	0.37
9	2	0.15	0.21	1.39	2.48	0.69	-0.38
10	2	0.27	1.46	1.74	3.03	-0.96	4.55
10	17	-0.27	-1.46	-1.54	-3.03	-0.50	-3.25
11	17	0.12	1.25	0.68	1.20	0.50	3.62
11	18	-0.12	-1.25	-0.35	-1.20	-1.27	-1.76
12	18	0.12	1.25	0.35	1.20	1.27	1.76
12	19	-0.12	-1.25	-0.08	-1.20	-1.53	-0.24
13	19	-0.02	1.25	-0.78	-0.95	1.53	0.61
13	20	0.02	-1.25	0.99	0.95	-0.69	0.59
14	20	-0.17	1.25	-1.85	-3.10	0.69	-0.22
14	4	0.17	-1.25	1.93	3.10	-0.06	0.64
15	4	0.47	1.80	1.42	2.48	-0.19	5.58
15	21	-0.47	-1.80	-0.89	-2.48	-2.54	-1.31
16	21	0.32	1.80	0.03	0.33	2.54	1.68
16	22	-0.32	-1.80	0.00	-0.33	-2.54	-1.44
17	22	0.32	1.80	-0.00	0.33	2.54	1.44
17	23	-0.32	-1.80	0.19	-0.33	-2.46	0.05
18	23	0.17	1.80	-1.05	-1.82	2.46	0.32
18	6	-0.17	-1.80	1.42	1.82	-0.39	2.70
19	6	0.92	1.88	1.94	3.63	0.24	4.56
19	24	-0.92	-1.88	-1.71	-3.63	-2.12	-2.63
20	24	0.77	1.88	0.85	1.48	2.12	3.00
20	25	-0.77	-1.88	-0.64	-1.48	-2.83	-1.20
21	25	0.62	1.88	-0.22	-0.67	2.83	1.57
21	26	-0.62	-1.88	0.34	0.67	-2.69	-0.59
22	26	0.62	1.88	-0.34	-0.67	2.69	0.59
22	27	-0.62	-1.88	0.82	0.67	-1.42	3.51
23	27	0.47	1.88	-1.68	-2.82	1.42	-3.15
23	8	-0.47	-1.88	1.75	2.82	-0.87	3.75
24	8	1.25	1.89	1.61	2.65	0.85	3.89
24	28	0.56	-1.89	-1.47	-2.65	-1.83	-2.68

25	28	-0.71	1.89	0.61	0.50	1.83	3.05
25	29	0.71	-1.89	-0.19	-0.50	-2.58	0.47
26	29	-0.71	1.89	0.19	0.50	2.58	-0.47
26	30	0.71	-1.89	-0.01	-0.50	-2.67	2.05
27	30	-0.86	1.89	-0.85	-1.65	2.67	-1.68
27	31	0.86	-1.89	1.07	1.65	-1.75	3.49
28	31	-1.01	1.89	-1.93	-3.80	1.75	-3.12
28	10	1.01	-1.89	2.09	3.80	-0.33	4.45
29	10	-0.26	1.84	1.28	1.66	0.43	2.84
29	32	0.26	-1.84	-0.84	-1.66	-2.55	0.82
30	32	-0.41	1.84	-0.02	-0.49	2.55	-0.46
30	33	0.41	-1.84	0.14	0.49	-2.50	1.39
31	33	-0.41	1.84	-0.14	-0.49	2.50	-1.39
31	34	0.41	-1.84	0.24	0.49	-2.42	2.22
32	34	-0.56	1.84	-1.10	-2.64	2.42	-1.85
32	12	0.56	-1.84	1.56	2.64	0.30	5.61
33	12	0.09	1.35	1.79	2.90	-0.10	0.64
33	35	-0.09	-1.35	-1.65	-2.90	-1.02	0.24
34	35	-0.06	1.35	0.79	0.75	1.02	0.13
34	36	0.06	-1.35	-0.57	-0.75	-1.67	1.16
35	36	-0.21	1.35	-0.29	-1.40	1.67	-0.79
35	37	0.21	-1.35	0.49	1.40	-1.33	1.99
36	37	-0.21	1.35	-0.49	-1.40	1.33	-1.99
36	38	0.21	-1.35	0.89	1.40	-0.09	4.43
37	38	-0.35	1.56	-1.75	-3.22	0.09	-4.06
37	14	0.35	-1.56	1.90	3.22	1.18	5.14
38	14	0.15	-0.21	1.42	2.48	-0.93	-0.42
38	39	-0.15	0.21	-1.36	-2.48	0.56	0.37
39	39	0.00	0.00	0.50	0.00	-0.56	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: W11 Name: Angle: -75

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.16	0.94	6.11	75.92	-0.27	-1.88
1	2	-0.25	-0.94	-3.15	-5.50	0.27	-1.49
2	3	0.25	0.33	6.47	80.25	-0.25	-2.50
2	4	-0.34	-0.33	-3.35	-5.59	0.25	-2.32
3	5	0.29	0.05	6.49	80.50	-0.15	-2.76
3	6	-0.39	-0.05	-3.38	-5.46	0.15	-2.86
4	7	0.31	0.00	6.49	80.57	-0.03	-2.82
4	8	-0.41	-0.00	-3.38	-5.48	0.03	-3.01
5	9	0.30	-0.04	6.49	80.55	0.10	-2.77
5	10	-0.39	0.04	-3.38	-5.46	-0.10	-2.88
6	11	0.25	-0.30	6.48	80.37	0.20	-2.51
6	12	-0.34	0.30	-3.36	-5.54	-0.20	-2.35
7	13	0.18	-0.98	6.45	80.10	0.25	-2.16
7	14	-0.28	0.98	-3.34	-5.69	-0.25	-1.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.52	0.00	0.60	0.00
9	16	-0.15	-0.21	-1.38	-2.48	-0.60	0.37
9	2	0.15	0.21	1.40	2.48	0.70	-0.38
10	2	0.10	0.73	1.75	3.02	-0.97	1.88
10	17	-0.10	-0.73	-1.55	-3.02	-0.50	-1.23
11	17	-0.05	0.52	0.69	1.20	0.50	1.60
11	18	0.05	-0.52	-0.36	-1.20	-1.28	-0.82
12	18	-0.05	0.52	0.36	1.20	1.28	0.82
12	19	0.05	-0.52	-0.08	-1.20	-1.54	-0.19
13	19	-0.19	0.52	-0.78	-0.95	1.54	0.56
13	20	0.19	-0.52	0.99	0.95	-0.70	-0.06

14	20	-0.34	0.52	-1.85	-3.10	0.70	0.43
14	4	0.34	-0.52	1.93	3.10	-0.07	-0.26
15	4	0.00	0.85	1.42	2.49	-0.18	2.58
15	21	-0.00	-0.85	-0.89	-2.49	-2.56	-0.57
16	21	-0.15	0.85	0.03	0.33	2.56	0.94
16	22	0.15	-0.85	0.00	-0.33	-2.56	-0.83
17	22	-0.15	0.85	-0.00	0.33	2.56	0.83
17	23	0.15	-0.85	0.19	-0.33	-2.48	-0.13
18	23	-0.29	0.85	-1.05	-1.82	2.48	0.50
18	6	0.29	-0.85	1.43	1.82	-0.41	0.92
19	6	0.10	0.90	1.95	3.64	0.25	1.94
19	24	-0.10	-0.90	-1.72	-3.64	-2.13	-1.02
20	24	-0.05	0.90	0.86	1.49	2.13	1.39
20	25	0.05	-0.90	-0.64	-1.49	-2.85	-0.52
21	25	-0.20	0.90	-0.22	-0.66	2.85	0.89
21	26	0.20	-0.90	0.34	0.66	-2.71	-0.43
22	26	-0.20	0.90	-0.34	-0.66	2.71	0.43
22	27	0.20	-0.90	0.83	0.66	-1.44	1.53
23	27	-0.34	0.90	-1.69	-2.81	1.44	-1.16
23	8	0.34	-0.90	1.76	2.81	-0.89	1.45
24	8	0.06	0.90	1.62	2.67	0.86	1.55
24	28	-0.31	-0.90	-1.47	-2.67	-1.85	-0.98
25	28	0.16	0.90	0.61	0.52	1.85	1.35
25	29	-0.16	-0.90	-0.19	-0.52	-2.60	0.33
26	29	0.16	0.90	0.19	0.52	2.60	-0.33
26	30	-0.16	-0.90	-0.00	-0.52	-2.68	1.09
27	30	0.02	0.90	-0.86	-1.64	2.68	-0.72
27	31	-0.02	-0.90	1.07	1.64	-1.76	1.58
28	31	-0.13	0.90	-1.93	-3.79	1.76	-1.21
28	10	0.13	-0.90	2.09	3.79	-0.34	1.85
29	10	0.26	0.86	1.29	1.67	0.44	1.03
29	32	-0.26	-0.86	-0.84	-1.67	-2.56	0.69
30	32	0.11	0.86	-0.02	-0.48	2.56	-0.33
30	33	-0.11	-0.86	0.14	0.48	-2.52	0.76
31	33	0.11	0.86	-0.14	-0.48	2.52	-0.76
31	34	-0.11	-0.86	0.24	0.48	-2.43	1.15
32	34	-0.03	0.86	-1.10	-2.63	2.43	-0.78
32	12	0.03	-0.86	1.56	2.63	0.30	2.55
33	12	0.31	0.57	1.80	2.91	-0.10	-0.20
33	35	-0.31	-0.57	-1.65	-2.91	-1.02	0.57
34	35	0.16	0.57	0.79	0.76	1.02	-0.20
34	36	-0.16	-0.57	-0.58	-0.76	-1.68	0.74
35	36	0.02	0.57	-0.28	-1.39	1.68	-0.37
35	37	-0.02	-0.57	0.49	1.39	-1.33	0.88
36	37	0.02	0.57	-0.49	-1.39	1.33	-0.88
36	38	-0.02	-0.57	0.89	1.39	-0.09	1.90
37	38	-0.13	0.77	-1.75	-3.21	0.09	-1.53
37	14	0.13	-0.77	1.91	3.21	1.18	2.07
38	14	0.15	-0.21	1.43	2.48	-0.93	-0.42
38	39	-0.15	0.21	-1.37	-2.48	0.56	0.37
39	39	0.00	0.00	0.51	0.00	-0.56	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL1 Name: Angle: 75

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.18	0.94	-0.34	-6.34	0.05	-1.71
1	2	-0.18	-0.94	0.34	0.89	-0.05	-1.12
2	3	0.25	0.36	-0.36	-6.72	0.05	-2.22
2	4	-0.25	-0.36	0.36	0.92	-0.05	-1.77

3	5	0.30	0.07	-0.37	-6.77	0.03	-2.48
3	6	-0.30	-0.07	0.37	0.89	-0.03	-2.30
4	7	0.31	0.00	-0.37	-6.78	0.00	-2.56
4	8	-0.31	-0.00	0.37	0.90	-0.00	-2.46
5	9	0.30	-0.06	-0.37	-6.77	-0.02	-2.49
5	10	-0.30	0.06	0.37	0.89	0.02	-2.31
6	11	0.25	-0.33	-0.36	-6.74	-0.04	-2.23
6	12	-0.25	0.33	0.36	0.91	0.04	-1.80
7	13	0.20	-0.98	-0.36	-6.70	-0.05	-1.95
7	14	-0.20	0.98	0.36	0.92	0.05	-1.22
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.10	-0.32	0.14	-0.15	0.00	0.25
9	2	0.10	0.32	-0.14	0.15	-0.01	-0.27
10	2	0.08	0.62	-0.20	-1.04	0.06	1.39
10	17	-0.08	-0.62	0.20	1.04	0.12	-0.84
11	17	-0.02	0.30	-0.06	-0.18	-0.12	1.09
11	18	0.02	-0.30	0.06	0.18	0.21	-0.64
12	18	-0.02	0.30	-0.06	-0.18	-0.21	0.64
12	19	0.02	-0.30	0.06	0.18	0.28	-0.28
13	19	-0.12	0.30	0.08	0.17	-0.28	0.53
13	20	0.12	-0.30	-0.08	-0.17	0.20	-0.24
14	20	-0.22	0.30	0.22	0.52	-0.20	0.49
14	4	0.22	-0.30	-0.22	-0.52	0.13	-0.39
15	4	0.03	0.66	-0.14	-0.40	-0.08	2.16
15	21	-0.03	-0.66	0.14	0.40	0.41	-0.61
16	21	-0.07	0.66	0.00	-0.05	-0.41	0.86
16	22	0.07	-0.66	-0.00	0.05	0.41	-0.78
17	22	-0.07	0.66	0.00	-0.05	-0.41	0.78
17	23	0.07	-0.66	-0.00	0.05	0.41	-0.23
18	23	-0.17	0.66	0.14	0.30	-0.41	0.48
18	6	0.17	-0.66	-0.14	-0.30	0.18	0.61
19	6	0.13	0.72	-0.23	-0.59	-0.15	1.68
19	24	-0.13	-0.72	0.23	0.59	0.38	-0.94
20	24	0.03	0.72	-0.09	-0.24	-0.38	1.19
20	25	-0.03	-0.72	0.09	0.24	0.46	-0.50
21	25	-0.07	0.72	0.05	0.11	-0.46	0.74
21	26	0.07	-0.72	-0.05	-0.11	0.44	-0.37
22	26	-0.07	0.72	0.05	0.11	-0.44	0.37
22	27	0.07	-0.72	-0.05	-0.11	0.32	1.21
23	27	-0.17	0.72	0.20	0.46	-0.32	-0.96
23	8	0.17	-0.72	-0.20	-0.46	0.25	1.19
24	8	0.14	0.73	-0.17	-0.44	-0.25	1.27
24	28	-0.14	-0.73	0.17	0.44	0.36	-0.81
25	28	0.04	0.73	-0.03	-0.08	-0.36	1.06
25	29	-0.04	-0.73	0.03	0.08	0.42	0.30
26	29	0.04	0.73	-0.03	-0.08	-0.42	-0.30
26	30	-0.04	-0.73	0.03	0.08	0.44	0.90
27	30	-0.05	0.73	0.11	0.27	-0.44	-0.66
27	31	0.05	-0.73	-0.11	-0.27	0.34	1.35
28	31	-0.15	0.73	0.25	0.62	-0.34	-1.10
28	10	0.15	-0.73	-0.25	-0.62	0.16	1.62
29	10	0.15	0.67	-0.12	-0.28	-0.18	0.70
29	32	-0.15	-0.67	0.12	0.28	0.42	0.64
30	32	0.05	0.67	0.02	0.08	-0.42	-0.39
30	33	-0.05	-0.67	-0.02	-0.08	0.40	0.73
31	33	0.05	0.67	0.02	0.08	-0.40	-0.73
31	34	-0.05	-0.67	-0.02	-0.08	0.39	1.03
32	34	-0.05	0.67	0.16	0.43	-0.39	-0.78
32	12	0.05	-0.67	-0.16	-0.43	0.06	2.16
33	12	0.20	0.34	-0.20	-0.49	-0.10	-0.36
33	35	-0.20	-0.34	0.20	0.49	0.23	0.58
34	35	0.10	0.34	-0.06	-0.13	-0.23	-0.33

34	36	-0.10	-0.34	0.06	0.13	0.29	0.66
35	36	0.00	0.34	0.08	0.22	-0.29	-0.42
35	37	-0.00	-0.34	-0.08	-0.22	0.21	0.72
36	37	0.00	0.34	0.08	0.22	-0.21	-0.72
36	38	-0.00	-0.34	-0.08	-0.22	0.07	1.34
37	38	-0.10	0.66	0.22	1.07	-0.07	-1.10
37	14	0.10	-0.66	-0.22	-1.07	-0.08	1.56
38	14	0.10	-0.32	-0.14	0.15	0.04	-0.33
38	39	-0.10	0.32	0.14	-0.15	0.00	0.25
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL2 Name: Angle: 60

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.30	1.60	-0.25	-4.66	0.04	-2.91
1	2	-0.30	-1.60	0.25	0.63	-0.04	-1.90
2	3	0.43	0.61	-0.26	-4.93	0.03	-3.79
2	4	-0.43	-0.61	0.26	0.69	-0.03	-3.02
3	5	0.51	0.12	-0.27	-4.96	0.02	-4.22
3	6	-0.51	-0.12	0.27	0.66	-0.02	-3.91
4	7	0.53	0.01	-0.27	-4.97	0.00	-4.36
4	8	-0.53	-0.01	0.27	0.66	-0.00	-4.19
5	9	0.51	-0.09	-0.27	-4.97	-0.01	-4.24
5	10	-0.51	0.09	0.27	0.66	0.01	-3.94
6	11	0.43	-0.56	-0.27	-4.94	-0.03	-3.81
6	12	-0.43	0.56	0.27	0.68	0.03	-3.07
7	13	0.34	-1.67	-0.27	-4.92	-0.03	-3.32
7	14	-0.34	1.67	0.27	0.66	0.03	-2.08
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.17	-0.54	0.10	-0.60	0.00	0.42
9	2	0.17	0.54	-0.10	0.60	-0.01	-0.46
10	2	0.13	1.05	-0.15	-1.24	0.05	2.36
10	17	-0.13	-1.05	0.15	1.24	0.09	-1.43
11	17	-0.04	0.51	-0.04	-0.12	-0.09	1.85
11	18	0.04	-0.51	0.04	0.12	0.15	-1.09
12	18	-0.04	0.51	-0.04	-0.12	-0.15	1.09
12	19	0.04	-0.51	0.04	0.12	0.21	-0.48
13	19	-0.21	0.51	0.06	0.14	-0.21	0.90
13	20	0.21	-0.51	-0.06	-0.14	0.15	-0.41
14	20	-0.38	0.51	0.16	0.40	-0.15	0.83
14	4	0.38	-0.51	-0.16	-0.40	0.10	-0.66
15	4	0.05	1.12	-0.10	-0.29	-0.06	3.69
15	21	-0.05	-1.12	0.10	0.29	0.31	-1.04
16	21	-0.12	1.12	-0.00	-0.03	-0.31	1.47
16	22	0.12	-1.12	0.00	0.03	0.31	-1.32
17	22	-0.12	1.12	-0.00	-0.03	-0.31	1.32
17	23	0.12	-1.12	0.00	0.03	0.31	-0.40
18	23	-0.29	1.12	0.10	0.23	-0.31	0.82
18	6	0.29	-1.12	-0.10	-0.23	0.14	1.05
19	6	0.22	1.23	-0.17	-0.43	-0.12	2.86
19	24	-0.22	-1.23	0.17	0.43	0.29	-1.60
20	24	0.05	1.23	-0.06	-0.18	-0.29	2.03
20	25	-0.05	-1.23	0.06	0.18	0.35	-0.85
21	25	-0.12	1.23	0.04	0.08	-0.35	1.27
21	26	0.12	-1.23	-0.04	-0.08	0.33	-0.63
22	26	-0.12	1.23	0.04	0.08	-0.33	0.63
22	27	0.12	-1.23	-0.04	-0.08	0.24	2.06
23	27	-0.29	1.23	0.14	0.34	-0.24	-1.63

23	8	0.29	-1.23	-0.14	-0.34	0.19	2.03
24	8	0.25	1.24	-0.13	-0.32	-0.19	2.17
24	28	-0.25	-1.24	0.13	0.32	0.27	-1.38
25	28	0.08	1.24	-0.02	-0.06	-0.27	1.80
25	29	-0.08	-1.24	0.02	0.06	0.31	0.50
26	29	0.08	1.24	-0.02	-0.06	-0.31	-0.50
26	30	-0.08	-1.24	0.02	0.06	0.33	1.54
27	30	-0.09	1.24	0.08	0.19	-0.33	-1.12
27	31	0.09	-1.24	-0.08	-0.19	0.26	2.30
28	31	-0.26	1.24	0.18	0.45	-0.26	-1.88
28	10	0.26	-1.24	-0.18	-0.45	0.13	2.75
29	10	0.25	1.14	-0.09	-0.21	-0.14	1.19
29	32	-0.25	-1.14	0.09	0.21	0.31	1.09
30	32	0.08	1.14	0.02	0.05	-0.31	-0.67
30	33	-0.08	-1.14	-0.02	-0.05	0.30	1.24
31	33	0.08	1.14	0.02	0.05	-0.30	-1.24
31	34	-0.08	-1.14	-0.02	-0.05	0.29	1.76
32	34	-0.09	1.14	0.12	0.31	-0.29	-1.34
32	12	0.09	-1.14	-0.12	-0.31	0.05	3.68
33	12	0.34	0.59	-0.15	-0.37	-0.08	-0.61
33	35	-0.34	-0.59	0.15	0.37	0.17	0.99
34	35	0.17	0.59	-0.04	-0.11	-0.17	-0.57
34	36	-0.17	-0.59	0.04	0.11	0.21	1.13
35	36	0.00	0.59	0.06	0.15	-0.21	-0.71
35	37	-0.00	-0.59	-0.06	-0.15	0.16	1.23
36	37	0.00	0.59	0.06	0.15	-0.16	-1.23
36	38	-0.00	-0.59	-0.06	-0.15	0.05	2.29
37	38	-0.17	1.13	0.16	1.26	-0.05	-1.87
37	14	0.17	-1.13	-0.16	-1.26	-0.06	2.65
38	14	0.17	-0.54	-0.10	0.60	0.03	-0.57
38	39	-0.17	0.54	0.10	-0.60	0.00	0.42
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL3 Name: Angle: 45

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.50	2.65	-0.11	-2.04	0.02	-4.83
1	2	-0.50	-2.65	0.11	0.24	-0.02	-3.16
2	3	0.71	1.01	-0.11	-2.13	0.02	-6.30
2	4	-0.71	-1.01	0.11	0.32	-0.02	-5.03
3	5	0.85	0.19	-0.12	-2.15	0.01	-7.03
3	6	-0.85	-0.19	0.12	0.30	-0.01	-6.51
4	7	0.89	0.01	-0.12	-2.16	0.00	-7.26
4	8	-0.89	-0.01	0.12	0.29	-0.00	-6.98
5	9	0.85	-0.16	-0.12	-2.16	-0.01	-7.05
5	10	-0.85	0.16	0.12	0.30	0.01	-6.56
6	11	0.71	-0.93	-0.11	-2.14	-0.01	-6.33
6	12	-0.71	0.93	0.11	0.31	0.01	-5.10
7	13	0.56	-2.78	-0.12	-2.15	-0.02	-5.52
7	14	-0.56	2.78	0.12	0.26	0.02	-3.47
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.28	-0.90	0.04	-1.32	0.00	0.70
9	2	0.28	0.90	-0.04	1.32	-0.00	-0.77
10	2	0.22	1.75	-0.07	-1.56	0.02	3.93
10	17	-0.22	-1.75	0.07	1.56	0.04	-2.38
11	17	-0.06	0.85	-0.02	-0.02	-0.04	3.08
11	18	0.06	-0.85	0.02	0.02	0.07	-1.82
12	18	-0.06	0.85	-0.02	-0.02	-0.07	1.82

12	19	0.06	-0.85	0.02	0.02	0.10	-0.79
13	19	-0.35	0.85	0.02	0.09	-0.10	1.49
13	20	0.35	-0.85	-0.02	-0.09	0.08	-0.68
14	20	-0.63	0.85	0.07	0.21	-0.08	1.39
14	4	0.63	-0.85	-0.07	-0.21	0.06	-1.10
15	4	0.08	1.86	-0.05	-0.11	-0.04	6.13
15	21	-0.08	-1.86	0.05	0.11	0.15	-1.74
16	21	-0.20	1.86	-0.00	0.00	-0.15	2.44
16	22	0.20	-1.86	0.00	-0.00	0.15	-2.20
17	22	-0.20	1.86	-0.00	0.00	-0.15	2.20
17	23	0.20	-1.86	0.00	-0.00	0.15	-0.66
18	23	-0.48	1.86	0.04	0.11	-0.15	1.37
18	6	0.48	-1.86	-0.04	-0.11	0.08	1.74
19	6	0.36	2.05	-0.07	-0.18	-0.07	4.77
19	24	-0.36	-2.05	0.07	0.18	0.14	-2.67
20	24	0.08	2.05	-0.03	-0.07	-0.14	3.37
20	25	-0.08	-2.05	0.03	0.07	0.17	-1.41
21	25	-0.20	2.05	0.02	0.04	-0.17	2.11
21	26	0.20	-2.05	-0.02	-0.04	0.16	-1.05
22	26	-0.20	2.05	0.02	0.04	-0.16	1.05
22	27	0.20	-2.05	-0.02	-0.04	0.12	3.42
23	27	-0.48	2.05	0.06	0.15	-0.12	-2.72
23	8	0.48	-2.05	-0.06	-0.15	0.10	3.37
24	8	0.41	2.06	-0.05	-0.14	-0.10	3.60
24	28	-0.41	-2.06	0.05	0.14	0.13	-2.29
25	28	0.13	2.06	-0.01	-0.03	-0.13	2.99
25	29	-0.13	-2.06	0.01	0.03	0.15	0.84
26	29	0.13	2.06	-0.01	-0.03	-0.15	-0.84
26	30	-0.13	-2.06	0.01	0.03	0.16	2.56
27	30	-0.15	2.06	0.04	0.08	-0.16	-1.86
27	31	0.15	-2.06	-0.04	-0.08	0.13	3.83
28	31	-0.44	2.06	0.08	0.19	-0.13	-3.13
28	10	0.44	-2.06	-0.08	-0.19	0.07	4.58
29	10	0.41	1.90	-0.04	-0.10	-0.08	1.98
29	32	-0.41	-1.90	0.04	0.10	0.15	1.81
30	32	0.13	1.90	0.01	0.01	-0.15	-1.11
30	33	-0.13	-1.90	-0.01	-0.01	0.14	2.07
31	33	0.13	1.90	0.01	0.01	-0.14	-2.07
31	34	-0.13	-1.90	-0.01	-0.01	0.14	2.93
32	34	-0.15	1.90	0.05	0.12	-0.14	-2.22
32	12	0.15	-1.90	-0.05	-0.12	0.03	6.12
33	12	0.57	0.98	-0.06	-0.19	-0.04	-1.01
33	35	-0.57	-0.98	0.06	0.19	0.08	1.65
34	35	0.28	0.98	-0.02	-0.07	-0.08	-0.95
34	36	-0.28	-0.98	0.02	0.07	0.10	1.88
35	36	0.00	0.98	0.03	0.04	-0.10	-1.18
35	37	-0.00	-0.98	-0.03	-0.04	0.07	2.05
36	37	0.00	0.98	0.03	0.04	-0.07	-2.05
36	38	-0.00	-0.98	-0.03	-0.04	0.02	3.81
37	38	-0.28	1.88	0.07	1.58	-0.02	-3.11
37	14	0.28	-1.88	-0.07	-1.58	-0.03	4.41
38	14	0.28	-0.90	-0.04	1.32	0.01	-0.94
38	39	-0.28	0.90	0.04	-1.32	0.00	0.70
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL4 Name: Angle: 30

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.59	3.13	0.00	0.11	0.00	-5.70

1	2	-0.59	-3.13	-0.00	-0.07	-0.00	-3.73
2	3	0.84	1.19	0.01	0.16	0.00	-7.43
2	4	-0.84	-1.19	-0.01	0.01	-0.00	-5.93
3	5	1.00	0.23	0.01	0.15	0.00	-8.29
3	6	-1.00	-0.23	-0.01	-0.00	-0.00	-7.67
4	7	1.05	0.01	0.01	0.15	0.00	-8.56
4	8	-1.05	-0.01	-0.01	-0.01	-0.00	-8.23
5	9	1.00	-0.19	0.01	0.15	-0.00	-8.32
5	10	-1.00	0.19	-0.01	-0.00	0.00	-7.73
6	11	0.84	-1.09	0.01	0.15	-0.00	-7.47
6	12	-0.84	1.09	-0.01	0.00	0.00	-6.02
7	13	0.66	-3.28	0.00	0.12	-0.00	-6.51
7	14	-0.66	3.28	-0.00	-0.06	0.00	-4.09
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.33	-1.06	-0.00	-1.69	0.00	0.83
9	2	0.33	1.06	0.00	1.69	0.00	-0.91
10	2	0.26	2.07	-0.00	-1.62	0.00	4.64
10	17	-0.26	-2.07	0.00	1.62	-0.00	-2.80
11	17	-0.07	1.00	-0.00	0.06	0.00	3.64
11	18	0.07	-1.00	0.00	-0.06	0.00	-2.14
12	18	-0.07	1.00	-0.00	0.06	-0.00	2.14
12	19	0.07	-1.00	0.00	-0.06	0.01	-0.93
13	19	-0.41	1.00	-0.01	0.05	-0.01	1.76
13	20	0.41	-1.00	0.01	-0.05	0.01	-0.80
14	20	-0.74	1.00	-0.01	0.04	-0.01	1.63
14	4	0.74	-1.00	0.01	-0.04	0.02	-1.30
15	4	0.10	2.19	0.00	0.03	-0.01	7.23
15	21	-0.10	-2.19	-0.00	-0.03	0.01	-2.05
16	21	-0.24	2.19	-0.00	0.02	-0.01	2.88
16	22	0.24	-2.19	0.00	-0.02	0.01	-2.59
17	22	-0.24	2.19	-0.00	0.02	-0.01	2.59
17	23	0.24	-2.19	0.00	-0.02	0.01	-0.78
18	23	-0.57	2.19	-0.00	0.02	-0.01	1.61
18	6	0.57	-2.19	0.00	-0.02	0.02	2.05
19	6	0.43	2.42	0.00	0.02	-0.02	5.62
19	24	-0.43	-2.42	-0.00	-0.02	0.02	-3.14
20	24	0.10	2.42	0.00	0.01	-0.02	3.97
20	25	-0.10	-2.42	-0.00	-0.01	0.01	-1.66
21	25	-0.24	2.42	-0.00	0.00	-0.01	2.49
21	26	0.24	-2.42	0.00	-0.00	0.02	-1.24
22	26	-0.24	2.42	-0.00	0.00	-0.02	1.24
22	27	0.24	-2.42	0.00	-0.00	0.02	4.04
23	27	-0.57	2.42	-0.00	-0.00	-0.02	-3.21
23	8	0.57	-2.42	0.00	0.00	0.02	3.98
24	8	0.48	2.43	0.00	0.00	-0.02	4.25
24	28	-0.48	-2.43	-0.00	-0.00	0.02	-2.70
25	28	0.15	2.43	0.00	-0.00	-0.02	3.53
25	29	-0.15	-2.43	-0.00	0.00	0.01	0.99
26	29	0.15	2.43	0.00	-0.00	-0.01	-0.99
26	30	-0.15	-2.43	-0.00	0.00	0.01	3.02
27	30	-0.18	2.43	-0.00	-0.01	-0.01	-2.19
27	31	0.18	-2.43	0.00	0.01	0.02	4.52
28	31	-0.52	2.43	-0.00	-0.02	-0.02	-3.69
28	10	0.52	-2.43	0.00	0.02	0.02	5.40
29	10	0.49	2.24	0.00	-0.01	-0.02	2.34
29	32	-0.49	-2.24	-0.00	0.01	0.01	2.14
30	32	0.16	2.24	0.00	-0.02	-0.01	-1.31
30	33	-0.16	-2.24	-0.00	0.02	0.01	2.44
31	33	0.16	2.24	0.00	-0.02	-0.01	-2.44
31	34	-0.16	-2.24	-0.00	0.02	0.01	3.45
32	34	-0.18	2.24	-0.00	-0.03	-0.01	-2.62
32	12	0.18	-2.24	0.00	0.03	0.01	7.22

33	12	0.67	1.15	0.01	-0.03	-0.01	-1.20
33	35	-0.67	-1.15	-0.01	0.03	0.01	1.95
34	35	0.33	1.15	0.01	-0.04	-0.01	-1.12
34	36	-0.33	-1.15	-0.01	0.04	0.00	2.22
35	36	0.00	1.15	0.00	-0.05	-0.00	-1.39
35	37	-0.00	-1.15	-0.00	0.05	0.00	2.41
36	37	0.00	1.15	0.00	-0.05	-0.00	-2.41
36	38	-0.00	-1.15	-0.00	0.05	-0.00	4.49
37	38	-0.33	2.22	-0.00	1.63	0.00	-3.66
37	14	0.33	-2.22	0.00	-1.63	-0.00	5.20
38	14	0.33	-1.06	0.00	1.69	-0.00	-1.11
38	39	-0.33	1.06	-0.00	-1.69	0.00	0.83
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL5 Name: Angle: 15

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.61	3.21	0.13	2.43	-0.02	-5.85
1	2	-0.61	-3.21	-0.13	-0.40	0.02	-3.83
2	3	0.86	1.22	0.14	2.62	-0.01	-7.63
2	4	-0.86	-1.22	-0.14	-0.32	0.01	-6.09
3	5	1.02	0.23	0.14	2.63	-0.01	-8.51
3	6	-1.02	-0.23	-0.14	-0.33	0.01	-7.88
4	7	1.08	0.01	0.14	2.63	-0.00	-8.79
4	8	-1.08	-0.01	-0.14	-0.33	0.00	-8.45
5	9	1.03	-0.19	0.14	2.63	0.01	-8.54
5	10	-1.03	0.19	-0.14	-0.33	-0.01	-7.94
6	11	0.87	-1.12	0.14	2.62	0.01	-7.67
6	12	-0.87	1.12	-0.14	-0.33	-0.01	-6.18
7	13	0.68	-3.37	0.14	2.57	0.01	-6.68
7	14	-0.68	3.37	-0.14	-0.41	-0.01	-4.20
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.34	-1.09	-0.05	-1.87	0.00	0.85
9	2	0.34	1.09	0.05	1.87	0.00	-0.93
10	2	0.26	2.12	0.07	-1.46	-0.02	4.76
10	17	-0.26	-2.12	-0.07	1.46	-0.04	-2.88
11	17	-0.08	1.03	0.02	0.13	0.04	3.73
11	18	0.08	-1.03	-0.02	-0.13	-0.07	-2.20
12	18	-0.08	1.03	0.02	0.13	0.07	2.20
12	19	0.08	-1.03	-0.02	-0.13	-0.09	-0.96
13	19	-0.42	1.03	-0.04	-0.00	0.09	1.81
13	20	0.42	-1.03	0.04	0.00	-0.06	-0.82
14	20	-0.76	1.03	-0.09	-0.14	0.06	1.68
14	4	0.76	-1.03	0.09	0.14	-0.03	-1.34
15	4	0.10	2.25	0.05	0.18	0.01	7.43
15	21	-0.10	-2.25	-0.05	-0.18	-0.14	-2.10
16	21	-0.24	2.25	-0.00	0.05	0.14	2.96
16	22	0.24	-2.25	0.00	-0.05	-0.14	-2.66
17	22	-0.24	2.25	-0.00	0.05	0.14	2.66
17	23	0.24	-2.25	0.00	-0.05	-0.13	-0.80
18	23	-0.58	2.25	-0.06	-0.09	0.13	1.66
18	6	0.58	-2.25	0.06	0.09	-0.04	2.11
19	6	0.44	2.48	0.09	0.24	0.03	5.77
19	24	-0.44	-2.48	-0.09	-0.24	-0.12	-3.23
20	24	0.10	2.48	0.03	0.10	0.12	4.08
20	25	-0.10	-2.48	-0.03	-0.10	-0.15	-1.70
21	25	-0.24	2.48	-0.02	-0.03	0.15	2.55
21	26	0.24	-2.48	0.02	0.03	-0.14	-1.27

22	26	-0.24	2.48	-0.02	-0.03	0.14	1.27
22	27	0.24	-2.48	0.02	0.03	-0.09	4.14
23	27	-0.58	2.48	-0.08	-0.17	0.09	-3.29
23	8	0.58	-2.48	0.08	0.17	-0.07	4.08
24	8	0.49	2.49	0.07	0.16	0.07	4.36
24	28	-0.49	-2.49	-0.07	-0.16	-0.11	-2.77
25	28	0.15	2.49	0.01	0.03	0.11	3.63
25	29	-0.15	-2.49	-0.01	-0.03	-0.13	1.02
26	29	0.15	2.49	0.01	0.03	0.13	-1.02
26	30	-0.15	-2.49	-0.01	-0.03	-0.15	3.10
27	30	-0.19	2.49	-0.04	-0.11	0.15	-2.25
27	31	0.19	-2.49	0.04	0.11	-0.11	4.64
28	31	-0.53	2.49	-0.10	-0.24	0.11	-3.78
28	10	0.53	-2.49	0.10	0.24	-0.04	5.54
29	10	0.50	2.30	0.05	0.09	0.04	2.40
29	32	-0.50	-2.30	-0.05	-0.09	-0.14	2.19
30	32	0.16	2.30	-0.01	-0.05	0.14	-1.34
30	33	-0.16	-2.30	0.01	0.05	-0.14	2.50
31	33	0.16	2.30	-0.01	-0.05	0.14	-2.50
31	34	-0.16	-2.30	0.01	0.05	-0.13	3.55
32	34	-0.18	2.30	-0.06	-0.19	0.13	-2.69
32	12	0.18	-2.30	0.06	0.19	-0.01	7.41
33	12	0.68	1.18	0.08	0.14	0.02	-1.23
33	35	-0.68	-1.18	-0.08	-0.14	-0.07	2.00
34	35	0.34	1.18	0.03	0.00	0.07	-1.15
34	36	-0.34	-1.18	-0.03	-0.00	-0.10	2.28
35	36	0.00	1.18	-0.03	-0.13	0.10	-1.42
35	37	-0.00	-1.18	0.03	0.13	-0.07	2.48
36	37	0.00	1.18	-0.03	-0.13	0.07	-2.48
36	38	-0.00	-1.18	0.03	0.13	-0.03	4.61
37	38	-0.34	2.28	-0.08	1.46	0.03	-3.76
37	14	0.34	-2.28	0.08	-1.46	0.03	5.34
38	14	0.34	-1.09	0.05	1.87	-0.01	-1.14
38	39	-0.34	1.09	-0.05	-1.87	0.00	0.85
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL6 Name: Angle: 0

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.66	3.51	0.27	5.04	-0.04	-6.39
1	2	-0.66	-3.51	-0.27	-0.78	0.04	-4.18
2	3	0.94	1.33	0.29	5.40	-0.03	-8.32
2	4	-0.94	-1.33	-0.29	-0.70	0.03	-6.65
3	5	1.12	0.26	0.30	5.43	-0.02	-9.29
3	6	-1.12	-0.26	-0.30	-0.69	0.02	-8.60
4	7	1.18	0.01	0.30	5.43	-0.00	-9.59
4	8	-1.18	-0.01	-0.30	-0.70	0.00	-9.22
5	9	1.12	-0.21	0.30	5.43	0.01	-9.32
5	10	-1.12	0.21	-0.30	-0.70	-0.01	-8.66
6	11	0.94	-1.22	0.29	5.41	0.03	-8.37
6	12	-0.94	1.22	-0.29	-0.70	-0.03	-6.74
7	13	0.74	-3.68	0.28	5.34	0.03	-7.29
7	14	-0.74	3.68	-0.28	-0.80	-0.03	-4.58
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.37	-1.19	-0.11	-2.17	0.00	0.93
9	2	0.37	1.19	0.11	2.17	0.01	-1.01
10	2	0.29	2.32	0.15	-1.39	-0.04	5.20
10	17	-0.29	-2.32	-0.15	1.39	-0.09	-3.14

11	17	-0.08	1.12	0.04	0.22	0.09	4.07
11	18	0.08	-1.12	-0.04	-0.22	-0.15	-2.40
12	18	-0.08	1.12	0.04	0.22	0.15	2.40
12	19	0.08	-1.12	-0.04	-0.22	-0.20	-1.04
13	19	-0.46	1.12	-0.07	-0.06	0.20	1.97
13	20	0.46	-1.12	0.07	0.06	-0.14	-0.90
14	20	-0.83	1.12	-0.18	-0.34	0.14	1.83
14	4	0.83	-1.12	0.18	0.34	-0.07	-1.46
15	4	0.11	2.45	0.11	0.35	0.04	8.11
15	21	-0.11	-2.45	-0.11	-0.35	-0.30	-2.30
16	21	-0.26	2.45	-0.00	0.07	0.30	3.23
16	22	0.26	-2.45	0.00	-0.07	-0.30	-2.90
17	22	-0.26	2.45	-0.00	0.07	0.30	2.90
17	23	0.26	-2.45	0.00	-0.07	-0.30	-0.88
18	23	-0.64	2.45	-0.12	-0.21	0.30	1.81
18	6	0.64	-2.45	0.12	0.21	-0.11	2.30
19	6	0.48	2.71	0.18	0.49	0.09	6.30
19	24	-0.48	-2.71	-0.18	-0.49	-0.27	-3.52
20	24	0.11	2.71	0.07	0.20	0.27	4.45
20	25	-0.11	-2.71	-0.07	-0.20	-0.34	-1.86
21	25	-0.26	2.71	-0.04	-0.08	0.34	2.79
21	26	0.26	-2.71	0.04	0.08	-0.32	-1.38
22	26	-0.26	2.71	-0.04	-0.08	0.32	1.38
22	27	0.26	-2.71	0.04	0.08	-0.22	4.52
23	27	-0.64	2.71	-0.16	-0.36	0.22	-3.59
23	8	0.64	-2.71	0.16	0.36	-0.17	4.46
24	8	0.54	2.72	0.14	0.34	0.16	4.76
24	28	-0.54	-2.72	-0.14	-0.34	-0.25	-3.03
25	28	0.17	2.72	0.03	0.06	0.25	3.96
25	29	-0.17	-2.72	-0.03	-0.06	-0.30	1.11
26	29	0.17	2.72	0.03	0.06	0.30	-1.11
26	30	-0.17	-2.72	-0.03	-0.06	-0.32	3.39
27	30	-0.20	2.72	-0.09	-0.22	0.32	-2.46
27	31	0.20	-2.72	0.09	0.22	-0.24	5.06
28	31	-0.58	2.72	-0.20	-0.50	0.24	-4.13
28	10	0.58	-2.72	0.20	0.50	-0.10	6.05
29	10	0.55	2.51	0.10	0.20	0.11	2.62
29	32	-0.55	-2.51	-0.10	-0.20	-0.31	2.39
30	32	0.17	2.51	-0.02	-0.09	0.31	-1.46
30	33	-0.17	-2.51	0.02	0.09	-0.30	2.73
31	33	0.17	2.51	-0.02	-0.09	0.30	-2.73
31	34	-0.17	-2.51	0.02	0.09	-0.29	3.87
32	34	-0.20	2.51	-0.13	-0.37	0.29	-2.94
32	12	0.20	-2.51	0.13	0.37	-0.03	8.08
33	12	0.75	1.29	0.17	0.33	0.05	-1.34
33	35	-0.75	-1.29	-0.17	-0.33	-0.16	2.18
34	35	0.37	1.29	0.05	0.05	0.16	-1.25
34	36	-0.37	-1.29	-0.05	-0.05	-0.21	2.49
35	36	0.00	1.29	-0.06	-0.23	0.21	-1.55
35	37	-0.00	-1.29	0.06	0.23	-0.16	2.70
36	37	0.00	1.29	-0.06	-0.23	0.16	-2.70
36	38	-0.00	-1.29	0.06	0.23	-0.06	5.04
37	38	-0.37	2.48	-0.17	1.37	0.06	-4.11
37	14	0.37	-2.48	0.17	-1.37	0.06	5.83
38	14	0.37	-1.19	0.11	2.17	-0.03	-1.25
38	39	-0.37	1.19	-0.11	-2.17	0.00	0.93
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL7 Name: Angle: -15

Memb	Node	Fx	Fy	Fz	Mx	My	Mz

		kip	kip	kip	kft	kft	kft
1	1	0.56	2.96	0.34	6.45	-0.05	-5.39
1	2	-0.56	-2.96	-0.34	-0.97	0.05	-3.53
2	3	0.79	1.12	0.37	6.89	-0.04	-7.02
2	4	-0.79	-1.12	-0.37	-0.91	0.04	-5.61
3	5	0.94	0.22	0.38	6.93	-0.03	-7.83
3	6	-0.94	-0.22	-0.38	-0.89	0.03	-7.25
4	7	0.99	0.01	0.38	6.94	-0.00	-8.09
4	8	-0.99	-0.01	-0.38	-0.90	0.00	-7.78
5	9	0.95	-0.18	0.38	6.93	0.02	-7.86
5	10	-0.95	0.18	-0.38	-0.90	-0.02	-7.31
6	11	0.80	-1.03	0.38	6.91	0.03	-7.06
6	12	-0.80	1.03	-0.38	-0.90	-0.03	-5.69
7	13	0.63	-3.10	0.36	6.83	0.04	-6.15
7	14	-0.63	3.10	-0.36	-0.99	-0.04	-3.86
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.31	-1.01	-0.14	-1.95	0.00	0.79
9	2	0.31	1.01	0.14	1.95	0.01	-0.86
10	2	0.24	1.95	0.20	-0.98	-0.06	4.38
10	17	-0.24	-1.95	-0.20	0.98	-0.12	-2.65
11	17	-0.07	0.95	0.05	0.25	0.12	3.44
11	18	0.07	-0.95	-0.05	-0.25	-0.20	-2.03
12	18	-0.07	0.95	0.05	0.25	0.20	2.03
12	19	0.07	-0.95	-0.05	-0.25	-0.27	-0.88
13	19	-0.38	0.95	-0.09	-0.11	0.27	1.67
13	20	0.38	-0.95	0.09	0.11	-0.18	-0.76
14	20	-0.70	0.95	-0.23	-0.47	0.18	1.54
14	4	0.70	-0.95	0.23	0.47	-0.10	-1.23
15	4	0.09	2.07	0.14	0.44	0.06	6.84
15	21	-0.09	-2.07	-0.14	-0.44	-0.40	-1.94
16	21	-0.22	2.07	-0.00	0.08	0.40	2.72
16	22	0.22	-2.07	0.00	-0.08	-0.40	-2.45
17	22	-0.22	2.07	-0.00	0.08	0.40	2.45
17	23	0.22	-2.07	0.00	-0.08	-0.39	-0.74
18	23	-0.54	2.07	-0.15	-0.28	0.39	1.53
18	6	0.54	-2.07	0.15	0.28	-0.15	1.94
19	6	0.41	2.29	0.23	0.62	0.12	5.31
19	24	-0.41	-2.29	-0.23	-0.62	-0.36	-2.97
20	24	0.09	2.29	0.09	0.26	0.36	3.76
20	25	-0.09	-2.29	-0.09	-0.26	-0.44	-1.57
21	25	-0.22	2.29	-0.06	-0.10	0.44	2.35
21	26	0.22	-2.29	0.06	0.10	-0.41	-1.17
22	26	-0.22	2.29	-0.06	-0.10	0.41	1.17
22	27	0.22	-2.29	0.06	0.10	-0.29	3.82
23	27	-0.54	2.29	-0.20	-0.46	0.29	-3.03
23	8	0.54	-2.29	0.20	0.46	-0.23	3.76
24	8	0.46	2.30	0.18	0.44	0.22	4.02
24	28	-0.46	-2.30	-0.18	-0.44	-0.34	-2.55
25	28	0.14	2.30	0.03	0.08	0.34	3.34
25	29	-0.14	-2.30	-0.03	-0.08	-0.40	0.93
26	29	0.14	2.30	0.03	0.08	0.40	-0.93
26	30	-0.14	-2.30	-0.03	-0.08	-0.42	2.86
27	30	-0.17	2.30	-0.11	-0.28	0.42	-2.07
27	31	0.17	-2.30	0.11	0.28	-0.32	4.27
28	31	-0.49	2.30	-0.25	-0.64	0.32	-3.49
28	10	0.49	-2.30	0.25	0.64	-0.14	5.10
29	10	0.46	2.12	0.12	0.26	0.16	2.21
29	32	-0.46	-2.12	-0.12	-0.26	-0.40	2.02
30	32	0.15	2.12	-0.02	-0.10	0.40	-1.23
30	33	-0.15	-2.12	0.02	0.10	-0.39	2.31
31	33	0.15	2.12	-0.02	-0.10	0.39	-2.31

31	34	-0.15	-2.12	0.02	0.10	-0.38	3.26
32	34	-0.17	2.12	-0.16	-0.46	0.38	-2.48
32	12	0.17	-2.12	0.16	0.46	-0.04	6.82
33	12	0.63	1.09	0.21	0.44	0.08	-1.13
33	35	-0.63	-1.09	-0.21	-0.44	-0.21	1.84
34	35	0.32	1.09	0.07	0.08	0.21	-1.05
34	36	-0.32	-1.09	-0.07	-0.08	-0.28	2.10
35	36	0.00	1.09	-0.08	-0.28	0.28	-1.31
35	37	-0.00	-1.09	0.08	0.28	-0.21	2.28
36	37	0.00	1.09	-0.08	-0.28	0.21	-2.28
36	38	-0.00	-1.09	0.08	0.28	-0.07	4.25
37	38	-0.31	2.09	-0.22	0.96	0.07	-3.46
37	14	0.31	-2.09	0.22	-0.96	0.08	4.91
38	14	0.31	-1.01	0.14	1.95	-0.04	-1.05
38	39	-0.31	1.01	-0.14	-1.95	0.00	0.79
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL8 Name: Angle: -30

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.49	2.62	0.43	8.16	-0.06	-4.77
1	2	-0.49	-2.62	-0.43	-1.21	0.06	-3.12
2	3	0.70	1.00	0.47	8.70	-0.06	-6.22
2	4	-0.70	-1.00	-0.47	-1.16	0.06	-4.97
3	5	0.84	0.19	0.48	8.75	-0.03	-6.94
3	6	-0.84	-0.19	-0.48	-1.14	0.03	-6.43
4	7	0.88	0.01	0.48	8.76	-0.01	-7.17
4	8	-0.88	-0.01	-0.48	-1.14	0.01	-6.89
5	9	0.84	-0.16	0.48	8.76	0.02	-6.96
5	10	-0.84	0.16	-0.48	-1.14	-0.02	-6.48
6	11	0.71	-0.91	0.47	8.72	0.04	-6.25
6	12	-0.71	0.91	-0.47	-1.15	-0.04	-5.04
7	13	0.55	-2.75	0.46	8.63	0.06	-5.45
7	14	-0.55	2.75	-0.46	-1.24	-0.06	-3.42
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.28	-0.89	-0.18	-1.87	0.00	0.70
9	2	0.28	0.89	0.18	1.87	0.01	-0.76
10	2	0.22	1.73	0.25	-0.66	-0.07	3.88
10	17	-0.22	-1.73	-0.25	0.66	-0.15	-2.35
11	17	-0.06	0.84	0.07	0.30	0.15	3.04
11	18	0.06	-0.84	-0.07	-0.30	-0.26	-1.80
12	18	-0.06	0.84	0.07	0.30	0.26	1.80
12	19	0.06	-0.84	-0.07	-0.30	-0.34	-0.78
13	19	-0.34	0.84	-0.11	-0.15	0.34	1.48
13	20	0.34	-0.84	0.11	0.15	-0.24	-0.67
14	20	-0.62	0.84	-0.29	-0.61	0.24	1.37
14	4	0.62	-0.84	0.29	0.61	-0.14	-1.09
15	4	0.08	1.83	0.18	0.55	0.08	6.06
15	21	-0.08	-1.83	-0.18	-0.55	-0.51	-1.72
16	21	-0.20	1.83	-0.00	0.10	0.51	2.41
16	22	0.20	-1.83	0.00	-0.10	-0.51	-2.17
17	22	-0.20	1.83	-0.00	0.10	0.51	2.17
17	23	0.20	-1.83	0.00	-0.10	-0.51	-0.66
18	23	-0.48	1.83	-0.18	-0.36	0.51	1.35
18	6	0.48	-1.83	0.18	0.36	-0.20	1.72
19	6	0.36	2.02	0.29	0.78	0.16	4.71
19	24	-0.36	-2.02	-0.29	-0.78	-0.46	-2.63
20	24	0.08	2.02	0.11	0.32	0.46	3.33

20	25	-0.08	-2.02	-0.11	-0.32	-0.57	-1.39
21	25	-0.20	2.02	-0.07	-0.13	0.57	2.08
21	26	0.20	-2.02	0.07	0.13	-0.53	-1.03
22	26	-0.20	2.02	-0.07	-0.13	0.53	1.03
22	27	0.20	-2.02	0.07	0.13	-0.38	3.38
23	27	-0.48	2.02	-0.25	-0.59	0.38	-2.69
23	8	0.48	-2.02	0.25	0.59	-0.30	3.33
24	8	0.40	2.03	0.22	0.56	0.29	3.56
24	28	-0.40	-2.03	-0.22	-0.56	-0.43	-2.26
25	28	0.13	2.03	0.04	0.10	0.43	2.96
25	29	-0.13	-2.03	-0.04	-0.10	-0.51	0.83
26	29	0.13	2.03	0.04	0.10	0.51	-0.83
26	30	-0.13	-2.03	-0.04	-0.10	-0.54	2.53
27	30	-0.15	2.03	-0.14	-0.35	0.54	-1.84
27	31	0.15	-2.03	0.14	0.35	-0.41	3.78
28	31	-0.43	2.03	-0.32	-0.80	0.41	-3.09
28	10	0.43	-2.03	0.32	0.80	-0.18	4.52
29	10	0.41	1.88	0.15	0.33	0.21	1.96
29	32	-0.41	-1.88	-0.15	-0.33	-0.51	1.79
30	32	0.13	1.88	-0.03	-0.12	0.51	-1.09
30	33	-0.13	-1.88	0.03	0.12	-0.50	2.04
31	33	0.13	1.88	-0.03	-0.12	0.50	-2.04
31	34	-0.13	-1.88	0.03	0.12	-0.49	2.89
32	34	-0.15	1.88	-0.21	-0.58	0.49	-2.20
32	12	0.15	-1.88	0.21	0.58	-0.06	6.04
33	12	0.56	0.96	0.26	0.57	0.10	-1.00
33	35	-0.56	-0.96	-0.26	-0.57	-0.28	1.63
34	35	0.28	0.96	0.08	0.12	0.28	-0.93
34	36	-0.28	-0.96	-0.08	-0.12	-0.36	1.86
35	36	0.00	0.96	-0.10	-0.33	0.36	-1.16
35	37	-0.00	-0.96	0.10	0.33	-0.27	2.02
36	37	0.00	0.96	-0.10	-0.33	0.27	-2.02
36	38	-0.00	-0.96	0.10	0.33	-0.09	3.76
37	38	-0.28	1.86	-0.28	0.62	0.09	-3.07
37	14	0.28	-1.86	0.28	-0.62	0.10	4.35
38	14	0.28	-0.89	0.18	1.87	-0.05	-0.93
38	39	-0.28	0.89	-0.18	-1.87	0.00	0.70
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL9 Name: Angle: -45

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.37	1.98	0.46	8.69	-0.07	-3.60
1	2	-0.37	-1.98	-0.46	-1.27	0.07	-2.35
2	3	0.53	0.75	0.50	9.26	-0.06	-4.69
2	4	-0.53	-0.75	-0.50	-1.24	0.06	-3.74
3	5	0.63	0.14	0.51	9.32	-0.04	-5.23
3	6	-0.63	-0.14	-0.51	-1.21	0.04	-4.84
4	7	0.66	0.01	0.51	9.33	-0.01	-5.40
4	8	-0.66	-0.01	-0.51	-1.22	0.01	-5.19
5	9	0.63	-0.12	0.51	9.33	0.02	-5.25
5	10	-0.63	0.12	-0.51	-1.22	-0.02	-4.88
6	11	0.53	-0.69	0.50	9.29	0.05	-4.71
6	12	-0.53	0.69	-0.50	-1.23	-0.05	-3.80
7	13	0.42	-2.07	0.49	9.20	0.06	-4.11
7	14	-0.42	2.07	-0.49	-1.31	-0.06	-2.58
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.21	-0.67	-0.19	-1.55	0.00	0.52

9	2	0.21	0.67	0.19	1.55	0.01	-0.57
10	2	0.16	1.30	0.27	-0.27	-0.08	2.93
10	17	-0.16	-1.30	-0.27	0.27	-0.16	-1.77
11	17	-0.05	0.63	0.08	0.31	0.16	2.29
11	18	0.05	-0.63	-0.08	-0.31	-0.27	-1.35
12	18	-0.05	0.63	0.08	0.31	0.27	1.35
12	19	0.05	-0.63	-0.08	-0.31	-0.37	-0.59
13	19	-0.26	0.63	-0.12	-0.18	0.37	1.11
13	20	0.26	-0.63	0.12	0.18	-0.26	-0.51
14	20	-0.47	0.63	-0.31	-0.66	0.26	1.03
14	4	0.47	-0.63	0.31	0.66	-0.15	-0.82
15	4	0.06	1.38	0.19	0.58	0.09	4.57
15	21	-0.06	-1.38	-0.19	-0.58	-0.55	-1.29
16	21	-0.15	1.38	-0.00	0.10	0.55	1.82
16	22	0.15	-1.38	0.00	-0.10	-0.55	-1.63
17	22	-0.15	1.38	-0.00	0.10	0.55	1.63
17	23	0.15	-1.38	0.00	-0.10	-0.54	-0.49
18	23	-0.36	1.38	-0.20	-0.39	0.54	1.02
18	6	0.36	-1.38	0.20	0.39	-0.22	1.30
19	6	0.27	1.53	0.31	0.83	0.18	3.55
19	24	-0.27	-1.53	-0.31	-0.83	-0.50	-1.98
20	24	0.06	1.53	0.12	0.34	0.50	2.51
20	25	-0.06	-1.53	-0.12	-0.34	-0.61	-1.05
21	25	-0.15	1.53	-0.08	-0.14	0.61	1.57
21	26	0.15	-1.53	0.08	0.14	-0.57	-0.78
22	26	-0.15	1.53	-0.08	-0.14	0.57	0.78
22	27	0.15	-1.53	0.08	0.14	-0.41	2.55
23	27	-0.36	1.53	-0.27	-0.63	0.41	-2.02
23	8	0.36	-1.53	0.27	0.63	-0.32	2.51
24	8	0.30	1.53	0.24	0.60	0.32	2.68
24	28	-0.30	-1.53	-0.24	-0.60	-0.47	-1.70
25	28	0.09	1.53	0.04	0.11	0.47	2.23
25	29	-0.09	-1.53	-0.04	-0.11	-0.55	0.62
26	29	0.09	1.53	0.04	0.11	0.55	-0.62
26	30	-0.09	-1.53	-0.04	-0.11	-0.59	1.91
27	30	-0.12	1.53	-0.15	-0.37	0.59	-1.38
27	31	0.12	-1.53	0.15	0.37	-0.44	2.85
28	31	-0.32	1.53	-0.34	-0.86	0.44	-2.33
28	10	0.32	-1.53	0.34	0.86	-0.20	3.41
29	10	0.31	1.41	0.16	0.36	0.22	1.47
29	32	-0.31	-1.41	-0.16	-0.36	-0.55	1.35
30	32	0.10	1.41	-0.03	-0.12	0.55	-0.82
30	33	-0.10	-1.41	0.03	0.12	-0.54	1.54
31	33	0.10	1.41	-0.03	-0.12	0.54	-1.54
31	34	-0.10	-1.41	0.03	0.12	-0.52	2.18
32	34	-0.11	1.41	-0.22	-0.61	0.52	-1.65
32	12	0.11	-1.41	0.22	0.61	-0.07	4.55
33	12	0.42	0.73	0.28	0.62	0.12	-0.76
33	35	-0.42	-0.73	-0.28	-0.62	-0.30	1.23
34	35	0.21	0.73	0.09	0.14	0.30	-0.70
34	36	-0.21	-0.73	-0.09	-0.14	-0.38	1.40
35	36	0.00	0.73	-0.11	-0.34	0.38	-0.88
35	37	-0.00	-0.73	0.11	0.34	-0.29	1.52
36	37	0.00	0.73	-0.11	-0.34	0.29	-1.52
36	38	-0.00	-0.73	0.11	0.34	-0.10	2.84
37	38	-0.21	1.40	-0.30	0.24	0.10	-2.31
37	14	0.21	-1.40	0.30	-0.24	0.11	3.28
38	14	0.21	-0.67	0.19	1.55	-0.05	-0.70
38	39	-0.21	0.67	-0.19	-1.55	0.00	0.52
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Report

Loadcase ID: WL10 Name: Angle: -60

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.15	0.79	0.43	8.09	-0.06	-1.44
1	2	-0.15	-0.79	-0.43	-1.17	0.06	-0.94
2	3	0.21	0.30	0.46	8.60	-0.06	-1.87
2	4	-0.21	-0.30	-0.46	-1.16	0.06	-1.50
3	5	0.25	0.06	0.47	8.65	-0.03	-2.09
3	6	-0.25	-0.06	-0.47	-1.13	0.03	-1.93
4	7	0.26	0.00	0.47	8.67	-0.01	-2.16
4	8	-0.26	-0.00	-0.47	-1.14	0.01	-2.08
5	9	0.25	-0.05	0.47	8.66	0.02	-2.10
5	10	-0.25	0.05	-0.47	-1.13	-0.02	-1.95
6	11	0.21	-0.28	0.47	8.63	0.04	-1.88
6	12	-0.21	0.28	-0.47	-1.15	-0.04	-1.52
7	13	0.17	-0.83	0.46	8.55	0.06	-1.64
7	14	-0.17	0.83	-0.46	-1.20	-0.06	-1.03
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.08	-0.27	-0.18	-0.87	0.00	0.21
9	2	0.08	0.27	0.18	0.87	0.01	-0.23
10	2	0.06	0.52	0.25	0.29	-0.07	1.17
10	17	-0.06	-0.52	-0.25	-0.29	-0.15	-0.71
11	17	-0.02	0.25	0.07	0.27	0.15	0.92
11	18	0.02	-0.25	-0.07	-0.27	-0.26	-0.54
12	18	-0.02	0.25	0.07	0.27	0.26	0.54
12	19	0.02	-0.25	-0.07	-0.27	-0.35	-0.24
13	19	-0.10	0.25	-0.11	-0.18	0.35	0.44
13	20	0.10	-0.25	0.11	0.18	-0.24	-0.20
14	20	-0.19	0.25	-0.29	-0.63	0.24	0.41
14	4	0.19	-0.25	0.29	0.63	-0.15	-0.33
15	4	0.02	0.55	0.18	0.53	0.09	1.82
15	21	-0.02	-0.55	-0.18	-0.53	-0.51	-0.52
16	21	-0.06	0.55	-0.00	0.08	0.51	0.73
16	22	0.06	-0.55	0.00	-0.08	-0.51	-0.65
17	22	-0.06	0.55	-0.00	0.08	0.51	0.65
17	23	0.06	-0.55	0.00	-0.08	-0.51	-0.20
18	23	-0.14	0.55	-0.18	-0.37	0.51	0.41
18	6	0.14	-0.55	0.18	0.37	-0.21	0.52
19	6	0.11	0.61	0.29	0.76	0.18	1.42
19	24	-0.11	-0.61	-0.29	-0.76	-0.47	-0.79
20	24	0.02	0.61	0.11	0.32	0.47	1.00
20	25	-0.02	-0.61	-0.11	-0.32	-0.58	-0.42
21	25	-0.06	0.61	-0.07	-0.13	0.58	0.63
21	26	0.06	-0.61	0.07	0.13	-0.54	-0.31
22	26	-0.06	0.61	-0.07	-0.13	0.54	0.31
22	27	0.06	-0.61	0.07	0.13	-0.39	1.02
23	27	-0.14	0.61	-0.25	-0.58	0.39	-0.81
23	8	0.14	-0.61	0.25	0.58	-0.31	1.00
24	8	0.12	0.61	0.22	0.55	0.30	1.07
24	28	-0.12	-0.61	-0.22	-0.55	-0.44	-0.68
25	28	0.04	0.61	0.04	0.11	0.44	0.89
25	29	-0.04	-0.61	-0.04	-0.11	-0.52	0.25
26	29	0.04	0.61	0.04	0.11	0.52	-0.25
26	30	-0.04	-0.61	-0.04	-0.11	-0.55	0.76
27	30	-0.05	0.61	-0.14	-0.34	0.55	-0.55
27	31	0.05	-0.61	0.14	0.34	-0.42	1.14
28	31	-0.13	0.61	-0.32	-0.79	0.42	-0.93
28	10	0.13	-0.61	0.32	0.79	-0.19	1.36
29	10	0.12	0.57	0.15	0.34	0.22	0.59
29	32	-0.12	-0.57	-0.15	-0.34	-0.52	0.54

30	32	0.04	0.57	-0.03	-0.11	0.52	-0.33
30	33	-0.04	-0.57	0.03	0.11	-0.51	0.62
31	33	0.04	0.57	-0.03	-0.11	0.51	-0.62
31	34	-0.04	-0.57	0.03	0.11	-0.49	0.87
32	34	-0.04	0.57	-0.21	-0.56	0.49	-0.66
32	12	0.04	-0.57	0.21	0.56	-0.07	1.82
33	12	0.17	0.29	0.26	0.59	0.11	-0.30
33	35	-0.17	-0.29	-0.26	-0.59	-0.28	0.49
34	35	0.08	0.29	0.08	0.14	0.28	-0.28
34	36	-0.08	-0.29	-0.08	-0.14	-0.36	0.56
35	36	0.00	0.29	-0.10	-0.31	0.36	-0.35
35	37	-0.00	-0.29	0.10	0.31	-0.27	0.61
36	37	0.00	0.29	-0.10	-0.31	0.27	-0.61
36	38	-0.00	-0.29	0.10	0.31	-0.09	1.13
37	38	-0.08	0.56	-0.28	-0.33	0.09	-0.92
37	14	0.08	-0.56	0.28	0.33	0.11	1.31
38	14	0.08	-0.27	0.18	0.87	-0.05	-0.28
38	39	-0.08	0.27	-0.18	-0.87	0.00	0.21
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: WL11 Name: Angle: -75

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	0.01	0.05	0.42	7.75	-0.06	-0.08
1	2	-0.01	-0.05	-0.42	-1.10	0.06	-0.05
2	3	0.01	0.02	0.44	8.23	-0.05	-0.11
2	4	-0.01	-0.02	-0.44	-1.12	0.05	-0.09
3	5	0.01	0.00	0.45	8.28	-0.03	-0.12
3	6	-0.01	-0.00	-0.45	-1.09	0.03	-0.11
4	7	0.02	0.00	0.45	8.30	-0.01	-0.12
4	8	-0.02	-0.00	-0.45	-1.09	0.01	-0.12
5	9	0.01	-0.00	0.45	8.30	0.02	-0.12
5	10	-0.01	0.00	-0.45	-1.09	-0.02	-0.11
6	11	0.01	-0.02	0.45	8.26	0.04	-0.11
6	12	-0.01	0.02	-0.45	-1.11	-0.04	-0.09
7	13	0.01	-0.05	0.44	8.19	0.06	-0.09
7	14	-0.01	0.05	-0.44	-1.14	-0.06	-0.06
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-0.00	-0.02	-0.17	-0.45	0.00	0.01
9	2	0.00	0.02	0.17	0.45	0.01	-0.01
10	2	0.00	0.03	0.24	0.65	-0.07	0.07
10	17	-0.00	-0.03	-0.24	-0.65	-0.14	-0.04
11	17	-0.00	0.01	0.07	0.24	0.14	0.05
11	18	0.00	-0.01	-0.07	-0.24	-0.25	-0.03
12	18	-0.00	0.01	0.07	0.24	0.25	0.03
12	19	0.00	-0.01	-0.07	-0.24	-0.33	-0.01
13	19	-0.01	0.01	-0.10	-0.19	0.33	0.03
13	20	0.01	-0.01	0.10	0.19	-0.24	-0.01
14	20	-0.01	0.01	-0.27	-0.62	0.24	0.02
14	4	0.01	-0.01	0.27	0.62	-0.15	-0.02
15	4	0.00	0.03	0.17	0.50	0.09	0.11
15	21	-0.00	-0.03	-0.17	-0.50	-0.50	-0.03
16	21	-0.00	0.03	-0.00	0.07	0.50	0.04
16	22	0.00	-0.03	0.00	-0.07	-0.50	-0.04
17	22	-0.00	0.03	-0.00	0.07	0.50	0.04
17	23	0.00	-0.03	0.00	-0.07	-0.50	-0.01
18	23	-0.01	0.03	-0.17	-0.36	0.50	0.02
18	6	0.01	-0.03	0.17	0.36	-0.21	0.03

19	6	0.01	0.04	0.28	0.73	0.17	0.08
19	24	-0.01	-0.04	-0.28	-0.73	-0.46	-0.05
20	24	0.00	0.04	0.10	0.30	0.46	0.06
20	25	-0.00	-0.04	-0.10	-0.30	-0.56	-0.02
21	25	-0.00	0.04	-0.07	-0.13	0.56	0.04
21	26	0.00	-0.04	0.07	0.13	-0.52	-0.02
22	26	-0.00	0.04	-0.07	-0.13	0.52	0.02
22	27	0.00	-0.04	0.07	0.13	-0.38	0.06
23	27	-0.01	0.04	-0.24	-0.56	0.38	-0.05
23	8	0.01	-0.04	0.24	0.56	-0.30	0.06
24	8	0.01	0.04	0.21	0.53	0.29	0.06
24	28	-0.01	-0.04	-0.21	-0.53	-0.43	-0.04
25	28	0.00	0.04	0.04	0.10	0.43	0.05
25	29	-0.00	-0.04	-0.04	-0.10	-0.50	0.01
26	29	0.00	0.04	0.04	0.10	0.50	-0.01
26	30	-0.00	-0.04	-0.04	-0.10	-0.53	0.04
27	30	-0.00	0.04	-0.13	-0.33	0.53	-0.03
27	31	0.00	-0.04	0.13	0.33	-0.41	0.07
28	31	-0.01	0.04	-0.31	-0.76	0.41	-0.05
28	10	0.01	-0.04	0.31	0.76	-0.19	0.08
29	10	0.01	0.03	0.15	0.33	0.21	0.03
29	32	-0.01	-0.03	-0.15	-0.33	-0.50	0.03
30	32	0.00	0.03	-0.03	-0.10	0.50	-0.02
30	33	-0.00	-0.03	0.03	0.10	-0.49	0.04
31	33	0.00	0.03	-0.03	-0.10	0.49	-0.04
31	34	-0.00	-0.03	0.03	0.10	-0.48	0.05
32	34	-0.00	0.03	-0.20	-0.53	0.48	-0.04
32	12	0.00	-0.03	0.20	0.53	-0.07	0.10
33	12	0.01	0.02	0.25	0.58	0.11	-0.02
33	35	-0.01	-0.02	-0.25	-0.58	-0.27	0.03
34	35	0.00	0.02	0.08	0.15	0.27	-0.02
34	36	-0.00	-0.02	-0.08	-0.15	-0.35	0.03
35	36	0.00	0.02	-0.10	-0.28	0.35	-0.02
35	37	0.00	-0.02	0.10	0.28	-0.26	0.04
36	37	0.00	0.02	-0.10	-0.28	0.26	-0.04
36	38	0.00	-0.02	0.10	0.28	-0.08	0.07
37	38	-0.00	0.03	-0.27	-0.69	0.08	-0.05
37	14	0.00	-0.03	0.27	0.69	0.10	0.08
38	14	0.00	-0.02	0.17	0.45	-0.05	-0.02
38	39	-0.00	0.02	-0.17	-0.45	0.00	0.01
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: EQ1 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	15.15	39.88	3.26	60.82	-0.47	-137.86
1	2	-15.15	-39.88	-3.26	-8.66	0.47	-104.53
2	3	20.93	11.73	3.49	64.61	-0.43	-178.11
2	4	-20.93	-11.73	-3.49	-8.79	0.43	-156.83
3	5	23.27	1.02	3.53	65.03	-0.26	-190.41
3	6	-23.27	-1.02	-3.53	-8.55	0.26	-181.86
4	7	23.87	0.14	3.54	65.16	-0.05	-193.59
4	8	-23.87	-0.14	-3.54	-8.57	0.05	-188.32
5	9	23.33	-0.45	3.54	65.12	0.17	-190.72
5	10	-23.33	0.45	-3.54	-8.55	-0.17	-182.57
6	11	21.05	-10.38	3.51	64.81	0.34	-178.63
6	12	-21.05	10.38	-3.51	-8.70	-0.34	-158.12
7	13	17.17	-41.94	3.46	64.33	0.44	-158.00
7	14	-17.17	41.94	-3.46	-8.97	-0.44	-116.66

8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	-8.04	0.00	-1.35	-3.38	0.00	20.11
9	2	8.04	0.00	1.35	3.38	0.10	-20.11
10	2	7.11	39.88	1.91	5.29	-0.57	124.64
10	17	-7.11	-39.88	-1.91	-5.29	-1.12	-89.25
11	17	-0.94	39.88	0.56	1.91	1.12	109.36
11	18	0.94	-39.88	-0.56	-1.91	-1.95	-50.02
12	18	-0.94	39.88	0.56	1.91	1.95	50.02
12	19	0.94	-39.88	-0.56	-1.91	-2.63	-1.72
13	19	-8.98	39.88	-0.79	-1.47	2.63	21.83
13	20	8.98	-39.88	0.79	1.47	-1.87	16.38
14	20	-17.02	39.88	-2.14	-4.84	1.87	3.73
14	4	17.02	-39.88	2.14	4.84	-1.16	9.48
15	4	3.91	51.61	1.34	3.94	0.73	147.35
15	21	-3.91	-51.61	-1.34	-3.94	-3.91	-25.15
16	21	-4.13	51.61	-0.01	0.56	3.91	45.26
16	22	4.13	-51.61	0.01	-0.56	-3.91	-38.42
17	22	-4.13	51.61	-0.01	0.56	3.91	38.42
17	23	4.13	-51.61	0.01	-0.56	-3.90	4.18
18	23	-12.17	51.61	-1.36	-2.81	3.90	15.92
18	6	12.17	-51.61	1.36	2.81	-1.63	70.51
19	6	11.10	52.63	2.17	5.74	1.37	111.35
19	24	-11.10	-52.63	-2.17	-5.74	-3.60	-57.44
20	24	3.05	52.63	0.82	2.36	3.60	77.55
20	25	-3.05	-52.63	-0.82	-2.36	-4.38	-27.13
21	25	-4.99	52.63	-0.53	-1.02	4.38	47.24
21	26	4.99	-52.63	0.53	1.02	-4.11	-19.98
22	26	-4.99	52.63	-0.53	-1.02	4.11	19.98
22	27	4.99	-52.63	0.53	1.02	-2.96	94.81
23	27	-13.03	52.63	-1.88	-4.40	2.96	-74.70
23	8	13.03	-52.63	1.88	4.40	-2.36	91.50
24	8	10.84	52.77	1.66	4.18	2.31	96.82
24	28	-10.84	-52.77	-1.66	-4.18	-3.37	-63.12
25	28	2.80	52.77	0.31	0.80	3.37	83.22
25	29	-2.80	-52.77	-0.31	-0.80	-3.94	15.00
26	29	2.80	52.77	0.31	0.80	3.94	-15.00
26	30	-2.80	-52.77	-0.31	-0.80	-4.19	59.19
27	30	-5.25	52.77	-1.05	-2.58	4.19	-39.08
27	31	5.25	-52.77	1.05	2.58	-3.19	89.63
28	31	-13.29	52.77	-2.40	-5.95	3.19	-69.52
28	10	13.29	-52.77	2.40	5.95	-1.50	106.71
29	10	10.04	52.32	1.14	2.59	1.67	75.86
29	32	-10.04	-52.32	-1.14	-2.59	-3.94	28.46
30	32	2.00	52.32	-0.21	-0.78	3.94	-8.35
30	33	-2.00	-52.32	0.21	0.78	-3.84	34.83
31	33	2.00	52.32	-0.21	-0.78	3.84	-34.83
31	34	-2.00	-52.32	0.21	0.78	-3.74	58.46
32	34	-6.04	52.32	-1.56	-4.16	3.74	-38.36
32	12	6.04	-52.32	1.56	4.16	-0.54	145.51
33	12	15.00	41.94	1.94	4.54	0.88	12.61
33	35	-15.00	-41.94	-1.94	-4.54	-2.14	14.68
34	35	6.96	41.94	0.59	1.16	2.14	5.43
34	36	-6.96	-41.94	-0.59	-1.16	-2.71	34.74
35	36	-1.08	41.94	-0.76	-2.22	2.71	-14.64
35	37	1.08	-41.94	0.76	2.22	-2.04	52.03
36	37	-1.08	41.94	-0.76	-2.22	2.04	-52.03
36	38	1.08	-41.94	0.76	2.22	-0.67	127.82
37	38	-9.12	41.94	-2.11	-5.59	0.67	-107.71
37	14	9.12	-41.94	2.11	5.59	0.79	136.77
38	14	8.04	0.00	1.35	3.38	-0.36	-20.11
38	39	-8.04	0.00	-1.35	-3.38	0.00	20.11
39	39	0.00	0.00	0.00	0.00	0.00	0.00

39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: EQ2 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-15.15	-39.88	3.26	60.82	-0.47	137.86
1	2	15.15	39.88	-3.26	-8.66	0.47	104.53
2	3	-20.93	-11.73	3.49	64.61	-0.43	178.11
2	4	20.93	11.73	-3.49	-8.79	0.43	156.83
3	5	-23.27	-1.02	3.53	65.03	-0.26	190.41
3	6	23.27	1.02	-3.53	-8.55	0.26	181.86
4	7	-23.87	-0.14	3.54	65.16	-0.05	193.59
4	8	23.87	0.14	-3.54	-8.57	0.05	188.32
5	9	-23.33	0.45	3.54	65.12	0.17	190.72
5	10	23.33	-0.45	-3.54	-8.55	-0.17	182.57
6	11	-21.05	10.38	3.51	64.81	0.34	178.63
6	12	21.05	-10.38	-3.51	-8.70	-0.34	158.12
7	13	-17.17	41.94	3.46	64.33	0.44	158.00
7	14	17.17	-41.94	-3.46	-8.97	-0.44	116.66
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	8.04	0.00	-1.35	-3.38	0.00	-20.11
9	2	-8.04	0.00	1.35	3.38	0.10	20.11
10	2	-7.11	-39.88	1.91	5.29	-0.57	-124.64
10	17	7.11	39.88	-1.91	-5.29	-1.12	89.25
11	17	0.94	-39.88	0.56	1.91	1.12	-109.36
11	18	-0.94	39.88	-0.56	-1.91	-1.95	50.02
12	18	0.94	-39.88	0.56	1.91	1.95	-50.02
12	19	-0.94	39.88	-0.56	-1.91	-2.63	1.72
13	19	8.98	-39.88	-0.79	-1.47	2.63	-21.83
13	20	-8.98	39.88	0.79	1.47	-1.87	-16.38
14	20	17.02	-39.88	-2.14	-4.84	1.87	-3.73
14	4	-17.02	39.88	2.14	4.84	-1.16	-9.48
15	4	-3.91	-51.61	1.34	3.94	0.73	-147.35
15	21	3.91	51.61	-1.34	-3.94	-3.91	25.15
16	21	4.13	-51.61	-0.01	0.56	3.91	-45.26
16	22	-4.13	51.61	0.01	-0.56	-3.91	38.42
17	22	4.13	-51.61	-0.01	0.56	3.91	-38.42
17	23	-4.13	51.61	0.01	-0.56	-3.90	-4.18
18	23	12.17	-51.61	-1.36	-2.81	3.90	-15.92
18	6	-12.17	51.61	1.36	2.81	-1.63	-70.51
19	6	-11.10	-52.63	2.17	5.74	1.37	-111.35
19	24	11.10	52.63	-2.17	-5.74	-3.60	57.44
20	24	-3.05	-52.63	0.82	2.36	3.60	-77.55
20	25	3.05	52.63	-0.82	-2.36	-4.38	27.13
21	25	4.99	-52.63	-0.53	-1.02	4.38	-47.24
21	26	-4.99	52.63	0.53	1.02	-4.11	19.98
22	26	4.99	-52.63	-0.53	-1.02	4.11	-19.98
22	27	-4.99	52.63	0.53	1.02	-2.96	-94.81
23	27	13.03	-52.63	-1.88	-4.40	2.96	74.70
23	8	-13.03	52.63	1.88	4.40	-2.36	-91.50
24	8	-10.84	-52.77	1.66	4.18	2.31	-96.82
24	28	10.84	52.77	-1.66	-4.18	-3.37	63.12
25	28	-2.80	-52.77	0.31	0.80	3.37	-83.22
25	29	2.80	52.77	-0.31	-0.80	-3.94	-15.00
26	29	-2.80	-52.77	0.31	0.80	3.94	15.00
26	30	2.80	52.77	-0.31	-0.80	-4.19	-59.19
27	30	5.25	-52.77	-1.05	-2.58	4.19	39.08
27	31	-5.25	52.77	1.05	2.58	-3.19	-89.63
28	31	13.29	-52.77	-2.40	-5.95	3.19	69.52

28	10	-13.29	52.77	2.40	5.95	-1.50	-106.71
29	10	-10.04	-52.32	1.14	2.59	1.67	-75.86
29	32	10.04	52.32	-1.14	-2.59	-3.94	-28.46
30	32	-2.00	-52.32	-0.21	-0.78	3.94	8.35
30	33	2.00	52.32	0.21	0.78	-3.84	-34.83
31	33	-2.00	-52.32	-0.21	-0.78	3.84	34.83
31	34	2.00	52.32	0.21	0.78	-3.74	-58.46
32	34	6.04	-52.32	-1.56	-4.16	3.74	38.36
32	12	-6.04	52.32	1.56	4.16	-0.54	-145.51
33	12	-15.00	-41.94	1.94	4.54	0.88	-12.61
33	35	15.00	41.94	-1.94	-4.54	-2.14	-14.68
34	35	-6.96	-41.94	0.59	1.16	2.14	-5.43
34	36	6.96	41.94	-0.59	-1.16	-2.71	-34.74
35	36	1.08	-41.94	-0.76	-2.22	2.71	14.64
35	37	-1.08	41.94	0.76	2.22	-2.04	-52.03
36	37	1.08	-41.94	-0.76	-2.22	2.04	52.03
36	38	-1.08	41.94	0.76	2.22	-0.67	-127.82
37	38	9.12	-41.94	-2.11	-5.59	0.67	107.71
37	14	-9.12	41.94	2.11	5.59	0.79	-136.77
38	14	-8.04	0.00	1.35	3.38	-0.36	20.11
38	39	8.04	0.00	-1.35	-3.38	0.00	-20.11
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: EQ3 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-4.54	-11.97	-10.87	-202.73	1.58	41.36
1	2	4.54	11.97	10.87	28.88	-1.58	31.36
2	3	-6.28	-3.52	-11.63	-215.36	1.44	53.43
2	4	6.28	3.52	11.63	29.29	-1.44	47.05
3	5	-6.98	-0.31	-11.77	-216.78	0.86	57.12
3	6	6.98	0.31	11.77	28.50	-0.86	54.56
4	7	-7.16	-0.04	-11.79	-217.19	0.15	58.08
4	8	7.16	0.04	11.79	28.58	-0.15	56.50
5	9	-7.00	0.14	-11.78	-217.05	-0.56	57.22
5	10	7.00	-0.14	11.78	28.49	0.56	54.77
6	11	-6.31	3.11	-11.69	-216.04	-1.13	53.59
6	12	6.31	-3.11	11.69	29.00	1.13	47.44
7	13	-5.15	12.58	-11.53	-214.42	-1.45	47.40
7	14	5.15	-12.58	11.53	29.90	1.45	35.00
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	2.41	0.00	4.50	11.26	0.00	-6.03
9	2	-2.41	0.00	-4.50	-11.26	-0.32	6.03
10	2	-2.13	-11.97	-6.36	-17.62	1.90	-37.39
10	17	2.13	11.97	6.36	17.62	3.75	26.78
11	17	0.28	-11.97	-1.86	-6.37	-3.75	-32.81
11	18	-0.28	11.97	1.86	6.37	6.51	15.01
12	18	0.28	-11.97	-1.86	-6.37	-6.51	-15.01
12	19	-0.28	11.97	1.86	6.37	8.76	0.52
13	19	2.69	-11.97	2.64	4.89	-8.76	-6.55
13	20	-2.69	11.97	-2.64	-4.89	6.23	-4.91
14	20	5.11	-11.97	7.15	16.15	-6.23	-1.12
14	4	-5.11	11.97	-7.15	-16.15	3.86	-2.84
15	4	-1.17	-15.48	-4.48	-13.14	-2.42	-44.20
15	21	1.17	15.48	4.48	13.14	13.03	7.54
16	21	1.24	-15.48	0.02	-1.88	-13.03	-13.58
16	22	-1.24	15.48	-0.02	1.88	13.03	11.53
17	22	1.24	-15.48	0.02	-1.88	-13.03	-11.53

17	23	-1.24	15.48	-0.02	1.88	13.01	-1.26
18	23	3.65	-15.48	4.52	9.38	-13.01	-4.78
18	6	-3.65	15.48	-4.52	-9.38	5.44	-21.15
19	6	-3.33	-15.79	-7.24	-19.12	-4.57	-33.40
19	24	3.33	15.79	7.24	19.12	11.99	17.23
20	24	-0.92	-15.79	-2.74	-7.86	-11.99	-23.27
20	25	0.92	15.79	2.74	7.86	14.62	8.14
21	25	1.50	-15.79	1.76	3.40	-14.62	-14.17
21	26	-1.50	15.79	-1.76	-3.40	13.70	5.99
22	26	1.50	-15.79	1.76	3.40	-13.70	-5.99
22	27	-1.50	15.79	-1.76	-3.40	9.86	-28.44
23	27	3.91	-15.79	6.27	14.65	-9.86	22.41
23	8	-3.91	15.79	-6.27	-14.65	7.86	-27.45
24	8	-3.25	-15.83	-5.52	-13.93	-7.70	-29.05
24	28	3.25	15.83	5.52	13.93	11.23	18.94
25	28	-0.84	-15.83	-1.02	-2.67	-11.23	-24.97
25	29	0.84	15.83	1.02	2.67	13.13	-4.50
26	29	-0.84	-15.83	-1.02	-2.67	-13.13	4.50
26	30	0.84	15.83	1.02	2.67	13.98	-17.76
27	30	1.57	-15.83	3.48	8.59	-13.98	11.72
27	31	-1.57	15.83	-3.48	-8.59	10.64	-26.89
28	31	3.99	-15.83	7.99	19.85	-10.64	20.86
28	10	-3.99	15.83	-7.99	-19.85	5.01	-32.01
29	10	-3.01	-15.70	-3.80	-8.64	-5.57	-22.76
29	32	3.01	15.70	3.80	8.64	13.15	-8.54
30	32	-0.60	-15.70	0.71	2.61	-13.15	2.51
30	33	0.60	15.70	-0.71	-2.61	12.79	-10.45
31	33	-0.60	-15.70	0.71	2.61	-12.79	10.45
31	34	0.60	15.70	-0.71	-2.61	12.47	-17.54
32	34	1.81	-15.70	5.21	13.87	-12.47	11.51
32	12	-1.81	15.70	-5.21	-13.87	1.80	-43.65
33	12	-4.50	-12.58	-6.48	-15.13	-2.93	-3.78
33	35	4.50	12.58	6.48	15.13	7.15	-4.40
34	35	-2.09	-12.58	-1.98	-3.87	-7.15	-1.63
34	36	2.09	12.58	1.98	3.87	9.04	-10.42
35	36	0.32	-12.58	2.53	7.39	-9.04	4.39
35	37	-0.32	12.58	-2.53	-7.39	6.79	-15.61
36	37	0.32	-12.58	2.53	7.39	-6.79	15.61
36	38	-0.32	12.58	-2.53	-7.39	2.22	-38.35
37	38	2.74	-12.58	7.03	18.65	-2.22	32.31
37	14	-2.74	12.58	-7.03	-18.65	-2.65	-41.03
38	14	-2.41	0.00	-4.50	-11.26	1.19	6.03
38	39	2.41	0.00	4.50	11.26	0.00	-6.03
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Loadcase ID: EQ4 Name:

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-4.54	-11.97	10.87	202.73	-1.58	41.36
1	2	4.54	11.97	-10.87	-28.88	1.58	31.36
2	3	-6.28	-3.52	11.63	215.36	-1.44	53.43
2	4	6.28	3.52	-11.63	-29.29	1.44	47.05
3	5	-6.98	-0.31	11.77	216.78	-0.86	57.12
3	6	6.98	0.31	-11.77	-28.50	0.86	54.56
4	7	-7.16	-0.04	11.79	217.19	-0.15	58.08
4	8	7.16	0.04	-11.79	-28.58	0.15	56.50
5	9	-7.00	0.14	11.78	217.05	0.56	57.22
5	10	7.00	-0.14	-11.78	-28.49	-0.56	54.77
6	11	-6.31	3.11	11.69	216.04	1.13	53.59

6	12	6.31	-3.11	-11.69	-29.00	-1.13	47.44
7	13	-5.15	12.58	11.53	214.42	1.45	47.40
7	14	5.15	-12.58	-11.53	-29.90	-1.45	35.00
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	0.00	0.00	0.00	0.00	0.00
9	16	2.41	0.00	-4.50	-11.26	0.00	-6.03
9	2	-2.41	0.00	4.50	11.26	0.32	6.03
10	2	-2.13	-11.97	6.36	17.62	-1.90	-37.39
10	17	2.13	11.97	-6.36	-17.62	-3.75	26.78
11	17	0.28	-11.97	1.86	6.37	3.75	-32.81
11	18	-0.28	11.97	-1.86	-6.37	-6.51	15.01
12	18	0.28	-11.97	1.86	6.37	6.51	-15.01
12	19	-0.28	11.97	-1.86	-6.37	-8.76	0.52
13	19	2.69	-11.97	-2.64	-4.89	8.76	-6.55
13	20	-2.69	11.97	2.64	4.89	-6.23	-4.91
14	20	5.11	-11.97	-7.15	-16.15	6.23	-1.12
14	4	-5.11	11.97	7.15	16.15	-3.86	-2.84
15	4	-1.17	-15.48	4.48	13.14	2.42	-44.20
15	21	1.17	15.48	-4.48	-13.14	-13.03	7.54
16	21	1.24	-15.48	-0.02	1.88	13.03	-13.58
16	22	-1.24	15.48	0.02	-1.88	-13.03	11.53
17	22	1.24	-15.48	-0.02	1.88	13.03	-11.53
17	23	-1.24	15.48	0.02	-1.88	-13.01	-1.26
18	23	3.65	-15.48	-4.52	-9.38	13.01	-4.78
18	6	-3.65	15.48	4.52	9.38	-5.44	-21.15
19	6	-3.33	-15.79	7.24	19.12	4.57	-33.40
19	24	3.33	15.79	-7.24	-19.12	-11.99	17.23
20	24	-0.92	-15.79	2.74	7.86	11.99	-23.27
20	25	0.92	15.79	-2.74	-7.86	-14.62	8.14
21	25	1.50	-15.79	-1.76	-3.40	14.62	-14.17
21	26	-1.50	15.79	1.76	3.40	-13.70	5.99
22	26	1.50	-15.79	-1.76	-3.40	13.70	-5.99
22	27	-1.50	15.79	1.76	3.40	-9.86	-28.44
23	27	3.91	-15.79	-6.27	-14.65	9.86	22.41
23	8	-3.91	15.79	6.27	14.65	-7.86	-27.45
24	8	-3.25	-15.83	5.52	13.93	7.70	-29.05
24	28	3.25	15.83	-5.52	-13.93	-11.23	18.94
25	28	-0.84	-15.83	1.02	2.67	11.23	-24.97
25	29	0.84	15.83	-1.02	-2.67	-13.13	-4.50
26	29	-0.84	-15.83	1.02	2.67	13.13	4.50
26	30	0.84	15.83	-1.02	-2.67	-13.98	-17.76
27	30	1.57	-15.83	-3.48	-8.59	13.98	11.72
27	31	-1.57	15.83	3.48	8.59	-10.64	-26.89
28	31	3.99	-15.83	-7.99	-19.85	10.64	20.86
28	10	-3.99	15.83	7.99	19.85	-5.01	-32.01
29	10	-3.01	-15.70	3.80	8.64	5.57	-22.76
29	32	3.01	15.70	-3.80	-8.64	-13.15	-8.54
30	32	-0.60	-15.70	-0.71	-2.61	13.15	2.51
30	33	0.60	15.70	0.71	2.61	-12.79	-10.45
31	33	-0.60	-15.70	-0.71	-2.61	12.79	10.45
31	34	0.60	15.70	0.71	2.61	-12.47	-17.54
32	34	1.81	-15.70	-5.21	-13.87	12.47	11.51
32	12	-1.81	15.70	5.21	13.87	-1.80	-43.65
33	12	-4.50	-12.58	6.48	15.13	2.93	-3.78
33	35	4.50	12.58	-6.48	-15.13	-7.15	-4.40
34	35	-2.09	-12.58	1.98	3.87	7.15	-1.63
34	36	2.09	12.58	-1.98	-3.87	-9.04	-10.42
35	36	0.32	-12.58	-2.53	-7.39	9.04	4.39
35	37	-0.32	12.58	2.53	7.39	-6.79	-15.61
36	37	0.32	-12.58	-2.53	-7.39	6.79	15.61
36	38	-0.32	12.58	2.53	7.39	-2.22	-38.35
37	38	2.74	-12.58	-7.03	-18.65	2.22	32.31
37	14	-2.74	12.58	7.03	18.65	2.65	-41.03

38	14	-2.41	0.00	4.50	11.26	-1.19	6.03
38	39	2.41	0.00	-4.50	-11.26	0.00	-6.03
39	39	0.00	0.00	0.00	0.00	0.00	0.00
39	40	0.00	0.00	0.00	0.00	0.00	0.00

COMBINATION OF LOADS FROM FRAME ANALYSIS (only controlling ones):

Combination No. 1
Group Id: AR Svc I Name: AREMA Service I

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	18.11	253.77	0.22	18.51	4.00	-101.30
1	2	-18.11	-215.29	-0.22	-14.95	-4.00	-188.39
2	3	23.23	399.41	0.18	16.60	4.66	-130.13
2	4	-23.23	-359.07	-0.18	-13.65	-4.66	-241.55
3	5	10.57	506.46	0.43	15.08	4.85	-64.26
3	6	-10.57	-465.96	-0.43	-8.27	-4.85	-104.86
4	7	-5.66	495.64	0.98	15.18	4.84	20.29
4	8	5.66	-455.14	-0.98	0.52	-4.84	70.27
5	9	-13.23	402.23	1.69	16.16	4.59	59.05
5	10	13.23	-361.73	-1.69	10.84	-4.59	152.67
6	11	-9.24	294.12	0.89	9.32	4.27	36.84
6	12	9.24	-253.62	-0.89	4.97	-4.27	110.98
7	13	-6.43	213.66	0.89	6.83	4.08	21.50
7	14	6.43	-173.16	-0.89	7.34	-4.08	81.44
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-1.18	-79.76	-0.36	-108.03	0.00	16.89
9	2	1.18	80.13	0.36	108.03	0.03	-22.54
10	2	16.93	135.16	-0.14	-93.07	3.98	210.93
10	17	-16.93	-130.51	0.14	93.07	-3.86	-93.08
11	17	15.75	62.85	-0.50	13.15	3.86	96.03
11	18	-15.75	-55.04	0.50	-13.15	-3.12	-8.33
12	18	15.75	55.04	-0.50	13.15	3.12	8.33
12	19	-15.75	-48.68	0.50	-13.15	-2.51	54.46
13	19	14.57	-18.98	-0.86	-94.87	2.51	-51.51
13	20	-14.57	24.01	0.86	94.87	-1.69	30.92
14	20	13.39	-91.67	-1.22	11.35	1.69	-27.97
14	4	-13.39	93.41	1.22	-11.35	-1.29	-2.68
15	4	36.62	265.66	-1.03	25.00	5.95	244.23
15	21	-36.62	-253.23	1.03	-25.00	-3.50	370.01
16	21	35.44	50.68	-1.39	-296.60	3.50	-367.06
16	22	-35.44	-49.98	1.39	296.60	-3.32	373.72
17	22	35.44	49.98	-1.39	-296.60	3.32	-373.72
17	23	-35.44	-45.65	1.39	296.60	-2.17	413.19
18	23	34.26	-156.90	-1.75	23.20	2.17	-410.24
18	6	-34.26	165.69	1.75	-23.20	0.77	140.14
19	6	44.83	300.27	-1.33	31.47	4.09	-35.28
19	24	-44.83	-294.90	1.33	-31.47	-2.73	340.05
20	24	43.65	92.35	-1.69	-290.13	2.73	-337.10
20	25	-43.65	-87.32	1.69	290.13	-1.11	423.15
21	25	42.47	-115.23	-2.05	29.67	1.11	-420.20
21	26	-42.47	117.95	2.05	-29.67	-0.05	359.81
22	26	42.47	-117.95	-2.05	29.67	0.05	-359.81
22	27	-42.47	129.40	2.05	-29.67	4.42	90.10
23	27	41.68	-283.99	-2.29	-215.69	-4.42	-88.13
23	8	-41.68	285.66	2.29	215.69	5.15	-2.80
24	8	36.02	169.48	-1.31	-216.21	-0.30	-67.47
24	28	-36.02	-166.13	1.31	216.21	1.14	174.64
25	28	35.23	11.54	-1.55	27.95	-1.14	-172.66

25	29	-35.23	-1.77	1.55	-27.95	4.02	185.06
26	29	35.23	1.77	-1.55	27.95	-4.02	-185.06
26	30	-35.23	2.62	1.55	-27.95	5.31	184.70
27	30	34.44	-157.21	-1.79	-217.41	-5.31	-182.72
27	31	-34.44	162.24	1.79	217.41	7.02	29.73
28	31	33.65	-316.82	-2.03	26.75	-7.02	-27.76
28	10	-33.65	320.52	2.03	-26.75	8.45	-196.83
29	10	20.41	41.21	-0.34	15.91	-3.86	44.16
29	32	-20.41	-30.74	0.34	-15.91	4.54	27.57
30	32	19.62	-36.92	-0.58	-91.82	-4.54	-25.59
30	33	-19.62	39.58	0.58	91.82	4.83	6.24
31	33	19.62	-39.58	-0.58	-91.82	-4.83	-6.24
31	34	-19.62	41.95	0.58	91.82	5.09	-12.18
32	34	18.83	-109.61	-0.82	14.71	-5.09	14.16
32	12	-18.83	120.36	0.82	-14.71	6.77	-249.67
33	12	9.59	133.26	0.07	9.74	-2.50	138.69
33	35	-9.59	-129.84	-0.07	-9.74	2.45	-53.10
34	35	8.80	62.18	-0.17	-97.99	-2.45	55.08
34	36	-8.80	-57.15	0.17	97.99	2.61	2.07
35	36	8.01	-10.51	-0.41	8.54	-2.61	-0.10
35	37	-8.01	15.19	0.41	-8.54	2.97	-11.35
36	37	8.01	-15.19	-0.41	8.54	-2.97	11.35
36	38	-8.01	24.68	0.41	-8.54	3.70	-47.38
37	38	7.22	-90.54	-0.65	-96.34	-3.70	49.35
37	14	-7.22	94.17	0.65	96.34	4.15	-113.33
38	14	0.79	78.99	0.24	-103.68	-0.06	31.89
38	39	-0.79	-77.59	-0.24	103.68	0.00	-11.14
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 35
Group Id: AR Svc III Name: AREMA Service III

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	24.74	272.84	16.26	300.38	6.79	-155.13
1	2	-23.23	-234.37	-15.81	-44.40	-6.79	-226.78
2	3	32.19	410.29	16.55	308.58	8.52	-199.72
2	4	-30.65	-369.95	-16.08	-48.12	-8.52	-301.10
3	5	20.09	515.71	16.43	302.55	9.86	-136.81
3	6	-18.55	-475.21	-15.97	-43.96	-9.86	-170.41
4	7	3.49	503.18	16.63	297.49	10.82	-50.30
4	8	-1.96	-462.68	-16.17	-35.70	-10.82	8.64
5	9	-4.72	404.78	16.92	292.58	11.00	-8.12
5	10	6.25	-364.28	-16.45	-26.20	-11.00	97.77
6	11	-1.53	286.90	15.47	278.43	10.84	-26.06
6	12	3.06	-246.40	-15.01	-35.21	-10.84	64.66
7	13	0.17	189.95	14.53	267.08	10.71	-35.49
7	14	1.36	-149.45	-14.06	-38.91	-10.71	46.97
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.04	0.00	0.04	-13.94
9	16	-3.91	-83.27	-6.99	-130.07	-0.04	23.72
9	2	3.91	83.64	6.99	130.07	0.54	-29.62
10	2	19.32	150.73	8.81	-85.67	6.26	256.40
10	17	-19.32	-146.07	-8.80	85.67	-14.07	-124.74
11	17	15.41	74.90	1.84	9.62	14.07	134.52
11	18	-15.41	-67.09	-1.82	-9.62	-16.79	-28.89
12	18	15.41	67.09	1.82	9.62	16.79	28.89
12	19	-15.41	-60.73	-1.80	-9.62	-18.99	48.50
13	19	11.50	-5.66	-5.15	-112.89	18.99	-38.72
13	20	-11.50	10.69	5.17	112.89	-14.04	30.89
14	20	7.58	-77.09	-12.13	-25.16	14.04	-21.11

14	4	-7.58	78.83	12.13	25.16	-10.02	-4.71
15	4	38.24	291.13	3.95	22.96	18.54	305.81
15	21	-38.24	-278.70	-3.92	-22.96	-27.85	368.74
16	21	34.33	71.24	-3.04	-322.90	27.85	-358.96
16	22	-34.33	-70.55	3.04	322.90	-27.45	368.35
17	22	34.33	70.55	-3.04	-322.90	27.45	-368.35
17	23	-34.33	-66.21	3.05	322.90	-24.93	424.79
18	23	30.41	-141.24	-10.01	-11.82	24.93	-415.01
18	6	-30.41	150.03	10.04	11.82	-8.15	171.12
19	6	48.97	325.18	5.93	32.15	18.01	-0.72
19	24	-48.97	-319.80	-5.91	-32.15	-24.07	331.00
20	24	45.06	112.35	-1.04	-313.71	24.07	-321.22
20	25	-45.06	-107.32	1.06	313.71	-23.07	426.42
21	25	41.14	-100.14	-8.01	-2.63	23.07	-416.64
21	26	-41.14	102.85	8.02	2.63	-18.92	364.07
22	26	41.14	-102.85	-8.02	-2.63	18.92	-364.07
22	27	-41.14	114.30	8.05	2.63	-1.39	127.29
23	27	38.08	-271.74	-13.39	-265.24	1.39	-119.63
23	8	-38.08	273.41	13.40	265.24	2.89	32.61
24	8	40.04	189.27	2.77	-229.53	7.93	-41.26
24	28	-38.23	-185.91	-2.76	229.53	-9.69	161.06
25	28	35.17	28.48	-2.57	6.39	9.69	-153.40
25	29	-35.17	-18.71	2.60	-6.39	-4.87	197.32
26	29	35.17	18.71	-2.60	6.39	4.87	-197.32
26	30	-35.17	-14.31	2.62	-6.39	-2.69	211.15
27	30	32.11	-143.12	-7.95	-256.21	2.69	-203.49
27	31	-32.11	148.15	7.97	256.21	4.94	63.99
28	31	29.05	-305.58	-13.30	-20.28	-4.94	-56.34
28	10	-29.05	309.28	13.31	20.28	14.32	-160.33
29	10	22.80	55.00	3.14	5.92	-3.32	62.56
29	32	-22.80	-44.53	-3.11	-5.92	-2.91	36.68
30	32	19.73	-21.86	-2.23	-112.55	2.91	-29.03
30	33	-19.73	24.52	2.24	112.55	-1.78	17.29
31	33	19.73	-24.52	-2.24	-112.55	1.78	-17.29
31	34	-19.73	26.89	2.24	112.55	-0.77	5.68
32	34	16.67	-93.29	-7.58	-20.76	0.77	1.98
32	12	-16.67	104.04	7.61	20.76	14.79	-204.05
33	12	13.61	142.36	7.39	14.45	-3.95	139.40
33	35	-13.61	-138.95	-7.38	-14.45	-0.85	-47.88
34	35	10.55	72.55	2.05	-104.02	0.85	55.54
34	36	-10.55	-67.52	-2.03	104.02	-2.81	11.55
35	36	7.49	1.13	-3.30	-12.23	2.81	-3.89
35	37	-7.49	3.55	3.32	12.23	0.14	2.81
36	37	7.49	-3.55	-3.32	-12.23	-0.14	-2.81
36	38	-7.49	13.04	3.34	12.23	6.16	-12.18
37	38	4.43	-72.86	-8.68	-120.29	-6.16	19.84
37	14	-4.43	76.50	8.69	120.29	12.17	-71.57
38	14	3.06	72.95	5.37	-81.38	-1.46	24.61
38	39	-3.06	-71.56	-5.37	81.38	0.04	-5.46
39	39	0.00	11.73	0.04	0.00	-0.04	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 57
Group Id: AR Svc III Name: AREMA Service III

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	19.46	256.62	16.22	310.57	6.67	-115.82
1	2	-20.97	-218.15	-16.67	-46.88	-6.67	-209.49
2	3	25.42	408.05	16.49	319.29	8.42	-149.94
2	4	-26.95	-367.71	-16.96	-51.13	-8.42	-270.91
3	5	12.18	520.72	16.40	313.41	9.83	-80.97

3	6	-13.71	-480.22	-16.86	-46.78	-9.83	-128.02
4	7	-4.84	510.09	16.60	308.38	10.87	7.80
4	8	3.31	-469.59	-17.07	-38.43	-10.87	55.45
5	9	-12.72	413.30	16.90	303.44	11.13	48.15
5	10	11.18	-372.80	-17.36	-28.80	-11.13	141.10
6	11	-8.47	301.68	15.43	289.08	11.04	24.60
6	12	6.94	-261.18	-15.89	-37.96	-11.04	96.76
7	13	-5.82	218.70	14.54	277.90	10.94	10.07
7	14	4.29	-178.20	-15.01	-40.91	-10.94	68.86
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	-0.04	0.00	-0.04	-13.94
9	16	-2.57	-76.25	-7.33	-119.98	0.04	20.36
9	2	2.57	76.62	7.33	119.98	0.48	-25.76
10	2	18.40	141.53	9.35	-73.10	6.20	235.25
10	17	-18.40	-136.87	-9.36	73.10	-14.50	-111.75
11	17	15.83	72.72	2.00	10.06	14.50	118.17
11	18	-15.83	-64.91	-2.02	-10.06	-17.48	-15.79
12	18	15.83	64.91	2.02	10.06	17.48	15.79
12	19	-15.83	-58.55	-2.04	-10.06	-19.94	58.96
13	19	13.27	-10.37	-5.33	-117.48	19.94	-52.54
13	20	-13.27	15.40	5.31	117.48	-14.84	40.20
14	20	10.70	-84.32	-12.68	-26.76	14.84	-33.78
14	4	-10.70	86.06	12.67	26.76	-10.65	5.56
15	4	37.65	281.65	4.28	24.37	19.07	265.35
15	21	-37.65	-269.22	-4.32	-24.37	-29.26	386.75
16	21	35.08	59.24	-3.04	-326.51	29.26	-380.33
16	22	-35.08	-58.54	3.04	326.51	-28.85	388.13
17	22	35.08	58.54	-3.04	-326.51	28.85	-388.13
17	23	-35.08	-54.21	3.03	326.51	-26.35	434.66
18	23	32.51	-155.78	-10.39	-12.45	26.35	-428.24
18	6	-32.51	164.57	10.37	12.45	-8.97	160.02
19	6	46.22	315.65	6.49	34.34	18.80	-31.99
19	24	-46.22	-310.27	-6.51	-34.34	-25.46	352.51
20	24	43.65	100.29	-0.85	-316.55	25.46	-346.09
20	25	-43.65	-95.26	0.84	316.55	-24.65	439.75
21	25	41.09	-114.72	-8.20	-2.49	24.65	-433.33
21	26	-41.09	117.44	8.20	2.49	-20.40	373.20
22	26	41.09	-117.44	-8.20	-2.49	20.40	-373.20
22	27	-41.09	128.89	8.16	2.49	-2.57	104.60
23	27	39.37	-288.85	-13.91	-270.12	2.57	-100.31
23	8	-39.37	290.53	13.90	270.12	1.87	7.83
24	8	36.06	179.06	3.17	-231.69	9.00	-63.28
24	28	-37.87	-175.71	-3.18	231.69	-11.03	176.56
25	28	36.15	15.75	-2.57	7.22	11.03	-172.27
25	29	-36.15	-5.98	2.54	-7.22	-6.27	192.49
26	29	36.15	5.98	-2.54	7.22	6.27	-192.49
26	30	-36.15	-1.58	2.53	-7.22	-4.15	195.66
27	30	34.43	-158.38	-8.27	-260.41	4.15	-191.36
27	31	-34.43	163.41	8.26	260.41	3.76	37.25
28	31	32.71	-323.37	-14.00	-21.50	-3.76	-32.95
28	10	-32.71	327.07	13.99	21.50	13.62	-196.25
29	10	21.53	45.74	3.37	7.30	-2.49	55.14
29	32	-21.53	-35.27	-3.40	-7.30	-4.27	25.62
30	32	19.81	-33.66	-2.34	-116.19	4.27	-21.33
30	33	-19.81	36.31	2.33	116.19	-3.08	3.62
31	33	19.81	-36.31	-2.33	-116.19	3.08	-3.62
31	34	-19.81	38.68	2.33	116.19	-2.03	-13.32
32	34	18.10	-107.61	-8.07	-21.42	2.03	17.62
32	12	-18.10	118.36	8.04	21.42	14.46	-249.02
33	12	11.16	142.82	7.85	16.53	-3.43	152.26
33	35	-11.16	-139.40	-7.86	-16.53	-1.68	-60.45
34	35	9.44	70.48	2.12	-106.96	1.68	64.75
34	36	-9.44	-65.45	-2.13	106.96	-3.72	0.35

35	36	7.72	-3.48	-3.61	-12.19	3.72	3.94
35	37	-7.72	8.16	3.60	12.19	-0.51	-9.13
36	37	7.72	-8.16	-3.60	-12.19	0.51	9.13
36	38	-7.72	17.64	3.57	12.19	5.97	-32.44
37	38	6.00	-89.54	-9.31	-140.39	-5.97	36.74
37	14	-6.00	93.18	9.30	140.39	12.42	-100.03
38	14	1.72	85.02	5.71	-99.48	-1.47	31.17
38	39	-1.72	-83.63	-5.71	99.48	-0.04	-8.82
39	39	0.00	11.73	-0.04	0.00	0.04	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 101
Group Id: AR Svc III Name: AREMA Service III

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	11.47	234.69	-15.82	-263.36	1.22	-47.47
1	2	-12.98	-196.22	15.36	14.49	-1.22	-149.99
2	3	14.27	388.52	-16.18	-275.38	0.81	-60.53
2	4	-15.81	-348.18	15.71	20.83	-0.81	-182.01
3	5	1.05	497.21	-15.58	-272.39	-0.16	8.29
3	6	-2.59	-456.71	15.11	27.43	0.16	-39.30
4	7	-14.81	488.11	-14.67	-267.14	-1.13	90.89
4	8	13.28	-447.61	14.20	36.73	1.13	131.89
5	9	-21.75	399.68	-13.54	-260.25	-1.82	126.23
5	10	20.22	-359.18	13.08	47.89	1.82	207.57
6	11	-16.95	301.34	-13.68	-259.79	-2.29	99.74
6	12	15.42	-260.84	13.22	45.15	2.29	157.30
7	13	-13.04	237.37	-12.76	-253.42	-2.54	78.48
7	14	11.50	-196.87	12.29	53.59	2.54	115.92
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	-0.04	0.00	-0.04	-13.94
9	16	1.55	-76.25	6.27	-85.98	0.04	10.06
9	2	-1.55	76.62	-6.27	85.98	-0.49	-15.46
10	2	14.53	119.60	-9.09	-100.47	1.70	165.45
10	17	-14.53	-114.94	9.07	100.47	6.35	-61.41
11	17	16.08	50.79	-2.84	16.69	-6.35	57.53
11	18	-16.08	-42.98	2.82	-16.69	10.56	12.22
12	18	16.08	42.98	-2.82	16.69	-10.56	-12.22
12	19	-16.08	-36.62	2.80	-16.69	13.96	60.41
13	19	17.64	-32.30	3.44	-76.85	-13.96	-64.30
13	20	-17.64	37.33	-3.45	76.85	10.66	30.94
14	20	19.19	-106.26	9.69	47.86	-10.66	-34.82
14	4	-19.19	107.99	-9.69	-47.86	7.45	-0.66
15	4	34.99	240.19	-6.02	27.04	-6.64	182.66
15	21	-34.99	-227.76	5.98	-27.04	20.84	371.27
16	21	36.55	30.11	0.25	-270.31	-20.84	-375.15
16	22	-36.55	-29.42	-0.26	270.31	20.81	379.10
17	22	36.55	29.42	0.26	-270.31	-20.81	-379.10
17	23	-36.55	-25.09	-0.27	270.31	20.59	401.59
18	23	38.10	-172.56	6.50	58.22	-20.59	-405.47
18	6	-38.10	181.35	-6.53	-58.22	9.68	109.15
19	6	40.68	275.37	-8.58	30.79	-9.84	-69.84
19	24	-40.68	-269.99	8.57	-30.79	18.62	349.11
20	24	42.24	72.35	-2.33	-266.56	-18.62	-352.99
20	25	-42.24	-67.32	2.32	266.56	20.85	419.88
21	25	43.79	-130.33	3.92	61.97	-20.85	-423.76
21	26	-43.79	133.05	-3.93	-61.97	18.82	355.54
22	26	43.79	-133.05	3.93	61.97	-18.82	-355.54
22	27	-43.79	144.49	-3.96	-61.97	10.22	52.92
23	27	45.27	-296.23	8.82	-166.15	-10.22	-56.63
23	8	-45.27	297.91	-8.82	166.15	7.40	-38.21

24	8	31.99	149.70	-5.38	-202.88	-8.53	-93.68
24	28	-33.80	-146.35	5.37	202.88	11.97	188.21
25	28	35.28	-5.39	-0.52	49.51	-11.97	-191.92
25	29	-35.28	15.16	0.49	-49.51	12.91	172.79
26	29	35.28	-15.16	-0.49	49.51	-12.91	-172.79
26	30	-35.28	19.56	0.48	-49.51	13.31	158.25
27	30	36.76	-171.30	4.38	-178.60	-13.31	-161.96
27	31	-36.76	176.33	-4.39	178.60	9.11	-4.53
28	31	38.24	-328.07	9.25	73.79	-9.11	0.83
28	10	-38.24	331.77	-9.26	-73.79	2.59	-233.34
29	10	18.03	27.41	-3.82	25.90	-4.41	25.77
29	32	-18.03	-16.94	3.78	-25.90	11.99	18.45
30	32	19.51	-51.98	1.07	-71.09	-11.99	-22.16
30	33	-19.51	54.64	-1.08	71.09	11.44	-4.82
31	33	19.51	-54.64	1.08	-71.09	-11.44	4.82
31	34	-19.51	57.01	-1.09	71.09	10.95	-30.04
32	34	20.99	-125.93	5.94	50.18	-10.95	26.34
32	12	-20.99	136.69	-5.97	-50.18	-1.25	-295.28
33	12	5.58	124.15	-7.25	5.03	-1.04	137.98
33	35	-5.58	-120.73	7.24	-5.03	5.75	-58.32
34	35	7.06	51.81	-2.38	-91.96	-5.75	54.62
34	36	-7.06	-46.78	2.37	91.96	8.02	-7.40
35	36	8.54	-22.14	2.49	29.31	-8.02	3.69
35	37	-8.54	26.82	-2.50	-29.31	5.80	-25.52
36	37	8.54	-26.82	2.50	29.31	-5.80	25.52
36	38	-8.54	36.31	-2.53	-29.31	1.25	-82.57
37	38	10.02	-108.21	7.39	-72.39	-1.25	78.87
37	14	-10.02	111.85	-7.40	72.39	-3.88	-155.09
38	14	-1.48	85.02	-4.89	-125.98	1.34	39.17
38	39	1.48	-83.63	4.89	125.98	-0.04	-16.82
39	39	0.00	11.73	-0.04	0.00	0.04	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 249
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	18.36	251.83	2.75	61.73	1.42	-154.47
1	2	-18.36	-213.36	-2.75	-17.75	-1.42	-139.24
2	3	22.78	254.48	3.56	67.56	1.73	-187.54
2	4	-22.78	-214.14	-3.56	-10.67	-1.73	-177.01
3	5	23.94	252.60	3.45	65.92	1.93	-193.78
3	6	-23.94	-212.10	-3.45	-10.73	-1.93	-189.21
4	7	23.91	253.86	3.46	64.80	2.16	-193.89
4	8	-23.91	-213.36	-3.46	-9.37	-2.16	-188.73
5	9	22.68	251.16	3.68	64.63	2.35	-187.56
5	10	-22.68	-210.66	-3.68	-5.71	-2.35	-175.26
6	11	19.30	232.58	3.51	62.27	2.47	-169.86
6	12	-19.30	-192.08	-3.51	-6.18	-2.47	-138.86
7	13	13.80	181.52	3.91	62.96	2.51	-140.77
7	14	-13.80	-141.02	-3.91	-0.38	-2.51	-80.02
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-8.04	-79.76	-1.35	-110.51	0.00	34.04
9	2	8.04	80.13	1.35	110.51	0.10	-39.70
10	2	10.31	133.23	1.40	-92.76	1.33	178.94
10	17	-10.31	-128.57	-1.40	92.76	-2.57	-62.81
11	17	2.27	60.91	0.05	11.00	2.57	82.91
11	18	-2.27	-53.10	-0.05	-11.00	-2.64	1.90
12	18	2.27	53.10	0.05	11.00	2.64	-1.90
12	19	-2.27	-46.74	-0.05	-11.00	-2.69	62.35

13	19	-5.77	-20.92	-1.30	-99.51	2.69	-42.25
13	20	5.77	25.95	1.30	99.51	-1.44	19.80
14	20	-13.81	-93.61	-2.66	4.24	1.44	0.30
14	4	13.81	95.34	2.66	-4.24	-0.56	-31.59
15	4	8.97	118.79	0.90	14.91	2.29	208.61
15	21	-8.97	-106.36	-0.90	-14.91	-4.43	57.93
16	21	0.93	38.70	-0.45	-95.60	4.43	-37.82
16	22	-0.93	-38.01	0.45	95.60	-4.37	42.90
17	22	0.93	38.01	-0.45	-95.60	4.37	-42.90
17	23	-0.93	-33.68	0.45	95.60	-3.99	72.49
18	23	-7.11	-33.98	-1.80	8.15	3.99	-52.38
18	6	7.11	42.78	1.80	-8.15	-0.98	-11.89
19	6	16.82	169.32	1.65	18.89	2.91	201.10
19	24	-16.82	-163.95	-1.65	-18.89	-4.60	-30.44
20	24	8.78	96.29	0.30	-91.62	4.60	50.54
20	25	-8.78	-91.26	-0.30	91.62	-4.88	39.28
21	25	0.74	23.60	-1.05	12.13	4.88	-19.17
21	26	-0.74	-20.88	1.05	-12.13	-4.34	30.69
22	26	0.74	20.88	-1.05	12.13	4.34	-30.69
22	27	-0.74	-9.43	1.05	-12.13	-2.04	63.74
23	27	-7.30	-58.23	-2.40	-98.37	2.04	-43.64
23	8	7.30	59.91	2.40	98.37	-1.27	24.78
24	8	16.61	153.45	1.06	-89.00	3.43	163.95
24	28	-16.61	-150.10	-1.06	89.00	-4.10	-67.02
25	28	8.57	82.44	-0.29	14.75	4.10	87.13
25	29	-8.57	-72.67	0.29	-14.75	-3.56	57.23
26	29	8.57	72.67	-0.29	14.75	3.56	-57.23
26	30	-8.57	-68.27	0.29	-14.75	-3.32	116.24
27	30	0.53	0.61	-1.64	-95.76	3.32	-96.13
27	31	-0.53	4.42	1.64	95.76	-1.74	94.31
28	31	-7.52	-72.08	-2.99	7.99	1.74	-74.20
28	10	7.52	75.78	2.99	-7.99	0.37	22.10
29	10	15.16	134.88	0.69	13.70	1.98	153.16
29	32	-15.16	-124.42	-0.69	-13.70	-3.36	105.36
30	32	7.12	56.76	-0.66	-96.80	3.36	-85.25
30	33	-7.12	-54.10	0.66	96.80	-3.02	113.30
31	33	7.12	54.10	-0.66	-96.80	3.02	-113.30
31	34	-7.12	-51.73	0.66	96.80	-2.72	137.21
32	34	-0.92	-15.93	-2.01	6.95	2.72	-117.10
32	12	0.92	26.69	2.01	-6.95	1.40	73.46
33	12	18.37	165.40	1.49	13.13	1.07	65.41
33	35	-18.37	-161.98	-1.49	-13.13	-2.04	41.09
34	35	10.33	94.32	0.14	-97.38	2.04	-20.99
34	36	-10.33	-89.29	-0.14	97.38	-2.17	108.92
35	36	2.29	21.63	-1.21	6.37	2.17	-88.82
35	37	-2.29	-16.95	1.21	-6.37	-1.09	106.02
36	37	2.29	16.95	-1.21	6.37	1.09	-106.02
36	38	-2.29	-7.47	1.21	-6.37	1.09	128.08
37	38	-5.76	-58.39	-2.56	-101.28	-1.09	-107.98
37	14	5.76	62.03	2.56	101.28	2.86	66.26
38	14	8.04	78.99	1.35	-100.90	-0.36	13.76
38	39	-8.04	-77.59	-1.35	100.90	0.00	6.99
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 250
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-11.94	172.06	2.75	61.73	1.42	121.26
1	2	11.94	-133.59	-2.75	-17.75	-1.42	69.82

2	3	-19.08	231.02	3.56	67.56	1.73	168.67
2	4	19.08	-190.68	-3.56	-10.67	-1.73	136.65
3	5	-22.60	250.56	3.45	65.92	1.93	187.04
3	6	22.60	-210.06	-3.45	-10.73	-1.93	174.51
4	7	-23.83	253.59	3.46	64.80	2.16	193.29
4	8	23.83	-213.09	-3.46	-9.37	-2.16	187.91
5	9	-23.99	252.07	3.68	64.63	2.35	193.88
5	10	23.99	-211.57	-3.68	-5.71	-2.35	189.88
6	11	-22.80	253.34	3.51	62.27	2.47	187.40
6	12	22.80	-212.84	-3.51	-6.18	-2.47	177.37
7	13	-20.53	265.39	3.91	62.96	2.51	175.23
7	14	20.53	-224.89	-3.91	-0.38	-2.51	153.30
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	8.04	-79.76	-1.35	-110.51	0.00	-6.17
9	2	-8.04	80.13	1.35	110.51	0.10	0.52
10	2	-3.90	53.46	1.40	-92.76	1.33	-70.33
10	17	3.90	-48.80	-1.40	92.76	-2.57	115.70
11	17	4.14	-18.86	0.05	11.00	2.57	-135.80
11	18	-4.14	26.67	-0.05	-11.00	-2.64	101.94
12	18	4.14	-26.67	0.05	11.00	2.64	-101.94
12	19	-4.14	33.03	-0.05	-11.00	-2.69	65.79
13	19	12.19	-100.69	-1.30	-99.51	2.69	-85.90
13	20	-12.19	105.71	1.30	99.51	-1.44	-12.95
14	20	20.23	-173.37	-2.66	4.24	1.44	-7.16
14	4	-20.23	175.11	2.66	-4.24	-0.56	-50.56
15	4	1.15	15.57	0.90	14.91	2.29	-86.09
15	21	-1.15	-3.14	-0.90	-14.91	-4.43	108.23
16	21	9.19	-64.52	-0.45	-95.60	4.43	-128.34
16	22	-9.19	65.22	0.45	95.60	-4.37	119.74
17	22	9.19	-65.22	-0.45	-95.60	4.37	-119.74
17	23	-9.19	69.55	0.45	95.60	-3.99	64.12
18	23	17.23	-137.21	-1.80	8.15	3.99	-84.23
18	6	-17.23	146.00	1.80	-8.15	-0.98	-152.91
19	6	-5.37	64.06	1.65	18.89	2.91	-21.60
19	24	5.37	-58.68	-1.65	-18.89	-4.60	84.45
20	24	2.68	-8.98	0.30	-91.62	4.60	-104.56
20	25	-2.68	14.01	-0.30	91.62	-4.88	93.55
21	25	10.72	-81.67	-1.05	12.13	4.88	-113.65
21	26	-10.72	84.39	1.05	-12.13	-4.34	70.65
22	26	10.72	-84.39	-1.05	12.13	4.34	-70.65
22	27	-10.72	95.84	1.05	-12.13	-2.04	-125.87
23	27	18.76	-163.50	-2.40	-98.37	2.04	105.77
23	8	-18.76	165.17	2.40	98.37	-1.27	-158.23
24	8	-5.07	47.91	1.06	-89.00	3.43	-29.68
24	28	5.07	-44.56	-1.06	89.00	-4.10	59.21
25	28	2.98	-23.10	-0.29	14.75	4.10	-79.32
25	29	-2.98	32.87	0.29	-14.75	-3.56	27.23
26	29	2.98	-32.87	-0.29	14.75	3.56	-27.23
26	30	-2.98	37.27	0.29	-14.75	-3.32	-2.14
27	30	11.02	-104.93	-1.64	-95.76	3.32	-17.96
27	31	-11.02	109.96	1.64	95.76	-1.74	-84.95
28	31	19.06	-177.62	-2.99	7.99	1.74	64.84
28	10	-19.06	181.32	2.99	-7.99	0.37	-191.33
29	10	-4.92	30.25	0.69	13.70	1.98	1.44
29	32	4.92	-19.78	-0.69	-13.70	-3.36	48.44
30	32	3.12	-47.88	-0.66	-96.80	3.36	-68.55
30	33	-3.12	50.53	0.66	96.80	-3.02	43.65
31	33	3.12	-50.53	-0.66	-96.80	3.02	-43.65
31	34	-3.12	52.91	0.66	96.80	-2.72	20.28
32	34	11.16	-120.57	-2.01	6.95	2.72	-40.38
32	12	-11.16	131.32	2.01	-6.95	1.40	-217.56
33	12	-11.64	81.52	1.49	13.13	1.07	40.19

33	35	11.64	-78.11	-1.49	-13.13	-2.04	11.74
34	35	-3.59	10.45	0.14	-97.38	2.04	-31.84
34	36	3.59	-5.42	-0.14	97.38	-2.17	39.44
35	36	4.45	-62.24	-1.21	6.37	2.17	-59.55
35	37	-4.45	66.92	1.21	-6.37	-1.09	1.97
36	37	4.45	-66.92	-1.21	6.37	1.09	-1.97
36	38	-4.45	76.41	1.21	-6.37	1.09	-127.55
37	38	12.49	-142.27	-2.56	-101.28	-1.09	107.45
37	14	-12.49	145.91	2.56	101.28	2.86	-207.27
38	14	-8.04	78.99	1.35	-100.90	-0.36	53.97
38	39	8.04	-77.59	-1.35	100.90	0.00	-33.22
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 251
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-1.34	199.98	-11.38	-201.82	3.48	24.75
1	2	1.34	-161.51	11.38	19.80	-3.48	-3.35
2	3	-4.43	239.23	-11.56	-212.40	3.60	44.00
2	4	4.43	-198.89	11.56	27.40	-3.60	26.87
3	5	-6.31	251.27	-11.85	-215.90	3.05	53.75
3	6	6.31	-210.77	11.85	26.32	-3.05	47.21
4	7	-7.12	253.68	-11.86	-217.56	2.36	57.78
4	8	7.12	-213.18	11.86	27.78	-2.36	56.09
5	9	-7.65	251.75	-11.64	-217.54	1.62	60.37
5	10	7.65	-211.25	11.64	31.33	-1.62	62.08
6	11	-8.07	246.08	-11.69	-218.58	1.00	62.36
6	12	8.07	-205.58	11.69	31.52	-1.00	66.69
7	13	-8.52	236.04	-11.08	-215.78	0.62	64.63
7	14	8.52	-195.54	11.08	38.49	-0.62	71.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	2.41	-79.76	4.50	-95.87	0.00	7.91
9	2	-2.41	80.13	-4.50	95.87	-0.32	-13.56
10	2	1.08	81.38	-6.87	-115.67	3.79	16.91
10	17	-1.08	-76.72	6.87	115.67	2.30	53.22
11	17	3.49	9.06	-2.37	2.72	-2.30	-59.25
11	18	-3.49	-1.25	2.37	-2.72	5.83	66.92
12	18	3.49	1.25	-2.37	2.72	-5.83	-66.92
12	19	-3.49	5.11	2.37	-2.72	8.70	64.59
13	19	5.90	-72.77	2.13	-93.15	-8.70	-70.62
13	20	-5.90	77.80	-2.13	93.15	6.65	-1.49
14	20	8.31	-145.46	6.64	25.24	-6.65	-4.55
14	4	-8.31	147.19	-6.64	-25.24	4.46	-43.92
15	4	3.88	51.70	-4.93	-2.17	-0.86	17.05
15	21	-3.88	-39.27	4.93	2.17	12.52	90.62
16	21	6.30	-28.39	-0.42	-98.04	-12.52	-96.66
16	22	-6.30	29.09	0.42	98.04	12.57	92.85
17	22	6.30	-29.09	-0.42	-98.04	-12.57	-92.85
17	23	-6.30	33.42	0.42	98.04	12.92	67.05
18	23	8.71	-101.08	4.08	20.35	-12.92	-73.08
18	6	-8.71	109.87	-4.08	-20.35	6.09	-103.55
19	6	2.40	100.90	-7.77	-5.97	-3.04	56.34
19	24	-2.40	-95.52	7.77	5.97	10.99	44.24
20	24	4.81	27.86	-3.26	-101.84	-10.99	-50.27
20	25	-4.81	-22.83	3.26	101.84	14.12	74.55
21	25	7.23	-44.83	1.24	16.55	-14.12	-80.59
21	26	-7.23	47.55	-1.24	-16.55	13.48	56.66
22	26	7.23	-47.55	1.24	16.55	-13.48	-56.66

22	27	-7.23	58.99	-1.24	-16.55	10.78	-59.51
23	27	9.64	-126.65	5.74	-79.32	-10.78	53.47
23	8	-9.64	128.33	-5.74	79.32	8.94	-94.18
24	8	2.52	84.85	-6.12	-107.11	-6.59	38.09
24	28	-2.52	-81.50	6.12	107.11	10.50	15.03
25	28	4.93	13.84	-1.62	11.28	-10.50	-21.06
25	29	-4.93	-4.07	1.62	-11.28	13.50	37.73
26	29	4.93	4.07	-1.62	11.28	-13.50	-37.73
26	30	-4.93	0.33	1.62	-11.28	14.86	39.29
27	30	7.35	-67.99	2.89	-84.59	-14.86	-45.32
27	31	-7.35	73.02	-2.89	84.59	12.09	-22.21
28	31	9.76	-140.68	7.39	33.80	-12.09	16.18
28	10	-9.76	144.38	-7.39	-33.80	6.88	-116.63
29	10	2.11	66.87	-4.25	2.47	-5.26	54.54
29	32	-2.11	-56.40	4.25	-2.47	13.73	68.36
30	32	4.52	-11.26	0.26	-93.40	-13.73	-74.39
30	33	-4.52	13.91	-0.26	93.40	13.60	68.03
31	33	4.52	-13.91	0.26	-93.40	-13.60	-68.03
31	34	-4.52	16.28	-0.26	93.40	13.49	61.20
32	34	6.93	-83.94	4.76	24.98	-13.49	-67.24
32	12	-6.93	94.70	-4.76	-24.98	3.74	-115.71
33	12	-1.13	110.88	-6.93	-6.54	-2.74	49.02
33	35	1.13	-107.46	6.93	6.54	7.25	22.01
34	35	1.28	39.80	-2.43	-102.41	-7.25	-28.04
34	36	-1.28	-34.77	2.43	102.41	9.58	63.76
35	36	3.69	-32.89	2.07	15.98	-9.58	-69.79
35	37	-3.69	37.57	-2.07	-15.98	7.73	38.39
36	37	3.69	-37.57	2.07	15.98	-7.73	-38.39
36	38	-3.69	47.06	-2.07	-15.98	3.98	-38.08
37	38	6.10	-112.92	6.58	-77.04	-3.98	32.05
37	14	-6.10	116.55	-6.58	77.04	-0.58	-111.53
38	14	-2.41	78.99	-4.50	-115.54	1.19	39.90
38	39	2.41	-77.59	4.50	115.54	0.00	-19.14
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 252
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-1.34	199.98	10.35	203.64	0.31	24.75
1	2	1.34	-161.51	-10.35	-37.97	-0.31	-3.35
2	3	-4.43	239.23	11.70	218.31	0.72	44.00
2	4	4.43	-198.89	-11.70	-31.17	-0.72	26.87
3	5	-6.31	251.27	11.69	217.67	1.33	53.75
3	6	6.31	-210.77	-11.69	-30.68	-1.33	47.21
4	7	-7.12	253.68	11.72	216.83	2.05	57.78
4	8	7.12	-213.18	-11.72	-29.38	-2.05	56.09
5	9	-7.65	251.75	11.93	216.57	2.74	60.37
5	10	7.65	-211.25	-11.93	-25.66	-2.74	62.08
6	11	-8.07	246.08	11.69	213.49	3.26	62.36
6	12	8.07	-205.58	-11.69	-26.48	-3.26	66.69
7	13	-8.52	236.04	11.98	213.06	3.52	64.63
7	14	8.52	-195.54	-11.98	-21.31	-3.52	71.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	2.41	-79.76	-4.50	-118.39	0.00	7.91
9	2	-2.41	80.13	4.50	118.39	0.32	-13.56
10	2	1.08	81.38	5.85	-80.42	-0.00	16.91
10	17	-1.08	-76.72	-5.85	80.42	-5.19	53.22
11	17	3.49	9.06	1.35	15.45	5.19	-59.25

11	18	-3.49	-1.25	-1.35	-15.45	-7.19	66.92
12	18	3.49	1.25	1.35	15.45	7.19	-66.92
12	19	-3.49	5.11	-1.35	-15.45	-8.83	64.59
13	19	5.90	-72.77	-3.16	-102.93	8.83	-70.62
13	20	-5.90	77.80	3.16	102.93	-5.80	-1.49
14	20	8.31	-145.46	-7.66	-7.06	5.80	-4.55
14	4	-8.31	147.19	7.66	7.06	-3.27	-43.92
15	4	3.88	51.70	4.04	24.10	3.99	17.05
15	21	-3.88	-39.27	-4.04	-24.10	-13.55	90.62
16	21	6.30	-28.39	-0.47	-94.28	13.55	-96.66
16	22	-6.30	29.09	0.47	94.28	-13.49	92.85
17	22	6.30	-29.09	-0.47	-94.28	13.49	-92.85
17	23	-6.30	33.42	0.47	94.28	-13.10	67.05
18	23	8.71	-101.08	-4.97	1.59	13.10	-73.08
18	6	-8.71	109.87	4.97	-1.59	-4.78	-103.55
19	6	2.40	100.90	6.72	32.27	6.11	56.34
19	24	-2.40	-95.52	-6.72	-32.27	-12.99	44.24
20	24	4.81	27.86	2.22	-86.12	12.99	-50.27
20	25	-4.81	-22.83	-2.22	86.12	-15.11	74.55
21	25	7.23	-44.83	-2.29	9.75	15.11	-80.59
21	26	-7.23	47.55	2.29	-9.75	-13.93	56.66
22	26	7.23	-47.55	-2.29	9.75	13.93	-56.66
22	27	-7.23	58.99	2.29	-9.75	-8.94	-59.51
23	27	9.64	-126.65	-6.79	-108.63	8.94	53.47
23	8	-9.64	128.33	6.79	108.63	-6.77	-94.18
24	8	2.52	84.85	4.92	-79.26	8.82	38.09
24	28	-2.52	-81.50	-4.92	79.26	-11.97	15.03
25	28	4.93	13.84	0.42	16.61	11.97	-21.06
25	29	-4.93	-4.07	-0.42	-16.61	-12.75	37.73
26	29	4.93	4.07	0.42	16.61	12.75	-37.73
26	30	-4.93	0.33	-0.42	-16.61	-13.10	39.29
27	30	7.35	-67.99	-4.08	-101.77	13.10	-45.32
27	31	-7.35	73.02	4.08	101.77	-9.19	-22.21
28	31	9.76	-140.68	-8.59	-5.90	9.19	16.18
28	10	-9.76	144.38	8.59	5.90	-3.14	-116.63
29	10	2.11	66.87	3.35	19.76	5.88	54.54
29	32	-2.11	-56.40	-3.35	-19.76	-12.56	68.36
30	32	4.52	-11.26	-1.16	-98.63	12.56	-74.39
30	33	-4.52	13.91	1.16	98.63	-11.97	68.03
31	33	4.52	-13.91	-1.16	-98.63	11.97	-68.03
31	34	-4.52	16.28	1.16	98.63	-11.45	61.20
32	34	6.93	-83.94	-5.66	-2.76	11.45	-67.24
32	12	-6.93	94.70	5.66	2.76	0.14	-115.71
33	12	-1.13	110.88	6.03	23.72	3.12	49.02
33	35	1.13	-107.46	-6.03	-23.72	-7.04	22.01
34	35	1.28	39.80	1.53	-94.67	7.04	-28.04
34	36	-1.28	-34.77	-1.53	94.67	-8.50	63.76
35	36	3.69	-32.89	-2.98	1.20	8.50	-69.79
35	37	-3.69	37.57	2.98	-1.20	-5.85	38.39
36	37	3.69	-37.57	-2.98	1.20	5.85	-38.39
36	38	-3.69	47.06	2.98	-1.20	-0.46	-38.08
37	38	6.10	-112.92	-7.48	-114.33	0.46	32.05
37	14	-6.10	116.55	7.48	114.33	4.72	-111.53
38	14	-2.41	78.99	4.50	-93.02	-1.19	39.90
38	39	2.41	-77.59	-4.50	93.02	0.00	-19.14
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 253
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft

1	1	-11.94	172.06	-3.77	-59.91	2.37	121.26
1	2	11.94	-133.59	3.77	-0.42	-2.37	69.82
2	3	-19.08	231.02	-3.42	-61.65	2.59	168.67
2	4	19.08	-190.68	3.42	6.90	-2.59	136.65
3	5	-22.60	250.56	-3.61	-64.15	2.45	187.04
3	6	22.60	-210.06	3.61	6.37	-2.45	174.51
4	7	-23.83	253.59	-3.61	-65.52	2.25	193.29
4	8	23.83	-213.09	3.61	7.78	-2.25	187.91
5	9	-23.99	252.07	-3.39	-65.60	2.01	193.88
5	10	23.99	-211.57	3.39	11.38	-2.01	189.88
6	11	-22.80	253.34	-3.51	-67.36	1.79	187.40
6	12	22.80	-212.84	3.51	11.22	-1.79	177.37
7	13	-20.53	265.39	-3.01	-65.69	1.63	175.23
7	14	20.53	-224.89	3.01	17.56	-1.63	153.30
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	8.04	-79.76	1.35	-103.75	0.00	-6.17
9	2	-8.04	80.13	-1.35	103.75	-0.10	0.52
10	2	-3.90	53.46	-2.42	-103.33	2.47	-70.33
10	17	3.90	-48.80	2.42	103.33	-0.32	115.70
11	17	4.14	-18.86	-1.07	7.18	0.32	-135.80
11	18	-4.14	26.67	1.07	-7.18	1.27	101.94
12	18	4.14	-26.67	-1.07	7.18	-1.27	-101.94
12	19	-4.14	33.03	1.07	-7.18	2.56	65.79
13	19	12.19	-100.69	0.28	-96.58	-2.56	-85.90
13	20	-12.19	105.71	-0.28	96.58	2.29	-12.95
14	20	20.23	-173.37	1.63	13.93	-2.29	-7.16
14	4	-20.23	175.11	-1.63	-13.93	1.75	-50.56
15	4	1.15	15.57	-1.79	7.03	0.84	-86.09
15	21	-1.15	-3.14	1.79	-7.03	3.39	108.23
16	21	9.19	-64.52	-0.44	-96.72	-3.39	-128.34
16	22	-9.19	65.22	0.44	96.72	3.45	119.74
17	22	9.19	-65.22	-0.44	-96.72	-3.45	-119.74
17	23	-9.19	69.55	0.44	96.72	3.81	64.12
18	23	17.23	-137.21	0.91	13.78	-3.81	-84.23
18	6	-17.23	146.00	-0.91	-13.78	2.28	-152.91
19	6	-5.37	64.06	-2.70	7.42	0.16	-21.60
19	24	5.37	-58.68	2.70	-7.42	2.60	84.45
20	24	2.68	-8.98	-1.35	-96.34	-2.60	-104.56
20	25	-2.68	14.01	1.35	96.34	3.89	93.55
21	25	10.72	-81.67	0.00	14.17	-3.89	-113.65
21	26	-10.72	84.39	-0.00	-14.17	3.89	70.65
22	26	10.72	-84.39	0.00	14.17	-3.89	-70.65
22	27	-10.72	95.84	-0.00	-14.17	3.88	-125.87
23	27	18.76	-163.50	1.36	-89.58	-3.88	105.77
23	8	-18.76	165.17	-1.36	89.58	3.44	-158.23
24	8	-5.07	47.91	-2.25	-97.36	-1.20	-29.68
24	28	5.07	-44.56	2.25	97.36	2.63	59.21
25	28	2.98	-23.10	-0.90	13.15	-2.63	-79.32
25	29	-2.98	32.87	0.90	-13.15	4.32	27.23
26	29	2.98	-32.87	-0.90	13.15	-4.32	-27.23
26	30	-2.98	37.27	0.90	-13.15	5.07	-2.14
27	30	11.02	-104.93	0.45	-90.60	-5.07	-17.96
27	31	-11.02	109.96	-0.45	90.60	4.64	-84.95
28	31	19.06	-177.62	1.80	19.90	-4.64	64.84
28	10	-19.06	181.32	-1.80	-19.90	3.37	-191.33
29	10	-4.92	30.25	-1.59	8.52	-1.36	1.44
29	32	4.92	-19.78	1.59	-8.52	4.53	48.44
30	32	3.12	-47.88	-0.24	-95.23	-4.53	-68.55
30	33	-3.12	50.53	0.24	95.23	4.65	43.65
31	33	3.12	-50.53	-0.24	-95.23	-4.65	-43.65
31	34	-3.12	52.91	0.24	95.23	4.76	20.28

32	34	11.16	-120.57	1.11	15.27	-4.76	-40.38
32	12	-11.16	131.32	-1.11	-15.27	2.48	-217.56
33	12	-11.64	81.52	-2.40	4.05	-0.69	40.19
33	35	11.64	-78.11	2.40	-4.05	2.25	11.74
34	35	-3.59	10.45	-1.04	-99.70	-2.25	-31.84
34	36	3.59	-5.42	1.04	99.70	3.25	39.44
35	36	4.45	-62.24	0.31	10.81	-3.25	-59.55
35	37	-4.45	66.92	-0.31	-10.81	2.98	1.97
36	37	4.45	-66.92	0.31	10.81	-2.98	-1.97
36	38	-4.45	76.41	-0.31	-10.81	2.42	-127.55
37	38	12.49	-142.27	1.66	-90.09	-2.42	107.45
37	14	-12.49	145.91	-1.66	90.09	1.28	-207.27
38	14	-8.04	78.99	-1.35	-107.66	0.36	53.97
38	39	8.04	-77.59	1.35	107.66	0.00	-33.22
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 254
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	18.36	251.83	-3.77	-59.91	2.37	-154.47
1	2	-18.36	-213.36	3.77	-0.42	-2.37	-139.24
2	3	22.78	254.48	-3.42	-61.65	2.59	-187.54
2	4	-22.78	-214.14	3.42	6.90	-2.59	-177.01
3	5	23.94	252.60	-3.61	-64.15	2.45	-193.78
3	6	-23.94	-212.10	3.61	6.37	-2.45	-189.21
4	7	23.91	253.86	-3.61	-65.52	2.25	-193.89
4	8	-23.91	-213.36	3.61	7.78	-2.25	-188.73
5	9	22.68	251.16	-3.39	-65.60	2.01	-187.56
5	10	-22.68	-210.66	3.39	11.38	-2.01	-175.26
6	11	19.30	232.58	-3.51	-67.36	1.79	-169.86
6	12	-19.30	-192.08	3.51	11.22	-1.79	-138.86
7	13	13.80	181.52	-3.01	-65.69	1.63	-140.77
7	14	-13.80	-141.02	3.01	17.56	-1.63	-80.02
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-8.04	-79.76	1.35	-103.75	0.00	34.04
9	2	8.04	80.13	-1.35	103.75	-0.10	-39.70
10	2	10.31	133.23	-2.42	-103.33	2.47	178.94
10	17	-10.31	-128.57	2.42	103.33	-0.32	-62.81
11	17	2.27	60.91	-1.07	7.18	0.32	82.91
11	18	-2.27	-53.10	1.07	-7.18	1.27	1.90
12	18	2.27	53.10	-1.07	7.18	-1.27	-1.90
12	19	-2.27	-46.74	1.07	-7.18	2.56	62.35
13	19	-5.77	-20.92	0.28	-96.58	-2.56	-42.25
13	20	5.77	25.95	-0.28	96.58	2.29	19.80
14	20	-13.81	-93.61	1.63	13.93	-2.29	0.30
14	4	13.81	95.34	-1.63	-13.93	1.75	-31.59
15	4	8.97	118.79	-1.79	7.03	0.84	208.61
15	21	-8.97	-106.36	1.79	-7.03	3.39	57.93
16	21	0.93	38.70	-0.44	-96.72	-3.39	-37.82
16	22	-0.93	-38.01	0.44	96.72	3.45	42.90
17	22	0.93	38.01	-0.44	-96.72	-3.45	-42.90
17	23	-0.93	-33.68	0.44	96.72	3.81	72.49
18	23	-7.11	-33.98	0.91	13.78	-3.81	-52.38
18	6	7.11	42.78	-0.91	-13.78	2.28	-11.89
19	6	16.82	169.32	-2.70	7.42	0.16	201.10
19	24	-16.82	-163.95	2.70	-7.42	2.60	-30.44
20	24	8.78	96.29	-1.35	-96.34	-2.60	50.54
20	25	-8.78	-91.26	1.35	96.34	3.89	39.28

21	25	0.74	23.60	0.00	14.17	-3.89	-19.17
21	26	-0.74	-20.88	-0.00	-14.17	3.89	30.69
22	26	0.74	20.88	0.00	14.17	-3.89	-30.69
22	27	-0.74	-9.43	-0.00	-14.17	3.88	63.74
23	27	-7.30	-58.23	1.36	-89.58	-3.88	-43.64
23	8	7.30	59.91	-1.36	89.58	3.44	24.78
24	8	16.61	153.45	-2.25	-97.36	-1.20	163.95
24	28	-16.61	-150.10	2.25	97.36	2.63	-67.02
25	28	8.57	82.44	-0.90	13.15	-2.63	87.13
25	29	-8.57	-72.67	0.90	-13.15	4.32	57.23
26	29	8.57	72.67	-0.90	13.15	-4.32	-57.23
26	30	-8.57	-68.27	0.90	-13.15	5.07	116.24
27	30	0.53	0.61	0.45	-90.60	-5.07	-96.13
27	31	-0.53	4.42	-0.45	90.60	4.64	94.31
28	31	-7.52	-72.08	1.80	19.90	-4.64	-74.20
28	10	7.52	75.78	-1.80	-19.90	3.37	22.10
29	10	15.16	134.88	-1.59	8.52	-1.36	153.16
29	32	-15.16	-124.42	1.59	-8.52	4.53	105.36
30	32	7.12	56.76	-0.24	-95.23	-4.53	-85.25
30	33	-7.12	-54.10	0.24	95.23	4.65	113.30
31	33	7.12	54.10	-0.24	-95.23	-4.65	-113.30
31	34	-7.12	-51.73	0.24	95.23	4.76	137.21
32	34	-0.92	-15.93	1.11	15.27	-4.76	-117.10
32	12	0.92	26.69	-1.11	-15.27	2.48	73.46
33	12	18.37	165.40	-2.40	4.05	-0.69	65.41
33	35	-18.37	-161.98	2.40	-4.05	2.25	41.09
34	35	10.33	94.32	-1.04	-99.70	-2.25	-20.99
34	36	-10.33	-89.29	1.04	99.70	3.25	108.92
35	36	2.29	21.63	0.31	10.81	-3.25	-88.82
35	37	-2.29	-16.95	-0.31	-10.81	2.98	106.02
36	37	2.29	16.95	0.31	10.81	-2.98	-106.02
36	38	-2.29	-7.47	-0.31	-10.81	2.42	128.08
37	38	-5.76	-58.39	1.66	-90.09	-2.42	-107.98
37	14	5.76	62.03	-1.66	90.09	1.28	66.26
38	14	8.04	78.99	-1.35	-107.66	0.36	13.76
38	39	-8.04	-77.59	1.35	107.66	0.00	6.99
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 255
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	7.75	223.91	10.35	203.64	0.31	-57.97
1	2	-7.75	-185.44	-10.35	-37.97	-0.31	-66.07
2	3	8.13	246.27	11.70	218.31	0.72	-62.87
2	4	-8.13	-205.93	-11.70	-31.17	-0.72	-67.23
3	5	7.65	251.89	11.69	217.67	1.33	-60.49
3	6	-7.65	-211.39	-11.69	-30.68	-1.33	-61.91
4	7	7.21	253.76	11.72	216.83	2.05	-58.38
4	8	-7.21	-213.26	-11.72	-29.38	-2.05	-56.90
5	9	6.34	251.48	11.93	216.57	2.74	-54.06
5	10	-6.34	-210.98	-11.93	-25.66	-2.74	-47.46
6	11	4.56	239.85	11.69	213.49	3.26	-44.82
6	12	-4.56	-199.35	-11.69	-26.48	-3.26	-28.18
7	13	1.78	210.87	11.98	213.06	3.52	-30.17
7	14	-1.78	-170.37	-11.98	-21.31	-3.52	1.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-2.41	-79.76	-4.50	-118.39	0.00	19.97
9	2	2.41	80.13	4.50	118.39	0.32	-25.62

10	2	5.34	105.31	5.85	-80.42	-0.00	91.69
10	17	-5.34	-100.65	-5.85	80.42	-5.19	-0.33
11	17	2.93	32.99	1.35	15.45	5.19	6.36
11	18	-2.93	-25.18	-1.35	-15.45	-7.19	36.91
12	18	2.93	25.18	1.35	15.45	7.19	-36.91
12	19	-2.93	-18.82	-1.35	-15.45	-8.83	63.56
13	19	0.51	-48.84	-3.16	-102.93	8.83	-57.53
13	20	-0.51	53.86	3.16	102.93	-5.80	8.34
14	20	-1.90	-121.52	-7.66	-7.06	5.80	-2.31
14	4	1.90	123.26	7.66	7.06	-3.27	-38.23
15	4	6.23	82.66	4.04	24.10	3.99	105.46
15	21	-6.23	-70.23	-4.04	-24.10	-13.55	75.53
16	21	3.82	2.57	-0.47	-94.28	13.55	-69.50
16	22	-3.82	-1.88	0.47	94.28	-13.49	69.80
17	22	3.82	1.88	-0.47	-94.28	13.49	-69.80
17	23	-3.82	2.45	0.47	94.28	-13.10	69.56
18	23	1.41	-70.11	-4.97	1.59	13.10	-63.53
18	6	-1.41	78.91	4.97	-1.59	-4.78	-61.25
19	6	9.06	132.48	6.72	32.27	6.11	123.15
19	24	-9.06	-127.10	-6.72	-32.27	-12.99	9.77
20	24	6.64	59.44	2.22	-86.12	12.99	-3.74
20	25	-6.64	-54.41	-2.22	86.12	-15.11	58.27
21	25	4.23	-13.25	-2.29	9.75	15.11	-52.24
21	26	-4.23	15.96	2.29	-9.75	-13.93	44.68
22	26	4.23	-15.96	-2.29	9.75	13.93	-44.68
22	27	-4.23	27.41	2.29	-9.75	-8.94	-2.62
23	27	1.82	-95.07	-6.79	-108.63	8.94	8.65
23	8	-1.82	96.75	6.79	108.63	-6.77	-39.27
24	8	9.02	116.51	4.92	-79.26	8.82	96.18
24	28	-9.02	-113.16	-4.92	79.26	-11.97	-22.84
25	28	6.61	45.50	0.42	16.61	11.97	28.87
25	29	-6.61	-35.73	-0.42	-16.61	-12.75	46.73
26	29	6.61	35.73	0.42	16.61	12.75	-46.73
26	30	-6.61	-31.33	-0.42	-16.61	-13.10	74.80
27	30	4.20	-36.33	-4.08	-101.77	13.10	-68.77
27	31	-4.20	41.36	4.08	101.77	-9.19	31.57
28	31	1.79	-109.02	-8.59	-5.90	9.19	-25.53
28	10	-1.79	112.72	8.59	5.90	-3.14	-52.60
29	10	8.13	98.26	3.35	19.76	5.88	100.06
29	32	-8.13	-87.79	-3.35	-19.76	-12.56	85.44
30	32	5.72	20.13	-1.16	-98.63	12.56	-79.41
30	33	-5.72	-17.48	1.16	98.63	-11.97	88.92
31	33	5.72	17.48	-1.16	-98.63	11.97	-88.92
31	34	-5.72	-15.11	1.16	98.63	-11.45	96.28
32	34	3.31	-52.55	-5.66	-2.76	11.45	-90.25
32	12	-3.31	63.31	5.66	2.76	0.14	-28.40
33	12	7.87	136.04	6.03	23.72	3.12	56.58
33	35	-7.87	-132.63	-6.03	-23.72	-7.04	30.82
34	35	5.46	64.97	1.53	-94.67	7.04	-24.79
34	36	-5.46	-59.94	-1.53	94.67	-8.50	84.61
35	36	3.04	-7.72	-2.98	1.20	8.50	-78.57
35	37	-3.04	12.40	2.98	-1.20	-5.85	69.60
36	37	3.04	-12.40	-2.98	1.20	5.85	-69.60
36	38	-3.04	21.89	2.98	-1.20	-0.46	38.61
37	38	0.63	-87.75	-7.48	-114.33	0.46	-32.58
37	14	-0.63	91.39	7.48	114.33	4.72	-29.47
38	14	2.41	78.99	4.50	-93.02	-1.19	27.83
38	39	-2.41	-77.59	-4.50	93.02	0.00	-7.08
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 256
Group Id: AR Svc EQ Name: AREMA Svc VII EQ

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	7.75	223.91	-11.38	-201.82	3.48	-57.97
1	2	-7.75	-185.44	11.38	19.80	-3.48	-66.07
2	3	8.13	246.27	-11.56	-212.40	3.60	-62.87
2	4	-8.13	-205.93	11.56	27.40	-3.60	-67.23
3	5	7.65	251.89	-11.85	-215.90	3.05	-60.49
3	6	-7.65	-211.39	11.85	26.32	-3.05	-61.91
4	7	7.21	253.76	-11.86	-217.56	2.36	-58.38
4	8	-7.21	-213.26	11.86	27.78	-2.36	-56.90
5	9	6.34	251.48	-11.64	-217.54	1.62	-54.06
5	10	-6.34	-210.98	11.64	31.33	-1.62	-47.46
6	11	4.56	239.85	-11.69	-218.58	1.00	-44.82
6	12	-4.56	-199.35	11.69	31.52	-1.00	-28.18
7	13	1.78	210.87	-11.08	-215.78	0.62	-30.17
7	14	-1.78	-170.37	11.08	38.49	-0.62	1.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-2.41	-79.76	4.50	-95.87	0.00	19.97
9	2	2.41	80.13	-4.50	95.87	-0.32	-25.62
10	2	5.34	105.31	-6.87	-115.67	3.79	91.69
10	17	-5.34	-100.65	6.87	115.67	2.30	-0.33
11	17	2.93	32.99	-2.37	2.72	-2.30	6.36
11	18	-2.93	-25.18	2.37	-2.72	5.83	36.91
12	18	2.93	25.18	-2.37	2.72	-5.83	-36.91
12	19	-2.93	-18.82	2.37	-2.72	8.70	63.56
13	19	0.51	-48.84	2.13	-93.15	-8.70	-57.53
13	20	-0.51	53.86	-2.13	93.15	6.65	8.34
14	20	-1.90	-121.52	6.64	25.24	-6.65	-2.31
14	4	1.90	123.26	-6.64	-25.24	4.46	-38.23
15	4	6.23	82.66	-4.93	-2.17	-0.86	105.46
15	21	-6.23	-70.23	4.93	2.17	12.52	75.53
16	21	3.82	2.57	-0.42	-98.04	-12.52	-69.50
16	22	-3.82	-1.88	0.42	98.04	12.57	69.80
17	22	3.82	1.88	-0.42	-98.04	-12.57	-69.80
17	23	-3.82	2.45	0.42	98.04	12.92	69.56
18	23	1.41	-70.11	4.08	20.35	-12.92	-63.53
18	6	-1.41	78.91	-4.08	-20.35	6.09	-61.25
19	6	9.06	132.48	-7.77	-5.97	-3.04	123.15
19	24	-9.06	-127.10	7.77	5.97	10.99	9.77
20	24	6.64	59.44	-3.26	-101.84	-10.99	-3.74
20	25	-6.64	-54.41	3.26	101.84	14.12	58.27
21	25	4.23	-13.25	1.24	16.55	-14.12	-52.24
21	26	-4.23	15.96	-1.24	-16.55	13.48	44.68
22	26	4.23	-15.96	1.24	16.55	-13.48	-44.68
22	27	-4.23	27.41	-1.24	-16.55	10.78	-2.62
23	27	1.82	-95.07	5.74	-79.32	-10.78	8.65
23	8	-1.82	96.75	-5.74	79.32	8.94	-39.27
24	8	9.02	116.51	-6.12	-107.11	-6.59	96.18
24	28	-9.02	-113.16	6.12	107.11	10.50	-22.84
25	28	6.61	45.50	-1.62	11.28	-10.50	28.87
25	29	-6.61	-35.73	1.62	-11.28	13.50	46.73
26	29	6.61	35.73	-1.62	11.28	-13.50	-46.73
26	30	-6.61	-31.33	1.62	-11.28	14.86	74.80
27	30	4.20	-36.33	2.89	-84.59	-14.86	-68.77
27	31	-4.20	41.36	-2.89	84.59	12.09	31.57
28	31	1.79	-109.02	7.39	33.80	-12.09	-25.53
28	10	-1.79	112.72	-7.39	-33.80	6.88	-52.60
29	10	8.13	98.26	-4.25	2.47	-5.26	100.06
29	32	-8.13	-87.79	4.25	-2.47	13.73	85.44
30	32	5.72	20.13	0.26	-93.40	-13.73	-79.41

30	33	-5.72	-17.48	-0.26	93.40	13.60	88.92
31	33	5.72	17.48	0.26	-93.40	-13.60	-88.92
31	34	-5.72	-15.11	-0.26	93.40	13.49	96.28
32	34	3.31	-52.55	4.76	24.98	-13.49	-90.25
32	12	-3.31	63.31	-4.76	-24.98	3.74	-28.40
33	12	7.87	136.04	-6.93	-6.54	-2.74	56.58
33	35	-7.87	-132.63	6.93	6.54	7.25	30.82
34	35	5.46	64.97	-2.43	-102.41	-7.25	-24.79
34	36	-5.46	-59.94	2.43	102.41	9.58	84.61
35	36	3.04	-7.72	2.07	15.98	-9.58	-78.57
35	37	-3.04	12.40	-2.07	-15.98	7.73	69.60
36	37	3.04	-12.40	2.07	15.98	-7.73	-69.60
36	38	-3.04	21.89	-2.07	-15.98	3.98	38.61
37	38	0.63	-87.75	6.58	-77.04	-3.98	-32.58
37	14	-0.63	91.39	-6.58	77.04	-0.58	-29.47
38	14	2.41	78.99	-4.50	-115.54	1.19	27.83
38	39	-2.41	-77.59	4.50	115.54	0.00	-7.08
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 257
Group Id: AR Derail Name: AREMA Svc Derail

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	27.53	462.84	-2.02	-2.87	4.60	-156.32
1	2	-27.53	-424.36	2.02	-29.41	-4.60	-284.17
2	3	10.75	626.35	0.48	7.91	5.13	-69.65
2	4	-10.75	-586.01	-0.48	-0.21	-5.13	-102.36
3	5	-8.48	587.00	0.17	3.30	4.88	31.16
3	6	8.48	-546.50	-0.17	-0.58	-4.88	104.60
4	7	-14.74	469.94	0.52	2.39	4.49	63.12
4	8	14.74	-429.44	-0.52	5.90	-4.49	172.68
5	9	-10.60	337.62	0.66	0.65	4.03	40.36
5	10	10.60	-297.12	-0.66	9.96	-4.03	129.27
6	11	-2.87	256.50	0.03	-4.97	3.67	-1.07
6	12	2.87	-216.00	-0.03	5.48	-3.67	47.03
7	13	-1.58	204.61	0.15	-6.41	3.47	-8.01
7	14	1.58	-164.11	-0.15	8.87	-3.47	33.36
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	0.00	-79.76	0.00	-107.13	0.00	13.94
9	2	0.00	80.13	0.00	107.13	0.00	-19.59
10	2	27.53	344.23	-2.02	-77.72	4.60	303.76
10	17	-27.53	-339.58	2.02	77.72	-2.81	-0.43
11	17	27.53	271.92	-2.02	29.41	2.81	0.43
11	18	-27.53	-264.10	2.02	-29.41	0.19	398.32
12	18	27.53	264.10	-2.02	29.41	-0.19	-398.32
12	19	-27.53	-257.75	2.02	-29.41	2.63	714.28
13	19	27.53	-126.61	-2.02	-579.16	-2.63	-714.28
13	20	-27.53	131.64	2.02	579.16	4.56	590.60
14	20	27.53	-516.00	-2.02	29.41	-4.56	-590.60
14	4	-27.53	517.74	2.02	-29.41	5.23	419.40
15	4	38.28	68.27	-1.54	29.62	-0.10	-317.04
15	21	-38.28	-55.84	1.54	-29.62	3.74	463.96
16	21	38.28	-117.39	-1.54	-244.66	-3.74	-463.96
16	22	-38.28	118.09	1.54	244.66	3.94	448.36
17	22	38.28	-118.09	-1.54	-244.66	-3.94	-448.36
17	23	-38.28	122.42	1.54	244.66	5.21	349.10
18	23	38.28	-295.65	-1.54	29.62	-5.21	-349.10
18	6	-38.28	304.44	1.54	-29.62	7.78	-153.36
19	6	29.80	242.06	-1.37	30.20	-2.90	48.76

19	24	-29.80	-236.68	1.37	-30.20	4.30	196.39
20	24	29.80	63.45	-1.37	-244.08	-4.30	-196.39
20	25	-29.80	-58.42	1.37	244.08	5.60	254.76
21	25	29.80	-114.81	-1.37	30.20	-5.60	-254.76
21	26	-29.80	117.53	1.37	-30.20	6.31	194.58
22	26	29.80	-117.53	-1.37	30.20	-6.31	-194.58
22	27	-29.80	128.98	1.37	-30.20	9.29	-74.20
23	27	29.80	-302.21	-1.37	-244.08	-9.29	74.20
23	8	-29.80	303.88	1.37	244.08	9.73	-170.95
24	8	15.06	125.56	-0.85	-249.98	-5.24	-1.73
24	28	-15.06	-122.20	0.85	249.98	5.78	80.84
25	28	15.06	-51.03	-0.85	24.30	-5.78	-80.84
25	29	-15.06	60.80	0.85	-24.30	7.36	-23.24
26	29	15.06	-60.80	-0.85	24.30	-7.36	23.24
26	30	-15.06	65.20	0.85	-24.30	8.07	-75.99
27	30	15.06	-132.86	-0.85	-82.82	-8.07	75.99
27	31	-15.06	137.88	0.85	82.82	8.88	-205.65
28	31	15.06	-205.54	-0.85	24.30	-8.88	205.65
28	10	-15.06	209.24	0.85	-24.30	9.48	-351.82
29	10	4.46	87.88	-0.19	14.35	-5.44	222.55
29	32	-4.46	-77.41	0.19	-14.35	5.81	-57.77
30	32	4.46	9.75	-0.19	-92.78	-5.81	57.77
30	33	-4.46	-7.09	0.19	92.78	5.91	-53.51
31	33	4.46	7.09	-0.19	-92.78	-5.91	53.51
31	34	-4.46	-4.72	0.19	92.78	5.99	-50.84
32	34	4.46	-62.94	-0.19	14.35	-5.99	50.84
32	12	-4.46	73.69	0.19	-14.35	6.37	-190.76
33	12	1.58	142.30	-0.15	8.87	-2.70	143.73
33	35	-1.58	-138.89	0.15	-8.87	2.80	-52.26
34	35	1.58	71.23	-0.15	-98.26	-2.80	52.26
34	36	-1.58	-66.20	0.15	98.26	2.95	13.56
35	36	1.58	-1.46	-0.15	8.87	-2.95	-13.56
35	37	-1.58	6.14	0.15	-8.87	3.09	10.17
36	37	1.58	-6.14	-0.15	8.87	-3.09	-10.17
36	38	-1.58	15.63	0.15	-8.87	3.37	-9.51
37	38	1.58	-81.49	-0.15	-95.41	-3.37	9.51
37	14	-1.58	85.13	0.15	95.41	3.47	-67.22
38	14	0.00	78.99	0.00	-104.28	0.00	33.86
38	39	0.00	-77.59	0.00	104.28	0.00	-13.11
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 258
Group Id: AR Derail Name: AREMA Svc Derail

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	18.99	349.61	-2.75	-222.18	-16.46	-105.49
1	2	-18.99	-311.14	2.75	178.19	16.46	-198.31
2	3	9.59	477.41	7.16	-169.40	-19.83	-56.92
2	4	-9.59	-437.08	-7.16	283.89	19.83	-96.49
3	5	-4.95	466.50	4.38	-171.79	-22.24	19.28
3	6	4.95	-426.00	-4.38	241.95	22.24	59.91
4	7	-9.38	397.30	1.54	-173.31	-23.98	41.81
4	8	9.38	-356.80	-1.54	197.94	23.98	108.25
5	9	-8.01	311.81	-3.16	-184.11	-24.24	33.86
5	10	8.01	-271.31	3.16	133.51	24.24	94.34
6	11	-3.36	253.94	-4.72	-178.41	-23.28	8.74
6	12	3.36	-213.44	4.72	102.87	23.28	44.97
7	13	-2.88	212.26	-2.45	-152.91	-22.27	6.06
7	14	2.88	-171.76	2.45	113.77	22.27	40.01
8	15	0.00	0.00	0.00	0.00	0.00	0.00

8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	0.00	-79.76	0.00	-107.13	0.00	13.94
9	2	0.00	80.13	0.00	107.13	0.00	-19.59
10	2	18.99	231.01	-2.75	-285.32	-16.46	217.90
10	17	-18.99	-226.35	2.75	285.32	18.90	-15.02
11	17	18.99	158.69	-2.75	-178.19	-18.90	15.02
11	18	-18.99	-150.88	2.75	178.19	22.99	215.27
12	18	18.99	150.88	-2.75	-178.19	-22.99	-215.27
12	19	-18.99	-144.52	2.75	178.19	26.32	394.13
13	19	18.99	76.86	-2.75	-285.32	-26.32	-394.13
13	20	-18.99	-71.83	2.75	285.32	28.96	465.34
14	20	18.99	-391.24	-2.75	447.87	-28.96	-465.34
14	4	-18.99	392.97	2.75	-447.87	29.87	335.47
15	4	28.58	44.10	4.41	163.99	-49.70	-238.98
15	21	-28.58	-31.67	-4.41	-163.99	39.27	328.68
16	21	28.58	-35.99	4.41	56.86	-39.27	-328.68
16	22	-28.58	36.68	-4.41	-56.86	38.68	323.87
17	22	28.58	-36.68	4.41	56.86	-38.68	-323.87
17	23	-28.58	41.02	-4.41	-56.86	35.05	291.80
18	23	28.58	-240.48	4.41	372.67	-35.05	-291.80
18	6	-28.58	249.27	-4.41	-372.67	27.67	-118.26
19	6	23.63	176.74	8.79	130.72	-49.91	58.35
19	24	-23.63	-171.36	-8.79	-130.72	40.91	119.90
20	24	23.63	103.70	8.79	23.59	-40.91	-119.90
20	25	-23.63	-98.67	-8.79	-23.59	32.49	216.82
21	25	23.63	-100.79	8.79	339.41	-32.49	-216.82
21	26	-23.63	103.51	-8.79	-339.41	27.93	163.91
22	26	23.63	-103.51	8.79	339.41	-27.93	-163.91
22	27	-23.63	114.96	-8.79	-339.41	8.76	-74.30
23	27	23.63	-182.62	8.79	232.28	-8.76	74.30
23	8	-23.63	184.29	-8.79	-232.28	5.96	-132.87
24	8	14.25	172.51	10.33	34.34	-29.94	24.62
24	28	-14.25	-169.15	-10.33	-34.34	23.34	84.48
25	28	14.25	-30.31	10.33	350.15	-23.34	-84.48
25	29	-14.25	40.08	-10.33	-350.15	4.11	18.97
26	29	14.25	-40.08	10.33	350.15	-4.11	-18.97
26	30	-14.25	44.47	-10.33	-350.15	-4.54	-16.43
27	30	14.25	-112.13	10.33	243.02	4.54	16.43
27	31	-14.25	117.16	-10.33	-243.02	-14.44	-126.25
28	31	14.25	-184.82	10.33	350.15	14.44	126.25
28	10	-14.25	188.52	-10.33	-350.15	-21.72	-257.81
29	10	6.24	82.78	7.17	216.64	-2.52	163.47
29	32	-6.24	-72.32	-7.17	-216.64	-11.77	-8.83
30	32	6.24	4.66	7.17	109.51	11.77	8.83
30	33	-6.24	-2.00	-7.17	-109.51	-15.40	-7.15
31	33	6.24	2.00	7.17	109.51	15.40	7.15
31	34	-6.24	0.37	-7.17	-109.51	-18.64	-6.78
32	34	6.24	-68.03	7.17	216.64	18.64	6.78
32	12	-6.24	78.79	-7.17	-216.64	-33.32	-157.13
33	12	2.88	134.66	2.45	113.77	10.04	112.16
33	35	-2.88	-131.24	-2.45	-113.77	-11.63	-25.67
34	35	2.88	63.58	2.45	6.64	11.63	25.67
34	36	-2.88	-58.55	-2.45	-6.64	-13.98	32.83
35	36	2.88	-9.11	2.45	113.77	13.98	-32.83
35	37	-2.88	13.79	-2.45	-113.77	-16.16	22.62
36	37	2.88	-13.79	2.45	113.77	16.16	-22.62
36	38	-2.88	23.28	-2.45	-113.77	-20.58	-10.87
37	38	2.88	-89.14	2.45	9.49	20.58	10.87
37	14	-2.88	92.77	-2.45	-9.49	-22.27	-73.88
38	14	0.00	78.99	0.00	-104.28	0.00	33.86
38	39	0.00	-77.59	0.00	104.28	0.00	-13.11
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 259
Group Id: AR LF-1 Name: AREMA LFD 1

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	37.48	389.01	0.22	28.67	7.32	-204.90
1	2	-37.48	-335.15	-0.22	-25.20	-7.32	-394.72
2	3	50.06	702.86	-0.40	22.02	8.53	-274.36
2	4	-50.06	-646.38	0.40	-28.49	-8.53	-526.53
3	5	21.63	946.11	0.32	20.73	8.88	-126.43
3	6	-21.63	-889.41	-0.32	-15.66	-8.88	-219.57
4	7	-15.66	921.00	1.62	22.46	8.80	67.91
4	8	15.66	-864.30	-1.62	3.50	-8.80	182.63
5	9	-32.94	705.67	3.13	25.45	8.22	156.45
5	10	32.94	-648.97	-3.13	24.56	-8.22	370.55
6	11	-22.40	461.60	1.45	11.88	7.55	98.32
6	12	22.40	-404.90	-1.45	11.31	-7.55	260.11
7	13	-13.88	294.59	1.07	5.53	7.16	52.12
7	14	13.88	-237.89	-1.07	11.53	-7.16	170.00
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.00	0.00	0.00	-19.51
9	16	-1.65	-111.66	-0.50	-151.24	0.00	23.64
9	2	1.65	112.18	0.50	151.24	0.04	-31.56
10	2	35.82	222.97	-0.29	-126.04	7.28	426.27
10	17	-35.82	-216.45	0.29	126.04	-7.03	-231.35
11	17	34.17	121.72	-0.79	22.68	7.03	235.48
11	18	-34.17	-110.79	0.79	-22.68	-5.85	-62.51
12	18	34.17	110.79	-0.79	22.68	5.85	62.51
12	19	-34.17	-101.89	0.79	-22.68	-4.89	66.25
13	19	32.52	7.16	-1.30	-128.56	4.89	-62.12
13	20	-32.52	-0.12	1.30	128.56	-3.65	65.61
14	20	30.87	-94.60	-1.80	20.16	3.65	-61.48
14	4	-30.87	97.04	1.80	-20.16	-3.05	29.75
15	4	80.92	549.35	-2.20	48.66	11.58	496.78
15	21	-80.92	-531.95	2.20	-48.66	-6.37	783.22
16	21	79.27	123.96	-2.71	-598.58	6.37	-779.09
16	22	-79.27	-122.99	2.71	598.58	-6.01	795.45
17	22	79.27	122.99	-2.71	-598.58	6.01	-795.45
17	23	-79.27	-116.92	2.71	598.58	-3.77	894.46
18	23	77.62	-291.06	-3.21	46.14	3.77	-890.33
18	6	-77.62	303.37	3.21	-46.14	1.61	392.61
19	6	99.24	586.04	-2.90	61.80	7.27	-173.04
19	24	-99.24	-578.51	2.90	-61.80	-4.31	769.38
20	24	97.59	170.53	-3.40	-585.43	4.31	-765.25
20	25	-97.59	-163.49	3.40	585.43	-1.05	925.22
21	25	95.94	-244.49	-3.90	59.28	1.05	-921.09
21	26	-95.94	248.30	3.90	-59.28	0.97	793.46
22	26	95.94	-248.30	-3.90	59.28	-0.97	-793.46
22	27	-95.94	264.33	3.90	-59.28	9.48	234.50
23	27	94.83	-563.69	-4.24	-415.55	-9.48	-231.73
23	8	-94.83	566.04	4.24	415.55	10.84	51.40
24	8	79.18	298.26	-2.62	-419.04	-2.04	-234.03
24	28	-79.18	-293.56	2.62	419.04	3.71	423.01
25	28	78.07	-5.80	-2.95	54.11	-3.71	-420.24
25	29	-78.07	19.48	2.95	-54.11	9.20	396.71
26	29	78.07	-19.48	-2.95	54.11	-9.20	-396.71
26	30	-78.07	25.64	2.95	-54.11	11.68	377.82
27	30	76.96	-325.00	-3.29	-420.72	-11.68	-375.05
27	31	-76.96	332.04	3.29	420.72	14.83	60.37
28	31	75.86	-631.41	-3.62	52.43	-14.83	-57.61
28	10	-75.86	636.59	3.62	-52.43	17.38	-389.21

29	10	42.92	12.38	-0.50	27.87	-9.16	18.66
29	32	-42.92	2.27	0.50	-27.87	10.15	-8.58
30	32	41.81	-97.00	-0.84	-122.95	-10.15	11.35
30	33	-41.81	100.72	0.84	122.95	10.58	-61.37
31	33	41.81	-100.72	-0.84	-122.95	-10.58	61.37
31	34	-41.81	104.04	0.84	122.95	10.96	-107.63
32	34	40.71	-198.76	-1.17	26.19	-10.96	110.39
32	12	-40.71	213.82	1.17	-26.19	13.35	-532.90
33	12	18.31	191.09	0.28	14.89	-5.81	272.79
33	35	-18.31	-186.31	-0.28	-14.89	5.63	-150.03
34	35	17.20	91.58	-0.06	-135.93	-5.63	152.79
34	36	-17.20	-84.54	0.06	135.93	5.68	-68.44
35	36	16.09	-10.18	-0.39	13.21	-5.68	71.20
35	37	-16.09	16.73	0.39	-13.21	6.03	-83.20
36	37	16.09	-16.73	-0.39	13.21	-6.03	83.20
36	38	-16.09	30.02	0.39	-13.21	6.75	-125.45
37	38	14.99	-122.22	-0.73	-133.62	-6.75	128.21
37	14	-14.99	127.31	0.73	133.62	7.25	-214.65
38	14	1.11	110.58	0.34	-145.15	-0.09	44.65
38	39	-1.11	-108.63	-0.34	145.15	0.00	-15.59
39	39	0.00	16.43	0.00	0.00	0.00	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 261
Group Id: AR LF-1A Name: AREMA LFD 1A

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	32.59	456.78	0.40	33.31	7.21	-182.34
1	2	-32.59	-387.53	-0.40	-26.92	-7.21	-339.10
2	3	41.81	718.93	0.33	29.88	8.39	-234.23
2	4	-41.81	-646.32	-0.33	-24.56	-8.39	-434.79
3	5	19.03	911.64	0.77	27.15	8.73	-115.67
3	6	-19.03	-838.74	-0.77	-14.88	-8.73	-188.74
4	7	-10.19	892.16	1.77	27.32	8.72	36.53
4	8	10.19	-819.26	-1.77	0.93	-8.72	126.48
5	9	-23.82	724.02	3.04	29.09	8.26	106.30
5	10	23.82	-651.12	-3.04	19.52	-8.26	274.81
6	11	-16.63	529.42	1.61	16.78	7.69	66.31
6	12	16.63	-456.52	-1.61	8.95	-7.69	199.76
7	13	-11.58	384.58	1.59	12.29	7.35	38.69
7	14	11.58	-311.68	-1.59	13.21	-7.35	146.60
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	21.78	0.00	0.00	0.00	-25.09
9	16	-2.12	-143.56	-0.65	-194.45	0.00	30.40
9	2	2.12	144.23	0.65	194.45	0.05	-40.57
10	2	30.47	243.29	-0.25	-167.53	7.16	379.67
10	17	-30.47	-234.91	0.25	167.53	-6.94	-167.54
11	17	28.34	113.12	-0.90	23.68	6.94	172.85
11	18	-28.34	-99.06	0.90	-23.68	-5.61	-15.00
12	18	28.34	99.06	-0.90	23.68	5.61	15.00
12	19	-28.34	-87.62	0.90	-23.68	-4.52	98.03
13	19	26.22	-34.17	-1.54	-170.77	4.52	-92.72
13	20	-26.22	43.22	1.54	170.77	-3.04	55.65
14	20	24.09	-165.01	-2.19	20.44	3.04	-50.34
14	4	-24.09	168.14	2.19	-20.44	-2.32	-4.83
15	4	65.91	478.18	-1.86	45.00	10.71	439.62
15	21	-65.91	-455.81	1.86	-45.00	-6.31	666.01
16	21	63.78	91.22	-2.51	-533.88	6.31	-660.70
16	22	-63.78	-89.97	2.51	533.88	-5.98	672.70
17	22	63.78	89.97	-2.51	-533.88	5.98	-672.70
17	23	-63.78	-82.17	2.51	533.88	-3.91	743.74

18	23	61.66	-282.42	-3.16	41.76	3.91	-738.43
18	6	-61.66	298.24	3.16	-41.76	1.38	252.24
19	6	80.69	540.49	-2.39	56.64	7.35	-63.50
19	24	-80.69	-530.81	2.39	-56.64	-4.91	612.09
20	24	78.56	166.23	-3.04	-522.24	4.91	-606.78
20	25	-78.56	-157.17	3.04	522.24	-2.00	761.67
21	25	76.44	-207.42	-3.69	53.40	2.00	-756.36
21	26	-76.44	212.31	3.69	-53.40	-0.09	647.65
22	26	76.44	-212.31	-3.69	53.40	0.09	-647.65
22	27	-76.44	232.92	3.69	-53.40	7.95	162.19
23	27	75.02	-511.17	-4.12	-388.25	-7.95	-158.63
23	8	-75.02	514.19	4.12	388.25	9.26	-5.04
24	8	64.83	305.07	-2.35	-389.17	-0.54	-121.45
24	28	-64.83	-299.04	2.35	389.17	2.05	314.35
25	28	63.41	20.78	-2.78	50.32	-2.05	-310.79
25	29	-63.41	-3.19	2.78	-50.32	7.23	333.10
26	29	63.41	3.19	-2.78	50.32	-7.23	-333.10
26	30	-63.41	4.72	2.78	-50.32	9.56	332.46
27	30	61.98	-282.98	-3.22	-391.33	-9.56	-328.90
27	31	-61.98	292.03	3.22	391.33	12.64	53.51
28	31	60.56	-570.28	-3.65	48.16	-12.64	-49.96
28	10	-60.56	576.94	3.65	-48.16	15.21	-354.30
29	10	36.74	74.17	-0.61	28.64	-6.95	79.49
29	32	-36.74	-55.33	0.61	-28.64	8.17	49.62
30	32	35.32	-66.46	-1.04	-165.27	-8.17	-46.06
30	33	-35.32	71.24	1.04	165.27	8.70	11.23
31	33	35.32	-71.24	-1.04	-165.27	-8.70	-11.23
31	34	-35.32	75.51	1.04	165.27	9.17	-21.93
32	34	33.90	-197.30	-1.47	26.48	-9.17	25.48
32	12	-33.90	216.65	1.47	-26.48	12.19	-449.40
33	12	17.27	239.86	0.13	17.53	-4.49	249.64
33	35	-17.27	-233.71	-0.13	-17.53	4.41	-95.58
34	35	15.85	111.93	-0.30	-176.38	-4.41	99.14
34	36	-15.85	-102.87	0.30	176.38	4.69	3.73
35	36	14.42	-18.91	-0.73	15.37	-4.69	-0.18
35	37	-14.42	27.34	0.73	-15.37	5.34	-20.44
36	37	14.42	-27.34	-0.73	15.37	-5.34	20.44
36	38	-14.42	44.42	0.73	-15.37	6.66	-85.28
37	38	13.00	-162.97	-1.16	-173.41	-6.66	88.83
37	14	-13.00	169.51	1.16	173.41	7.47	-204.00
38	14	1.42	142.17	0.43	-186.62	-0.11	57.40
38	39	-1.42	-139.67	-0.43	186.62	0.00	-20.05
39	39	0.00	21.12	0.00	0.00	0.00	23.60
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 268
Group Id: AR LF-2 Name: AREMA LFD 2

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	10.04	309.61	-1.39	-27.12	2.92	-60.41
1	2	-5.81	-255.75	2.68	-7.05	-2.92	-61.10
2	3	9.45	339.26	-0.65	-25.98	3.25	-59.59
2	4	-5.16	-282.78	1.95	3.54	-3.25	-51.90
3	5	8.89	344.49	-0.89	-29.16	3.15	-56.90
3	6	-4.59	-287.79	2.19	2.84	-3.15	-45.55
4	7	8.43	345.50	-0.89	-30.97	3.01	-54.91
4	8	-4.14	-288.80	2.19	4.67	-3.01	-40.28
5	9	7.14	340.92	-0.59	-31.10	2.82	-48.28
5	10	-2.84	-284.22	1.89	9.57	-2.82	-26.17
6	11	4.63	322.89	-0.77	-33.62	2.63	-35.21
6	12	-0.33	-266.19	2.07	9.33	-2.63	0.89

7	13	1.59	282.88	-0.18	-32.01	2.48	-19.24
7	14	2.70	-226.18	1.48	17.06	-2.48	33.46
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.10	0.00	0.12	-19.51
9	16	-0.84	-118.15	0.79	-158.03	-0.12	21.61
9	2	0.84	118.67	-0.78	158.03	0.06	-29.98
10	2	4.97	137.08	-1.89	-150.98	2.86	91.08
10	17	-4.97	-130.56	1.93	150.98	-1.16	27.64
11	17	4.13	29.35	-1.04	11.49	1.16	-25.54
11	18	-4.13	-18.42	1.11	-11.49	0.44	61.07
12	18	4.13	18.42	-1.11	11.49	-0.44	-61.07
12	19	-4.13	-9.52	1.16	-11.49	1.82	77.98
13	19	3.29	-81.67	-0.27	-130.66	-1.82	-75.89
13	20	-3.29	88.71	0.32	130.66	2.10	-5.71
14	20	2.45	-179.90	0.57	15.93	-2.10	7.81
14	4	-2.45	182.33	-0.56	-15.93	1.91	-67.80
15	4	7.61	100.45	-1.39	12.39	1.33	119.70
15	21	-7.61	-83.05	1.50	-12.39	2.09	97.52
16	21	6.77	-8.13	-0.61	-129.77	-2.09	-95.43
16	22	-6.77	9.11	0.62	129.77	2.17	94.28
17	22	6.77	-9.11	-0.62	-129.77	-2.17	-94.28
17	23	-6.77	15.17	0.65	129.77	2.69	84.26
18	23	5.93	-106.36	0.24	16.83	-2.69	-82.16
18	6	-5.93	118.67	-0.16	-16.83	2.36	-106.25
19	6	10.52	169.12	-2.03	13.99	0.79	151.80
19	24	-10.52	-161.60	2.08	-13.99	1.31	17.55
20	24	9.68	70.41	-1.19	-128.17	-1.31	-15.45
20	25	-9.68	-63.37	1.23	128.17	2.47	79.53
21	25	8.84	-27.81	-0.34	18.43	-2.47	-77.43
21	26	-8.84	31.62	0.36	-18.43	2.65	62.03
22	26	8.84	-31.62	-0.36	18.43	-2.65	-62.03
22	27	-8.84	47.65	0.46	-18.43	3.55	-24.40
23	27	8.00	-138.83	0.43	-123.73	-3.55	26.50
23	8	-8.00	141.18	-0.41	123.73	3.42	-71.19
24	8	12.14	147.62	-1.78	-128.40	-0.40	111.48
24	28	-7.08	-142.93	1.81	128.40	1.55	-18.70
25	28	6.24	51.74	-0.92	18.20	-1.55	20.80
25	29	-6.24	-38.06	1.00	-18.20	3.33	62.78
26	29	6.24	38.06	-1.00	18.20	-3.33	-62.78
26	30	-6.24	-31.91	1.04	-18.20	4.19	92.07
27	30	5.40	-59.28	-0.15	-123.96	-4.19	-89.97
27	31	-5.40	66.32	0.19	123.96	4.35	29.82
28	31	4.56	-157.51	0.70	22.64	-4.35	-27.72
28	10	-4.56	162.69	-0.67	-22.64	3.87	-85.11
29	10	7.40	121.53	-1.23	13.07	-1.05	111.28
29	32	-7.40	-106.88	1.32	-13.07	3.58	116.45
30	32	6.57	15.69	-0.43	-129.08	-3.58	-114.35
30	33	-6.57	-11.97	0.45	129.08	3.81	121.35
31	33	6.57	11.97	-0.45	-129.08	-3.81	-121.35
31	34	-6.57	-8.65	0.47	129.08	4.02	126.01
32	34	5.73	-82.53	0.42	17.51	-4.02	-123.91
32	12	-5.73	97.59	-0.33	-17.51	3.25	-60.55
33	12	6.06	168.60	-1.74	8.18	-0.62	59.66
33	35	-6.06	-163.82	1.77	-8.18	1.76	48.47
34	35	5.22	72.63	-0.88	-133.98	-1.76	-46.37
34	36	-5.22	-65.59	0.92	133.98	2.63	112.57
35	36	4.38	-25.59	-0.03	12.62	-2.63	-110.48
35	37	-4.38	32.15	0.07	-12.62	2.68	84.74
36	37	4.38	-32.15	-0.07	12.62	-2.68	-84.74
36	38	-4.38	45.43	0.15	-12.62	2.88	14.64
37	38	3.54	-124.07	0.73	-109.67	-2.88	-12.54
37	14	-3.54	129.16	-0.70	109.67	2.38	-75.18
38	14	0.84	97.02	-0.78	-126.73	0.10	41.72

38	39	-0.84	-95.07	0.79	126.73	0.11	-16.26
39	39	0.00	16.43	0.10	0.00	-0.11	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 331
Group Id: AR LF-7 Name: AREMA LFD 7

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	18.36	251.83	2.75	61.73	1.42	-154.47
1	2	-18.36	-213.36	-2.75	-17.75	-1.42	-139.24
2	3	22.78	254.48	3.56	67.56	1.73	-187.54
2	4	-22.78	-214.14	-3.56	-10.67	-1.73	-177.01
3	5	23.94	252.60	3.45	65.92	1.93	-193.78
3	6	-23.94	-212.10	-3.45	-10.73	-1.93	-189.21
4	7	23.91	253.86	3.46	64.80	2.16	-193.89
4	8	-23.91	-213.36	-3.46	-9.37	-2.16	-188.73
5	9	22.68	251.16	3.68	64.63	2.35	-187.56
5	10	-22.68	-210.66	-3.68	-5.71	-2.35	-175.26
6	11	19.30	232.58	3.51	62.27	2.47	-169.86
6	12	-19.30	-192.08	-3.51	-6.18	-2.47	-138.86
7	13	13.80	181.52	3.91	62.96	2.51	-140.77
7	14	-13.80	-141.02	-3.91	-0.38	-2.51	-80.02
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	-8.04	-79.76	-1.35	-110.51	0.00	34.04
9	2	8.04	80.13	1.35	110.51	0.10	-39.70
10	2	10.31	133.23	1.40	-92.76	1.33	178.94
10	17	-10.31	-128.57	-1.40	92.76	-2.57	-62.81
11	17	2.27	60.91	0.05	11.00	2.57	82.91
11	18	-2.27	-53.10	-0.05	-11.00	-2.64	1.90
12	18	2.27	53.10	0.05	11.00	2.64	-1.90
12	19	-2.27	-46.74	-0.05	-11.00	-2.69	62.35
13	19	-5.77	-20.92	-1.30	-99.51	2.69	-42.25
13	20	5.77	25.95	1.30	99.51	-1.44	19.80
14	20	-13.81	-93.61	-2.66	4.24	1.44	0.30
14	4	13.81	95.34	2.66	-4.24	-0.56	-31.59
15	4	8.97	118.79	0.90	14.91	2.29	208.61
15	21	-8.97	-106.36	-0.90	-14.91	-4.43	57.93
16	21	0.93	38.70	-0.45	-95.60	4.43	-37.82
16	22	-0.93	-38.01	0.45	95.60	-4.37	42.90
17	22	0.93	38.01	-0.45	-95.60	4.37	-42.90
17	23	-0.93	-33.68	0.45	95.60	-3.99	72.49
18	23	-7.11	-33.98	-1.80	8.15	3.99	-52.38
18	6	7.11	42.78	1.80	-8.15	-0.98	-11.89
19	6	16.82	169.32	1.65	18.89	2.91	201.10
19	24	-16.82	-163.95	-1.65	-18.89	-4.60	-30.44
20	24	8.78	96.29	0.30	-91.62	4.60	50.54
20	25	-8.78	-91.26	-0.30	91.62	-4.88	39.28
21	25	0.74	23.60	-1.05	12.13	4.88	-19.17
21	26	-0.74	-20.88	1.05	-12.13	-4.34	30.69
22	26	0.74	20.88	-1.05	12.13	4.34	-30.69
22	27	-0.74	-9.43	1.05	-12.13	-2.04	63.74
23	27	-7.30	-58.23	-2.40	-98.37	2.04	-43.64
23	8	7.30	59.91	2.40	98.37	-1.27	24.78
24	8	16.61	153.45	1.06	-89.00	3.43	163.95
24	28	-16.61	-150.10	-1.06	89.00	-4.10	-67.02
25	28	8.57	82.44	-0.29	14.75	4.10	87.13
25	29	-8.57	-72.67	0.29	-14.75	-3.56	57.23
26	29	8.57	72.67	-0.29	14.75	3.56	-57.23
26	30	-8.57	-68.27	0.29	-14.75	-3.32	116.24
27	30	0.53	0.61	-1.64	-95.76	3.32	-96.13

27	31	-0.53	4.42	1.64	95.76	-1.74	94.31
28	31	-7.52	-72.08	-2.99	7.99	1.74	-74.20
28	10	7.52	75.78	2.99	-7.99	0.37	22.10
29	10	15.16	134.88	0.69	13.70	1.98	153.16
29	32	-15.16	-124.42	-0.69	-13.70	-3.36	105.36
30	32	7.12	56.76	-0.66	-96.80	3.36	-85.25
30	33	-7.12	-54.10	0.66	96.80	-3.02	113.30
31	33	7.12	54.10	-0.66	-96.80	3.02	-113.30
31	34	-7.12	-51.73	0.66	96.80	-2.72	137.21
32	34	-0.92	-15.93	-2.01	6.95	2.72	-117.10
32	12	0.92	26.69	2.01	-6.95	1.40	73.46
33	12	18.37	165.40	1.49	13.13	1.07	65.41
33	35	-18.37	-161.98	-1.49	-13.13	-2.04	41.09
34	35	10.33	94.32	0.14	-97.38	2.04	-20.99
34	36	-10.33	-89.29	-0.14	97.38	-2.17	108.92
35	36	2.29	21.63	-1.21	6.37	2.17	-88.82
35	37	-2.29	-16.95	1.21	-6.37	-1.09	106.02
36	37	2.29	16.95	-1.21	6.37	1.09	-106.02
36	38	-2.29	-7.47	1.21	-6.37	1.09	128.08
37	38	-5.76	-58.39	-2.56	-101.28	-1.09	-107.98
37	14	5.76	62.03	2.56	101.28	2.86	66.26
38	14	8.04	78.99	1.35	-100.90	-0.36	13.76
38	39	-8.04	-77.59	-1.35	100.90	0.00	6.99
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 332
Group Id: AR LF-7 Name: AREMA LFD 7

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-11.94	172.06	2.75	61.73	1.42	121.26
1	2	11.94	-133.59	-2.75	-17.75	-1.42	69.82
2	3	-19.08	231.02	3.56	67.56	1.73	168.67
2	4	19.08	-190.68	-3.56	-10.67	-1.73	136.65
3	5	-22.60	250.56	3.45	65.92	1.93	187.04
3	6	22.60	-210.06	-3.45	-10.73	-1.93	174.51
4	7	-23.83	253.59	3.46	64.80	2.16	193.29
4	8	23.83	-213.09	-3.46	-9.37	-2.16	187.91
5	9	-23.99	252.07	3.68	64.63	2.35	193.88
5	10	23.99	-211.57	-3.68	-5.71	-2.35	189.88
6	11	-22.80	253.34	3.51	62.27	2.47	187.40
6	12	22.80	-212.84	-3.51	-6.18	-2.47	177.37
7	13	-20.53	265.39	3.91	62.96	2.51	175.23
7	14	20.53	-224.89	-3.91	-0.38	-2.51	153.30
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	8.04	-79.76	-1.35	-110.51	0.00	-6.17
9	2	-8.04	80.13	1.35	110.51	0.10	0.52
10	2	-3.90	53.46	1.40	-92.76	1.33	-70.33
10	17	3.90	-48.80	-1.40	92.76	-2.57	115.70
11	17	4.14	-18.86	0.05	11.00	2.57	-135.80
11	18	-4.14	26.67	-0.05	-11.00	-2.64	101.94
12	18	4.14	-26.67	0.05	11.00	2.64	-101.94
12	19	-4.14	33.03	-0.05	-11.00	-2.69	65.79
13	19	12.19	-100.69	-1.30	-99.51	2.69	-85.90
13	20	-12.19	105.71	1.30	99.51	-1.44	-12.95
14	20	20.23	-173.37	-2.66	4.24	1.44	-7.16
14	4	-20.23	175.11	2.66	-4.24	-0.56	-50.56
15	4	1.15	15.57	0.90	14.91	2.29	-86.09
15	21	-1.15	-3.14	-0.90	-14.91	-4.43	108.23
16	21	9.19	-64.52	-0.45	-95.60	4.43	-128.34

16	22	-9.19	65.22	0.45	95.60	-4.37	119.74
17	22	9.19	-65.22	-0.45	-95.60	4.37	-119.74
17	23	-9.19	69.55	0.45	95.60	-3.99	64.12
18	23	17.23	-137.21	-1.80	8.15	3.99	-84.23
18	6	-17.23	146.00	1.80	-8.15	-0.98	-152.91
19	6	-5.37	64.06	1.65	18.89	2.91	-21.60
19	24	5.37	-58.68	-1.65	-18.89	-4.60	84.45
20	24	2.68	-8.98	0.30	-91.62	4.60	-104.56
20	25	-2.68	14.01	-0.30	91.62	-4.88	93.55
21	25	10.72	-81.67	-1.05	12.13	4.88	-113.65
21	26	-10.72	84.39	1.05	-12.13	-4.34	70.65
22	26	10.72	-84.39	-1.05	12.13	4.34	-70.65
22	27	-10.72	95.84	1.05	-12.13	-2.04	-125.87
23	27	18.76	-163.50	-2.40	-98.37	2.04	105.77
23	8	-18.76	165.17	2.40	98.37	-1.27	-158.23
24	8	-5.07	47.91	1.06	-89.00	3.43	-29.68
24	28	5.07	-44.56	-1.06	89.00	-4.10	59.21
25	28	2.98	-23.10	-0.29	14.75	4.10	-79.32
25	29	-2.98	32.87	0.29	-14.75	-3.56	27.23
26	29	2.98	-32.87	-0.29	14.75	3.56	-27.23
26	30	-2.98	37.27	0.29	-14.75	-3.32	-2.14
27	30	11.02	-104.93	-1.64	-95.76	3.32	-17.96
27	31	-11.02	109.96	1.64	95.76	-1.74	-84.95
28	31	19.06	-177.62	-2.99	7.99	1.74	64.84
28	10	-19.06	181.32	2.99	-7.99	0.37	-191.33
29	10	-4.92	30.25	0.69	13.70	1.98	1.44
29	32	4.92	-19.78	-0.69	-13.70	-3.36	48.44
30	32	3.12	-47.88	-0.66	-96.80	3.36	-68.55
30	33	-3.12	50.53	0.66	96.80	-3.02	43.65
31	33	3.12	-50.53	-0.66	-96.80	3.02	-43.65
31	34	-3.12	52.91	0.66	96.80	-2.72	20.28
32	34	11.16	-120.57	-2.01	6.95	2.72	-40.38
32	12	-11.16	131.32	2.01	-6.95	1.40	-217.56
33	12	-11.64	81.52	1.49	13.13	1.07	40.19
33	35	11.64	-78.11	-1.49	-13.13	-2.04	11.74
34	35	-3.59	10.45	0.14	-97.38	2.04	-31.84
34	36	3.59	-5.42	-0.14	97.38	-2.17	39.44
35	36	4.45	-62.24	-1.21	6.37	2.17	-59.55
35	37	-4.45	66.92	1.21	-6.37	-1.09	1.97
36	37	4.45	-66.92	-1.21	6.37	1.09	-1.97
36	38	-4.45	76.41	1.21	-6.37	1.09	-127.55
37	38	12.49	-142.27	-2.56	-101.28	-1.09	107.45
37	14	-12.49	145.91	2.56	101.28	2.86	-207.27
38	14	-8.04	78.99	1.35	-100.90	-0.36	53.97
38	39	8.04	-77.59	-1.35	100.90	0.00	-33.22
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 333
Group Id: AR LF-7 Name: AREMA LFD 7

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-1.34	199.98	-11.38	-201.82	3.48	24.75
1	2	1.34	-161.51	11.38	19.80	-3.48	-3.35
2	3	-4.43	239.23	-11.56	-212.40	3.60	44.00
2	4	4.43	-198.89	11.56	27.40	-3.60	26.87
3	5	-6.31	251.27	-11.85	-215.90	3.05	53.75
3	6	6.31	-210.77	11.85	26.32	-3.05	47.21
4	7	-7.12	253.68	-11.86	-217.56	2.36	57.78
4	8	7.12	-213.18	11.86	27.78	-2.36	56.09
5	9	-7.65	251.75	-11.64	-217.54	1.62	60.37

5	10	7.65	-211.25	11.64	31.33	-1.62	62.08
6	11	-8.07	246.08	-11.69	-218.58	1.00	62.36
6	12	8.07	-205.58	11.69	31.52	-1.00	66.69
7	13	-8.52	236.04	-11.08	-215.78	0.62	64.63
7	14	8.52	-195.54	11.08	38.49	-0.62	71.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	2.41	-79.76	4.50	-95.87	0.00	7.91
9	2	-2.41	80.13	-4.50	95.87	-0.32	-13.56
10	2	1.08	81.38	-6.87	-115.67	3.79	16.91
10	17	-1.08	-76.72	6.87	115.67	2.30	53.22
11	17	3.49	9.06	-2.37	2.72	-2.30	-59.25
11	18	-3.49	-1.25	2.37	-2.72	5.83	66.92
12	18	3.49	1.25	-2.37	2.72	-5.83	-66.92
12	19	-3.49	5.11	2.37	-2.72	8.70	64.59
13	19	5.90	-72.77	2.13	-93.15	-8.70	-70.62
13	20	-5.90	77.80	-2.13	93.15	6.65	-1.49
14	20	8.31	-145.46	6.64	25.24	-6.65	-4.55
14	4	-8.31	147.19	-6.64	-25.24	4.46	-43.92
15	4	3.88	51.70	-4.93	-2.17	-0.86	17.05
15	21	-3.88	-39.27	4.93	2.17	12.52	90.62
16	21	6.30	-28.39	-0.42	-98.04	-12.52	-96.66
16	22	-6.30	29.09	0.42	98.04	12.57	92.85
17	22	6.30	-29.09	-0.42	-98.04	-12.57	-92.85
17	23	-6.30	33.42	0.42	98.04	12.92	67.05
18	23	8.71	-101.08	4.08	20.35	-12.92	-73.08
18	6	-8.71	109.87	-4.08	-20.35	6.09	-103.55
19	6	2.40	100.90	-7.77	-5.97	-3.04	56.34
19	24	-2.40	-95.52	7.77	5.97	10.99	44.24
20	24	4.81	27.86	-3.26	-101.84	-10.99	-50.27
20	25	-4.81	-22.83	3.26	101.84	14.12	74.55
21	25	7.23	-44.83	1.24	16.55	-14.12	-80.59
21	26	-7.23	47.55	-1.24	-16.55	13.48	56.66
22	26	7.23	-47.55	1.24	16.55	-13.48	-56.66
22	27	-7.23	58.99	-1.24	-16.55	10.78	-59.51
23	27	9.64	-126.65	5.74	-79.32	-10.78	53.47
23	8	-9.64	128.33	-5.74	79.32	8.94	-94.18
24	8	2.52	84.85	-6.12	-107.11	-6.59	38.09
24	28	-2.52	-81.50	6.12	107.11	10.50	15.03
25	28	4.93	13.84	-1.62	11.28	-10.50	-21.06
25	29	-4.93	-4.07	1.62	-11.28	13.50	37.73
26	29	4.93	4.07	-1.62	11.28	-13.50	-37.73
26	30	-4.93	0.33	1.62	-11.28	14.86	39.29
27	30	7.35	-67.99	2.89	-84.59	-14.86	-45.32
27	31	-7.35	73.02	-2.89	84.59	12.09	-22.21
28	31	9.76	-140.68	7.39	33.80	-12.09	16.18
28	10	-9.76	144.38	-7.39	-33.80	6.88	-116.63
29	10	2.11	66.87	-4.25	2.47	-5.26	54.54
29	32	-2.11	-56.40	4.25	-2.47	13.73	68.36
30	32	4.52	-11.26	0.26	-93.40	-13.73	-74.39
30	33	-4.52	13.91	-0.26	93.40	13.60	68.03
31	33	4.52	-13.91	0.26	-93.40	-13.60	-68.03
31	34	-4.52	16.28	-0.26	93.40	13.49	61.20
32	34	6.93	-83.94	4.76	24.98	-13.49	-67.24
32	12	-6.93	94.70	-4.76	-24.98	3.74	-115.71
33	12	-1.13	110.88	-6.93	-6.54	-2.74	49.02
33	35	1.13	-107.46	6.93	6.54	7.25	22.01
34	35	1.28	39.80	-2.43	-102.41	-7.25	-28.04
34	36	-1.28	-34.77	2.43	102.41	9.58	63.76
35	36	3.69	-32.89	2.07	15.98	-9.58	-69.79
35	37	-3.69	37.57	-2.07	-15.98	7.73	38.39
36	37	3.69	-37.57	2.07	15.98	-7.73	-38.39
36	38	-3.69	47.06	-2.07	-15.98	3.98	-38.08

37	38	6.10	-112.92	6.58	-77.04	-3.98	32.05
37	14	-6.10	116.55	-6.58	77.04	-0.58	-111.53
38	14	-2.41	78.99	-4.50	-115.54	1.19	39.90
38	39	2.41	-77.59	4.50	115.54	0.00	-19.14
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 334
Group Id: AR LF-7 Name: AREMA LFD 7

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	-1.34	199.98	10.35	203.64	0.31	24.75
1	2	1.34	-161.51	-10.35	-37.97	-0.31	-3.35
2	3	-4.43	239.23	11.70	218.31	0.72	44.00
2	4	4.43	-198.89	-11.70	-31.17	-0.72	26.87
3	5	-6.31	251.27	11.69	217.67	1.33	53.75
3	6	6.31	-210.77	-11.69	-30.68	-1.33	47.21
4	7	-7.12	253.68	11.72	216.83	2.05	57.78
4	8	7.12	-213.18	-11.72	-29.38	-2.05	56.09
5	9	-7.65	251.75	11.93	216.57	2.74	60.37
5	10	7.65	-211.25	-11.93	-25.66	-2.74	62.08
6	11	-8.07	246.08	11.69	213.49	3.26	62.36
6	12	8.07	-205.58	-11.69	-26.48	-3.26	66.69
7	13	-8.52	236.04	11.98	213.06	3.52	64.63
7	14	8.52	-195.54	-11.98	-21.31	-3.52	71.64
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	12.10	0.00	0.00	0.00	-13.94
9	16	2.41	-79.76	-4.50	-118.39	0.00	7.91
9	2	-2.41	80.13	4.50	118.39	0.32	-13.56
10	2	1.08	81.38	5.85	-80.42	-0.00	16.91
10	17	-1.08	-76.72	-5.85	80.42	-5.19	53.22
11	17	3.49	9.06	1.35	15.45	5.19	-59.25
11	18	-3.49	-1.25	-1.35	-15.45	-7.19	66.92
12	18	3.49	1.25	1.35	15.45	7.19	-66.92
12	19	-3.49	5.11	-1.35	-15.45	-8.83	64.59
13	19	5.90	-72.77	-3.16	-102.93	8.83	-70.62
13	20	-5.90	77.80	3.16	102.93	-5.80	-1.49
14	20	8.31	-145.46	-7.66	-7.06	5.80	-4.55
14	4	-8.31	147.19	7.66	7.06	-3.27	-43.92
15	4	3.88	51.70	4.04	24.10	3.99	17.05
15	21	-3.88	-39.27	-4.04	-24.10	-13.55	90.62
16	21	6.30	-28.39	-0.47	-94.28	13.55	-96.66
16	22	-6.30	29.09	0.47	94.28	-13.49	92.85
17	22	6.30	-29.09	-0.47	-94.28	13.49	-92.85
17	23	-6.30	33.42	0.47	94.28	-13.10	67.05
18	23	8.71	-101.08	-4.97	1.59	13.10	-73.08
18	6	-8.71	109.87	4.97	-1.59	-4.78	-103.55
19	6	2.40	100.90	6.72	32.27	6.11	56.34
19	24	-2.40	-95.52	-6.72	-32.27	-12.99	44.24
20	24	4.81	27.86	2.22	-86.12	12.99	-50.27
20	25	-4.81	-22.83	-2.22	86.12	-15.11	74.55
21	25	7.23	-44.83	-2.29	9.75	15.11	-80.59
21	26	-7.23	47.55	2.29	-9.75	-13.93	56.66
22	26	7.23	-47.55	-2.29	9.75	13.93	-56.66
22	27	-7.23	58.99	2.29	-9.75	-8.94	-59.51
23	27	9.64	-126.65	-6.79	-108.63	8.94	53.47
23	8	-9.64	128.33	6.79	108.63	-6.77	-94.18
24	8	2.52	84.85	4.92	-79.26	8.82	38.09
24	28	-2.52	-81.50	-4.92	79.26	-11.97	15.03
25	28	4.93	13.84	0.42	16.61	11.97	-21.06
25	29	-4.93	-4.07	-0.42	-16.61	-12.75	37.73

26	29	4.93	4.07	0.42	16.61	12.75	-37.73
26	30	-4.93	0.33	-0.42	-16.61	-13.10	39.29
27	30	7.35	-67.99	-4.08	-101.77	13.10	-45.32
27	31	-7.35	73.02	4.08	101.77	-9.19	-22.21
28	31	9.76	-140.68	-8.59	-5.90	9.19	16.18
28	10	-9.76	144.38	8.59	5.90	-3.14	-116.63
29	10	2.11	66.87	3.35	19.76	5.88	54.54
29	32	-2.11	-56.40	-3.35	-19.76	-12.56	68.36
30	32	4.52	-11.26	-1.16	-98.63	12.56	-74.39
30	33	-4.52	13.91	1.16	98.63	-11.97	68.03
31	33	4.52	-13.91	-1.16	-98.63	11.97	-68.03
31	34	-4.52	16.28	1.16	98.63	-11.45	61.20
32	34	6.93	-83.94	-5.66	-2.76	11.45	-67.24
32	12	-6.93	94.70	5.66	2.76	0.14	-115.71
33	12	-1.13	110.88	6.03	23.72	3.12	49.02
33	35	1.13	-107.46	-6.03	-23.72	-7.04	22.01
34	35	1.28	39.80	1.53	-94.67	7.04	-28.04
34	36	-1.28	-34.77	-1.53	94.67	-8.50	63.76
35	36	3.69	-32.89	-2.98	1.20	8.50	-69.79
35	37	-3.69	37.57	2.98	-1.20	-5.85	38.39
36	37	3.69	-37.57	-2.98	1.20	5.85	-38.39
36	38	-3.69	47.06	2.98	-1.20	-0.46	-38.08
37	38	6.10	-112.92	-7.48	-114.33	0.46	32.05
37	14	-6.10	116.55	7.48	114.33	4.72	-111.53
38	14	-2.41	78.99	4.50	-93.02	-1.19	39.90
38	39	2.41	-77.59	-4.50	93.02	0.00	-19.14
39	39	0.00	11.73	0.00	0.00	0.00	13.11
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 1 C
Group Id: AR LF-1 Name: AREMA LFD 1

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	37.48	389.01	0.22	28.67	7.32	-204.90
1	2	-37.48	-335.15	-0.22	-25.20	-7.32	-394.72
2	3	50.06	702.86	-0.40	22.02	8.53	-274.36
2	4	-50.06	-646.38	0.40	-28.49	-8.53	-526.53
3	5	21.63	946.11	0.32	20.73	8.88	-126.43
3	6	-21.63	-889.41	-0.32	-15.66	-8.88	-219.57
4	7	-15.66	921.00	1.62	22.46	8.80	67.91
4	8	15.66	-864.30	-1.62	3.50	-8.80	182.63
5	9	-32.94	705.67	3.13	25.45	8.22	156.45
5	10	32.94	-648.97	-3.13	24.56	-8.22	370.55
6	11	-22.40	461.60	1.45	11.88	7.55	98.32
6	12	22.40	-404.90	-1.45	11.31	-7.55	260.11
7	13	-13.88	294.59	1.07	5.53	7.16	52.12
7	14	13.88	-237.89	-1.07	11.53	-7.16	170.00
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.00	0.00	0.00	-19.51
9	16	-1.65	-111.66	-0.50	-151.24	0.00	23.64
9	2	1.65	112.18	0.50	151.24	0.04	-31.56
10	2	35.82	222.97	-0.29	-126.04	7.28	426.27
10	17	-35.82	-216.45	0.29	126.04	-7.03	-231.35
11	17	34.17	121.72	-0.79	22.68	7.03	235.48
11	18	-34.17	-110.79	0.79	-22.68	-5.85	-62.51
12	18	34.17	110.79	-0.79	22.68	5.85	62.51
12	19	-34.17	-101.89	0.79	-22.68	-4.89	66.25
13	19	32.52	7.16	-1.30	-128.56	4.89	-62.12
13	20	-32.52	-0.12	1.30	128.56	-3.65	65.61
14	20	30.87	-94.60	-1.80	20.16	3.65	-61.48

14	4	-30.87	97.04	1.80	-20.16	-3.05	29.75
15	4	80.92	549.35	-2.20	48.66	11.58	496.78
15	21	-80.92	-531.95	2.20	-48.66	-6.37	783.22
16	21	79.27	123.96	-2.71	-598.58	6.37	-779.09
16	22	-79.27	-122.99	2.71	598.58	-6.01	795.45
17	22	79.27	122.99	-2.71	-598.58	6.01	-795.45
17	23	-79.27	-116.92	2.71	598.58	-3.77	894.46
18	23	77.62	-291.06	-3.21	46.14	3.77	-890.33
18	6	-77.62	303.37	3.21	-46.14	1.61	392.61
19	6	99.24	586.04	-2.90	61.80	7.27	-173.04
19	24	-99.24	-578.51	2.90	-61.80	-4.31	769.38
20	24	97.59	170.53	-3.40	-585.43	4.31	-765.25
20	25	-97.59	-163.49	3.40	585.43	-1.05	925.22
21	25	95.94	-244.49	-3.90	59.28	1.05	-921.09
21	26	-95.94	248.30	3.90	-59.28	0.97	793.46
22	26	95.94	-248.30	-3.90	59.28	-0.97	-793.46
22	27	-95.94	264.33	3.90	-59.28	9.48	234.50
23	27	94.83	-563.69	-4.24	-415.55	-9.48	-231.73
23	8	-94.83	566.04	4.24	415.55	10.84	51.40
24	8	79.18	298.26	-2.62	-419.04	-2.04	-234.03
24	28	-79.18	-293.56	2.62	419.04	3.71	423.01
25	28	78.07	-5.80	-2.95	54.11	-3.71	-420.24
25	29	-78.07	19.48	2.95	-54.11	9.20	396.71
26	29	78.07	-19.48	-2.95	54.11	-9.20	-396.71
26	30	-78.07	25.64	2.95	-54.11	11.68	377.82
27	30	76.96	-325.00	-3.29	-420.72	-11.68	-375.05
27	31	-76.96	332.04	3.29	420.72	14.83	60.37
28	31	75.86	-631.41	-3.62	52.43	-14.83	-57.61
28	10	-75.86	636.59	3.62	-52.43	17.38	-389.21
29	10	42.92	12.38	-0.50	27.87	-9.16	18.66
29	32	-42.92	2.27	0.50	-27.87	10.15	-8.58
30	32	41.81	-97.00	-0.84	-122.95	-10.15	11.35
30	33	-41.81	100.72	0.84	122.95	10.58	-61.37
31	33	41.81	-100.72	-0.84	-122.95	-10.58	61.37
31	34	-41.81	104.04	0.84	122.95	10.96	-107.63
32	34	40.71	-198.76	-1.17	26.19	-10.96	110.39
32	12	-40.71	213.82	1.17	-26.19	13.35	-532.90
33	12	18.31	191.09	0.28	14.89	-5.81	272.79
33	35	-18.31	-186.31	-0.28	-14.89	5.63	-150.03
34	35	17.20	91.58	-0.06	-135.93	-5.63	152.79
34	36	-17.20	-84.54	0.06	135.93	5.68	-68.44
35	36	16.09	-10.18	-0.39	13.21	-5.68	71.20
35	37	-16.09	16.73	0.39	-13.21	6.03	-83.20
36	37	16.09	-16.73	-0.39	13.21	-6.03	83.20
36	38	-16.09	30.02	0.39	-13.21	6.75	-125.45
37	38	14.99	-122.22	-0.73	-133.62	-6.75	128.21
37	14	-14.99	127.31	0.73	133.62	7.25	-214.65
38	14	1.11	110.58	0.34	-145.15	-0.09	44.65
38	39	-1.11	-108.63	-0.34	145.15	0.00	-15.59
39	39	0.00	16.43	0.00	0.00	0.00	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combinations applied to column elements only:

Combination No. 2 C
Group Id: AR LF-1 Name: AREMA LFD 1

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	20.31	334.14	-6.57	-256.57	1.29	-111.36

1	2	-20.31	-280.27	6.57	151.37	-1.29	-213.58
2	3	26.40	506.06	-0.07	-234.17	0.49	-145.17
2	4	-26.40	-449.59	0.07	233.11	-0.49	-277.17
3	5	13.43	642.20	8.88	-185.90	-2.81	-77.99
3	6	-13.43	-585.50	-8.88	327.96	2.81	-136.96
4	7	-5.96	643.27	8.76	-183.48	-7.55	23.02
4	8	5.96	-586.57	-8.76	323.71	7.55	72.40
5	9	-16.34	540.19	3.18	-207.56	-11.51	76.28
5	10	16.34	-483.49	-3.18	258.45	11.51	185.12
6	11	-12.96	408.18	-4.40	-240.60	-13.28	57.04
6	12	12.96	-351.48	4.40	170.12	13.28	150.32
7	13	-9.73	304.98	-5.16	-236.74	-13.33	39.28
7	14	9.73	-248.28	5.16	154.22	13.33	116.41
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.00	0.00	0.00	-19.51
9	16	0.00	-111.66	0.00	-149.98	0.00	19.51
9	2	0.00	112.18	0.00	149.98	0.00	-27.43
10	2	20.31	168.09	-6.57	-301.35	1.29	241.00
10	17	-20.31	-161.57	6.57	301.35	4.54	-94.77
11	17	18.24	66.85	-7.20	-152.95	-4.54	99.95
11	18	-18.24	-55.91	7.20	152.95	15.26	-8.63
12	18	18.24	55.91	-7.20	-152.95	-15.26	8.63
12	19	-18.24	-47.01	7.20	152.95	23.99	53.69
13	19	18.24	-47.71	-7.20	-302.92	-23.99	-53.69
13	20	-18.24	54.75	7.20	302.92	30.89	4.62
14	20	16.16	-149.48	-7.83	-154.52	-30.89	0.56
14	4	-16.16	151.91	7.83	154.52	33.48	-50.47
15	4	42.56	297.68	-7.90	-387.63	-33.00	327.65
15	21	-42.56	-280.28	7.90	387.63	51.70	356.52
16	21	42.56	185.55	-7.90	-537.60	-51.70	-356.52
16	22	-42.56	-184.58	7.90	537.60	52.75	381.04
17	22	42.56	184.58	-7.90	-537.60	-52.75	-381.04
17	23	-42.56	-178.51	7.90	537.60	59.27	530.89
18	23	40.49	-228.29	-8.53	104.93	-59.27	-525.71
18	6	-40.49	240.60	8.53	-104.93	73.56	133.10
19	6	53.92	344.89	0.35	-223.03	-76.37	3.86
19	24	-53.92	-337.37	-0.35	223.03	76.01	345.51
20	24	53.92	242.64	0.35	-373.01	-76.01	-345.51
20	25	-53.92	-235.60	-0.35	373.01	75.68	574.55
21	25	51.85	-171.20	-0.28	269.53	-75.68	-569.37
21	26	-51.85	175.01	0.28	-269.53	75.83	479.71
22	26	51.85	-175.01	-0.28	269.53	-75.83	-479.71
22	27	-51.85	191.04	0.28	-269.53	76.44	80.57
23	27	51.85	-285.76	-0.28	119.55	-76.44	-80.57
23	8	-51.85	288.11	0.28	-119.55	76.53	-11.03
24	8	45.89	298.46	8.48	-204.17	-84.08	-61.37
24	28	-45.89	-293.77	-8.48	204.17	78.66	250.47
25	28	44.52	-3.77	8.06	265.88	-78.66	-247.04
25	29	-44.52	17.45	-8.06	-265.88	63.66	227.30
26	29	44.52	-17.45	8.06	265.88	-63.66	-227.30
26	30	-44.52	23.60	-8.06	-265.88	56.91	210.11
27	30	44.52	-118.33	8.06	115.90	-56.91	-210.11
27	31	-44.52	125.37	-8.06	-115.90	49.18	93.40
28	31	43.14	-422.90	7.64	585.94	-49.18	-89.97
28	10	-43.14	428.08	-7.64	-585.94	43.80	-209.89
29	10	26.81	55.42	10.82	327.49	-55.31	24.77
29	32	-26.81	-40.76	-10.82	-327.49	33.73	71.11
30	32	26.81	-53.96	10.82	177.51	-33.73	-71.11
30	33	-26.81	57.68	-10.82	-177.51	28.25	42.86
31	33	26.81	-57.68	10.82	177.51	-28.25	-42.86
31	34	-26.81	61.00	-10.82	-177.51	23.36	16.05
32	34	25.43	-155.73	10.40	326.44	-23.36	-12.62
32	12	-25.43	170.78	-10.40	-326.44	2.06	-321.75

33	12	12.47	180.70	6.00	156.32	-15.34	171.44
33	35	-12.47	-175.91	-6.00	-156.32	11.44	-55.43
34	35	12.47	81.19	6.00	6.34	-11.44	55.43
34	36	-12.47	-74.15	-6.00	-6.34	5.69	18.97
35	36	11.10	-20.57	5.58	155.27	-5.69	-15.54
35	37	-11.10	27.13	-5.58	-155.27	0.72	-5.73
36	37	11.10	-27.13	5.58	155.27	-0.72	5.73
36	38	-11.10	40.41	-5.58	-155.27	-9.36	-66.75
37	38	11.10	-132.61	5.58	9.28	9.36	66.75
37	14	-11.10	137.71	-5.58	-9.28	-13.22	-160.39
38	14	1.37	110.58	0.42	-144.94	-0.11	43.98
38	39	-1.37	-108.63	-0.42	144.94	0.00	-14.93
39	39	0.00	16.43	0.00	0.00	0.00	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 32 C
Group Id: AR LF-3 Name: AREMA LFD 3

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	33.06	375.06	27.75	492.52	9.15	-204.34
1	2	-31.84	-321.19	-25.48	-69.54	-9.15	-313.40
2	3	42.96	574.43	28.43	508.10	11.60	-262.97
2	4	-41.69	-517.95	-26.07	-75.10	-11.60	-412.66
3	5	25.46	725.78	28.30	500.01	13.64	-171.98
3	6	-24.20	-669.08	-25.94	-69.03	-13.64	-223.76
4	7	2.02	709.30	28.59	493.01	15.16	-49.81
4	8	-0.76	-652.60	-26.23	-57.43	-15.16	29.10
5	9	-9.31	572.45	28.99	486.07	15.60	8.44
5	10	10.58	-515.75	-26.63	-44.02	-15.60	152.26
6	11	-4.35	410.57	26.93	465.93	15.52	-19.27
6	12	5.62	-353.87	-24.57	-56.82	-15.52	100.64
7	13	-1.63	281.39	25.62	449.83	15.42	-34.36
7	14	2.89	-224.69	-23.26	-61.71	-15.42	72.07
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.31	0.00	0.36	-19.51
9	16	-4.93	-112.75	-11.21	-178.94	-0.36	31.85
9	2	4.93	113.27	11.22	178.94	1.15	-39.83
10	2	26.91	207.93	14.26	-109.40	8.00	353.24
10	17	-26.91	-201.41	-14.14	109.40	-20.59	-171.66
11	17	21.98	105.60	3.24	15.06	20.59	184.00
11	18	-21.98	-94.66	-3.04	-15.06	-25.26	-35.02
12	18	21.98	94.66	3.04	15.06	25.26	35.02
12	19	-21.98	-85.76	-2.87	-15.06	-28.84	74.21
13	19	17.05	-8.96	-8.02	-162.16	28.84	-61.88
13	20	-17.05	16.00	8.15	162.16	-21.09	49.92
14	20	12.11	-110.73	-19.05	-39.43	21.09	-37.59
14	4	-12.11	113.16	19.10	39.43	-14.77	0.51
15	4	53.81	404.79	6.97	35.68	26.38	412.15
15	21	-53.81	-387.39	-6.65	-35.68	-42.50	525.61
16	21	48.87	95.18	-4.25	-454.23	42.50	-513.27
16	22	-48.87	-94.21	4.27	454.23	-41.94	525.82
17	22	48.87	94.21	-4.27	-454.23	41.94	-525.82
17	23	-48.87	-88.14	4.38	454.23	-38.37	601.07
18	23	43.94	-204.06	-15.27	-18.81	38.37	-588.74
18	6	-43.94	216.37	15.50	18.81	-12.60	236.71
19	6	68.14	452.71	10.44	50.22	26.24	-12.95
19	24	-68.14	-445.18	-10.30	-50.22	-36.86	472.73
20	24	63.21	152.97	-0.60	-439.68	36.86	-460.40
20	25	-63.21	-145.93	0.73	439.68	-36.22	603.55
21	25	58.28	-146.28	-11.62	-4.26	36.22	-591.22

21	26	-58.28	150.08	11.69	4.26	-30.18	514.47
22	26	58.28	-150.08	-11.69	-4.26	30.18	-514.47
22	27	-58.28	166.11	11.99	4.26	-4.36	169.69
23	27	54.53	-388.29	-20.62	-377.61	4.36	-160.34
23	8	-54.53	390.63	20.66	377.61	2.23	36.01
24	8	55.29	261.97	5.57	-320.18	12.93	-65.11
24	28	-52.77	-257.28	-5.48	320.18	-16.46	230.91
25	28	49.03	35.10	-3.15	10.03	16.46	-221.55
25	29	-49.03	-21.42	3.40	-10.03	-10.36	274.16
26	29	49.03	21.42	-3.40	10.03	10.36	-274.16
26	30	-49.03	-15.27	3.52	-10.03	-7.46	289.52
27	30	45.29	-206.91	-12.15	-363.32	7.46	-280.17
27	31	-45.29	213.95	12.27	363.32	4.23	78.61
28	31	41.54	-436.12	-20.90	-33.12	-4.23	-69.25
28	10	-41.54	441.30	21.00	33.12	19.00	-239.94
29	10	30.97	74.45	5.63	10.91	-3.40	87.68
29	32	-30.97	-59.80	-5.36	-10.91	-7.57	46.17
30	32	27.22	-34.93	-3.27	-160.64	7.57	-36.81
30	33	-27.22	38.65	3.34	160.64	-5.90	18.19
31	33	27.22	-38.65	-3.34	-160.64	5.90	-18.19
31	34	-27.22	41.97	3.40	160.64	-4.37	-0.02
32	34	23.48	-136.69	-12.03	-32.24	4.37	9.38
32	12	-23.48	151.75	12.30	32.24	20.54	-304.76
33	12	17.86	202.12	12.27	24.58	-5.02	204.12
33	35	-17.86	-197.34	-12.18	-24.58	-2.94	-74.17
34	35	14.12	102.62	3.55	-146.97	2.94	83.53
34	36	-14.12	-95.58	-3.42	146.97	-6.28	11.39
35	36	10.38	0.85	-5.21	-18.56	6.28	-2.03
35	37	-10.38	5.70	5.33	18.56	-1.58	-0.13
36	37	10.38	-5.70	-5.33	-18.56	1.58	0.13
36	38	-10.38	18.98	5.57	18.56	8.26	-22.43
37	38	6.63	-110.10	-14.20	-184.40	-8.26	31.79
37	14	-6.63	115.19	14.29	184.40	18.13	-109.83
38	14	3.74	109.49	8.97	-122.70	-2.71	37.77
38	39	-3.74	-107.55	-8.93	122.70	0.34	-9.00
39	39	0.00	16.43	0.30	0.00	-0.34	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

Combination No. 34 C
Group Id: AR LF-3 Name: AREMA LFD 3

Memb	Node	Fx kip	Fy kip	Fz kip	Mx kft	My kft	Mz kft
1	1	31.98	372.90	27.83	493.41	9.15	-197.07
1	2	-31.44	-319.03	-25.53	-69.38	-9.15	-309.62
2	3	41.63	573.64	28.51	509.03	11.60	-254.01
2	4	-41.07	-517.17	-26.12	-75.00	-11.60	-406.86
3	5	24.02	725.64	28.38	500.95	13.63	-162.37
3	6	-23.46	-668.94	-25.99	-68.92	-13.63	-216.69
4	7	0.53	709.30	28.67	493.95	15.16	-39.94
4	8	0.03	-652.60	-26.28	-57.32	-15.16	36.61
5	9	-10.77	572.56	29.08	487.02	15.60	18.07
5	10	11.33	-515.86	-26.68	-43.91	-15.60	159.37
6	11	-5.69	411.28	27.02	466.89	15.51	-10.28
6	12	6.25	-354.58	-24.63	-56.71	-15.51	106.49
7	13	-2.81	283.66	25.71	450.82	15.41	-26.17
7	14	3.37	-226.96	-23.32	-61.55	-15.41	76.33
8	15	0.00	0.00	0.00	0.00	0.00	0.00
8	16	0.00	16.94	0.36	0.00	0.42	-19.51
9	16	-4.76	-112.18	-11.24	-178.00	-0.42	31.41
9	2	4.76	112.70	11.25	178.00	1.21	-39.35

10	2	26.69	206.33	14.28	-108.61	7.94	348.97
10	17	-26.69	-199.81	-14.15	108.61	-20.55	-168.81
11	17	21.93	104.57	3.27	15.00	20.55	180.70
11	18	-21.93	-93.63	-3.04	-15.00	-25.24	-33.26
12	18	21.93	93.63	3.04	15.00	25.24	33.26
12	19	-21.93	-84.73	-2.85	-15.00	-28.81	74.73
13	19	17.17	-9.99	-8.03	-162.18	28.81	-62.84
13	20	-17.17	17.03	8.18	162.18	-21.04	49.90
14	20	12.42	-111.76	-19.06	-39.39	21.04	-38.00
14	4	-12.42	114.19	19.11	39.39	-14.72	0.58
15	4	53.48	402.98	7.01	35.61	26.32	406.27
15	21	-53.48	-385.58	-6.64	-35.61	-42.47	527.20
16	21	48.73	93.37	-4.24	-454.24	42.47	-515.31
16	22	-48.73	-92.40	4.26	454.24	-41.91	527.61
17	22	48.73	92.40	-4.26	-454.24	41.91	-527.61
17	23	-48.73	-86.33	4.39	454.24	-38.34	601.37
18	23	43.97	-205.88	-15.27	-18.78	38.34	-589.48
18	6	-43.97	218.18	15.53	18.78	-12.55	234.41
19	6	67.43	450.75	10.46	50.15	26.19	-17.72
19	24	-67.43	-443.23	-10.30	-50.15	-36.82	475.50
20	24	62.67	151.02	-0.58	-439.71	36.82	-463.61
20	25	-62.67	-143.98	0.73	439.71	-36.19	604.89
21	25	57.91	-148.23	-11.60	-4.24	36.19	-593.00
21	26	-57.91	152.04	11.69	4.24	-30.16	515.24
22	26	57.91	-152.04	-11.69	-4.24	30.16	-515.24
22	27	-57.91	168.06	12.03	4.24	-4.30	166.21
23	27	54.35	-390.24	-20.64	-377.54	4.30	-157.29
23	8	-54.35	392.58	20.69	377.54	2.29	32.34
24	8	54.32	260.01	5.59	-320.22	12.87	-68.95
24	28	-53.05	-255.32	-5.49	320.22	-16.41	233.50
25	28	49.48	33.14	-3.12	10.03	16.41	-224.59
25	29	-49.48	-19.46	3.41	-10.03	-10.34	273.54
26	29	49.48	19.46	-3.41	10.03	10.34	-273.54
26	30	-49.48	-13.31	3.54	-10.03	-7.43	287.26
27	30	45.91	-208.87	-12.15	-363.27	7.43	-278.35
27	31	-45.91	215.91	12.30	363.27	4.28	74.91
28	31	42.35	-438.08	-20.91	-33.02	-4.28	-65.99
28	10	-42.35	443.26	21.02	33.02	19.05	-244.58
29	10	31.02	72.60	5.67	10.89	-3.46	85.20
29	32	-31.02	-57.94	-5.36	-10.89	-7.53	44.94
30	32	27.45	-36.78	-3.25	-160.61	7.53	-36.03
30	33	-27.45	40.50	3.33	160.61	-5.87	16.47
31	33	27.45	-40.50	-3.33	-160.61	5.87	-16.47
31	34	-27.45	43.82	3.40	160.61	-4.34	-2.58
32	34	23.89	-138.55	-12.01	-32.16	4.34	11.50
32	12	-23.89	153.60	12.33	32.16	20.59	-310.68
33	12	17.64	200.98	12.29	24.55	-5.08	204.18
33	35	-17.64	-196.20	-12.19	-24.55	-2.89	-74.98
34	35	14.07	101.47	3.58	-146.95	2.89	83.90
34	36	-14.07	-94.43	-3.43	146.95	-6.24	9.93
35	36	10.50	-0.29	-5.18	-18.50	6.24	-1.01
35	37	-10.50	6.85	5.32	18.50	-1.56	-2.17
36	37	10.50	-6.85	-5.32	-18.50	1.56	2.17
36	38	-10.50	20.13	5.60	18.50	8.30	-26.55
37	38	6.94	-111.81	-14.21	-185.19	-8.30	35.46
37	14	-6.94	116.90	14.32	185.19	18.18	-114.69
38	14	3.57	110.06	9.00	-123.64	-2.77	38.36
38	39	-3.57	-108.11	-8.96	123.64	0.39	-9.44
39	39	0.00	16.43	0.35	0.00	-0.39	18.36
39	40	0.00	0.00	0.00	0.00	0.00	0.00

♀

CAP DESIGN
==========

Code: AASHTO STANDARD (17th Edition 2002) - Ultimate Strength Design
Units: US
Pier View : Upstation.

DESIGN PARAMETERS:
==========

f'c = 4000.0 psi
Fy flex = 60000.0 psi Fy shear = 60000.0 psi
phi flex = 0.90 phi shear = 0.85
Ec = 3834.3 ksi Es = 29000.0 ksi
crack control factor z = 170.00 kips / in
Concrete Type : Normal Weight.
Design : face of column.

CAP GEOMETRY:
==========

Straight Cap : Length(X) = 34.75 ft Depth(Z) = 84.00 in

Cap Section Properties:
==========

Sec.	Area ft ^2	Iz in ^4	Iy in ^4
1	35.00	1512000.00	2963520.00

MAIN REINFORCEMENT:
==========

	Bar size	Quantity	Bar dist. in	As total in^2	From ft	To ft	Hook
TOP	US#8[M25]	2	2.69	1.580	0.00	34.75	Both 90
BOTTOM	US#8[M25]	2	2.69	1.580	0.00	34.75	Both 90

STIRRUPS:
==========

From ft	To ft	Stirrup Size	n legs	Spacing in	Aprv/s in^2 / ft	Bar Type
0.00	7.25	US#4[M13]	4	24.00	0.40	Stirrup
7.25	10.58	US#4[M13]	4	12.00	0.80	Stirrup
10.58	13.27	US#4[M13]	4	24.00	0.40	Stirrup
13.27	14.23	US#4[M13]	4	12.00	0.80	Stirrup
14.23	16.93	US#4[M13]	4	24.00	0.40	Stirrup

16.93	17.89	US#4[M13]	4	12.00	0.80 Stirrup
17.89	20.59	US#4[M13]	4	24.00	0.40 Stirrup
20.59	24.24	US#4[M13]	4	12.00	0.80 Stirrup
24.24	25.20	US#4[M13]	4	24.00	0.40 Stirrup
25.20	27.25	US#4[M13]	4	12.00	0.80 Stirrup
27.25	34.75	US#4[M13]	4	24.00	0.40 Stirrup

Clear Cover on Sides = 2.00 in

FLEXURE DESIGN:
==========

Span 1: From 0.00 ft To 2.38 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2

Span 2: From 2.38 ft To 7.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.4	4.8	60	101.9	434.7	332	0.53	1.58	1.58	0.00	1.58	1.58
			-62.5	-434.7	259	0.00	1.58	1.58	0.32	1.58	1.58

Span 3: From 7.25 ft To 12.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.5	9.8	60	795.4	1057.9	259	4.13	1.58*	1.58*	0.00	1.58	1.58
			0.0	-434.7	0	0.00	1.58	1.58	0.00	1.58	1.58

Report

Span 4: From 12.25 ft To 17.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.5	14.8	60	793.5	1055.3	259	4.12	1.58*	1.58*	0.00	1.58	1.58
			0.0	-434.7	0	0.00	1.58	1.58	0.00	1.58	1.58

Span 5: From 17.25 ft To 22.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.5	19.8	60	396.7	527.6	259	2.05	1.58*	1.58*	0.00	1.58	1.58
			0.0	-434.7	0	0.00	1.58	1.58	0.00	1.58	1.58

Span 6: From 22.25 ft To 27.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.5	24.8	60	121.3	434.7	268	0.63	1.58	1.58	0.00	1.58	1.58
			-61.4	-434.7	259	0.00	1.58	1.58	0.32	1.58	1.58

Span 7: From 27.25 ft To 32.25 ft

Loc	AbsLoc	H	Mmax	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
			Mmin	pMn	Comb	Asb-req	Asb-prv	Asb-eff	Ast-req	Ast-prv	Ast-eff
ft	ft	in	kips-ft	kips-ft		in^2	in^2	in^2	in^2	in^2	in^2
2.5	29.8	60	106.0	434.7	331	0.55	1.58	1.58	0.00	1.58	1.58
			-83.2	-434.7	259	0.00	1.58	1.58	0.43	1.58	1.58

Span 8: From 32.25 ft To 34.75 ft

```
 Loc  AbsLoc  H    Mmax    pMn   Comb  Asb-req  Asb-prv  Asb-eff  Ast-req  Ast-prv
Ast-eff
                  Mmin    pMn   Comb  Asb-req  Asb-prv  Asb-eff  Ast-req  Ast-prv
Ast-eff
  ft    ft   in  kips-ft  kips-ft        in^2     in^2     in^2     in^2     in^2
 in^2
-------------------------------------------------------------------------------------
----------
```

Note:
* The provided reinforcement is not adequate, either less than required or larger than maximum allowed.

SHEAR AND TORSION DESIGN:
==========

Span 1: From 0.00 ft To 2.38 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
```

Span 2: From 2.38 ft To 7.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.38   4.75
```

Span 3: From 7.25 ft To 12.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.50   9.75
```

Span 4: From 12.25 ft To 17.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.50  14.75
```

Span 5: From 17.25 ft To 22.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.50  19.75
```

Span 6: From 22.25 ft To 27.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.50  24.75
```

Span 7: From 27.25 ft To 32.25 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
  2.50  29.75
```

Span 8: From 32.25 ft To 34.75 ft

```
  Loc  AbsLoc Pos   Vu   Comb    Tu   Comb phi*Vn   T-lim   Avs/s 2Ats/s  Av/s
Aprv/s   Alt
   ft     ft       kips       kips-ft       kips   kips-ft  <--------- in^2/ft
-------->    in^2
-------------------------------------------------------------------------------------
------------
```

Note:

- Pos is the design position. L suggests the calculation is done at immediate left of "Loc" and R suggests at immediate right of it.
- T-lim is the limiting value of torsion for the concrete section. If actual torsion is higher than this value, torsional steel has to be provided.
- Avs/s is the required area of steel per unit length for shear force.
- 2Ats/s is the required area of steel per unit length for two legs of torsional reinforcement.
- Av/s is the total required area of steel per unit length due to shear plus torsion.
- Aprvs/s is the total provided area of transverse steel reinforcement.
- # Vu is greater tha phi*Vn.
- Alt is the total longitudinal steel required due to torsion in addition to the REQUIRED flexural steel.

CRACKING/FATIGUE CHECK:
==========

Span 1: From 0.00 ft To 2.38 ft

Loc	AbsLoc	H	<------ Cracking ------> fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	<------ Fatigue ------> fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	

Span 2: From 2.38 ft To 7.25 ft

Loc	AbsLoc	H	fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	
2.38	4.8	60.0	3.9	0.19	35	9.3	0.40
			54.0	2.56*	257	47.3	2.19*

Span 3: From 7.25 ft To 12.25 ft

Loc	AbsLoc	H	fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	
2.50	9.8	60.0	0.0	0.00	0	0.0	0.00
			60.8	2.89*	257	49.8	2.45*

Span 4: From 12.25 ft To 17.25 ft

Loc	AbsLoc	H	fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	
2.50	14.8	60.0	0.0	0.00	0	0.0	0.00
			50.6	2.40*	57	41.9	1.93*

Span 5: From 17.25 ft To 22.25 ft

Loc	AbsLoc	H	fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	
2.50	19.8	60.0	3.2	0.15	257	9.7	0.41
			26.8	1.27*	35	20.3	0.92

Span 6: From 22.25 ft To 27.25 ft

Loc	AbsLoc	H	fs-t / fs-b	ratio fs-t / ratio fs-b	Comb / Comb	fs-t / fs-b	ratio fs-t / ratio fs-b
ft	ft	in	ksi			ksi	
2.50	24.8	60.0	7.3	0.34	257	17.9	0.74
			15.4	0.73	249	0.0	0.00

Span 7: From 27.25 ft To 32.25 ft

Loc ft	AbsLoc ft	H in	<------ Cracking ------> fs-t fs-b ksi	ratio fs-t ratio fs-b	Comb Comb	<------ Fatigue ------> fs-t fs-b ksi	ratio fs-t ratio fs-b
2.50	29.8	60.0	3.5	0.16	101	9.7	0.40
			14.4	0.68	249	0.0	0.00

Span 8: From 32.25 ft To 34.75 ft

Loc ft	AbsLoc ft	H in	<------ Cracking ------> fs-t fs-b ksi	ratio fs-t ratio fs-b	Comb Comb	<------ Fatigue ------> fs-t fs-b ksi	ratio fs-t ratio fs-b

Note:
* Cracking / fatigue checking failed.

♀

COLUMN DESIGN
==========

COLUMN DESIGN - Column: 1

Column Type: Rectangular 57.00 x 48.00 in

Code: AASHTO STANDARD (17th Edition 2002) - Factored Load Design
Units: US
Pier View : Upstation.
Design/Analysis Method: No Slenderness Considered.

Column Section Properties:
==========

Sec.	Area ft^2	Ix in^4	Iz in^4
0	19.00	525312.00	740772.00

DESIGN PARAMETERS:
==========
f'c = 4000.0 psi fy = 60000.0 psi
phi flex = 0.90 phi axial = 0.70
Ec = 3834.3 ksi Es = 29000 ksi
Concrete Type : Normal Weight.

Reinforcement:
==========
Rebar Pattern: Rectangular
Rebar Orientation: Face Parallel

Layer	Dir	Size	No. bars	Bar Dist. in	From ft	To ft	Hook
1	X	US#5[M16]	8	2.94	0.00	16.00	None

1	Z	US#5[M16]	4	2.94	0.00	16.00	None

Note:
Bar Dist refers to the distance between center of reinforcement and concrete surface.

Layer	Size	Type	Pitch in	From ft	To ft
1	US#5[M16]	Ties	12.00	0.00	16.00

Design values used - (e-min effect included).
==========

(global coordinates)

Loc ft	Comb	Fx kips	Fy kips	Fz kips	Mx kips-ft	My kips-ft	Mz kips-ft
526.00	1C	37.5	389.0	0.2	66.1	7.3	-204.9
542.00	1C	-37.5	335.1	-0.2	-57.0	7.3	-394.7
526.00	34C	32.0	372.9	27.8	493.4	9.2	-197.1
542.00	34C	-31.4	319.0	-25.5	-69.4	9.2	-309.6

Column Design
==========

Bot/Top Elev. ft	Comb	Pu kips	Mux kips-ft	Muz kips-ft	pMn kips-ft	Incl deg	pPn/Pu	pMn/Mu
526.00	34C	372.9	493.4	197.1	1394.2	21.77	1.00	2.62
542.00	1C	335.1	57.0	394.7	1528.4	81.79	1.00	3.83

Column Design
==========

Bot/Top Elev. ft	As_min in^2	As_max in^2	As_prov in^2
526.00	0.00	218.88	7.44
542.00	0.00	218.88	7.44

Note:
Min reinforcement = 0.0000 % of Ag.
♀
COMBINED FOOTING DESIGN

Code: AASHTO STANDARD (17th Edition 2002) - Ultimate Strength Design
Units: US
Pier View : Upstation.

Geometry:
=========
Name : pile ftg
Shape : Rectangular, Type : Pile/Shaft Cap

Bf(X) = 40.00 ft, Hf(Z) = 19.33 ft, Thickness(Y) = 48.00 in

Ag = 773.33 ft^2, Ix = 1175.56 ft^2, Iz = 2640.00 ft^2

Footing concentric.
Columns located on the footing:

Column No.	1	at x = 0.00 ft,	Rectangular	57.00 in x	48.00 in
Column No.	2	at x = 4.88 ft,	Rectangular	60.00 in x	48.00 in
Column No.	3	at x = 9.88 ft,	Rectangular	60.00 in x	48.00 in
Column No.	4	at x = 14.88 ft,	Rectangular	60.00 in x	48.00 in
Column No.	5	at x = 19.88 ft,	Rectangular	60.00 in x	48.00 in
Column No.	6	at x = 24.88 ft,	Rectangular	60.00 in x	48.00 in
Column No.	7	at x = 29.88 ft,	Rectangular	60.00 in x	48.00 in

Piles: Round Size: W = 16.00 in
Service Capacity: 180.00 kips
Factored Capacity: 0.00 kips
Lateral Resistance: 28.80 kips
Piles Section Properties: Area = 1.40 ft^2 Ix = 3216.99 in^4 Iz = 3216.99 in^4

Design Parameters:
==========

f'c = 4000.00 psi fy = 60000.00 psi
phi flex = 0.90 phi shear = 0.85
Ec = 3834.3 ksi Es = 29000.0 ksi
Crack control factor z = 1.00 kips/in
Concrete Type : Normal Weight.

Reinforcement Schedule:
==========:

Dir	Quantity	Size	Bar dist. in	As total in^2	From ft	To ft	Hook
X	10	US#11[M36]	4.00	15.60	0.00	40.00	Both 90
Z	60	US#11[M36]	5.41	93.60	----	----	None

Pile Reactions:
==========

Pile Reactions, Service (Without the reduction of overstress allowance):
==========

Pile	X in	Z in	Batter X degree	Batter Z degree	comb	Ovs	P, kips	Mxx, kft	Mzz, kft	Pile Reac. kips
1	24.0	92.0	0.0	0.0	258	1.700	-3132.84	1251.99	5231.81	200.48*
					250	1.500	-2342.03	-547.22	-3353.17	90.67
2	72.0	92.0	0.0	0.0	258	1.700	-3132.84	1251.99	5231.81	192.55*
					250	1.500	-2342.03	-547.22		

```
-3353.17      95.75
  3  120.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     184.62*
                                             250    1.500   -2342.03    -547.22
-3353.17     100.83
  4  168.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     176.70
                                             252    1.500   -2342.03   -1823.89
-1073.15     102.77
  5  216.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     168.77
                                             252    1.500   -2342.03   -1823.89
-1073.15     104.39
  6  264.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     160.84
                                             255    1.500   -2342.03   -1823.89
881.16     104.54
  7  312.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     152.92
                                             255    1.500   -2342.03   -1823.89
881.16     103.20
  8  360.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     144.99
                                             249    1.500   -2342.03    -547.22
3161.18     101.56
  9  408.0   92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     137.06
                                             249    1.500   -2342.03    -547.22
3161.18      96.77
 10  456.0   92.0    14.0         0.0       258    1.700   -3132.84    1251.99
5231.81     129.14
                                             249    1.500   -2342.03    -547.22
3161.18      91.98
 11  456.0  -92.0    14.0         0.0       258    1.700   -3132.84    1251.99
5231.81     112.81
                                             254    1.500   -2342.03     547.06
3161.18      91.98
 12  408.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     120.73
                                             254    1.500   -2342.03     547.06
3161.18      96.77
 13  360.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     128.66
                                             254    1.500   -2342.03     547.06
3161.18     101.56
 14  312.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     136.59
                                             256    1.500   -2342.03    1823.72
881.16     103.21
 15  264.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     144.51
                                             256    1.500   -2342.03    1823.72
881.16     104.54
 16  216.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     152.44
                                             251    1.500   -2342.03    1823.72
-1073.15     104.39
 17  168.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     160.37
                                             251    1.500   -2342.03    1823.72
-1073.15     102.77
 18  120.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     168.29
```

```
                                                 253    1.500   -2342.03     547.06
-3353.17     100.83
 19   72.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     176.22
                                                 253    1.500   -2342.03     547.06
-3353.17      95.75
 20   24.0  -92.0     0.0         0.0       258    1.700   -3132.84    1251.99
5231.81     184.15*
                                                 253    1.500   -2342.03     547.06
-3353.17      90.67
```

Pile Reactions, Factored:
==========

```
Pile     X       Z   Batter X   Batter Z    |-------- Load Effect @ Footing
Bot.--------|         Pile Reac.
        in      in   degree     degree       comb   Ovs    P, kips    Mxx, kft
Mzz, kft   kips
-------------------------------------------------------------------------------------
------------------------
  1   24.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     298.62*
                                                 332     ---    -2342.03    -547.22
-3353.17      90.67*
  2   72.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     292.92*
                                                 332     ---    -2342.03    -547.22
-3353.17      95.75*
  3  120.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     287.23*
                                                 332     ---    -2342.03    -547.22
-3353.17     100.83*
  4  168.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     281.54*
                                                 334     ---    -2342.03   -1823.89
-1073.15     102.77*
  5  216.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     275.84*
                                                 334     ---    -2342.03   -1823.89
-1073.15     104.39*
  6  264.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     270.15*
                                                 334     ---    -2342.03   -1823.89
-1073.15     106.02*
  7  312.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     264.46*
                                                 331     ---    -2342.03    -547.22
3161.18     106.35*
  8  360.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     258.77*
                                                 331     ---    -2342.03    -547.22
3161.18     101.56*
  9  408.0   92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     253.07*
                                                 331     ---    -2342.03    -547.22
3161.18      96.77*
 10  456.0   92.0   14.0         0.0        261     ---    -5487.89    -214.05
3757.07     247.38*
                                                 331     ---    -2342.03    -547.22
3161.18      91.98*
 11  456.0  -92.0   14.0         0.0        261     ---    -5487.89    -214.05
3757.07     250.17*
```

```
                                                    331     ---    -2342.03    -547.22
3161.18      99.12*
 12  408.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     255.87*
                                                    331     ---    -2342.03    -547.22
3161.18     103.91*
 13  360.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     261.56*
                                                    331     ---    -2342.03    -547.22
3161.18     108.70*
 14  312.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     267.25*
                                                    333     ---    -2342.03    1823.72
-1073.15     107.65*
 15  264.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     272.94*
                                                    333     ---    -2342.03    1823.72
-1073.15     106.02*
 16  216.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     278.64*
                                                    333     ---    -2342.03    1823.72
-1073.15     104.39*
 17  168.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     284.33*
                                                    333     ---    -2342.03    1823.72
-1073.15     102.77*
 18  120.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     290.02*
                                                    333     ---    -2342.03    1823.72
-1073.15     101.14*
 19   72.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     295.71*
                                                    333     ---    -2342.03    1823.72
-1073.15      99.52*
 20   24.0  -92.0    0.0         0.0        261     ---    -5487.89    -214.05
3757.07     301.41*
                                                    332     ---    -2342.03    -547.22
-3353.17      97.81*


Pile Reactions, Service (After the reduction of overstress allowance):
======================================================================

Pile     X       Z   Batter X   Batter Z    |-------- Load Effect @ Footing
Bot.--------|         Pile Reac.
        in      in   degree     degree       comb   Ovs    P, kips    Mxx, kft
Mzz, kft   kips
-------------------------------------------------------------------------------------
------------------------
  1   24.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     165.90
                                                    250    1.500   -2342.03    -547.22
-3353.17      60.45
  2   72.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     162.73
                                                    250    1.500   -2342.03    -547.22
-3353.17      63.83
  3  120.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     159.57
                                                    250    1.500   -2342.03    -547.22
-3353.17      67.22
  4  168.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     156.41
```

```
                                                    252    1.500   -2342.03   -1823.89
-1073.15      68.51
  5  216.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     153.25
                                                    252    1.500   -2342.03   -1823.89
-1073.15      69.60
  6  264.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     150.08
                                                    255    1.500   -2342.03   -1823.89
881.16      69.69
  7  312.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     146.92
                                                    255    1.500   -2342.03   -1823.89
881.16      68.80
  8  360.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     143.76
                                                    249    1.500   -2342.03    -547.22
3161.18      67.71
  9  408.0   92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     140.60
                                                    249    1.500   -2342.03    -547.22
3161.18      64.51
 10  456.0   92.0    14.0         0.0         1    1.000   -3048.83    -118.92
2087.26     137.43
                                                    249    1.500   -2342.03    -547.22
3161.18      61.32
 11  456.0  -92.0    14.0         0.0         1    1.000   -3048.83    -118.92
2087.26     138.99
                                                    254    1.500   -2342.03     547.06
3161.18      61.32
 12  408.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     142.15
                                                    254    1.500   -2342.03     547.06
3161.18      64.51
 13  360.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     145.31
                                                    254    1.500   -2342.03     547.06
3161.18      67.71
 14  312.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     148.47
                                                    256    1.500   -2342.03    1823.72
881.16      68.80
 15  264.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     151.64
                                                    256    1.500   -2342.03    1823.72
881.16      69.69
 16  216.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     154.80
                                                    251    1.500   -2342.03    1823.72
-1073.15      69.60
 17  168.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     157.96
                                                    251    1.500   -2342.03    1823.72
-1073.15      68.51
 18  120.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     161.12
                                                    253    1.500   -2342.03     547.06
-3353.17      67.22
 19   72.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
2087.26     164.29
                                                    253    1.500   -2342.03     547.06
-3353.17      63.83
 20   24.0  -92.0     0.0         0.0         1    1.000   -3048.83    -118.92
```

2087.26 167.45
253 1.500 -2342.03 547.06
-3353.17 60.45

Note:
* Service Force in pile is greater than service pile capacity.
* Factored Force in pile is greater than factored pile capacity.
Load effects on pile are calculated at centroid of the bottom of the footing.
Both the max. and min. pile reaction are reported for each individual pile.
Positive pile reaction represents pile subject to compression load; negative pile reaction represents pile subject to uplift.
Coordinate system of pile layout see Geometry Tab>Footing Pile>Edit Pile.

Pile Lateral Resistance Check X
==========

-Controlling load combination number	249
-Lateral loads on all piles(kips)	144.763
-Batter angle(deg)	0
-Available lateral resistance due to batter(kips)	0.000
-Direct shear resistance of all piles(kips)	576.000
-Total pile lateral resistance(kips)	576.000
-Is the lateral resistance due to batter greater than lateral load on all piles?	NO
-Is the total pile lateral resistance greater than the lateral load on all piles?	YES

Pile Lateral Resistance Check Z
==========

-Controlling load combination number	292
-Lateral loads on all piles(kips)	195.206
-Batter angle(deg)	0
-Available lateral resistance due to batter(kips)	0.000
-Direct shear resistance of all piles(kips)	576.000
-Total pile lateral resistance(kips)	576.000
-Is the lateral resistance due to batter greater than lateral load on all piles?	NO
-Is the total pile lateral resistance greater than the lateral load on all piles?	YES

Max. Pile Reaction Used in Design:
==========

Factored pile reaction = 301.41 kips Comb 261

Service pile reaction = 242.12 kips Comb 257

Fatigue pile reaction = 125.67 kips Comb 257

Flexure:
==========

X direction

Loc	Mmax	Comb	Asb_req	Asb_prv	Asb_eff	Ast_req	Ast_prv	Ast_eff
	Mmin	Comb	Asb_req	Asb_prv	Asb_eff	Ast_req	Ast_prv	Ast_eff
ft	kft		in^2	in^2	in^2	in^2	in^2	in^2

-5.06	-0.0	261	0.00	15.60	0.00	0.00	0.00	0.00
	-0.0	261	0.00	15.60	0.00	0.00	0.00	0.00
-4.76	-0.0	261	0.00	15.60	2.09	0.00	0.00	0.00
	-0.0	261	0.00	15.60	2.09	0.00	0.00	0.00
-4.47	-0.0	261	0.00	15.60	4.18	0.00	0.00	0.00
	-0.0	261	0.00	15.60	4.18	0.00	0.00	0.00
-4.17	-0.0	261	0.00	15.60	6.27	0.00	0.00	0.00
	-0.0	261	0.00	15.60	6.27	0.00	0.00	0.00
-3.87	-0.0	261	0.00	15.60	8.36	0.00	0.00	0.00
	-0.0	261	0.00	15.60	8.36	0.00	0.00	0.00
-3.57	-0.0	261	0.00	15.60	10.45	0.00	0.00	0.00
	-0.0	261	0.00	15.60	10.45	0.00	0.00	0.00
-3.27	-0.0	261	0.00	15.60	12.54	0.00	0.00	0.00
	-0.0	261	0.00	15.60	12.54	0.00	0.00	0.00
-2.97	54.4	261	0.37	15.60	14.63	0.00	0.00	0.00
	-0.0	261	0.00	15.60	14.63	0.00	0.00	0.00
-2.67	234.4	261	1.58	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
-2.37	414.4	261	2.79	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
0.00	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
0.49	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
0.97	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
1.46	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
1.95	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
2.44	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00

	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
2.92	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
3.41	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
3.90	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
4.39	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
4.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
5.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
5.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
6.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
6.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
7.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
7.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
8.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
8.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
9.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
9.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00

10.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
10.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
11.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
11.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
12.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
12.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
13.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
13.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
14.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
14.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
15.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
15.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
16.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
16.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
17.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
17.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00

18.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
18.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
19.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
19.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
20.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
20.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
21.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
21.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
22.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
22.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
23.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
23.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
24.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
24.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
25.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
25.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00

	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
26.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
26.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
27.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
27.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
28.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
28.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
29.38	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
29.88	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
32.38	339.1	261	2.28	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
32.66	167.4	261	1.13	15.60	15.60	0.00	0.00	0.00
	-0.0	261	0.00	15.60	15.60	0.00	0.00	0.00
32.94	-0.0	261	0.00	15.60	13.95	0.00	0.00	0.00
	-0.0	261	0.00	15.60	13.95	0.00	0.00	0.00
33.23	-0.0	261	0.00	15.60	11.95	0.00	0.00	0.00
	-0.0	261	0.00	15.60	11.95	0.00	0.00	0.00
33.51	-0.0	261	0.00	15.60	9.96	0.00	0.00	0.00
	-0.0	261	0.00	15.60	9.96	0.00	0.00	0.00
33.80	-0.0	261	0.00	15.60	7.97	0.00	0.00	0.00
	-0.0	261	0.00	15.60	7.97	0.00	0.00	0.00
34.08	-0.0	261	0.00	15.60	5.98	0.00	0.00	0.00
	-0.0	261	0.00	15.60	5.98	0.00	0.00	0.00
34.37	-0.0	261	0.00	15.60	3.98	0.00	0.00	0.00

	-0.0	261	0.00	15.60	3.98	0.00	0.00	0.00
34.65	-0.0	261	0.00	15.60	1.99	0.00	0.00	0.00
	-0.0	261	0.00	15.60	1.99	0.00	0.00	0.00
34.94	-0.0	261	0.00	15.60	0.00	0.00	0.00	0.00
	-0.0	261	0.00	15.60	0.00	0.00	0.00	0.00

Z direction

Loc	Mmax	Comb	Asb_req	Asb_prv	Asb_eff	Ast_req	Ast_prv	Ast_eff
ft	kft		in^2	in^2	in^2	in^2	in^2	in^2
-2.00	16374.3	261	88.84	93.60	93.60	0.00	0.00	0.00
2.00	16374.5	261	88.84	93.60	93.60	0.00	0.00	0.00

Cracking/Fatigue
==========

X direction

	<---------- Cracking ---------->				<---------- Fatigue ---------->			
Loc	Mmax	Comb	fs-t	ratio fs-t	Mmax	Comb	fs-t	ratio fs-t
Loc	Mmin	Comb	fs-b	ratio fs-b	Mmin	Comb	fs-b	ratio fs-b
ft	kft		ksi		kft		ksi	
-5.06	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
-4.76	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-4.47	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-4.17	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-3.87	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-3.57	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-3.27	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00

	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
-2.97	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	43.7	257	0.85	0.05	22.69	257	0.44	0.02
-2.67	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	188.3	257	3.45	0.19	97.74	257	1.79	0.08
-2.37	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	332.9	257	6.11	0.33	172.79	257	3.17	0.14
0.00	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
0.49	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
0.97	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
1.46	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
1.95	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
2.44	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
2.92	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
3.41	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
3.90	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
4.39	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
4.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
5.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00

5.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
6.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
6.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
7.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
7.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
8.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
8.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
9.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
9.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
10.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
10.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
11.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
11.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
12.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
12.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
13.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00

13.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
14.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
14.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
15.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
15.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
16.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
16.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
17.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
17.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
18.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
18.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
19.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
19.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
20.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
20.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
21.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00

	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
21.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
22.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
22.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
23.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
23.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
24.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
24.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
25.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
25.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
26.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
26.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
27.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
27.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
28.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
28.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
29.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00

	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
29.88	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
32.38	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	272.4	257	5.00	0.27	141.38	257	2.59	0.11
32.66	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	134.5	257	2.47	0.13	69.82	257	1.28	0.05
32.94	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
33.23	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
33.51	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
33.80	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
34.08	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
34.37	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
34.65	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	-0.00	-0.00	-0.00	0	0.00	0.00
34.94	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00
	-0.0	0	0.00	-0.00	-0.00	0	0.00	0.00

Z direction

-2.00	13014.5	257	42.44	1.60 *	6415.84	257	20.92	4.98 *
2.00	13014.7	257	42.44	1.60 *	6415.95	257	20.92	4.98 *

Note:
* Cracking / fatigue ratio exceeds allowable.

One Way Shear :
==========

Col	Dist ft	Comb	d in	Vu kips	phi*Vc kips
X direction					
1	-34.94	----	------	Outside of Footing	
	34.94	261	0.00	0.0	0.0
2	-5.06	261	0.00	0.0	0.0
	34.94	261	0.00	0.0	0.0
3	-5.06	261	0.00	0.0	0.0
	34.94	261	0.00	0.0	0.0
4	-5.06	261	0.00	0.0	0.0
	34.94	261	0.00	0.0	0.0
5	-5.06	261	0.00	0.0	0.0
	34.94	261	0.00	0.0	0.0
6	-5.06	261	0.00	0.0	0.0
	34.94	261	0.00	0.0	0.0
7	-5.06	261	0.00	0.0	0.0
	-0.06	----	------	Outside of Footing	
Z direction					
	-5.55	261	42.59	3014.1 *	2198.0
	5.55	261	42.59	3014.1 *	2198.0

Note:
* Shear resistance is less than applied shear force.
You may increase the footing depth or provide stirrups.

Two Way Shear:
==========

#	Bo ft	Ao ft^2	Comb	Avg. d in	Vu kips	phi*Vc kips
Columns:						
1	31.70	62.65	261	42.59	1525.4	3483.5
2	32.20	64.54	261	42.59	243.5	3538.4
3	32.20	64.54	261	42.59	895.3	3538.4
4	32.20	64.54	261	42.59	681.5	3538.4
5	32.20	64.54	261	42.59	892.4	3538.4
6	32.20	64.54	261	42.59	266.7	3538.4
7	32.20	64.54	261	42.59	1523.3	3538.4
Piles - max:						
2	7.83	12.11	261	42.59	301.4	861.0
Piles - min:						
1	5.92	14.94	261	42.59	301.4	650.3

Note:
TWO WAY SHEAR IN FOOTING IS NOT DESIGNED AND STIRRUPS ARE NOT CONSIDERED.

♀

DESIGN CALCULATION COVER SHEET

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PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Pier Footing	CALC NO.:	**HAM562_0026_07SR**
	Shear Reinforcing	REV NO.:	**01**
FILE NAME(s):	*HAM562_0026_07SR Pier Ftg Shear.xmcd*	**SHEET:**	**1 OF 2**

SUPERSEDES CALC NO: 00 (Stage 2)

CALCULATION DESCRIPTION:

This will analyze the additional shear reinforcing required in the pier footing.

DESIGN BASIS OR REFERENCES

NS Underpass Design Criteria
AREMA (2013) Chapter 8, Section 5

MISCELLANEOUS NOTES:

Stage 3 Update: Shear Load increased due to increased deck thickness and increased girder sections

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/15/14		
01	Stage 3 Update	VDT	01/18/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/15/14	VDK	07/15/14				

Footing Shear Reinforcement

HAM-562-0026 Pier Foundation

Design Notes:

- *The loads given are outputs from RC-Pier analysis for the Pier design of HAM-562-0026*
- *All calculations comply with AREMA Code, specifically Chapter 8.*

$f_c := 4000psi \quad d := 43in$

$b_w := 480in \quad f_y := 60ksi$

SHEAR IN THE FOOTING:

$V_u := 3015 \cdot kip$ *Loads taken from RC-Pier output*

$\Phi V_c := \left(2 \cdot \sqrt{f_c \cdot psi} \cdot b_w \cdot d\right) \cdot .75 = 1958.082\,kip$ *AREMA Ch.8 Sec. 17.21.2*

REQUIRED SHEAR CAPACITY OF REINFORCING IN THE FOOTING:

$$\Phi V_s := \frac{\left(V_u - \Phi V_c\right)}{.75 \cdot 40ft} = 35.231\,klf$$

Try #4 bars @ 12" spacing:

$s := 12in$

$$A_v := \frac{\left(\Phi V_s \cdot s\right)}{f_v \cdot d} = 0.164\,\frac{1}{ft} \cdot in^2$$ *AREMA Ch.8 Sec. 17.21.3.1 EQ 17-35*

$$A_{prov} := .20\,\frac{(in)^2}{ft} = 0.200\,\frac{1}{ft} \cdot in^2$$

$CHECK := \text{if}\left(A_v < A_{prov}, \text{"OK"}, \text{"NO GOOD"}\right) = \text{"OK"}$

DESIGN CALCULATION COVER SHEET

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PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Loads***	**GF JOB NO:**	**54682**
	Retaining wall Loads for	CALC NO.:	**HAM562_0026_08**
	Abut5 Program	REV NO.:	**00**
FILE NAME(s):	*HAM562_0026_08.xlsx*	**SHEET: 1 OF 5**	

SUPERSEDES CALC NO:

CALCULATION DESCRIPTION:

This will calculate all loads applied to the wingwall on a per-foot basis for use in the Abut5 program. Four straight wing walls are proposed for Ham-562-0026 bridge. The wing wall located on the rear abutment in stage 1 is closest to the CL Track, therefore will have the highest surcharge and the highest soil load. The Southeast wing wall located on the rear abutment is designed and same reinforcement is used for all wingwalls. Three design points are considered one close to the edge of the abutment, one close to the middle of the retaining wall and a third located near the end of the wall.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
AREMA (2008) Chapter 15, Section 10
Calculation: HAM562_0026_03 (Girder Loads and Reactions)
Calculation: HAM562_0026C_01 (Elevation Data)
Revised Stage 1 Plans (after addressing comments)

MISCELLANEOUS NOTES:

Abut5 Calculates the abutment self-weight and earth loads automatically.

STAGE 2: Coulomb's equation is used for equivilant pressure.

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/18/14	EFD	07/30/14

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/18/14	VDK	07/18/14	VDT	07/28/14	EFD	07/30/14

Section 1: SE Wingwall, Design Point 1 (approx STA. 129+46) - 7.90 ft High

A select granular backfill will be used behind the abutment. For the design of the wingwall, Backfill Type 1 of AREMA Table 8-5-1 (Section 8-5.2.5) is will be specified. Type 2 will be used to be conservative. Coulomb's theory for a vertical wall, the equivilant fluid pressure will be used

Distance from Top of Rail to Top of Wall:	2.00 ft		*Round up… must coincide with a bousenesque level.*
Distance from Fill Face of wall to CL Rail:	15.00 ft		*Normal to the wall, this distance will be a CLT distance in bousensque*
Friction btwn backfill and stem concrete δ:	15.0 deg	0.2618 rad	*1/2 of internal friction angle (conservative)*
Angle of backfill β: 11.9 : 1	4.8 deg	0.0838 rad	*Enter 1000:1 for horz. slope (Top/wall to Bot/tie)*
Angle of Internal Friction ϕ:	30.0 deg	0.5236 rad	*AREMA Table 8-5-2*
Angle of Stem (Fill-Face) θ: 1 : 100.0	90.0 deg	1.5708 rad	*Angle from horizontal (less than 90 for a batter) (Enter 1:100 for a vertical face)*
AREMA Type 2 Soil Density	110.0 pcf		

	Coulomb	Rankine	(Equation from "All-In-One Civil Engineering PE")
K_a Numerator:	***0.750***	**0.750**	
K_a denominator Γ Term:	*2.431*	2.138	
K_a denominator Outside Term:	*0.966*	1.000	
K_a Denominator:	***2.348***	**2.138**	
Coefficient of Active Earth Pressure K_a:	***0.319***	**0.351**	*It should be noted, that the equivilant surcharge is meant to correctly model the moment in the stem. In general, this will overestimate the thrust (sliding). Therefore, as long as the analysis is OK for sliding, there is no need to be extra conservative.*
	For Comparison Only		
Equivalent Fluid Pressure Dry:	***35.1 psi***	**38.6 psi**	
Live Load Surcharge:	**4.5 ft**		*A minimum of 2.5' will be considered for construction loads*
Vertical Fluid Pressure (K_v):	***2.9 psi***	**3.2 psi**	*LRFD Equation 3.11.5.5-2*

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Calc:	VDT	Date:	7/18/2014
Check:	VDK	Date:	7/18/2014
Update:	VDT	Date:	7/28/2014
Verified:	EFD	Date:	7/30/2014

Lateral Pressure from Parallel Strip Loading

4 Different wall distances/heights considered.

Calculations as per Norfolk Southern Design Standards

Min. Depth of Resulting Table (Hs_{min}):	1.00 ft	Centerline Track Distance 1, CLT_1:	15.0 ft
Max Depth of Resulting Table (Hs_{max}):	41.00 ft	Centerline Track Distance 2, CLT_2:	15.0 ft
Spacing of Max Axle Load:	5.0 ft	Centerline Track Distance 3, CLT_3:	15.0 ft
Max Axle Load:	100.0 kip	Centerline Track Distance 4, CLT_4:	15.0 ft
Width of Tie (TL):	8.5 ft	Applied Pressure (q):	2.35 ksf

Hs	**β** *(Radians)*				**α** *(Radians)*				*Active Pressure,* **Ps** *(psf)*			
	β_1	β_2	β_3	β_4	α_1	α_2	α_3	α_4	Ps_1	Ps_2	Ps_3	Ps_4
0.00 ft	0.0000	0.0000	0.0000	0.0000	1.5708	1.5708	1.5708	1.5708	0.00	0.00	0.00	0.00
1.00 ft	0.0409	0.0409	0.0409	0.0409	1.4985	1.4985	1.4985	1.4985	121.74	121.74	121.74	121.74
2.00 ft	0.0804	0.0804	0.0804	0.0804	1.4271	1.4271	1.4271	1.4271	235.86	235.86	235.86	235.86
3.00 ft	0.1175	0.1175	0.1175	0.1175	1.3574	1.3574	1.3574	1.3574	335.99	335.99	335.99	335.99
4.00 ft	0.1513	0.1513	0.1513	0.1513	1.2902	1.2902	1.2902	1.2902	417.91	417.91	417.91	417.91
5.00 ft	0.1812	0.1812	0.1812	0.1812	1.2261	1.2261	1.2261	1.2261	479.78	479.78	479.78	479.78
6.00 ft	0.2069	0.2069	0.2069	0.2069	1.1652	1.1652	1.1652	1.1652	521.88	521.88	521.88	521.88
7.00 ft	0.2284	0.2284	0.2284	0.2284	1.1078	1.1078	1.1078	1.1078	546.03	546.03	546.03	546.03
8.00 ft	0.2459	0.2459	0.2459	0.2459	1.0540	1.0540	1.0540	1.0540	554.93	554.93	554.93	554.93
9.00 ft	0.2597	0.2597	0.2597	0.2597	1.0036	1.0036	1.0036	1.0036	551.58	551.58	551.58	551.58
10.00 ft	0.2702	0.2702	0.2702	0.2702	0.9566	0.9566	0.9566	0.9566	538.91	538.91	538.91	538.91
11.00 ft	0.2777	0.2777	0.2777	0.2777	0.9128	0.9128	0.9128	0.9128	519.55	519.55	519.55	519.55
12.00 ft	0.2829	0.2829	0.2829	0.2829	0.8719	0.8719	0.8719	0.8719	495.70	495.70	495.70	495.70
13.00 ft	0.2859	0.2859	0.2859	0.2859	0.8339	0.8339	0.8339	0.8339	469.13	469.13	469.13	469.13
14.00 ft	0.2872	0.2872	0.2872	0.2872	0.7984	0.7984	0.7984	0.7984	441.20	441.20	441.20	441.20
15.00 ft	0.2870	0.2870	0.2870	0.2870	0.7653	0.7653	0.7653	0.7653	412.94	412.94	412.94	412.94
16.00 ft	0.2857	0.2857	0.2857	0.2857	0.7345	0.7345	0.7345	0.7345	385.08	385.08	385.08	385.08
17.00 ft	0.2835	0.2835	0.2835	0.2835	0.7056	0.7056	0.7056	0.7056	358.12	358.12	358.12	358.12
18.00 ft	0.2806	0.2806	0.2806	0.2806	0.6787	0.6787	0.6787	0.6787	332.40	332.40	332.40	332.40
19.00 ft	0.2770	0.2770	0.2770	0.2770	0.6534	0.6534	0.6534	0.6534	308.10	308.10	308.10	308.10
20.00 ft	0.2731	0.2731	0.2731	0.2731	0.6297	0.6297	0.6297	0.6297	285.33	285.33	285.33	285.33
21.00 ft	0.2688	0.2688	0.2688	0.2688	0.6075	0.6075	0.6075	0.6075	264.12	264.12	264.12	264.12
22.00 ft	0.2643	0.2643	0.2643	0.2643	0.5867	0.5867	0.5867	0.5867	244.45	244.45	244.45	244.45
23.00 ft	0.2597	0.2597	0.2597	0.2597	0.5670	0.5670	0.5670	0.5670	226.28	226.28	226.28	226.28
24.00 ft	0.2549	0.2549	0.2549	0.2549	0.5486	0.5486	0.5486	0.5486	209.52	209.52	209.52	209.52
25.00 ft	0.2501	0.2501	0.2501	0.2501	0.5311	0.5311	0.5311	0.5311	194.11	194.11	194.11	194.11
26.00 ft	0.2453	0.2453	0.2453	0.2453	0.5147	0.5147	0.5147	0.5147	179.94	179.94	179.94	179.94
27.00 ft	0.2405	0.2405	0.2405	0.2405	0.4991	0.4991	0.4991	0.4991	166.94	166.94	166.94	166.94
28.00 ft	0.2357	0.2357	0.2357	0.2357	0.4844	0.4844	0.4844	0.4844	155.00	155.00	155.00	155.00
29.00 ft	0.2310	0.2310	0.2310	0.2310	0.4705	0.4705	0.4705	0.4705	144.04	144.04	144.04	144.04
30.00 ft	0.2264	0.2264	0.2264	0.2264	0.4573	0.4573	0.4573	0.4573	133.99	133.99	133.99	133.99
31.00 ft	0.2219	0.2219	0.2219	0.2219	0.4447	0.4447	0.4447	0.4447	124.76	124.76	124.76	124.76
32.00 ft	0.2175	0.2175	0.2175	0.2175	0.4328	0.4328	0.4328	0.4328	116.28	116.28	116.28	116.28
33.00 ft	0.2132	0.2132	0.2132	0.2132	0.4215	0.4215	0.4215	0.4215	108.49	108.49	108.49	108.49
34.00 ft	0.2089	0.2089	0.2089	0.2089	0.4107	0.4107	0.4107	0.4107	101.33	101.33	101.33	101.33
35.00 ft	0.2048	0.2048	0.2048	0.2048	0.4004	0.4004	0.4004	0.4004	94.74	94.74	94.74	94.74
36.00 ft	0.2009	0.2009	0.2009	0.2009	0.3906	0.3906	0.3906	0.3906	88.67	88.67	88.67	88.67
37.00 ft	0.1970	0.1970	0.1970	0.1970	0.3812	0.3812	0.3812	0.3812	83.07	83.07	83.07	83.07
38.00 ft	0.1932	0.1932	0.1932	0.1932	0.3723	0.3723	0.3723	0.3723	77.91	77.91	77.91	77.91
39.00 ft	0.1895	0.1895	0.1895	0.1895	0.3637	0.3637	0.3637	0.3637	73.14	73.14	73.14	73.14
40.00 ft	0.1860	0.1860	0.1860	0.1860	0.3555	0.3555	0.3555	0.3555	68.73	68.73	68.73	68.73
41.00 ft	0.1825	0.1825	0.1825	0.1825	0.3477	0.3477	0.3477	0.3477	64.65	64.65	64.65	64.65

Note: The following two pages contain numerical and graphical representations of these loads over a selected area.

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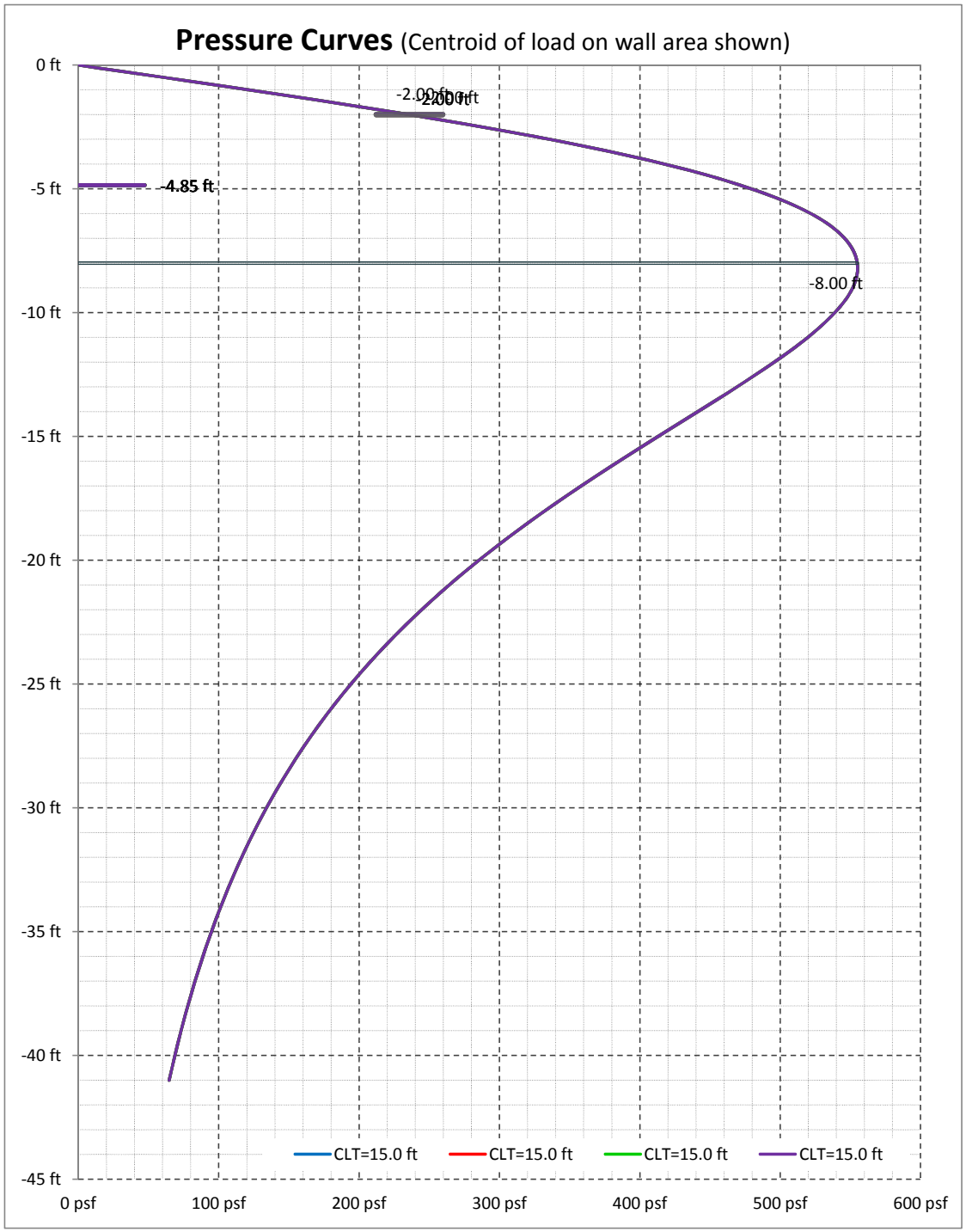
Calc:	VDT	Date:	7/18/2014
Check:	VDK	Date:	7/18/2014
Update:	VDT	Date:	7/28/2014
Verified:	EFD	Date:	7/30/2014

Numerical Summary of Forces

To gain total forces, the area under the graph is required. The area under the graph for the considered depth is divided by the total considered depth to arrive at a uniformly applied lateral pressure on any surface in question. The total lateral force is the total area under the graph. Simpsons Rule is used to arrive at the total area under the graph (median value force over a height is used)

Select the Top and Bottom of wall depths for each CLT under consideration. The ZERO elevation is the PGL Elevation. The bottom of wall elevation is the **bottom of stem**.	CLT=15.0 ft	CLT=15.0 ft	CLT=15.0 ft	CLT=15.0 ft
Top of Wall (Min. Depth Considered):	2.00 ft	2.00 ft	2.00 ft	2.00 ft
Bottom of Wall (Max. Depth Considered):	8.00 ft	8.00 ft	8.00 ft	8.00 ft
Height Considered:	**6.00 ft**	**6.00 ft**	**6.00 ft**	**6.00 ft**
Top and Bottom Applied Lateral Pressure on limits of the wall				
	Values at CLT Distances			
Data Below is intended to give summary values that can be used in the design of walls and surfaces affected by the surcharge. A graphical output is on the next page	CLT=15.0 ft	CLT=15.0 ft	CLT=15.0 ft	CLT=15.0 ft
Top of Wall Pressure	235.9 psf	235.9 psf	235.9 psf	235.9 psf
Bottom of Wall Pressure	554.9 psf	554.9 psf	554.9 psf	554.9 psf
Maximum Applied Lateral Pressure on limits of the wall				
Maximum Applied Lateral Pressure	554.9 psf	554.9 psf	554.9 psf	554.9 psf
Total Applied Lateral Pressure on limits of the wall *(as an equivilant point load)*				
Total Lateral Load (Per foot)	2.81 klf	2.81 klf	2.81 klf	2.81 klf
Centroid of Total Lateral Load (Distance down from zero)	4.85 ft	4.85 ft	4.85 ft	4.85 ft
Total Applied Moment due to Surcharge *(assumes fixed at max depth)*	8.9 k-ft	8.9 k-ft	8.9 k-ft	8.9 k-ft
Uniformly Applied Lateral Pressure on limits of the wall (For Lateral Stability) *(Total Applied Lateral Pressure **Thrust Controls;** Total lateral moment is not correct)*				
Uniformly Applied Lateral Load	469.2 psf	469.2 psf	469.2 psf	469.2 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	8.4 k-ft	8.4 k-ft	8.4 k-ft	8.4 k-ft
Difference in moment from that of the Total Point Load	-5%	-5%	-5%	-5%
Uniformly Applied Lateral Pressure on limits of the wall (For Moments/Deflections) *(Total Applied Lateral Pressure **Moment Controls;** Total lateral thrust is not correct)*				
Uniformly Applied Lateral Load	493.1 psf	493.1 psf	493.1 psf	493.1 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	8.9 k-ft	8.9 k-ft	8.9 k-ft	8.9 k-ft
Difference in moment from that of the Total Point Load	0%	0%	0%	0%
Total of Uniformly Applied Lateral Load	2.96 klf	2.96 klf	2.96 klf	2.96 klf
Difference in Load from that of the Total Point Load	5%	5%	5%	5%
Equvilant Live Load Surcharge (Assumes 110 PCF, AREMA Type 2)	4.5 ft	4.5 ft	4.5 ft	4.5 ft

A minimum of 2.5' of surcharge will be applied to the wingwalls, regardless of the pressure curve. Abut5 just simply takes the surcharge load (does not apply it through boussinesq.


Pressure Curves (Centroid of load on wall area shown)
0 ft
-5 ft
-10 ft
-15 ft
-20 ft
-25 ft
-30 ft
-35 ft
-40 ft
-45 ft
-2.00 ft
-4.85 ft
-8.00 ft
CLT=15.0 ft
CLT=15.0 ft
CLT=15.0 ft
CLT=15.0 ft
0 psf
100 psf
200 psf
300 psf
400 psf
500 psf
600 psf

DESIGN CALCULATION COVER SHEET

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PROJECT: **ODOT/EMH&T: HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
SUBJECT: ***Analysis***
Wingwall
Abut5 Program
FILE NAME(s): *AB5_0026_SE WW.dat &*
AB5_0026_SE WW.out

ODOT PID NO: *77889*
EMH&T JOB NO:
GF JOB NO: 54682
CALC NO.: **HAM562_0026_09**
REV NO.: **00**
SHEET: 1 OF 8

SUPERSEDES CALC NO: N/A

CALCULATION DESCRIPTION:

This will analyze the proposed wingwall utilizing previously calculated load, geometric, and soil input within the Abut5 program. The southeast WW will be analyzed (worst case), and the design will be applied to all wingwalls.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
Calculation: HAM562_0026_08 (Wingwall Loads)
Calculation: HAM562_0026_01 (Elevation Data)
Abut5 Users Manual (PennDOT)

MISCELLANEOUS NOTES:

Abut5 calculates the wingwall self-weight and earth loads automatically.

Loads input into Abut5 are to be grouped according to AASHTO but are very similar to AREMA Load Cases.

No tension is allowed in piles while vertical surcharge load is applied.

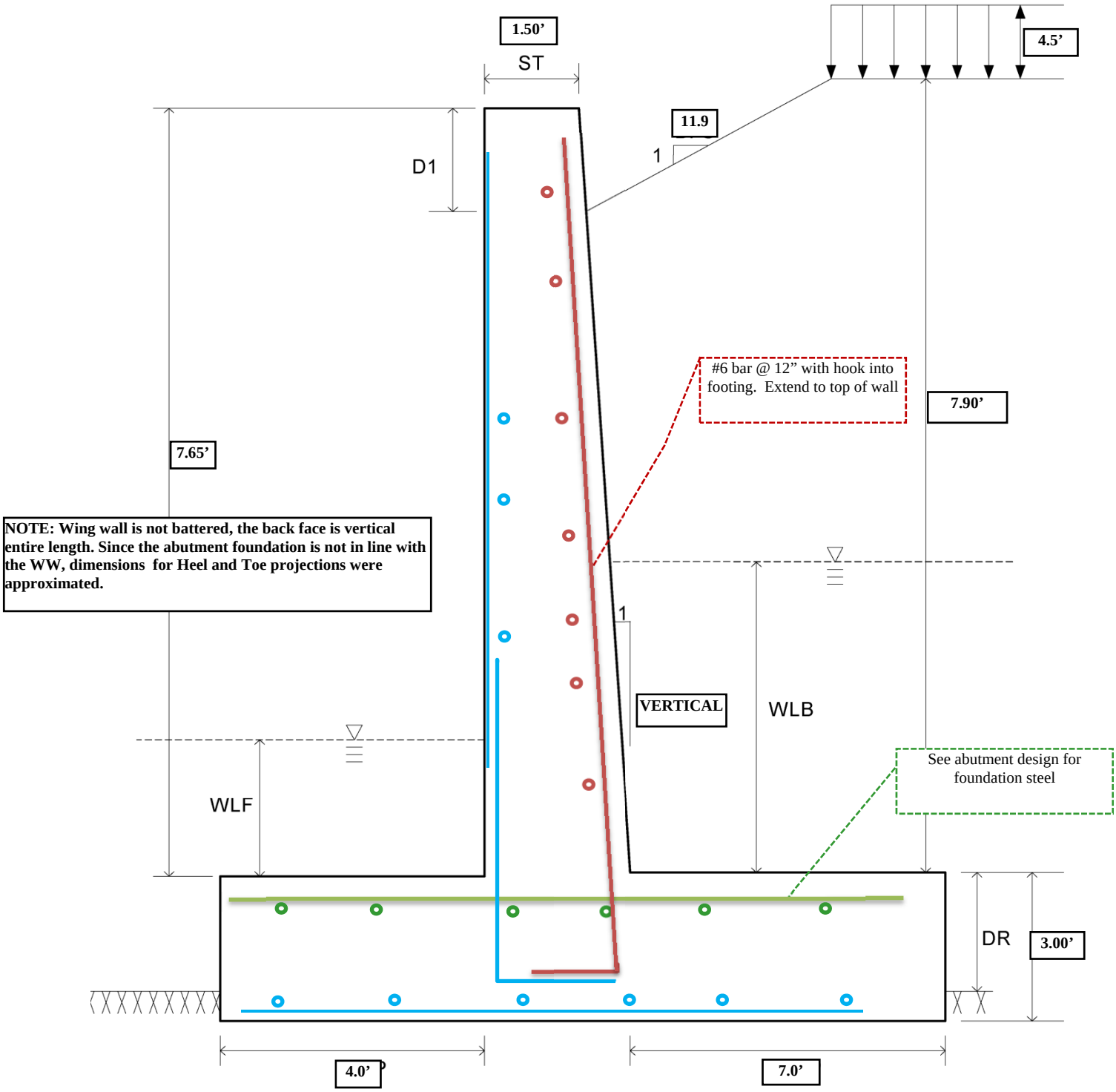
Minimum tension will be alowed in piles withour vertical surcharge load applied, since the lateral component is still applied. Minimum tension will be allowed for seismic.

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/18/14	EFD	07/30/14

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/18/14	VDK	07/18/14	VDT	07/28/14	EFD	07/30/14



Reinforcing Note: All other bars shall be #5's at 12". 3" Clear to bottom of footing. 2" clear to all other surfaces. Vertical stem rebar should be outside of horizontal rebar. Transverse footing rebars should be on the top/bottom of longitudinal rebar.

```
                    LFD Abutment and Retaining Wall                    333067

PROGRAM P4354040                                          07/18/2014 10:35
VERSION 5.4.0.0          LAST UPDATED 05/05/2005        DOCUMENTATION 05/2005

INPUT: AB5_00~1.DAT

*NE WINGWALL FOR HAM-562-0026 (CONTROLLING WW, WILL GOVERN DESIGN FOR A

WINGWALL ANALYSIS

                              ANALYSIS OF
                            RETAINING WALL

                      TYPE OF FOOTING : ON PILES

                                                                  EQUIV FLUID
DESIGN                    FTG    PILE            PILE              PRESSURE
METHOD   A OR D   TYPE   TYPE     D   EMBEDDED  ROWS   R OR S     DRY   SAT
  SL       A       3      2     14.0     Y       2               38.6

                      ALLOW SOIL   WATER  TOP FTG   WATER    TOP WALL   LIVE
COEFF OF  BACKFILL  PRESS OR AXIAL LEVEL  TO TOP    LEVEL     TO TOP    LOAD
FRICTION    SLOPE     PILE CAPAC    BACK  EMBANK    FRONT    BACKFILL   SURCH
            11.9        207.00             7.00                         4.50

TOP FTG  F'C                                  LATERAL                     PILE
TO ROCK  BACK   F'C    F'C  REBAR   PILE  PILE  PILE      REBAR  OVR  80%   ROW
SURFACE  WALL   STEM   FTG  GRADE  BATTER  OPT  CAPAC  Kv  DES   STR  RULE  OPT
               4000.  4000.   60.                0.0   3.2  Y     Y    N

  TOP OF
(BACK)WALL                                        MAX
TO TOP OF     TOP      PROJECTION          MAX    FTG
 FOOTING   THICKNESS   TOE   HEEL  T OR H  PROJ  WIDTH   H1     H2    H3    H4
   7.90      1.50      4.00  7.00

                           FRONT           HEIGHT
                           FACE   BRIDGE     OF
                           TO DL   SEAT   BACKWALL  BACK   FOOTING  PILE  FTG
 W1   W2   W3   BW1   BW2   REACT   WIDTH   BATTER  BATTER THICKNESS COST  COST
                                                          3.00

     TRIAL
 REBAR SPACING  BAR   BW    STEM    FTG    MIN
 1  2  3  4  5  LOC  EXPOS  EXPOS  EXPOS   As
 3  6  8  9 12   Y     S      S      S

     STEM REBAR COVER           FOOTING REBAR COVER
 VERT  HORIZ   VERT  HORIZ    LONG  TRANS   LONG  TRANS
 2.00   3.00   2.00   3.00    2.00   3.00   3.00   4.00

                                          LONG
                      WIND   WIND         FORCE
 DL     LL    WIND    ON     ON   UPWARD  FROM   CENTR  TEMP
REACT  REACT  ON LL  SUPER   SUB   WIND    LL    FORCE  FORCE


                              BACKWALL            ALLOW
    PARAPET OR EXTERNAL       LIVE LOAD  SEISMIC   PILE
 HORZ   DIST   VERT   DIST   VERT   HORZ   LOAD   UPLIFT
```

ROW NO	PILE BATTER	DISTANCE BETWEEN ROWS	PILE SPACING	PERCENT ROW BATTERED
1	3.0	3.00	3.50	50.0
2	3.0	4.50	3.50	50.0

14" DIA Piles, 7/16" thick with ODOT allowable 207 Kip per pile (after .05" thickness reduction due to corrosion)

REINFORCEMENT SUMMARY

REBAR SPACINGS (in):
3.
6.
8.
9.
12.

REBAR COVERS (in): (C.G. OF BAR TO OUTER FACE)

STEM BACK VERT	STEM BACK HORIZ	STEM FRONT VERT	STEM FRONT HORIZ	FOOTING TOP LONG	FOOTING TOP TRANS	FOOTING BOTTOM LONG	FOOTING BOTTOM TRANS
2.00	3.00	2.00	3.00	2.00	3.00	3.00	4.00

EXPOSURES:
BACK WALL -- SEVERE
STEM ------- SEVERE
FOOTING ---- SEVERE

MINIMUM AREA OF STEEL PER FOOT: 0.125 SQUARE INCHES

*** NOTE ***
- THE REBARS IN THE BOTTOM OF THE FOOTING ARE BELOW THE TOP OF THE PILES.

PILE FOOTING ANALYSIS

*** NOTE ***
- FOR THE TEMPORARY CONSTRUCTION LOADING CONDITION (GROUP T) - FILL HEIGHT TO ABUTMENT SEAT, LIVE LOAD SURCHARGE, BUOYANCY AND WIND ON SUBSTRUCTURE (IF APPLICABLE):
  > PILE CAPACITY HAS BEEN INCREASED BY A FACTOR OF 1.25.

- FOR PILE ROWS WITH BOTH VERTICAL AND BATTERED PILES, PILE LOADS ARE FOR THE MAXIMUM CONDITION (AXIAL LOAD IN BATTERED PILES).

STABILITY ANALYSIS (SERVICE LOADS) - WITH VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	SUM V	BAL. MOMENT	SUM H	O.T. MOMENT	FRONT ROW TO RESULT	PILE LOAD FRONT	PILE LOAD BACK	PILE LOAD ALLOW	LAT. RESIST	F.S. O.T.
1	18.23	87.18	3.67	15.12	3.95	7.98	57.77	207.00	14.34	5.77
2	14.45	64.50	1.93	6.43	4.02	5.56	46.55	258.75	17.93	10.03
3	18.23	87.18	3.67	15.12	3.95	7.98	57.77	258.75	17.93	5.77
4	18.23	87.18	3.67	15.12	3.95	7.98	57.77	258.75	17.93	5.77
5	14.45	64.50	1.93	6.43	4.02	5.56	46.55	289.80	20.08	10.03
6	18.23	87.18	3.67	15.12	3.95	7.98	57.77	289.80	20.08	5.77
T	17.98	85.41	3.67	15.12	3.91	8.51	56.35	258.75	17.93	5.65

STABILITY ANALYSIS (SERVICE LOADS) - WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	BAL. SUM V	BAL. MOMENT	O.T. SUM H	O.T. MOMENT	FRONT ROW TO RESULT	PILE LOAD FRONT	PILE LOAD BACK	PILE LOAD ALLOW	LAT. RESIST	F.S. O.T.
1	14.45	64.50	3.67	15.12	3.42	12.53	39.59	207.00	14.34	4.27
2	14.45	64.50	1.93	6.43	4.02	5.56	46.55	258.75	17.93	10.03
3	14.45	64.50	3.67	15.12	3.42	12.53	39.59	258.75	17.93	4.27
4	14.45	64.50	3.67	15.12	3.42	12.53	39.59	258.75	17.93	4.27
5	14.45	64.50	1.93	6.43	4.02	5.56	46.55	289.80	20.08	10.03
6	14.45	64.50	3.67	15.12	3.42	12.53	39.59	289.80	20.08	4.27
T	14.20	62.73	3.67	15.12	3.35	13.05	38.17	258.75	17.93	4.15

FOOTING ANALYSIS (SERVICE LOADS) - WITH VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	TOE MOMENT	TOE SHEAR @	HEEL MOMENT	HEEL SHEAR @
1	-1.39	0.41 F	12.81	-3.20 F
2	-2.06	-0.26 F	5.80	-3.87 F
3	-1.39	0.41 F	12.81	-3.20 F
4	-1.39	0.41 F	12.81	-3.20 F
5	-2.06	-0.26 F	5.80	-3.87 F
6	-1.39	0.41 F	12.81	-3.20 F
T	-1.24	0.56 F	13.60	-2.81 F

FOOTING ANALYSIS (SERVICE LOADS) - WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

AASHTO GROUP	TOE MOMENT	TOE SHEAR @	HEEL MOMENT	HEEL SHEAR @
1	-0.13	1.67 F	9.66	-1.94 F
2	-2.06	-0.26 F	5.80	-3.87 F
3	-0.13	1.67 F	9.66	-1.94 F
4	-0.13	1.67 F	9.66	-1.94 F
5	-2.06	-0.26 F	5.80	-3.87 F
6	-0.13	1.67 F	9.66	-1.94 F
T	0.02	-0.60 D	10.45	-1.55 F

FOOTING DESIGN - WITH AND WITHOUT VERTICAL COMPONENT OF LL SURCHARGE

FOOTING WIDTH	FOOTING THICKNESS	TOE PROJ	HEEL PROJ	EFFECTIVE DEPTH TOE	EFFECTIVE DEPTH HEEL
12.50	3.00	4.00	7.00	2.667	2.750

SHEAR STR TOE	ALLOWABLE SHEAR TOE	SHEAR STR HEEL	ALLOWABLE SHEAR HEEL	TRANS REINFORCEMENT TOE-BOT	TRANS REINFORCEMENT HEEL-TOP	LONGITUDINAL REINFORCEMENT
0.001	0.060	0.000	0.060	0.12	0.31	0.12

LONGITUDINAL MOMENT CALCULATIONS - WITH VERTICAL COMPONENT OF LL SURCHARGE
GROUP 1 GOVERNS

```
MAX UNIFORM LOAD (w)         =   1.458 K/FT
MAX UNIFORM SERVICE LOAD (w) =   1.458 K/FT
MAX PILE SPACING             =    3.50 FEET
MAX LONGITUDINAL MOMENT      =    0.89 K-FT
MAX LONG. MOMENT (SERVICE)   =    0.89 K-FT
```

PILE PATTERN

ROW	BATTER	DISTANCE	SPACING	% BATTERED
1	3.0 ON 12	3.00	3.50	50.0
2	3.0 ON 12	7.50	3.50	50.0

C.G. OF PILES 5.25 FT. FROM TOE I OF PILES PER FOOT 2.893
PILE DENSITY 0.5714 PILES PER FOOT

```
                    STEM ANALYSIS
                    -------------

DESIGN OF STEM SECTION AT  1.91 FT FROM TOP

AASHTO GROUP (SERVICE)    1      2      3      4      5      6      T
MOMENT                 0.39   0.05   0.39   0.39   0.05   0.39   0.87
AXIAL FORCE            0.44   0.44   0.44   0.44   0.44   0.44   0.44
SHEAR                  0.42   0.08   0.42   0.42   0.08   0.42   0.66

 SECTION    SHEAR    ALLOWABLE  BACK FACE
THICKNESS   STRESS     SHEAR      REINF
  1.500      0.003     0.060      0.125

DESIGN OF STEM SECTION AT  3.95 FT FROM TOP

AASHTO GROUP (SERVICE)    1      2      3      4      5      6      T
MOMENT                 1.75   0.40   1.75   1.75   0.40   1.75   2.78
AXIAL FORCE            0.89   0.89   0.89   0.89   0.89   0.89   0.89
SHEAR                  0.99   0.30   0.99   0.99   0.30   0.99   1.30

 SECTION    SHEAR    ALLOWABLE  BACK FACE
THICKNESS   STRESS     SHEAR      REINF
  1.500      0.007     0.060      0.125

DESIGN OF STEM SECTION AT  5.93 FT FROM TOP

AASHTO GROUP (SERVICE)    1      2      3      4      5      6      T
MOMENT                 4.39   1.34   4.39   4.39   1.34   4.39   6.09
AXIAL FORCE            1.33   1.33   1.33   1.33   1.33   1.33   1.33
SHEAR                  1.71   0.68   1.71   1.71   0.68   1.71   2.08

 SECTION    SHEAR    ALLOWABLE  BACK FACE
THICKNESS   STRESS     SHEAR      REINF
  1.500      0.011     0.060      0.179

DESIGN OF STEM SECTION AT  7.90 FT FROM TOP

AASHTO GROUP (SERVICE)    1      2      3      4      5      6      T
MOMENT                 8.59   3.17   8.59   8.59   3.17   8.59  11.11
AXIAL FORCE            1.78   1.78   1.78   1.78   1.78   1.78   1.78
SHEAR                  2.58   1.20   2.58   2.58   1.20   2.58   3.02

 SECTION    SHEAR    ALLOWABLE  BACK FACE
THICKNESS   STRESS     SHEAR      REINF
  1.500      0.016     0.060      0.347
```

SUMMARY OF STEEL DESIGN

FOOTING DESIGN

Top longitudinal reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

Bottom longitudinal reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

Top transverse reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

Bottom transverse reinforcement:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	5	0.310

STEM DESIGN

Vertical reinforcement on back face:

REBAR SPACING (in)	REBAR SIZE	ACTUAL As (sq in/ft)
At Section #3, 1.98 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #4, 3.95 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #5, 5.93 feet from the top:		
3	4	0.800
6	4	0.400
8	4	0.300
9	4	0.267
12	4	0.200
At Section #6, 7.90 feet from the top:		
3	5	1.240
6	5	0.620
8	5	0.465
9	5	0.413
12	6	0.440

```
          OPTIMUM REBAR DESIGN
          --------------------


FOOTING:


 Top longitudinal reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
Bottom longitudinal reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
  Top transverse reinforcement:
     Spacing       Rebar

       12.             6
        9.             5
        6.             5
        8.             5
        3.             5
 Bottom transverse reinforcement:
     Spacing       Rebar

       12.             5
        9.             5
        6.             5
        8.             5
        3.             5
```

Proposed Footing Reinforcing

Footing reinforcing for wingwall does not govern, see abutment design for controlling steel areas

```
STEM:


  Here is the design of the vertical
reinforcement
  in the back face of the stem.   For this
design,
  the  spacing and rebar size are the same for
the
  entire height of the wall.

  Vertical reinforcement on back of stem:
     Spacing       Rebar

       12.             6
        9.             5
        8.             5
        6.             5
        3.             5

STEEL DESIGNS LISTED FROM MOST DESIRABLE TO LEAST
OPTIMAL
```

Proposed Primary Stem Reinforcing

Rear Mat Vertical Bars:
#6's @ 12" hooked into foundation and extending to top of wall

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered **As Promised**

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Loads***	**GF JOB NO:**	**54682**
	Design for	CALC NO.:	**HAM562_0026_10**
	Expansion and Fixed bearings	REV NO.:	**02**
FILE NAME(s):	*HAM562_0026_10.xlsx*	**SHEET:**	**1 OF 13**

SUPERSEDES CALC NO: 01 (Stage 2)

CALCULATION DESCRIPTION:

This will calculate all loads applied to the bearings per girder for use in design of fixed and expanion bearings.

DESIGN BASIS OR REFERENCE

NS Underpass Design Criteria
AREMA (2013) Chapter 8, Section 5
AREMA (2014) Chapter 15, Section 5
Calculation: HAM562_0026_03 (Girder Loads and Reactions

MISCELLANEOUS NOTES:

Stage 3 Update: Change in internal elastomer thickness to accommodate increased loads on bearings.

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDK	04/11/14		
01	Stage 2 Update	CTM	07/28/14	VDT	08/01/14
02	Stage 3 Update	VDT	01/14/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
CTM	07/28/14	VDT	07/30/14	CTM	07/31/14	VDT	08/01/14

INPUT VALUES FOR BEARING DESIGN

NON-COMPOSITE DEAD LOAD REACTION: (FROM HAM562_0026_03)

Beam Weight (Steel) = **20.45 kips**

Concrete Weight (Composite Deck) = **17.83 kips**

BEAM WEIGHT AS %DL1 = 53.42%

TOTAL NON-COMPOSITE DEAD LOAD REACTION = 38.3 kips

COMPOSITE DEAD LOAD REACTION: (FROM HAM562_0026_03)

TOTAL COMPOSITE DEAD LOAD REACTION = 29.4 kips

FUTURE BALLAST AS % OF COMPOSITE DEAD LOAD = 25.73%

MAXIMUM AND MINIMUM LIVE LOAD REACTIONS (FROM HAM562_0026_03)

MAX LL REACTION (WITH IMPACT) = 185.2 kips

MIN LL REACTION = 0.0 kips

ROTATIONS

$$\theta = \frac{wL^3}{24EI}$$

L = 69.50 ft
E = 29000 ksi
I = 46001 in4

LONGITUDINAL

NON-COMPOSITE DEAD LOAD ROTATION =	0.001606	rad
COMPOSITE DEAD LOAD ROTATION =	0.0012321	rad
MAX LIVE LOAD ROTATION =	0.005056	rad
ROTATION UNCERTAINTIES =	0.005000	rad
TOTAL LONGITUDINAL ROTATION (a_L) =	0.012894	rad

TRANSVERSE

TOTAL TRANSVERSE ROTATION - UNCERTAINTIES (a_W) =	0.005000	rad

THERMAL MOVEMENTS

Total Bridge Length = **145.79 ft**

Span Length = **69.50 ft**
Span Width = **34.25 ft**

Expansion Length = **0.00 ft**
Expansion Width = **34.25 ft**

LONGITUDINAL LOAD (FROM HAM562_0026_03)

Total Bridge Load = **208.42 kips**
Total Girders = **9** (Phase B)

Load per Bearing = **23.16 kips**

LATERAL LOAD (FROM HAM562_0026_03)

Nosing Load = **25.00 kips**

Load per Bearing = **25.00 kips** (Worst Case)

STEEL BEAM DATA REQUIRED FOR LOAD PLATE THICKNESS (FROM HAM562_0026_03)

Bottom Flange Thickness = **3.000 in**

Are bearing stiffeners present? **YES**

Gannett Fleming Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

Calculation	**Elastomeric Bearing Design (Steel Beam Bridge)**
Description	*HAM-560-0026: Abutment (FIXED)*

GF Job No:	ODOT D8	Calculated	Checked	Backchecked	Updated	Verified
•054682	• SFN:	•CTM, 7/28/14	•VDT, 7/30/14	•CTM, 7/31/14	•CTM, 7/31/14 •VDT, 1/16/16	• VDT, 8/1/14

Bearing Type: **FIXED** (EXPANSION OR FIXED)

Bearing Plan Dimensions			Bearing Material Properties				Temperature Change						
Width (Normal to Beam)	Length (Parallel to Beam)	Area	Elastomer Durometer	G max (psi)	G min (psi)	Creep %	ΔT BDM 3.12.2	Beam Material	α (in / in / F)	Expansion Length	ΔL 0.000 in OR	Expansion Width	ΔW
20.00 in	14.00 in	280.00 si	50	110	80	25%	90.0 deg(f)	Steel	6.50E-06	0.00 ft	0.000 in	34.25 ft	0.240 in
				(AREMA Table 15-5-4)					(αTL or 1.25" per 100', AREMA 15-5.1.2.c)				

Bearing Laminations									Load Plate	Weld Properties		Anchor Bolt	
h-external	h-internal	No. shims	Shim Gauge (14 Ga. Standard)	t_s	Sh	T	Shape Factor (S_{ext})	Shape Factor (S_{int})	F_y	Size	Allowable Weld Stress	Diameter (1.25" min)	F_u
0.250 in	0.390 in	6	14 ga	0.0747 in	2.898 in	2.450 in	16.47	10.56	36 ksi	0.3125 in	12.60 ksi	1.2500 in	125 ksi
			(> 0.0598" AREMA 15-5.6.2.3)									(AREMA Table 15-5-3)	

Bearing Loads *(From previous sheet, "Bearing Load Inputs")*

DL1	DL2	+ LL	- LL	Max DL	Max (DL + LL)	Min DL (No Future Ballast)	Min (DL + LL)	Future Ballast (% of DL2)
38.3 k	29.4 k	185.2 k	0.0 k	67.7 k	252.9 k	60.1 k	60.1 k	25.73%

Summary of Design Checks

AASHTO 14.6.6.1 Thickness of Layers % of Allow. = 92% **OK**	AREMA 15-5.6.3.4 Compressive Stress % of Allow. = **97%** **OK**	AREMA 15-5.6.3.5 Compressive Deflection % of Allow. = **93%** **OK**	AREMA 15-6.3.7 Shear % of Allow. = 20% **OK**	AREMA 15-5.6.3.6 Rotation % of Allow. = 89% **OK**	AREMA 15-5.6.3.8 Stability % of Allow. = 62% **OK**	AREMA 15-5.6.3.9 Steel Reinforcement % of Allow. = 48% **OK**
AREMA 15-5.6.3.10 Expansion Bearing Anchorage % of Allow. = N/A **FIXED BRG**	AREMA 15-5.3.2.2 Anchor Bolt Shear % of Allow. = 56% **OK**	AASHTO 14.6.6.4 Uplift Check Min. Reaction = 60.10 k **OK**	Load Plate / Bottom Flange Weld Check % of Allow. = 51% **OK**	Load Plate Data Thickness 2.000 in +/- Bevel 0.501%		

AASHTO 14.6.6.1: Check Thickness of External, Internal Layers — **OK**

Is "h-external" / "h-internal" (0.250 / 0.390) Less than 70% ? **Calculated Ratio = 64.1%** % of Allow. = 92%

AREMA 15-5.6.3.4: Check Compressive Stress — **OK**

Max (DL + LL)	Area	f_a	1.10 ksi	GS/k (Ext)	GS/k (Int)		
252.88 k	280.00 si	0.903 ksi	1.100 ksi	1.035 ksi	0.929 ksi	fa / 1.1 ksi = 0.82	% of Allow. = 97%
						f_a / $(GS/k)_{min}$ = 0.97	

k =1.4 ext, 1.0 int

AREMA 15-5.6.3.5: Check Compressive Deflection — **OK**

% of Allow. = 93%

Layer	Quantity (#)	Total Thickness (in)	Dead Load e	Dead Load D (in)	Creep D (in)	Live Load e	Live Load D (in)	Total D (in)
External	2	0.500	0.0125	0.0063	0.0016	0.0309	0.0154	0.0233
Internal	5	1.950	0.0128	0.0249	0.0062	0.0318	0.0620	0.0932
Total		2.450		0.031	0.008		0.077	0.1164" ~ 2/16

ADJUST BEAM SEAT ELEVATION ? **NO!**

ODOT BDM 307.2.1

AREMA 15-6.3.7: Check Shear — **OK**

T	? ≥ ?	$2d_s$
2.450 in		0.481 in

% of Allow. = 20%

AREMA 15-5.6.3.6: Check Rotation — **OK**

$L * a_L + W * a_W$	? ≤ ?	$2d_c$
0.2064		0.2329

% of Allow. = 89%

AREMA 15-5.6.3.8: Check Stability — **OK**

Sh	? ≤ ?	W / 3	OR	L / 3	
2.898 in		6.667 in		4.667 in	*Width = 43.5%*
					Length = 62.1%

% of Allow. = 62%

AREMA 15-5.6.3.9: Check Steel Reinforcement — **OK**

t_s	? ≥ ?	$0.092 * t_i$
0.075 in		0.036 in

% of Allow. = 48%

AREMA 15-5.6.3.10: Expansion Bearing Anchorage — **FIXED BRG**

% of Allow. = N/A

1/5 of DL can be resisted before required anchorage

μ	MIN DL	μ * MIN DL	Brg Stiff	d_s	Fs MAX		μ * MIN DL
0.20	60.10 k	12.02 k	12.571 k/in	0.2404 in	3.02 k	? ≤ ?	12.02 k
(1/5)		*Max Resistance*	*Area * Gmax / T*	*Max Thermal*	*Max Applied*		*Max Resistance*

% of Allow. = 25%

DL Stress on Bearing must be > 200 psi to avoid anchorage

f_{DL}	? ≥ ?	200 psi
215 psi		

% of Allow. = 93%

Load per Anchor	Applied Shear Stress	Allowable Shear Stress
17.04 k	13.884 ksi	25.000 ksi
2 per bearing		*0.20 Fu*

AREMA 15-5.6.3.10: Anchor Bolt Shear — **OK**

% of Allow. = 56%

Min (DL + LL) = 60.10 k *<<< Ensure that there is no uplift*

AASHTO 14.6.6.4 : Check Uplift Using MIN (DL + LL) — **OK**

MINIMUM LOAD PLATE THICKNESS Using Equation From ODOT Elastomeric Bearing Design Data Sheet ($Ts = C * [(R*W)/(L+1)]^{1/2} - tf$):

Load Plate Fy	Bottom Flange Thickness (tf)	Bearing Stiffeners?	Max. Reaction R = DL + LL	W	L	C	Ts		Use Ts
50.0 ksi	3.000 in	YES	252.88 k	20.00 in	14.00 in	0.167	0.053 in	*1.5" Minimum is Typical*	2.000 in

Check Bottom Flange / Load Plate Weld — **OK**

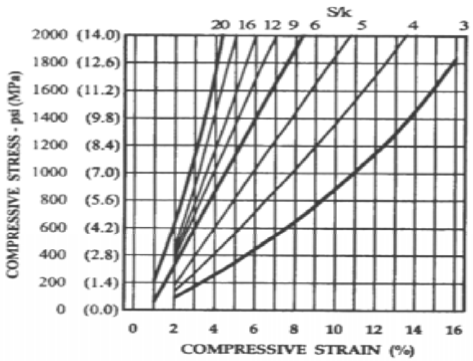
% of Allow. = 51%

Weld Capacity	Weld Length	Longitudinal Load	Weld Load
2.784 k/in	24.00 in	34.08 k	1.420 k/in

Load Plate Bevel

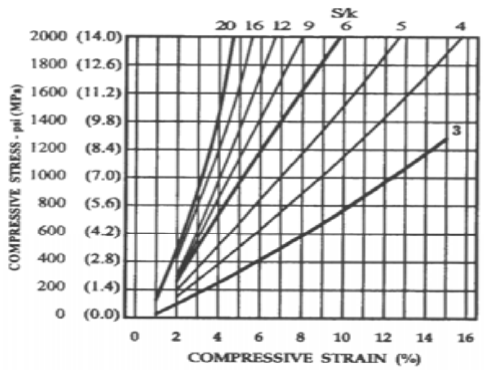
Girder Slope	Standard Beveled Load Plate Plate Thickness: Downstation	cL Brg	Upstation
0.501%	1.965 in	2.000 in	2.035 in

Appendix:



Compressive Stress/Strain of Steel Reinforced Neoprene Bearings (hardness of neoprene compound - 60 Durometer A)

Graph A



Compressive Stress/Strain of Steel Reinforced Neoprene Bearings (hardness of neoprene compound - 50 Durometer A)

Graph B

Compressive Strain Values (60 Durometer)

	S / k Factor						
Stress (psi)	**20**	**16**	**12**	**9**	**6**	**5**	
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
200	0.91%	0.95%	0.99%	1.03%	1.23%	1.60%	
400	1.50%	1.67%	1.84%	2.00%	2.32%	3.06%	
600	2.01%	2.32%	2.53%	2.71%	3.03%	4.02%	
800	2.36%	2.76%	3.09%	3.33%	3.76%	4.94%	
1000	2.73%	3.21%	3.56%	3.94%	4.52%	5.86%	
1200	3.16%	3.59%	4.12%	4.59%	5.29%	6.82%	
1400	3.49%	3.94%	4.60%	5.17%	6.03%	7.79%	
1600	3.82%	4.31%	5.08%	5.76%	6.77%	8.75%	
Exterior	1	1	1	0	0	0	2
Interior	1	1	1	0	0	0	2

Compressive Strain Values (50 Durometer)

	S / k Factor						
Stress (psi)	20	16	12	9	6	5	
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
200	0.96%	1.00%	1.04%	1.08%	1.19%	1.64%	
400	1.73%	1.88%	2.28%	2.42%	2.56%	3.24%	
600	2.27%	2.46%	2.91%	3.11%	3.41%	4.53%	
800	2.75%	3.00%	3.51%	3.80%	4.29%	5.74%	
1000	3.21%	3.52%	4.09%	4.52%	5.20%	6.95%	
1200	3.56%	3.99%	4.57%	5.22%	6.05%	8.16%	
1400	3.93%	4.46%	5.17%	5.93%	6.98%	9.37%	
1600	4.19%	4.88%	5.63%	6.60%	7.91%	10.52%	
Exterior	1	1	1	0	0	0	2
Interior	1	1	1	0	0	0	2

Exterior		1	Interior		1
S / k	11.765	2	S / k	10.558	2
Stress (psi)			Stress (psi)		
0	0.00%	0	0	0.00%	0
200	1.04%	1	200	1.06%	1
400	2.29%	2	400	2.35%	2
600	2.93%	3	600	3.01%	3
800	3.53%	4	800	3.65%	4
1000	4.12%	5	1000	4.30%	5
1200	4.62%	6	1200	4.88%	6
1400	5.23%	7	1400	5.54%	7
1600	5.71%	8	1600	6.10%	8
A * X^2 +	B * X +	C	A * X^2 +	B * X +	C
-0.0000013%	0.0054936%	0.0000000%	-0.0000011%	0.0055660%	0.0000000%
242 psi	1.25%	DL	242 psi	1.28%	DL
662 psi	3.09%	LL	662 psi	3.18%	LL

INPUT VALUES FOR BEARING DESIGN

NON-COMPOSITE DEAD LOAD REACTION: **(FROM HAM562_0026_03)**

Beam Weight (Steel) = **20.45 kips**

Concrete Weight (Composite Deck) = **17.83 kips**

BEAM WEIGHT AS %DL1 = 53.42%

TOTAL NON-COMPOSITE DEAD LOAD REACTION = 38.3 kips

COMPOSITE DEAD LOAD REACTION: **(FROM HAM562_0026_03)**

TOTAL COMPOSITE DEAD LOAD REACTION = 29.4 kips

FUTURE BALLAST AS % OF COMPOSITE DEAD LOAD = 25.73%

MAXIMUM AND MINIMUM LIVE LOAD REACTIONS **(FROM HAM562_0026_03)**

MAX LL REACTION (WITH IMPACT) = 185.2 kips

MIN LL REACTION = 0.0 kips

ROTATIONS

LONGITUDINAL

$$\theta = \frac{wL^3}{24EI}$$

L = 69.50 ft
E = 29000 ksi
I = 46001 in4

NON-COMPOSITE DEAD LOAD ROTATION = 0.001606 rad
COMPOSITE DEAD LOAD ROTATION = 0.0012321 rad
MAX LIVE LOAD ROTATION = 0.005056 rad
ROTATION UNCERTAINTIES = 0.005000 rad

TOTAL LONGITUDINAL ROTATION (a_L) = 0.012894 rad

TRANSVERSE

TOTAL TRANSVERSE ROTATION - UNCERTAINTIES (a_W) = 0.005000 rad

THERMAL MOVEMENTS

Total Bridge Length = **145.79 ft**

Span Length = **69.50 ft**
Span Width = **34.25 ft**

Expansion Length = **69.50 ft**
Expansion Width = **34.25 ft**

LONGITUDINAL LOAD **(FROM HAM562_0026_03)**

Total Bridge Load = **208.42 kips**
Total Girders = **9** (Phase B)

Load per Bearing = **23.16 kips**

LATERAL LOAD **(FROM HAM562_0026_03)**

Nosing Load = **25.00 kips**

Load per Bearing = **25.00 kips** (Worst Case)

STEEL BEAM DATA REQUIRED FOR LOAD PLATE THICKNESS **(FROM HAM562_0026_03)**

Bottom Flange Thickness = **3.000 in**

Are bearing stiffeners present? **YES**

Gannett Fleming Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

Calculation	**Elastomeric Bearing Design (Steel Beam Bridge)**
Description	*HAM-560-0026: Pier (EXPANSION)*

GF Job No:	ODOT D8	Calculated	Checked	Backchecked	Updated	Verified
•054682	• SFN:	•CTM, 7/28/14	•VDT, 7/30/14	•CTM, 7/31/14	•CTM, 7/31/14 •VDT, 1/16/16	• VDT, 8/1/14

Bearing Type: **EXPANSION** (EXPANSION OR FIXED)

Bearing Plan Dimensions			Bearing Material Properties				Temperature Change						
Width (Normal to Beam)	Length (Parallel to Beam)	Area	Elastomer Durometer	G max (psi)	G min (psi)	Creep %	ΔT BDM 3.12.2	Beam Material	α (in / in / F)	Expansion Length	ΔL 0.488 in OR	Expansion Width	ΔW
18.00 in	**16.00 in**	288.00 si	**50**	110	80	25%	90.0 deg(f)	**Steel**	6.50E-06	69.50 ft	0.869 in	34.25 ft	0.240 in
			(AREMA Table 15-5-4)						(αTL or 1.25" per 100', AREMA 15-5.1.2.c)				

Bearing Laminations									Load Plate	Weld Properties		Anchor Bolt	
h-external	h-internal	No. shims	Shim Gauge (14 Ga. Standard)	t_s	Sh	T	Shape Factor (S_{ext})	Shape Factor (S_{int})	F_y	Size	Allowable Weld Stress	Diameter (1.25" min)	F_u
0.150 in	**0.340 in**	**9**	**14 ga**	0.0747 in	3.692 in	3.020 in	28.24	12.46	**36 ksi**	**0.3125 in**	12.60 ksi	**1.2500 in**	**125 ksi**
			(> 0.0598" AREMA 15-5.6.2.3)									(AREMA Table 15-5-3)	

Bearing Loads *(From previous sheet, "Bearing Load Inputs")*

DL1	DL2	+ LL	- LL	Max DL	Max (DL + LL)	Min DL (No Future Ballast)	Min (DL + LL)	Future Ballast (% of DL2)
38.3 k	29.4 k	185.2 k	0.0 k	67.7 k	252.9 k	60.1 k	60.1 k	25.73%

Summary of Design Checks

AASHTO 14.6.6.1 Thickness of Layers	AREMA 15-5.6.3.4 Compressive Stress	AREMA 15-5.6.3.5 Compressive Deflection	AREMA 15-6.3.7 Shear	AREMA 15-5.6.3.6 Rotation	AREMA 15-5.6.3.8 Stability	AREMA 15-5.6.3.9 Steel Reinforcement
% of Allow. = 63%	% of Allow. = 88%	% of Allow. = **98%**	% of Allow. = 58%	% of Allow. = 92%	% of Allow. = 69%	% of Allow. = 42%
OK	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

AREMA 15-5.6.3.10 Expansion Bearing Anchorage	AREMA 15-5.3.2.2 Anchor Bolt Shear	AASHTO 14.6.6.4 Uplift Check	Load Plate / Bottom Flange Weld Check	Load Plate Data
% of Allow. = **96%**	% of Allow. = N/A	Min. Reaction = 60.10 k	% of Allow. = 44%	Thickness 2.000 in
NOT REQ'D	**N/A**	**OK**	**OK**	+/- Bevel 0.501%

AASHTO 14.6.6.1: Check Thickness of External, Internal Layers — **OK**

Is "h-external" / "h-internal" (0.150 / 0.340) Less than 70% ? **Calculated Ratio = 44.1%** % of Allow. = 63%

AREMA 15-5.6.3.4: Check Compressive Stress — **OK**

Max (DL + LL)	Area	f_a	1.00 ksi	GS/k (Ext)	GS/k (Int)		
252.88 k	288.00 si	0.878 ksi	1.000 ksi	1.613 ksi	0.997 ksi	fa / 1.0 ksi = 0.88	% of Allow. = 88%
						f_a / $(GS/k)_{min}$ = 0.88	

k =1.4 ext, 1.0 int

AREMA 15-5.6.3.5: Check Compressive Deflection — **OK**

% of Allow. = 98%

Layer	Quantity (#)	Total Thickness (in)	Dead Load e	Dead Load D (in)	Creep D (in)	Live Load e	Live Load D (in)	Total D (in)
External	2	0.300	0.0098	0.0029	0.0007	0.0237	0.0071	0.0108
Internal	8	2.720	0.0109	0.0296	0.0074	0.0273	0.0743	0.1113
Total		3.020		0.033	0.008		0.081	0.1220" ~ 2/16

ADJUST BEAM SEAT ELEVATION ? **NO!**

ODOT BDM 307.2.1

AREMA 15-6.3.7: Check Shear — **OK**

T	? ≥ ?	$2d_s$
3.020 in		1.738 in

% of Allow. = 58%

AREMA 15-5.6.3.6: Check Rotation — **OK**

$L * a_L + W * a_W$	? ≤ ?	$2d_c$
0.2251		0.2441

% of Allow. = 92%

AREMA 15-5.6.3.8: Check Stability — **OK**

Sh	? ≤ ?	W / 3	OR	L / 3	
3.692 in		6.000 in		5.333 in	*Width = 61.5%*
					Length = 69.2%

% of Allow. = 69%

AREMA 15-5.6.3.9: Check Steel Reinforcement — **OK**

t_s	? ≥ ?	$0.092 * t_i$
0.075 in		0.031 in

% of Allow. = 42%

AREMA 15-5.6.3.10: Expansion Bearing Anchorage — **NOT REQ'D**

% of Allow. = 96%

1/5 of DL can be resisted before required anchorage

μ	MIN DL	μ * MIN DL	Brg Stiff	d_s	Fs MAX		μ * MIN DL
0.20	60.10 k	12.02 k	10.490 k/in	0.9014 in	9.46 k	? ≤ ?	12.02 k
(1/5)		*Max Resistance*	*Area * Gmax / T*	*Max Thermal*	*Max Applied*		*Max Resistance*

% of Allow. = 79%

DL Stress on Bearing must be > 200 psi to avoid anchorage

f_{DL}	? ≥ ?	200 psi
209 psi		

% of Allow. = 96%

Load per Anchor	Applied Shear Stress	Allowable Shear Stress
17.04 k	13.884 ksi	25.000 ksi
2 per bearing		*0.20 Fu*

AREMA 15-5.6.3.10: Anchor Bolt Shear **N/A**

% of Allow. = 56%

Min (DL + LL) = 60.10 k *<<< Ensure that there is no uplift*

AASHTO 14.6.6.4 : Check Uplift Using MIN (DL + LL) **OK**

MINIMUM LOAD PLATE THICKNESS Using Equation From ODOT Elastomeric Bearing Design Data Sheet ($Ts = C * [(R*W)/(L+1)]^{1/2} - tf$):

Load Plate Fy	Bottom Flange Thickness (tf)	Bearing Stiffeners?	Max. Reaction R = DL + LL	W	L	C	Ts		Use Ts
50.0 ksi	3.000 in	YES	252.88 k	18.00 in	16.00 in	0.167	-0.214 in	*1.5" Minimum is Typical*	2.000 in

Check Bottom Flange / Load Plate Weld **OK**

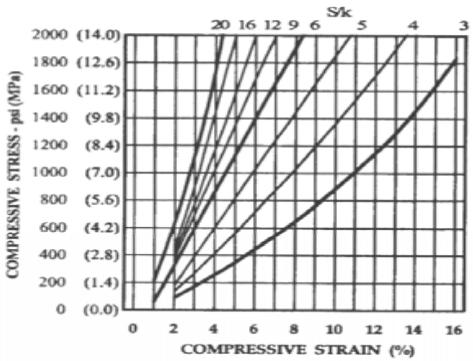
% of Allow. = 44%

Weld Capacity	Weld Length	Longitudinal Load	Weld Load
2.784 k/in	28.00 in	34.08 k	1.217 k/in

Load Plate Bevel

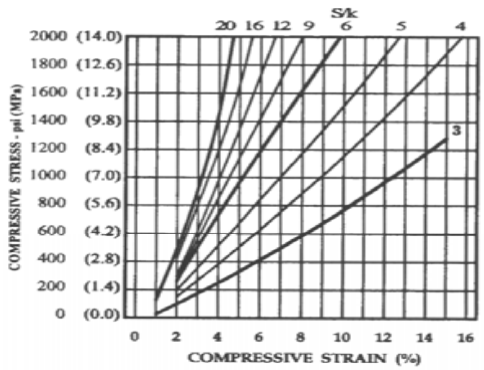
Girder Slope	Standard Beveled Load Plate Plate Thickness: Downstation	cL Brg	Upstation
0.501%	1.960 in	2.000 in	2.040 in

Appendix:



Compressive Stress/Strain of Steel Reinforced Neoprene Bearings (hardness of neoprene compound - 60 Durometer A)

Graph A



Compressive Stress/Strain of Steel Reinforced Neoprene Bearings (hardness of neoprene compound - 50 Durometer A)

Graph B

Compressive Strain Values (60 Durometer)

	S / k Factor						
Stress (psi)	20	16	12	9	6	5	
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
200	0.91%	0.95%	0.99%	1.03%	1.23%	1.60%	
400	1.50%	1.67%	1.84%	2.00%	2.32%	3.06%	
600	2.01%	2.32%	2.53%	2.71%	3.03%	4.02%	
800	2.36%	2.76%	3.09%	3.33%	3.76%	4.94%	
1000	2.73%	3.21%	3.56%	3.94%	4.52%	5.86%	
1200	3.16%	3.59%	4.12%	4.59%	5.29%	6.82%	
1400	3.49%	3.94%	4.60%	5.17%	6.03%	7.79%	
1600	3.82%	4.31%	5.08%	5.76%	6.77%	8.75%	
Exterior	0	0	0	0	0	0	0
Interior	1	1	0	0	0	0	0

Compressive Strain Values (50 Durometer)

	S / k Factor						
Stress (psi)	20	16	12	9	6	5	
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
200	0.96%	1.00%	1.04%	1.08%	1.19%	1.64%	
400	1.73%	1.88%	2.28%	2.42%	2.56%	3.24%	
600	2.27%	2.46%	2.91%	3.11%	3.41%	4.53%	
800	2.75%	3.00%	3.51%	3.80%	4.29%	5.74%	
1000	3.21%	3.52%	4.09%	4.52%	5.20%	6.95%	
1200	3.56%	3.99%	4.57%	5.22%	6.05%	8.16%	
1400	3.93%	4.46%	5.17%	5.93%	6.98%	9.37%	
1600	4.19%	4.88%	5.63%	6.60%	7.91%	10.52%	
Exterior	0	0	0	0	0	0	0
Interior	1	1	0	0	0	0	0

Exterior		1	Interior		1
S / k	20.168	0	S / k	12.457	0
Stress (psi)			Stress (psi)		
0	0.00%	0	0	0.00%	0
200	0.96%	1	200	1.04%	1
400	1.72%	2	400	2.01%	2
600	2.26%	3	600	2.63%	3
800	2.74%	4	800	3.22%	4
1000	3.20%	5	1000	3.79%	5
1200	3.54%	6	1200	4.37%	6
1400	3.91%	7	1400	4.93%	7
1600	4.16%	8	1600	5.49%	8
A * X^2 +	B * X +	C	A * X^2 +	B * X +	C
-0.0000012%	0.0044324%	0.0000000%	-0.0000009%	0.0048469%	0.0000000%
235 psi	0.98%	DL	235 psi	1.09%	DL
643 psi	2.37%	LL	643 psi	2.73%	LL

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Girder Connection Details	CALC NO.:	**HAM562_0026_11**
	MATHCAD	REV NO.:	**00**
FILE NAME(s):	*HAM562_0026_11 Connex.xmcd*	**SHEET:**	**1 OF 29**

SUPERSEDES CALC NO: N/A

CALCULATION DESCRIPTION:

This will analyze all of the steel connections to the girder, such as end and intermediate diaphragms and stiffners, both welded connections and bolted connections. The calculations will check every possible mode of failure.

DESIGN BASIS OR REFERENCES

NS Underpass Design Criteria
AREMA (2014) Chapter 15
HAM562_0026_03
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:

Stage 3: Updated Girder Sections

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/10/14		
01	Stage 3 Update	VDT	01/18/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	05/29/14	VDK	07/15/14	VDT	07/28/14		

LOAD AND GEOMETRIC DATA

Design notes

- Variables with a box around them require review/user input.
- Code references are made using the following abbreviations:
  - AREMA -AREMA Chapter 15 - Current Edition
  - NS - Norfolk Southern Public Policy Manual - Current Edition
  - BDM - ODOT LFD Bridge Design Manual (2004) - Current Edition
  - AA - AASHTO LFD
  - AISC - AISC Steel Construction Manual, Thirteenth Edition

1.0 GEOMETRIC AND LOAD DATA

1.1 GIRDER AND SPAN DATA

Girder Flange width: $B_f := 21in$

Girder Flange thickness: $T_f := 3in$

Depth of web: $D_w := 35in$

Girder Moment of Inertia: $I_{x_pg} := 46000.8in^4$ Girder section properties spreadsheet

Girder Web thickness: $T_w := .75in$

SpanLength of the girder: $span := 70ft$

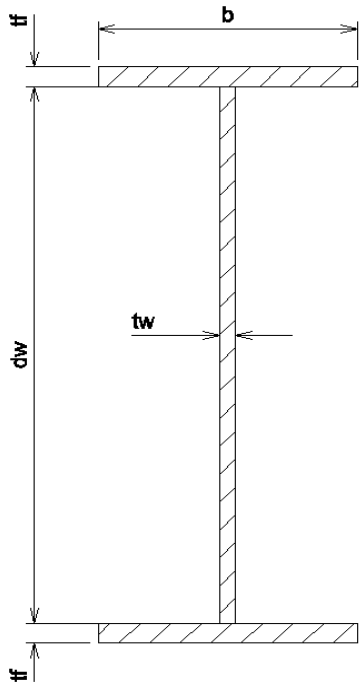
Skew angle of the bridge: $ang := 16.830deg$

Transverse Girder Spacing: $d_{girder} := 3.5ft$

Skewed girder spacing: $d_{skew} := d_{girder} \cdot \left(\frac{1}{\cos(ang)}\right) = 3.66\,ft$

1.2 END DIAPHRAGM AND JACKING STIFFENER DATA

1.2.1 SECTION 1: FULL SECTION



FULL SECTION

Flange width: $b_{f.ed} := 6 \cdot in$

Flange Thickness: $t_{f.ed} := 0.5 \cdot in$

Total depth of section: $d_{ed} := D_w - 3.5in = 31.5 \cdot in$

Height of web: $d_{w.ed} := d_{ed} - 2 \cdot t_{f.ed} = 30.5 \cdot in$

Thickness of Web: $t_{w.ed} := 0.5 \cdot in$

Area of the section: $A_{ed} := d_{w.ed} \cdot t_{w.ed} + b_{f.ed} \cdot \left(d_{ed} - d_{w.ed}\right) = 21.25 \cdot in^2$

Flange area: $A_{f.ed} := t_{f.ed} \cdot b_{f.ed} = 3 \cdot in^2$

Web area: $A_{w.ed} := d_{w.ed} \cdot t_{w.ed} = 15.25 \cdot in^2$

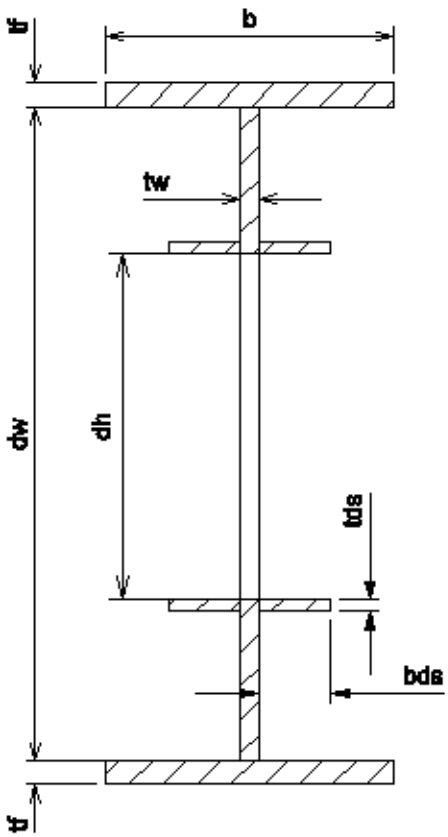
Mom. of Inertia: $I_{x.ed} := \frac{t_{w.ed} \cdot d_{w.ed}^3}{12} + \frac{b_{f.ed} \cdot \left(d_{ed}^3 - d_{w.ed}^3\right)}{12} = 2623.82 \cdot in^4$

Effective column height factor: $k := 0.75$ Table 15-1-11 Arema

Section Modulus: $S_{x.ed} := \frac{I_{x.ed}}{\left(\frac{d_{ed}}{2}\right)} = 166.59 \cdot in^3$

Radus of Gyration: $r_{x.ed} := \sqrt{\frac{I_{x.ed}}{A_{ed}}} = 11.11 \cdot in$

1.2.2 SECTION 2: SECTION AT ACCESS HOLE



SECTION AT ACCESS HOLE

Width of flange: $b_{f.ed} = 6 \cdot in$

Thickness of flange: $t_{f.ed} = 0.5 \cdot in$

Height of web: $d_{w.ed} = 30.5 \cdot in$

Total depth of section: $d_{ed} = 31.5 \cdot in$

Thickness of Web: $t_{w.ed} = 0.5 \cdot in$

Depth of hole: $d_{h.ed} := 24 \cdot in$

Half-Width of horizontal stiffener $b_{ds.ed} := 0 \cdot in$

Thickness of horizontal stiffener: $t_{ds.ed} := 0 \cdot in$

Minimum dia of access hole: $Dia_{access} := 15in$

Clearance to access hole from jacking points: $clear_{access} := 0.75in$

Minimum 15 in access hole to be provided as per NS Appendix H 2.5. 2.5 in spacing is provided on either sides to the jacking stiffener. It is assumed that a single jack will be used under each diaphragm, but to be conservative jacking stiffners will be analyzed to accept the full load

Area of section at hole:

$$A_{h.ed} := d_{w.ed} \cdot t_{w.ed} + b_{f.ed} \cdot \left(d_{ed} - d_{w.ed}\right) - d_{h.ed} \cdot t_{w.ed} + 4 \cdot b_{ds.ed} \cdot t_{ds.ed} \ldots = 9.25 \cdot in^2$$

Area of flange: $A_{f.ed} = 3 \cdot in^2$

Area of web with hole: $A_{w_h.ed} := d_{w.ed} \cdot t_{w.ed} - d_{h.ed} \cdot t_{w.ed} = 3.25 \cdot in^2$

Moment of Inertia of section at hole:

$$I_{x_h.ed} := \frac{t_{w.ed} \cdot d_{w.ed}^3}{12} - \frac{t_{w.ed} \cdot d_{h.ed}^3}{12} + \frac{b_{f.ed} \cdot \left(d_{ed}^3 - d_{w.ed}^3\right)}{12} + \frac{2 \cdot b_{ds.ed} \cdot \left[\left(d_{h.ed} + 2 \cdot t_{ds.ed}\right)^3 - d_{h.ed}^3\right]}{12} \ldots = 2047.82 \cdot in^4$$

Section modulus: $S_{_h.ed} := \dfrac{I_{x_h.ed}}{\left(\dfrac{d_{ed}}{2}\right)} = 130.02 \cdot in^3$

Radius of gyration: $r_{x_h.ed} := \sqrt{\dfrac{I_{x_h.ed}}{A_{h.ed}}} = 14.88 \cdot in$

1.2.3 JACKING STIFFENER DATA

Stiffener thickness: $t_{js} := 0.75 \cdot in$

Width of weld clip: $d_{weld} := 1.25 \cdot in$

Height of weld clip: $h_{weld} := 1.25 \cdot in$

1.3 END BEARING STIFFENER DATA

Stiffener plate thickness: $t_{end_stiff} := 1in$

Horizontal Leg of corner clip: $l_{cc.h.ebs} := 1in$

Stiffener width: $b_{end_stiff} := (B_f - T_w) \cdot 0.5 = 10.13 \cdot in$

Vertical Leg of corner clip: $l_{cc.v.ebs} := 1in$

Participating length of the web: $l_{web} := 25 \cdot t_{w.ed} = 12.5 \cdot in$ Arema 15-1.7.7. c

1.4 INTERMEDIATE STIFFENER AND INTERNAL DIAPHRAGM

1.4.1 STIFFENER SECTION PROPERTIES

Stiffener plate thickness: $t_{int_stiff} := 0.5in$

Horizontal Leg of corner clip: $l_{cc.h.ibs} := 1in$

Stiffener width: $b_{int_stiff} := 6in$

Vertical leg of corner clip: $l_{cc.v.ibs} := 2in$

Participating length of the web: $l_{int_web} := 25 \cdot T_w = 18.75 \cdot in$ Arema 15-1.7.7. c

Clear distance between stiffeners: $d_{int_stiff} := 144in$

Area of stiffener plate: $A_{int_stiff} := t_{int_stiff} \cdot b_{int_stiff} = 3 \cdot in^2$

Distance from centroid of plates to center of single plate: $d_{cent} := (T_w + b_{int_stiff}) \cdot 0.5 = 3.38 \cdot in$

Thickness of the stifffener connection plate: $t_{plate} := 0.5in$ NS Appendix H.2-4 B-3.b

1.4.2 DIAPHRAGM SECTION PROPERTIES

Width of flange: $b_{f_id} := 6 \cdot in$

Thickness of flange: $t_{f_id} := .5 \cdot in$

Height of web: $d_{w_id} := d_{w.ed} = 30.5 \cdot in$

Thickness of Web: $t_{w_id} := 0.5 \cdot in$

Total depth of section: $d_{id} := d_{w_id} + 2 \cdot t_{f_id} = 31.5 \cdot in$

Flange area: $A_{f_id} := t_{f_id} \cdot b_{f_id} = 3 \cdot in^2$

Web area: $A_{w_id} := d_{w_id} \cdot t_{w_id} = 15.25 \cdot in^2$

Area of the section: $A_{id} := d_{w_id} \cdot t_{w_id} + b_{f_id} \cdot (d_{id} - d_{w_id}) = 21.25 \cdot in^2$

Moment of Inertia of the section:

$$I_{x_id} := \frac{t_{w_id} \cdot d_{w_id}^3}{12} + \frac{b_{f_id} \cdot \left(d_{id}^3 - d_{w_id}^3\right)}{12} = 2623.82 \cdot in^4$$

Section Modulus: $S_{id} := \frac{I_{x_id}}{\left(\frac{d_{id}}{2}\right)} = 166.59 \cdot in^3$

Radus of Gyration: $r_{x_id} := \sqrt{\frac{I_{x_id}}{A_{id}}} = 11.11 \cdot in$

1.5 LATERAL BRACING

No Lateral Bracing needed on this project, ignore info below

Depth of lateral bracing: $D_{lat} := 4in$

Flange thickness: $T_{f.lat} := 0.5in$

Flange width: $B_{f.lat} := 4in$

Area of bracing: $A_{lat} := 3.8in^2$

Moment of inertia of the bracing: $I_{lat} := 5.56in^4$

Longitudinal spacing between bracing points: $Spa_{lat.l} := 4ft$

Dimensional parameters of the chosen angle are taken from AISC steel tables.

Lateral spacing between girders: $Spa_{lat.g} := d_{girder} = 3.5\,ft$

Length of the diagonal lateral brace: $Len_{lat} := \sqrt{Spa_{lat.l}^2 + Spa_{lat.g}^2} = 5.32\,ft$

Radius of gyration: $r_{lat} := \sqrt{\frac{I_{lat}}{A_{lat}}} = 1.21 \cdot in$

1.6 GIRDER LOADS

1.6.1 GIRDER REACTIONS

From girder design spreadsheet

Reaction due to dead load from span1: $R_{1T} := 65.50kip$

Reaction due to dead load from span2: $R_{2T} := 65.50kip$

Loads that act on the end bearing stiffener:

Maximum load on the stiffener from girder: $R_{max} := 250kip$ *Vertical forces due to DL+LL+I+CF+LF*

Fatigue load on the stiffener: $R_{sr} := 184.5kip$ *Vertical forces due to LL+I+CF+LF*

Loads that act on the Intermediate bearing stiffener:

Uniformly distributed load on the girder: $W_{load} := 6.387klf$ *Vertical forces due to DL+LL+I+CF+LF*

Concentrated derail load acting on the girder: $P_{derail} := 56.2kip$

Direct load acting on girder (vertical shear): $F_{v.pg} := 6.667klf$ *vertical load due to DL+LL+I+CF+LF+W*

Direct load is used in design of girder flange to web - full penetration groove weld.

Shear Stress in Girder: $R_{vg} := 8.5ksi$ *From girder design, Span 1 Tables tab*

Stress due to LL+I in Girder: $R_{LLI} := 14.39ksi$

1.6.2 LATERAL LOADS ON GIRDER

Used for Lateral Bracing, which is not needed on this project, therefore ignore the following info.

B1 Load combination with 125% overstress is considered for the lateral bracing design. Table 4.5 "Design of Modern Steel Railway Bridges" by John Unsworth.

There is no CWR force applicable for this particular bridge type and no lateral force due to LL+I+DL.

Lateral forces to be considered:

Lateral wind load on loaded bridge: $P_{lat.w} := 285plf + 300plf$ $P_{lat.w} = 0.59\,klf$ *wind on Superstructure+Live load*

Lateral force due to Nosing: $P_{lat.N} := 25kip$

Total lateral load acting on each diagonal brace: $P_{tot} := P_{lat.w} \cdot Spa_{lat.l} + P_{lat.N} = 27.34 \cdot kip$

2.0 MATERIAL DATA

2.1 PRIMARY GIRDER

STRUCTURAL STEEL: A709 GRADE 50S YIELD STRENGTH: $f_y := 50 \cdot ksi$ ULTIMATE STRENGTH: $f_u := 65 \cdot ksi$

Elastic modulus of steel: $E_s := 29000 \cdot ksi$ Unit weight of steel: $w_s := 490pcf$

$$ESFY := \sqrt{\frac{E_s}{f_y}} = 24.08 \qquad FYES := \frac{1}{ESFY} = 0.04$$

Number of Stress cycles is greater than 2,000,000 (for span lengths less than 100 ft) AREMA Table 15-1-7

Allowable Fatigue Stress: $F_f := 10ksi$ AREMA Table 15-1-10 Category C, Descr. 1.3

Allowable bearing stress: $F_{bear} := 0.83 \cdot f_y = 41.5\,ksi$ AREMA Table 15-1-11

2.2 BOLT AND WELD CONNECTIONS

2.2.1 BOLTS AND WELDS ALLOWABLE STRESSES

Allowable shear stress in A 325 bolts Table 15-1-11 Arema $S_{v.blt} := 17ksi$ *slip critical connection*

Allowable shear stress in fillet welds Table 15-1-13 Arema $S_{v.weld} := \min(19ksi, 0.35 \cdot f_y) = 17.5\,ksi$

Allowable shear stress in groove welds Table 15-1-13 Arema $S_{gr.weld} := 0.35 \cdot f_y = 17.5\,ksi$

Allowable Tension in A 325 bolts: Table 15-1-11 Arema $S_{p.blt.max} := 44000psi$

Acting on gross section as per AREMA Table 15-1-11 & Table 15-1-11a - Class A Standard Hole

2.2.2a BOLT CONNECTION PROPERTIES (7/8" Bolt):

STRUCTURAL BOLTS: 7/8" DIAMETER A325 SC (CLASS B, STANDARD HOLES)
Appendix H.4.1-2 -4.1 NS Steel grade

$d_{b78} := \frac{7}{8} \cdot in$ Appendix H.2-3 NS min. bolt diameter

These bolts will be used for the Lower Lateral Bracing

Allowable shear force in A 325 bolts: $R_{v78} := S_{v.blt} \cdot \pi \cdot d_{b78}^2 \cdot 0.25$

$R_{v78} = 10.22 \cdot kip$ (single shear)

Gross area of bolt: $A_{blt.g78} := \frac{\pi \cdot d_{b78}^2}{4}$ $A_{blt.g78} = 0.6 \cdot in^2$

Diameter of bolt hole: $Hole_{dg78} := d_{b78} + 0.125in$ AREMA 15-1.5.8(e) $Hole_{dg78} = 1.000 \cdot in$

Minimum bolt spacing: $spa_{min78} := 3.0 \cdot d_{b78} = 2.63 \cdot in$ AREMA 15-1.9.3 b

Minimum edge distance: $edge_{min78} := 1.75 \cdot d_{b78} = 1.53 \cdot in$ AREMA 15-1.9.4

2.2.2b BOLT CONNECTION PROPERTIES (1" Bolt):

STRUCTURAL BOLTS: 1" DIAMETER A325 SC (CLASS B, STANDARD HOLES)
Appendix H.4.1-2 -4.1 NS Steel grade

$d_{b1} := 1 \cdot in$ Appendix H.2-3 NS min. bolt diameter

These bolts will be used for all Girder to Diaphragm Connections

Allowable shear force in A 325 bolts: $R_{v1} := S_{v.blt} \cdot \pi \cdot d_{b1}^2 \cdot 0.25$

$R_{v1} = 13.35 \cdot kip$ (single shear)

Gross area of bolt: $A_{blt.g1} := \frac{\pi \cdot d_{b1}^2}{4}$ $A_{blt.g1} = 0.79 \cdot in^2$

Diameter of bolt hole: $Hole_{dg1} := d_{b1} + 0.125in$ AREMA 15-1.5.8(e) $Hole_{dg1} = 1.125 \cdot in$

Minimum bolt spacing: $spa_{min1} := 3.0 \cdot d_{b1} = 3 \cdot in$ AREMA 15-1.9.3 b

Minimum edge distance: $edge_{min1} := 1.75 \cdot d_{b1} = 1.75 \cdot in$ AREMA 15-1.9.4

2.2.3 END DIAPHRAGM TO BEARING STIFFENER CONNECTION

	Bolt Column 1 (Furthest from the Web):	Bolt Column 2
Total Number of Bolts in a Column:	$Bolts_{C1_ED} := 10$	$Bolts_{C2_ED} := 0$
Bolt Pitch:	$Pitch_{C1_ED} := 3 \cdot in$	$Pitch_{C2_ED} := Pitch_{C1_ED}$
Distance of First Bolt from Lowest Bolt (Stagger):	$BoltFirst_{C1_ED} := 0 \cdot in$	$BoltFirst_{C2_ED} := 0in$

Lateral Spacing of Bolt Column (C1 is the zero point... Set to ZERO if only one column) $Gage_{ED} := 0 \cdot in$

C/L of bolt to edge of diphragm web: $Db_{dwED} := 1.75in$

Edge distance of bolts (to top edge of web: $Edge_{dist.ED} := Round\left[\left[d_{w_id} - \left[\left(Bolts_{C1_ED} - 1\right) \cdot Pitch_{C1_ED}\right]\right] \cdot 0.50, 0.01in\right] = 1.75 \cdot in$

$CHK_{bED} := if\left(Db_{dwED} \geq edge_{min1} \wedge Edge_{dist.ED} \geq edge_{min1}, "OK", "NO\ GOOD"\right)$ $CHK_{bED} = "OK"$

2.2.4 GIRDER WEB TO INTERMEDIATE DIAPHRAGM WEB CONNECTION

	Bolt Column 1 (Furthest from the Web):	Bolt Column 2
Total Number of Bolts in a Column:	$Bolts_{C1_ID} := 10$	$Bolts_{C2_ID} := 0$
Bolt Pitch:	$Pitch_{C1_ID} := 3.0 \cdot in$	$Pitch_{C2_ID} := Pitch_{C1_ID}$
Distance of First Bolt from Lowest Bolt (Stagger):	$BoltFirst_{C1_ID} := 0 \cdot in$	$BoltFirst_{C2_ID} := 0in$

Lateral Spacing of Bolt Column (C1 is the zero point... Set to ZERO if only one column) $Gage_{ID} := 0 \cdot in$

C/L of bolt to edge of diaphragm web: $Db_{dwID} := 1.75 \cdot in$

Edge distance of bolts (to top edge of web):

$$Edge_{dist.ID} := Round\left[\left[d_{w_id} - \left[\left(Bolts_{C1_ID} - 1\right) \cdot Pitch_{C1_ID}\right]\right] \cdot 0.50, .01in\right] = 1.75 \cdot in$$

$$CHK_{bID} := if\left(Db_{dwID} \geq edge_{min1} \wedge Edge_{dist.ID} \geq edge_{min1}, \text{"OK"}, \text{"NO GOOD"}\right)$$

$$CHK_{bID} = \text{"OK"}$$

2.2.5 LATERAL BRACING TO STIFFENER CONNECTION PLATE

No Lateral Bracing needed on this project, ignore info below

	Bolt Column 1 (Furthest from the Web):	Bolt Column 2
Total Number of Bolts in a Column:	$Bolts_{C1_lt} := 4$	$Bolts_{C2_lt} := 0 \cdot Bolts_{C1_lt}$
Bolt Pitch:	$Pitch_{C1_lt} := 3.0 \cdot in$	$Pitch_{C2_lt} := Pitch_{C1_lt}$
Distance of First Bolt from Lowest Bolt (Stagger):	$BoltFirst_{C1_lt} := 0 \cdot in$	$BoltFirst_{C2_lt} := 0in$

Lateral Spacing of Bolt Column (C1 is the zero point... Set to ZERO if only one column) $Gage_{lt} := 0 \cdot in$

Horizontal distance between centroid of bolts and Point Load: $e_{lt} := 0 \cdot in$ *To Diaphragm Stiffening Girder*

Edge distance of bolts: $Edge_{dist.lt} := 1.75in$

2.2.6 WELD CONNECTION PROPERTIES

WELDING ELECTRODES: E70XX
Appendix H.4.1-2 -4.c NS

STIFFENER WELD: 5/16" $t_{weld} := \frac{5}{16} \cdot in$

AASHTO TABLE 6.13.3.4.1 - as nothing is given in AREMA

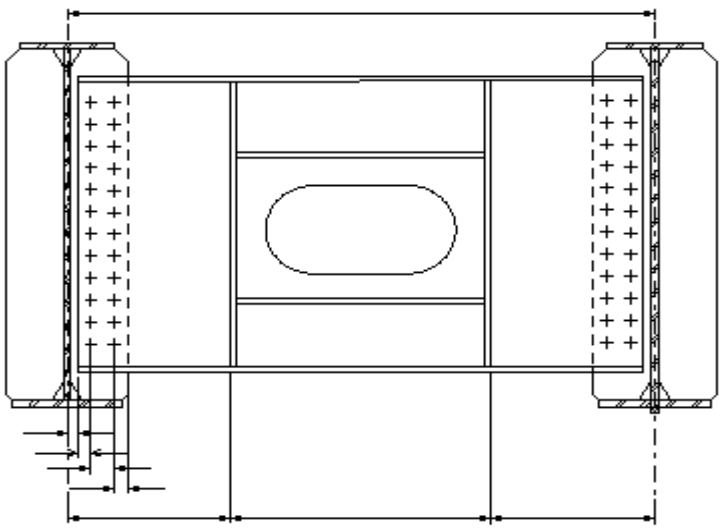
assume all fillet weld connections use same size.

Allowable shear force on weld: $R_{weld} := S_{v.weld} \cdot t_{weld} \cdot 0.707 = 3.87 \cdot \frac{kip}{in}$

END DIAPHRAGM (JACKING)

(AREMA/NSRR Design: Prosser Avenue Bridge)

DETERMINE THE ADEQUACY OF THE END DIAPHRAGM DURING JACKING. JACKING WILL BE REQUIRED TO REPLACE THE BEARINGS. THE JACKING OPERATION WILL BE CONDUCTED UNDER FULL DEAD LOAD ONLY (NO LIVE LOAD).

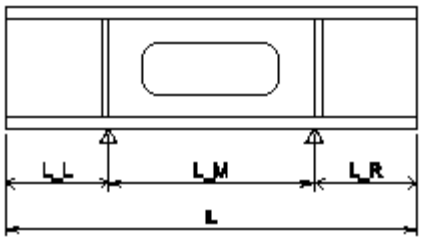


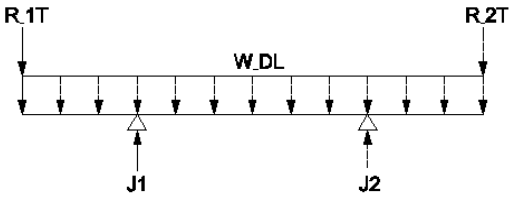
END DIAPHRAGM

3.0 DESIGN OF END DIAPHRAGM AND JACKING STIFFENER

3.1 LOAD CALCULATIONS FOR END DIAPHRAGM

assumed simply supported.





Distance between the jacking points: $L_M := Dia_{access} + 2clear_{access}$ $L_M = 16.5 \cdot in$

Distance from jacking stiffener to center of beam: $L_L := \left(d_{skew} - L_M\right) \cdot 0.5$ $L_L = 13.69 \cdot in$

Assuming the jacking points are symmetrical: $L_R := L_L$ $L_R = 13.69 \cdot in$

3.1.1. DEAD LOAD OF DIAPHRAGM:

Dead load of the diaphragm: $W_{DL} := A_{ed} \cdot w_s = 0.07\,klf$

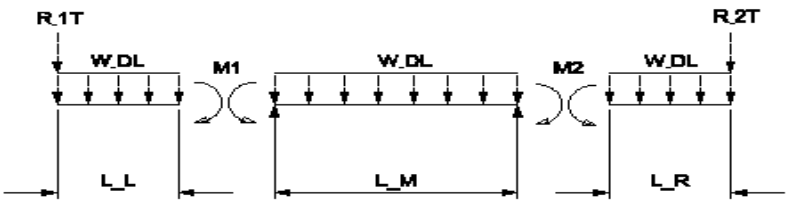
weight due to hole section is not reduced for conservative purpose

Additional dead load: $W_{ADDL} := 0 \cdot W_{DL} = 0$

Additional dead load due to the connections is incorporated in the girder reactions.

Total dead load: $W_{DL_T} := W_{DL} + W_{ADDL} = 0.07\,klf$

3.1.2 DETERMINE THE FORCES ON THE DIAPHRAGM:



Moment at left jacking stiffener: $M_1 := R_{1T} \cdot L_L + W_{DL_T} \cdot L_L \cdot \frac{L_L}{2} = 74.77 \cdot ft \cdot kip$

Moment at right jacking stiffener: $M_2 := R_{2T} \cdot L_R + W_{DL_T} \cdot L_R \cdot \frac{L_R}{2} = 74.77 \cdot ft \cdot kip$

Reactions at the location of left and right Jacking stiffener respectively:

$$V_1 := \left(W_{DL_T} \cdot L_L + R_{1T} + W_{DL_T} \cdot \frac{L_M}{2}\right) + \frac{(M_1 - M_2)}{L_M} = 65.63 \cdot kip \qquad J_1 := V_1 = 65.63 \cdot kip$$

$$V_2 := \left(W_{DL_T} \cdot L_R + R_{2T} + W_{DL_T} \cdot \frac{L_M}{2}\right) - \frac{(M_1 - M_2)}{L_M} = 65.63 \cdot kip \qquad J_2 := V_2 = 65.63 \cdot kip$$

3.2 CHECK FOR ADEQUACY OF END DIAPHRAGM:

3.2.1 CHECK BENDING STRESS IN THE MEMBER: AREMA 15-1.4.1

Allowable Diagonal tension in webs of girders: $F_{b_T} := 0.55 \cdot f_y = 27.5 \cdot ksi$ Table 15-1-11 AREMA

COMPRESSION LIMIT: CONSIDER ONLY SECTION ABOVE HOLE

Moment of Inertia of the section: $I_C := \frac{t_{f.ed} \cdot b_{f.ed}^3}{12} + \frac{\frac{(d_{w.ed} - d_{h.ed})}{2} \cdot t_{w.ed}^3}{12} = 9.03 \cdot in^4$

Area of the section: $A_C := t_{f.ed} \cdot b_{f.ed} + \frac{(d_{w.ed} - d_{h.ed})}{2} \cdot t_{w.ed} = 4.63 \cdot in^2$

Radius of gyration: $r_C := \sqrt{\frac{I_C}{A_C}} = 1.4 \cdot in$

Compression in extreme fibers of flexural members symmetrical about the principal axis

$$FC := \max\left[\frac{0.131 \cdot \pi \cdot E_s}{\frac{L_M \cdot d_{ed} \cdot \sqrt{1.3}}{A_{f.ed}}}, 0.55 \cdot f_y - \frac{0.55 \cdot f_y^2}{6.3 \cdot \pi^2 \cdot E_s} \cdot \left(\frac{L_M}{r_C}\right)^2\right] = 60.42 \cdot ksi$$

Table 15-1-11 AREMA

$$F_{b_C} := if\left(0.55 \cdot f_y < FC, 0.55 \cdot f_y, FC\right) = 27.5\,ksi$$

Bending Stress in Member: $f_b := \frac{\max(M_1, M_2)}{S_{_h.ed}} = 6.9 \cdot ksi$ $F_b := \min(F_{b_T}, F_{b_C}) = 27.5 \cdot ksi$

$CHK_b := if(f_b < F_b, "OK", "NO\ GOOD")$ $CHK_b = "OK"$

3.2.2 CHECK SHEAR STRESS IN THE MEMBER: AREMA 15-1.4.1

Allowable Shear in webs of rolled beams: $F_v := 0.35 \cdot f_y = 17.5 \cdot ksi$ Table 15-1-11 Arema

Shear Stress in the section: $f_v := \frac{\max(V_1, V_2)}{A_{h.ed}} = 7.1 \cdot ksi$

$CHK_v := if(f_v < F_v, "OK", "NO\ GOOD")$ $CHK_v = "OK"$

$DIAPHRAGM := if(CHK_b = "OK" \wedge CHK_v = "OK", "OK", "NO\ GOOD")$ $DIAPHRAGM = "OK"$

3.3 CHECK THE REQUIRED WELD SIZE FOR THE WEB-FLANGE CONNECTION:

Allowable shear force for Weld in consideration: $R_{weld} = 3.87 \cdot \frac{kip}{in}$

First moment of flange area: $Q_{ed} := A_{f.ed} \cdot \frac{(d_{w.ed} + t_{f.ed})}{2} = 46.5 \cdot in^3$

Horizontal shear force acting on the weld: $r_w := \frac{\max(V_1, V_2) \cdot Q_{ed}}{2 \cdot I_{x_h.ed}} = 0.75 \cdot \frac{kip}{in}$ *similar to shear between concrete slab and steel beam*

$CHK_W := \text{if}(r_w < R_{weld}, \text{"OK"}, \text{"NO GOOD"})$ $CHK_W = \text{"OK"}$

NO LIVE LOAD ON JACKING, THEREFORE NO FATIGUE CHECK IS REQUIERED

3.4 CHECK THE JACKING STIFFENERS

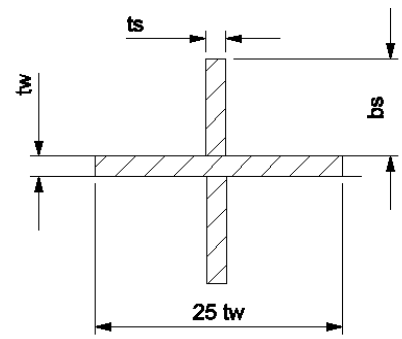
AREMA 15-1.7.7

Flange thickness of diaphragm: $t_{f.ed} = 0.5 \cdot in$

Flange width of diaphragm: $b_{f.ed} = 6 \cdot in$

Web depth of diaphragm: $d_{w.ed} = 30.5 \cdot in$

Stiffener thickness: $t_{js} = 0.75 \cdot in$



3.5 CHECK THE MINIMUM THICKNESS OF THE JACKING STIFFENER

Outstanding width: $l_s := 0.5(b_{f.ed} - t_{w.ed}) = 2.75 \cdot in$ *Equal to the outstanding width of the end diaphragm section*

Minimum thickness of stiffener: $t_{min} := \frac{l_s}{0.43ESFY} = 0.27 \cdot in$ AREMA 15.1.6.2 (a) (2)

$CHK_t := \text{if}(t_{js} > t_{min}, \text{"OK"}, \text{"NO GOOD"})$ $CHK_t = \text{"OK"}$

3.6 CHECK THE STRENGTH OF THE JACKING STIFFENER

Area of the column section: $A_c := 25 \cdot t_{w.ed} \cdot t_{w.ed} + 2 \cdot (l_s \cdot t_{js}) = 10.38 \cdot in^2$ AREMA 15.1.7.7 c

Moment of inertia of the section: $I_{y_s} := \frac{t_{js} \cdot (l_s + t_{w.ed} + l_s)^3}{12} = 13.5 \cdot in^4$

Radius of gyration: $r_{y_s} := \sqrt{\frac{I_{y_s}}{A_c}} = 1.14 \cdot in$

Stress in the member: $f_a := \frac{\max(J_1, J_2)}{A_c} = 6.33 \cdot ksi$

Slenderness of the member: $K_{js} := k \cdot \frac{d_{w.ed}}{r_{y_s}} = 20.05$

Lower limit of slenderness: $K_1 := \frac{0.629}{FYES} = 15.15$

Higher limit of slenderness: $K_2 := \frac{5.034}{FYES} = 121.23$

Allowable stress in the section:

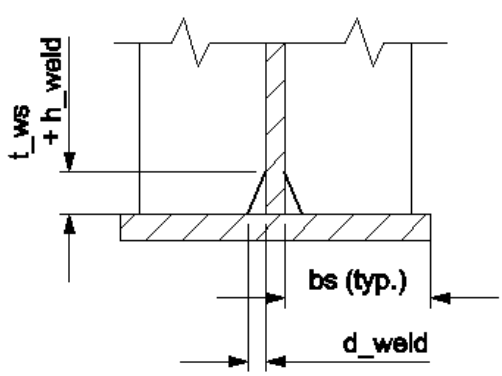
$$F_a := \text{if}\left[K_{js} < K_1, 0.55 \cdot f_y, \text{if}\left[K_{js} > K_1 \wedge K_{js} < K_2, 0.6 \cdot f_y - \left(17500 \cdot \frac{f_y}{E_s}\right)^{\frac{3}{2}} \cdot K_{js} \cdot psi, \frac{0.514 \cdot \pi^2 \cdot E_s}{K_{js}^2}\right]\right]$$

AREMA 15.1.4.1

$F_a = 26.68 \cdot ksi$

$CHK_a := \text{if}(f_a < F_a, \text{"OK"}, \text{"NO GOOD"})$ $CHK_a = \text{"OK"}$

3.7 CHECK THE BEARING STRESS ON THE BOTTOM FLANGE:



Stiffener weld thickness: $t_{weld} = 0.31 \cdot in$

Width of the stiffener: $l_s = 2.75 \cdot in$

Height of weld clip: $h_{weld} = 1.25 \cdot in$

Width of weld clip: $d_{weld} = 1.25 \cdot in$

Net width of stiffener: $b_{s_net} := l_s - d_{weld} = 1.5 \cdot in$

Area outside the corner clip of plate stiffener: $A_{b.js} := 2 \cdot b_{s_net} \cdot t_{js} = 2.25 \cdot in^2$

AREMA 15- 1.7.7 d

Bearing Stress in the member: $f_{b_f} := \frac{\max(J_1, J_2)}{A_{b.js}} = 29.17 \cdot ksi$

ALLOWABLE STRESS: $F_{bear} = 41.5\,ksi$ AREMA Table 15-1-11

$CHK_F := \text{if}(f_{b_f} < F_{bear}, \text{"OK"}, \text{"NO GOOD"})$ $CHK_F = \text{"OK"}$

3.8 CHECK THE WELD OF THE STIFFENER TO THE WEB:

Length of the weld: $L_{w.ed} := d_{w.ed} - 2\left(h_{weld} + t_{weld}\right) = 27.38 \cdot in$

Shear force in the weld: $r_{w_s.ed} := \dfrac{\max\left(J_1, J_2\right)}{4 \cdot L_{w.ed}} = 0.6 \cdot \dfrac{kip}{in}$ *Both side weld*

Allowable shear force in weld: $R_{weld} = 3.87 \cdot \dfrac{kip}{in}$

$CHK_{w_s} := if\left(r_{w_s.ed} < R_{weld}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{w_s} = \text{"OK"}$

$STIFFENER := if\left(CHK_t = \text{"OK"} \wedge CHK_a = \text{"OK"} \wedge CHK_F = \text{"OK"} \wedge CHK_{w_s} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"}\right)$

$STIFFENER = \text{"OK"}$

3.9 CONNECTION OF END DIAPHRAGM TO BEARING STIFFENER

3.9.1 BOLT CONNECTION DETAILS

Neutral Axis of Rows (Y-Bar) From Bottom Most Bolt

$$Ybar_{ED} := \frac{\sum_{\Delta = Bolts_{C1_ED}-1}^{0} \left(BoltFirst_{C1_ED} + \Delta \cdot Pitch_{C1_ED}\right) \ldots + \sum_{\sigma = Bolts_{C2_ED}-1}^{0} \left(BoltFirst_{C2_ED} + \sigma \cdot Pitch_{C2_ED}\right)}{Bolts_{C1_ED} + Bolts_{C2_ED}}$$

$Ybar_{ED} = 13.2 \cdot in$

Sum of Y Squared

$$SumY2_{ED} := \sum_{\Delta = Bolts_{C1_ED}-1}^{0} \left(BoltFirst_{C1_ED} + \Delta \cdot Pitch_{C1_ED} - Ybar_{ED}\right)^2 \ldots + \sum_{\sigma = Bolts_{C2_ED}-1}^{0} \left(BoltFirst_{C2_ED} + \sigma \cdot Pitch_{C2_ED} - Ybar_{ED}\right)^2$$

$SumY2_{ED} = 1180.08 \cdot in^2$

Neutral Axis of Columns (X-Bar) From Column 1 Bolts

$$Xbar_{ED} := \frac{Bolts_{C2_ED} \cdot Gage_{ED}}{Bolts_{C1_ED} + Bolts_{C2_ED}}$$

$Xbar_{ED} = 0 \cdot in$

Sum of X Squared $SumX2_{ED} := Bolts_{C1_ED} \cdot Xbar_{ED}^2 + Bolts_{C2_ED} \cdot \left(Gage_{ED} - Xbar_{ED}\right)^2$ $SumX2_{ED} = 0 \cdot in^2$

$$OffsetGage_{ED} := \sqrt{Gage_{ED}^2 + \min\left(Pitch_{C1_ED} - BoltFirst_{C1_ED}, Pitch_{C2_ED} - BoltFirst_{C2_ED}\right)^2} = 3 \cdot in$$

$$BoltSpacing := if\left(BoltFirst_{C1_ED} = 0 \wedge BoltFirst_{C2_ED} = 0 \wedge Gage_{ED} \neq 0, Gage_{ED}, OffsetGage_{ED}\right) = 3 \cdot in$$

Polar moment of Inertia of bolt configuration: $J_{ED} := SumX2_{ED} + SumY2_{ED}$ $J_{ED} = 1180.08 \cdot in^2$

Total Height of Bolt Array:

$$Bolt_{Ht} := \max\left[\left(Bolts_{C1_ED} - 1\right) \cdot Pitch_{C1_ED} + BoltFirst_{C1_ED}, \left(Bolts_{C2_ED} - 1\right) \cdot Pitch_{C2_ED} + BoltFirst_{C2_ED}\right] = 27 \cdot in$$

Number of bolts: $n_{ED} := Bolts_{C1_ED} + Bolts_{C2_ED} = 10$

Vertical location of centroid of bolt configuration: $y_{ED} := Ybar_{ED} = 13.2 \cdot in$

Horizontal location of centroid of bolt configuration: $x_{ED} := Xbar_{ED} = 0 \cdot in$

MinimumSpacing of bolts: $spa_{ED} := BoltSpacing = 3 \cdot in$

3.9.2 CHECK THE BOLT CONFIGURATION

$CHK_{Spa} := if\left(spa_{ED} \geq spa_{min1}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{Spa} = \text{"OK"}$

$CHK_{Edge} := if\left(Edge_{dist.ED} \geq edge_{min1}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{Edge} = \text{"OK"}$

3.9.3 CHECK THE SHEAR IN THE BOLTS:

Allowable Diaphragm Shear Stress: $\sigma_{a.v} := 0.35 \cdot f_y$ REF: AREMA Table 15-1-11 $\sigma_{a.v} = 17.5 \cdot ksi$

Required Shear Capacity of the connection: AREMA 15-1.11.4 (c) $P_{d.blt} := d_{w.ed} \cdot t_{w.ed} \cdot \sigma_{a.v} \cdot 0.5$ $P_{d.blt} = 133.44 \cdot kip$

Case 1 Vertical Shear/ Bolt: AREMA 15-11.4 (c) $F_{d.blt} := \frac{P_{d.blt}}{n_{ED}} \cdot 1.0$ $F_{d.blt} = 13.34 \cdot kip$

Bolt Eccentricity: $e_{ED} := \left(L_L + L_M + L_R\right) \cdot 0.5 - \left(Db_{dwED} + Xbar_{ED}\right) = 20.19 \cdot in$

Force acting on the bolt configuration: $V_{ED} := \max\left(R_{1T}, R_{2T}\right) \cdot \left(\frac{6}{5}\right) \cdot 0.5 = 39.3 \cdot kip$

Moment acting on the bolt configuration: $M_{ED} := V_{ED} \cdot e_{ED} = 66.12 \cdot kip \cdot ft$

Horizontal shear component due to reaction: $r_{vx} := 0$

Horizontal shear component due to moment: $r_{mx} := \frac{M_{ED} \cdot y_{ED}}{J_{ED}} = 8.88 \cdot kip$

Vertical shear component due to reaction: $r_{vy} := \frac{V_{ED}}{n_{ED}} = 3.93 \cdot kip$

Vertical shear component due to moment: $r_{my} := \frac{M_{ED} \cdot x_{ED}}{J_{ED}} = 0 \cdot kip$

Case 2 Shear force PER BOLT $r_v := \sqrt{\left(r_{vx} + r_{mx}\right)^2 + \left(r_{vy} + r_{my}\right)^2} = 9.71 \cdot kip$

$r_{vmax} := \max\left(r_v, F_{d.blt}\right) = 13.34 \cdot kip$

Allowable Shear force PER BOLT: $R_{v1} = 13.35 \cdot kip$

$CHK_{BOLT} := \text{if}\left(r_{vmax} < R_{v1}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{BOLT} = \text{"OK"}$

End Bearing Stiffener

DETERMINE THE REQUIRED WIDTH AND THICKNESS OF THE END BEARING STIFFENER

4.0 DESIGN END BEARING STIFFENER

4.1 CHECK THE ADEQUACY OF END BEARING STIFFENER

Loads computed in section 3.1 under end diaphragm are used for the design of end bearing stiffener.

4.1.1 CHECK STIFFENER DIMENSIONS

Max Stiffener Width, Lesser of the Following:

$$b_{s.max1} := \frac{(B_f - T_w)}{2} = 10.13 \cdot in \qquad b_{s.max2} := 0.43 \cdot t_{end_stiff} \cdot \sqrt{\frac{E_s}{f_y}} = 10.36 \cdot in$$

Arema 15-1.6.2 a (2)

Minimum thickness of Bearing stiffener:

$$t_{min.ebs} := \frac{b_{s.max1}}{0.43ESFY} = 0.98 \cdot in$$

AREMA 15-1.6.2 (a) (2)

$$CHK_{t.ebs} := if(t_{end_stiff} > t_{min.ebs}, "OK", "NO\ GOOD") \qquad CHK_{t.ebs} = "OK"$$

$$b_{s.max} := min(b_{s.max1}, b_{s.max2}) \qquad b_{s.max} = 10.13 \cdot in$$

$$CHK_w := if(b_{end_stiff} \le b_{s.max}, "OK", "NO\ GOOD") \qquad CHK_w = "OK"$$

4.1.2 STRENGTH OF THE BEARING STIFFENER

Designing the stiffener as a column, Contributing Area:

$$A_{ebs_col} := (l_{web} \cdot T_w) + 2 \cdot (b_{end_stiff} \cdot t_{end_stiff}) = 29.62 \cdot in^2$$

Moment of inertia of the section:

$$I_{yy} := \frac{1}{12} \cdot t_{end_stiff} \cdot (b_{end_stiff} + T_w + b_{end_stiff})^3 = 771.75 \cdot in^4$$

Radius of gyration:

$$r_{ebs} := \sqrt{\frac{I_{yy}}{A_{ebs_col}}} = 5.1 \cdot in$$

Slenderness ratio:

$$K_{ebs} := \frac{k \cdot D_w}{r_{ebs}} = 5.14$$

Depth of web is the length of the stiffener.

Allowable stress for high slender members:

$$F_{a1} := \frac{0.514 \cdot \pi^2 \cdot E_s}{(K_{ebs})^2} = 5561.87\ ksi$$

Table 15-1-11 Arema

Allowable stress for medium slender members: $F_{a2} := 0.60 \cdot f_y - \left(17500 \frac{f_y}{E_s}\right)^{\frac{3}{2}} \cdot K_{ebs} \cdot psi = 29.15\,ksi$

Allowable stress for thicker members: $F_{a3} := 0.55 \cdot f_y = 27.5\,ksi$

Allowable stress for the stiffener section: $F_{a_ebs} := if\left(K_{ebs} \ge \frac{5.034}{FYES}, F_{a1}, if\left(\frac{0.629}{FYES} < K_{ebs} < \frac{5.034}{FYES}, F_{a2}, if\left(K_{ebs} \le \frac{0.629}{FYES}, F_{a3}, \text{"Error"}\right)\right)\right)$

$F_{a_ebs} = 27.5 \cdot ksi$

Stress in the stiffener section: $f_{a_ebs} := \frac{R_{max}}{A_{ebs_col}} = 8.44 \cdot ksi$

$CHK_{sh.ebs} := if\left(f_{a_ebs} \le F_{a_ebs}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{sh.ebs} = \text{"OK"}$

4.1.3 BEARING STRESS ON THE BOTTOM FLANGE

Bearing stress caused by the stiffeners on the bottom flange is to be checked.

Allow 1" for corner clip for weld at the flange - web juncture.

Net width of the stiffener: $b_{ebs_net} := b_{end_stiff} - l_{cc.h.ebs} = 9.13 \cdot in$ *reducing width of clip*

Area in bearing due to 2 stiffeners: $A_{ebs} := 2 \cdot b_{ebs_net} \cdot t_{end_stiff} = 18.25 \cdot in^2$

Allowable bearing stress: $F_{bear} = 41.5\,ksi$ (AREMA 15-1-38)

Bearing stress in the stiffener: $f_{ebs} := \frac{R_{max}}{A_{ebs}} = 13.7 \cdot ksi$

$CHK_{bea.ebs} := if\left(f_{ebs} \le F_{bear}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{bea.ebs} = \text{"OK"}$

Check Plate Design

$PLATE := if\left(CHK_w = \text{"OK"} \wedge CHK_{t.ebs} = \text{"OK"} \wedge CHK_{sh.ebs} = \text{"OK"} \wedge CHK_{bea.ebs} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"}\right)$

$PLATE = \text{"OK"}$

4.1.4 WELD CONNECTION FOR END STIFFENERS

Allowable Shear force in weld: $R_{weld} = 3.87 \cdot \frac{kip}{in}$

Number of weld lines, $N_{ebs} := 2 \cdot 2 = 4$

Stress in weld: $f_{w_ebs} := \frac{R_{max}}{N_{ebs} \cdot \left(D_w - 2l_{cc.v.ebs}\right)} = 1.89 \cdot \frac{kip}{in}$

$WELD := if\left(f_{w_ebs} \le R_{weld}, \text{"OK"}, \text{"NO GOOD"}\right)$ $WELD = \text{"OK"}$

For a redundant load path structure, the allowable weld stress for transverse stiffeners corresponds to stress category C'. Arema Table 15-1-9, Description 4.1

Number of Stress cycles is greater than 2,000,000 (for span lengths less than 100 ft) Arema Table 15-1-7

Allowable Fatigue Stress: $F_{fw} := 12ksi$ Arema Table 15-1-10

Area of the weld: $A_{weld} := N_{ebs} \cdot \left(D_w - 2l_{cc.v.ebs}\right) \cdot 0.707 \cdot t_{weld} = 29.16 \cdot in^2$

Fatigue stress in weld: $f_f := \frac{R_{sr}}{A_{weld}} = 6.33 \cdot ksi$

$FATIGUE := if\left(f_f \le F_{fw}, "OK", "NO\ GOOD"\right)$

$FATIGUE = "OK"$

Min weld for 1.125" plate = 5/16" (AWS Table 2.1)

Appendix H.2-4 4b NS- Bearing stiffeners shall be milled to bear.

Check Design

$DESIGN := if(PLATE = "OK" \wedge WELD = "OK" \wedge FATIGUE = "OK", "OK", "NO\ GOOD")$

$DESIGN = "OK"$

Intermediate Stiffener and Diaphragm

DETERMINE THE REQUIRED WIDTH AND THICKNESS OF THE INTERNAL DIAPHRAGM AND INTERMEDIATE BEARING STIFFENER. DESIGN THE BOLTED CONNECTION BETWEEN THE STIFFENER AND THE DIAPHRAGM.

5.0 DESIGN INTERMEDIATE STIFFENER AND DIAPHRAGM

5.1 LOAD CALCULATIONS

5.1.1 Normal loading condition

Load under the normal conditions is due to the differential deflection of the adjacent girders caused because of the bridge skew.
Total Dead Load + Live Load + Impact Deflection (Equivalent Uniform Load) is used to ensure conservative design.

Deflection at mid span due to the UDL: $Delta_{mid} := \frac{5 \cdot W_{load} \cdot span^4}{384 \cdot E_s \cdot I_{x_pg}} = 2.59 \cdot in$

For any position of the rail load on the bridge, there will be a distance between the corresponding points over the adjacent girders due to the skew angle of the bridge. This difference causes a differential deflection that creates load onto the diaphragm. Calculations are done about mid point for simplicity.

Distance between corresponding points over the adjacent girder: $dist := d_{girder} \cdot tan(ang) = 12.7 \cdot in$

Point of interest from the support is at a distance: $a := span \cdot 0.5 - dist = 33.94\ ft$

Deflection at the point of interest: $Delta_a := \left(\frac{W_{load} \cdot a^4 + W_{load} \cdot span^3 \cdot a}{24 \cdot E_s \cdot I_{x_pg}} \right) - \left(\frac{W_{load} \cdot span \cdot a^3}{12 \cdot E_s \cdot I_{x_pg}} \right) = \blacksquare \cdot in$

Differential deflection: $Diff := Delta_{mid} - Delta_a = 0.0028 \cdot in$

Assuming the structural configuration of intermediate diaphragm connected to the girder as a cantilever, back calculating the concentrated load that can cause the above computed differential deflection to get the load.
Deflection at the cantilever due to concentrated load at tip of the beam is Pl^3/3EI , where P is the load and l is the span of the beam.

Equivalent load for the differential deflecion: $P := 3 \cdot \frac{E_s \cdot I_{x_id} \cdot Diff}{d_{girder}^3} = 8.75 \cdot kip$

End moments (assuming fixed-free cantilever condition): $M_{ser} := P \cdot d_{girder} = 30.62\ ft \cdot kip$

5.1.2 Derail Condition

"A single line of wheel loads (Q) equal to the design load per rail (Article 1.3.3) including full design impact is to be applied at an eccentricity of 5 feet from the centerline of track as shown in Figure 15-1-4, but no further than the edge of the deck or, for open decks, the bridge ties."

The entire load is assumed to act on a single girder for conservative purpose

NSRR standards allow 50% overstress in the derail load combination G

End moments (assuming fixed-free cantilever condition): $M_{derail} := P_{derail} \cdot d_{girder} = 196.7\ ft \cdot kip$

5.2 CHECK THE ADEQUACY OF INTERMEDIATE STIFFENER

5.2.1 CHECK INTERMEDIATE STIFFENER DIMENSIONS

Maximum depth of web without transverse stiffener: $D_{w_max} := 2.12 \cdot T_w \sqrt{\frac{E_s}{f_y}} = 38.29 \cdot in$ Arema 15-1.7.8 a

$CHK_{depth} := if(D_w > D_{w_max}, \text{"Stiffener req'd."}, \text{"Stiffener not req'd."})$ $CHK_{depth} = \text{"Stiffener not req'd."}$

Maximum clear spacing between the stiffeners: $d_{int_stiff_max} := \min\left(96in, D_w, 1.95 \cdot t_{int_stiff} \cdot \sqrt{\frac{E_s}{R_{vg}}}\right) = 35 \cdot in$
Arema 15-1.7.8 a

$CHK_{dist} := if(d_{int_stiff} < d_{int_stiff_max}, \text{"OK."}, \text{"NO GOOD"})$ $CHK_{dist} = \text{"NO GOOD"}$

Minimum moment of inertia of the section: $I_{min} := 2.5 \cdot t_{int_stiff}^3 \cdot d_{int_stiff} \cdot \left(\frac{D_w^2}{d_{int_stiff_max}^2} - 0.7\right) = 13.5 \cdot in^4$
Arema 15-1.7.8 a

Moment of inertia of stiffeners: $I_{int_stiff} := 2\left(A_{int_stiff} \cdot d_{cent}^2 + t_{int_stiff} \cdot \frac{b_{int_stiff}^3}{12}\right) = 86.34 \cdot in^4$

$CHK_{inertia} := if(I_{min} < I_{int_stiff}, \text{"OK."}, \text{"NO GOOD"})$ $CHK_{inertia} = \text{"OK."}$

Minimum width of the stiffener plate: $b_{int_stiff_min} := 2in + \frac{D_w + 2 \cdot T_f}{30} = 3.37 \cdot in$
Arema 15-1.7.8 b

Maximum width of the stiffener plate: $b_{int_stiff_max} := 16 \cdot t_{int_stiff} = 8 \cdot in$

$CHK_{width} := if(b_{int_stiff_min} < b_{int_stiff} < b_{int_stiff_max}, \text{"OK"}, \text{"NO GOOD"})$ $CHK_{width} = \text{"OK"}$

5.2.2 STRENGTH OF THE INTERMEDIATE BEARING STIFFENER

Designing the stiffener as a column, Contributing Area: $A_{ibs} := (l_{int_web} \cdot T_w) + 2 \cdot (b_{int_stiff} \cdot t_{int_stiff}) = 20.06 \cdot in^2$
Arema 15-1.7.7 c

Moment of inertia of the considered section: $I_{yy_int} := \frac{1}{12} \cdot t_{int_stiff} \cdot (b_{int_stiff} + T_w + b_{int_stiff})^3 = 86.36 \cdot in^4$

Radius of gyration: $r_{int} := \sqrt{\frac{I_{yy_int}}{A_{ibs}}} = 2.07 \cdot in$

Slenderness ratio: $K_{ibs} := \frac{k \cdot (D_w - t_{plate})}{r_{int}} = 12.47$

Allowable stress for high slender members: $F_{a1.ibs} := \frac{0.514 \cdot \pi^2 \cdot E_s}{(K_{ibs})^2} = 945.88\,ksi$ Table 15-1-11 Arema

Allowable stress for medium slender members: $F_{a2.ibs} := 0.60 \cdot f_y - \left(17500 \frac{f_y}{E_s}\right)^{\frac{3}{2}} \cdot K_{ibs} \cdot psi = 27.93\,ksi$

Allowable stress for thicker members: $F_{a3.ibs} := 0.55 \cdot f_y = 27.5\,ksi$

Allowable stress for the stiffener section:

$$F_{a_ibs} := if\left(K_{ibs} \ge \frac{5.034}{FYES}, F_{a1.ibs}, if\left(\frac{0.629}{FYES} < K_{ibs} < \frac{5.034}{FYES}, F_{a2.ibs}, if\left(K_{ibs} \le \frac{0.629}{FYES}, F_{a3.ibs}, "Error"\right)\right)\right)$$

$F_{a_ibs} = 27.5 \cdot ksi$

Stress in the stiffener section: $f_{a_ibs} := \frac{P}{A_{ibs}} = 0.44 \cdot ksi$

$CHK_1 := if\left(f_{a_ibs} \le F_{a_ibs}, "OK", "NO\ GOOD"\right)$ $CHK_1 = "OK"$

5.3 WELD CONNECTION FOR INTERMEDIATE STIFFENERS

Allowable Shear force in weld: $R_{weld} = 3.87 \cdot \frac{kip}{in}$

Number of weld lines, $N_{ibs} := 2 \cdot 2 = 4$

Stress in weld: $f_{w_ibs} := \frac{P}{N_{ibs} \cdot (D_w - 2l_{cc.v.ibs} - t_{plate})} = 0.07 \cdot \frac{kip}{in}$

$f_{w_ibs.derail} := \frac{P_{derail}}{N_{ibs} \cdot (D_w - 2l_{cc.v.ibs} - t_{plate})} = 0.46 \cdot \frac{kip}{in}$

$WELD_{ibs} := if\left(f_{w_ibs} < R_{weld} \wedge f_{w_ibs.derail} < 1.5 \cdot R_{weld}, "OK", "NO\ GOOD"\right)$ $WELD_{ibs} = "OK"$

5.4 CHECK THE ADEQUACY OF INTERNAL DIAPHRAGM

5.4.1 DIAPHRAGM MOMENT CAPACITY

Flexural stress in serviceable condition: $\sigma_{b.ser} := \frac{M_{ser}}{S_{id}} = 2.21 \cdot ksi$

Flexural stress in derail condition: $\sigma_{b.derail} := \frac{M_{derail}}{S_{id}} = 14.17 \cdot ksi$

Allowable flexural stress: $\sigma_b := 0.55 \cdot f_y = 27.5 \cdot ksi$ Arema Table 15-1-11

$CHK_2 := if\left(\sigma_{b.ser} < \sigma_b \wedge \sigma_{b.derail} < 1.5 \cdot \sigma_b, "OK", "NO\ GOOD"\right)$ $CHK_2 = "OK"$

5.4.2 DIAPHRAGM SHEAR CAPACITY

Shear stress in serviceable condition: $\sigma_{v.ser} := \frac{P}{A_{w_id}} = 0.57 \cdot ksi$

Shear stress in derail condition: $\sigma_{v.derail} := \frac{P_{derail}}{A_{w_id}} = 3.69 \cdot ksi$

Allowable shear stress: $\sigma_v := 0.35 \cdot f_y = 17.5 \cdot ksi$ Arema Table 15-1-11

$CHK_3 := if\left(\sigma_{v.ser} < \sigma_v \wedge \sigma_{v.derail} < 1.5 \cdot \sigma_v, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_3 = \text{"OK"}$

5.5 WEB BOLT SHEAR CAPACITY

(Shear Connection - Girder Web to Diaphragm Web Connection)

5.5.1 BOLT CONNECTION DETAILS

Neutral Axis of Rows (Y-Bar) From Bottom Most Bolt

$$Ybar_{ID} := \frac{\sum_{\Delta = Bolts_{C1_ID}-1}^{0} \left(BoltFirst_{C1_ID} + \Delta \cdot Pitch_{C1_ID}\right) \ldots + \sum_{\sigma = Bolts_{C2_ID}-1}^{0} \left(BoltFirst_{C2_ID} + \sigma \cdot Pitch_{C2_ID}\right)}{Bolts_{C1_ID} + Bolts_{C2_ID}}$$

$Ybar_{ID} = 13.2 \cdot in$

Sum of Y Squared

$$SumY2_{ID} := \sum_{\Delta = Bolts_{C1_ID}-1}^{0} \left(BoltFirst_{C1_ID} + \Delta \cdot Pitch_{C1_ID} - Ybar_{ID}\right)^2 \ldots + \sum_{\sigma = Bolts_{C2_ID}-1}^{0} \left(BoltFirst_{C2_ID} + \sigma \cdot Pitch_{C2_ID} - Ybar_{ID}\right)^2$$

$SumY2_{ID} = 1180.08 \cdot in$

Neutral Axis of Columns (X-Bar) From Column 1 Bolts

$$Xbar_{ID} := \frac{Bolts_{C2_ID} \cdot Gage_{ID}}{Bolts_{C1_ID} + Bolts_{C2_ID}}$$

$Xbar_{ID} = 0 \cdot in$

Sum of X Squared

$$SumX2_{ID} := Bolts_{C1_ID} \cdot Xbar_{ID}^2 + Bolts_{C2_ID} \cdot \left(Gage_{ID} - Xbar_{ID}\right)^2$$

$SumX2_{ID} = 0 \cdot in^2$

$$EccentricBolts := \sqrt{Gage_{ID}^2 + \min\left(Pitch_{C1_ID} - BoltFirst_{C1_ID}, Pitch_{C1_ID} - BoltFirst_{C2_ID}\right)^2} = 3 \cdot in$$

$$BoltSpacing_{ID} := if\left(BoltFirst_{C1_ID} = 0 \wedge BoltFirst_{C2_ID} = 0 \wedge Gage_{ID} \neq 0, Gage_{ID}, EccentricBolts\right) = 3 \cdot in$$

Polar moment of Inertia of bolt configuration: $J_{ID} := SumX2_{ID} + SumY2_{ID}$ $J_{ID} = 1180.08 \cdot in^2$

Total Height of Bolt Array:

$$Bolt_{Ht.Id} := \max\left[\left(Bolts_{C1_ID} - 1\right)\cdot Pitch_{C1_ID} + BoltFirst_{C1_ID}, \left(Bolts_{C2_ID} - 1\right)\cdot Pitch_{C2_ID} + BoltFirst_{C2_ID}\right] = 27\cdot in$$

Number of bolts: $n_{ID} := Bolts_{C1_ID} + Bolts_{C2_ID} = 10$

Vertical location of centroid of bolt configuration: $y_{ID} := Ybar_{ID} = 13.2\cdot in$

Horizontal location of centroid of bolt configuration: $x_{ID} := Xbar_{ID} = 0\cdot in$

MinimumSpacing of bolts: $spa_{ID} := BoltSpacing_{ID} = 3\cdot in$

$CHK_{Spa.ID} := if\left(spa_{ID} \ge spa_{min1}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{Spa.ID} = \text{"OK"}$

$CHK_{Edge.ID} := if\left(Edge_{dist.ID} \ge edge_{min1}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{Edge.ID} = \text{"OK"}$

5.5.2 DESIGN OF BOLT CONNECTION

Allowable Diaphragm Shear Stress: $\sigma_{a.v} := 0.35\cdot f_y$ *REF: AREMA Table 15-1-11* $\sigma_{a.v} = 17.5\cdot ksi$

Required Shear Capacity of the connection: AREMA 15-1.11.4 (c) $P_{d.bltVdg} := d_{w_id}\cdot t_{w_id}\cdot \sigma_{a.v}\cdot 0.5$ $P_{d.bltVdg} = 133.44\cdot kip$

Vertical Shear/ Bolt: AREMA 15-11.4 (c) $F_{d.bltVcf} := \frac{P_{d.bltVdg}}{n_{ID}}\cdot 1.0$ $F_{d.bltVcf} = 13.34\cdot kip$

Horizontal distance between centroid of bolts and centerline of girder web: $e_{ID} := 0.5B_f - Db_{dwID} - 0.5\cdot Gage_{ID} = 8.75\cdot in$ *0.5*thk of flange-edge distance-0.5*hor spacing of bolts*

Moment acting on the bolt configuration: $M_{blt.ser} := P\cdot e_{ID} = 6.38\,ft\cdot kip$ *Service condition*

Moment acting on the bolt configuration: $M_{blt.derail} := P_{derail}\cdot e_{ID} = 40.98\,ft\cdot kip$ *Derail condition*

Shear due to bending moment acting in the y direction on the bolt group

Force to bolt group at C/L of bolt pair-serviceable condition: $F_{blt.v.ser.y} := \frac{M_{blt.ser} \cdot x_{ID}}{J_{ID}}$ $F_{blt.v.ser.y} = 0 \cdot kip$

Force to bolt group at C/L of bolt pair- Derail condition: $F_{blt.v.derail.y} := \frac{M_{blt.derail} \cdot x_{ID}}{J_{ID}}$ $F_{blt.v.derail.y} = 0 \cdot kip$

Shear due to bending moment acting in the x direction on the bolt group

Force to bolt group at C/L of bolt pair-serviceable condition: $F_{blt.v.ser.x} := \frac{M_{blt.ser} \cdot y_{ID}}{J_{ID}}$ $F_{blt.v.ser.x} = 0.86 \cdot kip$

Force to bolt group at C/L of bolt pair- Derail condition: $F_{blt.v.derail.x} := \frac{M_{blt.derail} \cdot y_{ID}}{J_{ID}}$ $F_{blt.v.derail.x} = 5.5 \cdot kip$

Shear stress due to vertical shear acting in the y direction on the bolt group

Vertical design shear force per bolt-serviceable condition: $F_{d.bltV.ser} := \frac{P}{n_{ID}}$ $F_{d.bltV.ser} = 0.87 \cdot kip$

Vertical design shear force per bolt-Derail condition: $F_{d.bltV.derail} := \frac{P_{derail}}{n_{ID}}$ $F_{d.bltV.derail} = 5.62 \cdot kip$

Total Shear on a bolt: $F_{d.vT.ser} := \sqrt{F_{blt.v.ser.x}^2 + \left(F_{blt.v.ser.y} + F_{d.bltV.ser}\right)^2}$ $F_{d.vT.ser} = 1.22 \cdot kip$ *Service condition*

Total Shear on a bolt: $F_{d.vT.derail} := \sqrt{F_{blt.v.derail.x}^2 + \left(F_{blt.v.derail.y} + F_{d.bltV.derail}\right)^2}$

$F_{d.vT.derail} = 7.86 \cdot kip$ *Derail condition*

Shear Checks:

1/2 Diaphragm condition $CHK_4 := if\left(F_{d.bltVcf} \le R_{v1}, "OK", "NO\ GOOD"\right)$ $CHK_4 = "OK"$

Service condition $CHK_5 := if\left(F_{d.bltV.ser} \le R_{v1}, "OK", "NO\ GOOD"\right)$ $CHK_5 = "OK"$

Derail condition $CHK_6 := if\left(F_{d.bltV.derail} \le 1.5 \cdot R_{v1}, "OK", "NO\ GOOD"\right)$ $CHK_6 = "OK"$

5.6 - BLOCK SHEAR CAPACITY - STIFFENER WEB

This assumes a vertical force on stiffener equal to half the shear capacity of the diaphragm. Due to the bolts being in single shear, entire amount of that force will be carried to stiffener. It will be assumed that all bolts must shear through the entire web to fail; i.e. all bolt spacings + end space, each in single shear

C/L of bolt to edge of stiffener: $Db_s := Db_{dwID} + Gage_{ID}$ $\quad Db_s = 1.75 \cdot in$

Vertical force causing rupture: $F_{bs} := P_{d.bltVdg}$ $\quad F_{bs} = 133.44 \cdot kip$

Gross area subject to tension: $A_{gt} := Db_s \cdot t_{int_stiff}$ $\quad A_{gt} = 0.87 \cdot in^2$

$hc := if\left(Gage_{ID} = 0, 0.5, 1.5\right) = 0.5$

Net area subject to tension: $A_{Nt} := A_{gt} - hc \cdot \left(Hole_{dg1} \cdot t_{int_stiff}\right)$ $\quad A_{Nt} = 0.59 \cdot in^2$

Gross area subject to shear: $A_{gv} := \left[Bolt_{Ht.Id} + 0.5 \cdot \left(D_w - Bolt_{Ht.Id}\right)\right] \cdot t_{int_stiff}$ $\quad A_{gv} = 15.5 \cdot in^2$

Net area subject to shear: $A_{Nv} := A_{gv} - \left(\max\left(Bolts_{C1_ID}, Bolts_{C2_ID}\right) - 0.5\right) \cdot \left(Hole_{dg1} \cdot t_{int_stiff}\right)$ $\quad A_{Nv} = 10.16 \cdot in^2$

Maximum allowable force allowed for block shear

$P_1 := 0.30 \cdot f_u \cdot A_{Nv} + 0.50 \cdot f_u \cdot A_{Nt} = 217.34 \cdot kip$

$P_2 := 0.30 \cdot f_y \cdot A_{gv} + 0.50 \cdot f_u \cdot A_{Nt} = 251.8 \cdot kip$ $\quad$ AREMA 15-1.5.9 (e)

$P_{bs.a} := \min\left(P_1, P_2\right) = 217.34 \cdot kip$

Shear Stress Check: $CHK_7 := if\left(F_{bs} \le P_{bs.a}, \text{"OK"}, \text{"NO GOOD"}\right)$ $\quad CHK_7 = \text{"OK"}$

5.7 - BLOCK SHEAR CAPACITY- FAILURE OF DIAPHRAGM WEB AT CONNECTION

(Shear Connection - Girder Web to Diaphragm Web Connection)

This assumes a vertical force on the web equal to the shear capacity of the diaphragm. It will be assumed that all bolts must shear through the entire web and top flange to fail; i.e. all bolt spacings + spacing to the outside of the flange

Vertical force causing rupture: $F_{bs.dw} := P_{d.bltVdg}$ $\quad F_{bs.dw} = 133.44 \cdot kip$

Gross area subject to tension: $A_{gt.dw} := \left(Db_{dwID} + Gage_{ID}\right) \cdot t_{w_id}$ $\quad A_{gt.dw} = 0.87 \cdot in^2$

Net area subject to tension: $A_{Nt.dw} := A_{gt.dw} - hc \cdot \left(Hole_{dg1} \cdot t_{w_id}\right)$ $\quad A_{Nt.dw} = 0.59 \cdot in^2$

Gross area subject to shear: $A_{gv.dw} := \left[Bolt_{Ht.Id} + 0.5 \cdot \left(d_{w_id} - Bolt_{Ht.Id}\right)\right] \cdot t_{w_id}$

$A_{gv.dw} = 14.38 \cdot in^2$

Net area subject to shear: $A_{Nv.dw} := A_{gv.dw} - \left(\max\left(Bolts_{C1_ID}, Bolts_{C2_ID}\right) - 0.50\right) \cdot Hole_{dg1} \cdot t_{w_id} = 9.03 \cdot in^2$

Maximum allowable force allowed for block shear: Reference: AREMA 15-1.5.9 (e)

$P_{dw1} := 0.30 \cdot f_u \cdot A_{Nv.dw} + 0.50 \cdot f_u \cdot A_{Nt.dw} = 195.41 \cdot kip$

$P_{dw2} := 0.30 \cdot f_y \cdot A_{gv.dw} + 0.50 \cdot f_u \cdot A_{Nt.dw} = 234.92 \cdot kip$

$Max_{P.dw} := \min(P_{dw1}, P_{dw2}) = 195.41 \cdot kip$

Shear Stress Check: $CHK_8 := if(F_{bs.dw} \le Max_{P.dw}, "OK", "NO GOOD")$ $CHK_8 = "OK"$

5.8 - LOAD INDUCED FATIGUE ON GIRDER FLANGE

Max Allowable Stress in Flange: $\boxed{\sigma_{all.gf} := 16.0ksi}$ Reference: AREMA Table 15-1-9 Description 2.1

$CHK_9 := if(R_{LLI} \le \sigma_{all.gf}, "OK", "NO GOOD")$ $CHK_9 = "OK"$

Lateral Bracing and Connections

Not used on this project, ignore info below

DETERMINE THE REQUIRED SECTION OF THE LATERAL BRACING AND THE BOLT CONNECTION DETAILS OF LOWER LATERAL BRACING TO THE STIFFENER CONNECTION PLATE.

6.0 DESIGN LOWER LATERAL BRACING

(LLB may not be required for spans with concrete decks and girders less than 72". See AREMA 15-1.11.2)

6.1 CHECK FOR ADEQUACY OF BRACING AND CONNECTION

6.1.1 CHECK FOR COMPRESSION

Slenderness ratio: $K_{lat} := \frac{k \cdot Len_{lat}}{r_{lat}} = 39.55$

Allowable stress for high slender members: $\sigma_{a1} := \frac{0.514 \cdot \pi^2 \cdot E_s}{(K_{lat})^2} = 94.07\,ksi$ Table 15-1-13 Arema

Allowable stress for medium slender members: $\sigma_{a2} := 0.60 \cdot f_y - \left(17500 \cdot \frac{f_y}{E_s}\right)^{\frac{3}{2}} \cdot K_{lat}\,psi = 23.45\,ksi$

Allowable stress for thicker members: $\sigma_{a3} := 0.55 \cdot f_y = 27.5\,ksi$

Allowable stress for the stiffener section: $\sigma_{alo_lat} := \text{if}\left(K_{lat} \ge \frac{5.034}{FYES}, \sigma_{a1}, \text{if}\left(\frac{0.629}{FYES} < K_{lat} < \frac{5.034}{FYES}, \sigma_{a2}, \text{if}\left(K_{lat} \le \frac{0.629}{FYES}, \sigma_{a3}, \text{"Error"}\right)\right)\right)$

$\sigma_{alo_lat} = 23.45 \cdot ksi$

Stress in the lateral bracing member: $\sigma_{bra} := \frac{P_{tot}}{A_{lat}} = 7.19 \cdot ksi$

$CHK_{stress} := \text{if}\left(\sigma_{bra} \le 1.25 \cdot \sigma_{alo_lat}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{stress} = \text{"OK"}$

6.2 BOLTED CONNECTION OF LATERAL BRACING TO STIFFENER CONNECTION PLATE

Stiffener connection plate is the plate bolted to the tension flange of the primary girder for bearing of the intermediate stiffener. This would avoid the category C type fatigue failure specified in AREMA.

Number of bolts per connection: $n_{lt} := 4$

Shear stress per bolt: $\sigma_{v.lat} := \frac{P_{tot}}{A_{blt.g78} \cdot n_{lt}}$ $\sigma_{v.lat} = 11.37 \cdot ksi$

Spacing used in the connection: $Spa_{x.lat} := Pitch_{C1_lt}$

Moment of inertia of bolt group: $J_{lat.blts} := 2 \cdot \left[\left(0.5 \cdot Spa_{x.lat}\right)^2 + \left(1.5 \cdot Spa_{x.lat}\right)^2\right]$ $J_{lat.blts} = 45 \cdot in^2$

Moment due to lateral force on the bracing: $M_{lat} := 0$

Line of action of force passes through the connection.

Force in the bolt group at the C/L of configuration: $F_{b.lat} := \frac{M_{lat} \cdot \left(1.5 Spa_{x.lat}\right)}{2 \cdot \left[\left(0.5 \cdot Spa_{x.lat}\right)^2 + \left(1.5 \cdot Spa_{x.lat}\right)^2\right]}$ $F_{b.lat} = 0 \cdot kip$

Shear stress per bolt: $\sigma_{b.lat} := \frac{F_{b.lat}}{A_{blt.g78}}$ $\sigma_{b.lat} = 0 \cdot ksi$

Total shear force in the bolt: $\sigma_{tot} := \sqrt{\sigma_{b.lat}^2 + \sigma_{v.lat}^2}$ $\sigma_{tot} = 11.37 \cdot ksi$

$CHK_{blt.sh} := \text{if}\left(\sigma_{tot} \le S_{v.blt}, \text{"OK"}, \text{"NO GOOD"}\right)$ $CHK_{blt.sh} = \text{"OK"}$

Primary Girder Flange to Web Weld Connection
(AREMA/NSRR Design: Prosser Avenue Bridge)

DETERMINE THE REQUIRED WELD PROPERTIES FOR THE FLANGE TO WEB OF THE PRIMARY DECK GIRDER.

Flange-to-web full penetration groove welds are designed to transmit horizontal shear due to the variation of the bending moment over the girder and the direct pressure due to applied distributed load

11.0 DESIGN OF WELD CONNECTION

NS Appendix H.2-4 B2 Full penetration groove welds

11.1 SECTION PROPERTIES AND LOADING

Material properties and weld electrodes are as defined in the above sections.

Thickness of weld: $t_{w_pg} := \min(T_w, T_f) = 0.75 \cdot in$

Allowable shear force on weld: $R_{w_pg} := S_{gr.weld} \cdot t_{w_pg} = 13.12 \cdot \frac{kip}{in}$

Shear force at section under consideration: $F_{h.pg} := R_{max} = 250 \cdot kip$

11.2 CHECK THE ADEQUACY OF THE WELD CONNECTION

First moment of flange area: $Q_{pg} := B_f \cdot T_f \cdot \frac{(D_w + T_f)}{2} = 1197 \cdot in^3$

Horizontal shear force acting on the weld: $r_{wh_pg} := \frac{F_{h.pg} \cdot Q_{pg}}{I_{x_pg}} = 6.51 \cdot \frac{kip}{in}$

similar to shear between concrete slab and steel beam

Vertical shear force acting on the weld: $r_{wv_pg} := F_{v.pg} = 0.56 \cdot \frac{kip}{in}$

Total shear force acting on the weld: $r_{w_pg} := \sqrt{r_{wh_pg}^2 + r_{wv_pg}^2} = 6.53 \cdot \frac{kip}{in}$

$CHK_{sh.pg} := \text{if}(r_{w_pg} < R_{w_pg}, \text{"OK"}, \text{"NO GOOD"})$

$CHK_{sh.pg} = \text{"OK"}$

For a redundant load path structure, the allowable weld stress for complete joint penetration groove weld of web to flange corresponds to category C failure.

Arema Table 15-1-9 clause 5.3

Number of Stress cycles is greater than 2,000,000 (for span lengths less than 100 ft)

Arema Table 15-1-7

Horizontal shear force acting on the weld due to fatigue: $R_{wf_pg} := \frac{R_{sr} \cdot Q_{pg}}{I_{x_pg}} = 4.8 \cdot \frac{kip}{in}$

Stress due to fatigue: $f_{f.pg} := \frac{R_{wf_pg}}{t_{w_pg}} = 6.4\,ksi$

calculating the stress per unit inch of weld.

$FATIGUE_{pg} := \text{if}(f_{f.pg} \le F_f, \text{"OK"}, \text{"NO GOOD"})$

$FATIGUE_{pg} = \text{"OK"}$

DESIGN CALCULATION COVER SHEET

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PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Shear Stud design	CALC NO.:	**HAM562_0026_12**
	MATHCAD	REV NO.:	**01**
FILE NAME(s):	*HAM562_0026_12 Studs.xmcd*	**SHEET:**	**1 OF 8**

SUPERSEDES CALC NO: 00 (Stage 2)

CALCULATION DESCRIPTION:

This will analyze and design the shear stud connectors for composite action of the deck slab.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2014) Chapter 15
HAM562_0026_03
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:

Stage 3: Updated Girder Sections and Deck Thickness

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	VDT	07/15/14		
01	Stage 3 Update	VDT	01/18/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	07/15/14	VDK	07/15/14	VDT	11/06/14		

SHEAR STUD CONNECTORS

(AREMA/NSRR Design: HAM562-0026 Bridge)

Design notes

- Variables with a box around them require review/user input.
- Code references are made using the following abbreviations:
  - AREMA -AREMA Chapter 15 - Current Edition
  - NS - Norfolk Southern Public Policy Manual - Current Edition
  - BDM - ODOT LFD Bridge Design Manual (2004) - Current Edition
  - AA - AASHTO LFD
  - AISC - AISC Steel Construction Manual, Thirteenth Edition

Design the shear stud configuration for the girder. Check for the adequacy of the stud connectors.

1.0 INPUT DATA

1.1 GIRDER DATA

Girder Flange Width: $B_f := 21in$

Girder Web Thickness: $T_w := .75in$ HAM-562-0026_03

Girder Flange Thickness: $T_f := 3in$

Depth of web: $D_w := 35in$

Web area: $A_w := T_w \cdot D_w = 26.25 \cdot in^2$

Flange area: $A_f := B_f \cdot T_f = 63 \cdot in^2$

Total area of girder: $A_g := A_w + 2 \cdot A_f = 152.25 \cdot in^2$

Span length (C/C Bearings): $Len := 70ft$

Lateral Spacing of the beams (C/C): $Spa := 3.5ft$

Thickness of the concrete slab: $thk := 8in$ *effective slab thickness is taken as slab thickness minus one inch.*

1.2 SHEAR CONNECTOR DATA

studs transverse spacing: $spa_{trans} := 5in$

Height of stud: $H_{stud} := thk - 2in = 6 \cdot in$ AREMA 15-1.7.9.3.d

Diameter of stud: $Dia_{stud} := 0.875in$

Nominal cross section area of the stud: $XS_{stud} := \pi \cdot 0.25 \cdot Dia_{stud}^2 = 0.6 \cdot in^2$

Number of studs per row: $N_{stud} := 4$

Height to diameter ratio: $Ratio := \frac{H_{stud}}{Dia_{stud}} = 6.86$ AREMA 15-1.7.9.3.3.a

$CHK_{HeightRatio} := if(Ratio > 4, "OK", "NO GOOD")$ $CHK_{HeightRatio} = "OK"$

1.3 LOADING DATA

Shear stud designs are verified at every tenth point along the beam length (L).

Rows $i := 1 .. 11$ **Columns** $j := 1 .. 2$ $ORIGIN := 1$

$V_{LL_MAX} := 195.73$ $V_{DL_MAX} := 29.42$

$V_{LL_MIN} := 75$ $V_{DL_MIN} := 10$

Unfactored shears and moments

GIRDER DESIGN spreadsheet HAM562_0026_03

$$X := \begin{pmatrix} 0 \\ 0.1\cdot Len \\ 0.2\cdot Len \\ 0.3\cdot Len \\ 0.4\cdot Len \\ 0.5\cdot Len \\ 0.6\cdot Len \\ 0.7\cdot Len \\ 0.8\cdot Len \\ 0.9\cdot Len \\ Len \end{pmatrix}$$

$$V_{LL_I} := \begin{pmatrix} \max(1.0\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.8\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.6\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.4\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.2\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.00\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.2\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.4\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.6\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(0.8\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \\ \max(1.0\cdot V_{LL_MAX}, V_{LL_MIN}) & 0 \end{pmatrix} kip$$

$$V_{DL} := \begin{pmatrix} \max(1.0\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.8\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.6\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.4\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.2\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.0\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.2\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.4\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.6\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(0.8\cdot V_{DL_MAX}, V_{DL_MIN}) \\ \max(1.0\cdot V_{DL_MAX}, V_{DL_MIN}) \end{pmatrix} kip$$

$V_{LL_I} =$

195.73	0
156.58	0
117.44	0
78.29	0
75	0
75	0
75	0
78.29	0
117.44	0
156.58	0
195.73	0

$\cdot kip$

$V_{DL} =$

29.42
23.54
17.65
11.77
10
10
10
11.77
17.65
23.54
29.42

$\cdot kip$

TOTAL DL = 67.7 kips
V.DL = 67.7 - 20.45 (steel) - 17.83 (Non-composite) = 29.42 kips

TOTAL LL = 131.80 + 53.42 + 2.81 + 7.70 = 195.73 kips
Min. (maximum) LL = 1/2 axle load + 50% Impact = 75 kips
Minimum LL = unloaded = 0 kips (No negative moment - simple span)

DL_MIN is the local dead load due to all components steel, composite and non composite dead load over a tributary area of girder spacing rounded to 5 kip.

Intermediate supports are not provided during the casting and curing of the concrete. Therefore, self weight is not considered in maximum shear force as described in AREMA 15-1.7.9.2.h

1.4 MATERIAL PROPERTIES

Concrete Strength: $f'_c := 4000 \cdot psi$

Concrete Unit Weight: $\gamma_c := 150 \cdot pcf$

Steel Beam Yield Strength: $F_{y_girder} := 50ksi$

Deck Rebar Yield Strength: $F_{y_rebar} := 60ksi$

Top Concrete Clear Cover: $cc_{top} := 2.0in$

AREMA Table 8-2.7

Bott. Concrete Clear Cover: $cc_{bot} := 1.50in$

Modulus of Elasticity - Girder: $E_s := 29000ksi$

Modulus of Elasticity - Concrete: $E_c := 57000 \cdot \sqrt{f'_c \cdot psi} = 3605\,ksi$

Modulus ratio for n: $n := round\left(\frac{E_s}{E_c}\right) = 8$

2.0 SHEAR STUD DESIGN

2.1 TRANSFORMED COMPOSITE SECTION PROPERTIES

Effective width of flange on either side of beam: $b_{eff} := \min(Spa \cdot 0.5, 0.125 \cdot Len, 6 \cdot thk) = 1.75\,ft$ AREMA 15-1.7.9.2 c

Total effective flange width: $B_{f.eff} := 2 \cdot b_{eff} = 3.5\,ft$

Transformed compressive concrete area: $A_{c.tra} := \frac{B_{f.eff} \cdot thk}{n} = 42 \cdot in^2$

Neutral axis of the composite section from bottom of beam:

$$y_{NA} := \frac{B_f \cdot T_f \cdot T_f \cdot 0.5 + D_w \cdot T_w \cdot (0.5 \cdot D_w + T_f) + B_f \cdot T_f \cdot (D_w + T_f \cdot 1.5) + A_{c.tra} \cdot (D_w + 2 \cdot T_f + 0.5 \cdot thk)}{2B_f \cdot T_f + D_w \cdot T_w + A_{c.tra}} \qquad y_{NA} = 25.8 \cdot in$$

MOI of bottom flange: $I_{bf} := \frac{(B_f \cdot T_f^3)}{12} + (T_f \cdot B_f) \cdot (y_{NA} - 0.5 \cdot T_f)^2$ $\qquad I_{bf} = 37239.85 \cdot in^4$

MOI of web section: $I_w := \left(\frac{T_w \cdot D_w^3}{12}\right) + (D_w \cdot T_w) \cdot (T_f + 0.5 \cdot D_w - y_{NA})^2$ $\qquad I_w = 3416.3 \cdot in^4$

MOI of top flange: $I_{tf} := \frac{(B_f \cdot T_f^3)}{12} + (T_f \cdot B_f) \cdot (D_w + 1.5 \cdot T_f - y_{NA})^2$ $\qquad I_{tf} = 11876.39 \cdot in^4$

MOI of transformed concrete: $I_{tc} := \frac{\left(\frac{B_{f.eff}}{n} \cdot thk^3\right)}{12} + A_{c.tra} \cdot (D_w + 2 \cdot T_f + 0.5 \cdot thk - y_{NA})^2$ $\qquad I_{tc} = 15711.24 \cdot in^4$

Total moment of inertia of composite section: $I_{comp} := I_{bf} + I_{tf} + I_w + I_{tc}$ $\qquad I_{comp} = 68243.77 \cdot in^4$

Static moment of the transformed compressive concrete area about N.A. of composite section: $Q_{cc} := A_{c.tra} \cdot (D_w + 2 \cdot T_f + 0.5thk - y_{NA}) = 806.51 \cdot in^3$

2.2 SPACING OF SHEAR STUDS

2.2.1 Fatigue

Number of Stress Cycles > 2,000,000 AREMA Table 15-1.7.3.1.b

Allowable horizontal fatigue shear force range: $S_{r.des.stud} := 7000psi \cdot XS_{stud} = 4.21 \cdot kip$

Range of Vertical shear due to unfactored live load and impact (Difference in the max and min shear envelopes excluding dead loads): $V_{r_i} := V_{LL_I_{i,1}} - V_{LL_I_{i,2}}$

Range of horizontal shear: $S_{r_i} := V_{r_i} \cdot \frac{Q_{cc}}{I_{comp}}$

Spacing of Shear Studs (Fatigue): $spa_{fatigue_i} := \frac{N_{stud} \cdot S_{r.des.stud}}{S_{r_i}}$

2.2.2 Strength

Strength of Individual Shear Connector: $S_{m.des.stud} := 20000psi \cdot XS_{stud} = 12.03 \cdot kip$

Maximum vertical shear due to live load and impact load combined with any portion of dead load superimposed on composite span: $V_{m_i} := V_{LL_I_{i,1}} + V_{DL_i}$

Maximum horizontal shear: $S_{m_i} := V_{m_i} \cdot \frac{Q_{cc}}{I_{comp}}$

Spacing of Shear Studs (Strength): $spa_{strength_i} := \frac{N_{stud} \cdot S_{m.des.stud}}{S_{m_i}}$

2.2.3 Check Spacing

Clear distance between beam flange and edge of shear connector:

$$Distance_{clear} := \left[B_f - \left[spa_{trans} \cdot \left(N_{stud} - 1\right)\right]\right] \cdot 0.5 - Dia_{stud} \cdot 0.5 = 2.56 \cdot in$$

$$check_{trans} := if\left(Distance_{clear} > 1.5in \wedge spa_{trans} > 4 \cdot Dia_{stud}, "OK", "NO\ GOOD"\right)$$

AREMA 15-1.7.9.3.e and AA 6.10.10.1.3

$$check_{trans} = "OK"$$

Design Spacing of Shear Studs:

$$spa_{max_i} := 24 \cdot in$$

$$spa_{long_i} := if\left(spa_{strength_i} > spa_{fatigue_i}, spa_{fatigue_i}, spa_{strength_i}\right)$$

AREMA 15-1.7.9.3.b

$$spa_{final_i} := min\left(spa_{max_i}, spa_{strength_i}, spa_{fatigue_i}\right)$$

$$check_{long_i} := if\left(spa_{final_i} \le spa_{max_i} \wedge spa_{final_i} > 6 \cdot Dia_{stud}, "OK", "NO\ GOOD"\right)$$

$X_i =$		$spa_{fatigue_i} =$		$spa_{strength_i} =$		$spa_{long_i} =$		$spa_{final_i} =$		$check_{long_i} =$	
0	ft	7.28	·in	18.08	·in	7.28	·in	7.28	·in	"OK"	·in
7		9.1		22.6		9.1		9.1		"OK"	
14		12.13		30.13		12.13		12.13		"OK"	
21		18.2		45.2		18.2		18.2		"OK"	
28		19		47.89		19		19		"OK"	
35		19		47.89		19		19		"OK"	
42		19		47.89		19		19		"OK"	
49		18.2		45.2		18.2		18.2		"OK"	
56		12.13		30.13		12.13		12.13		"OK"	
63		9.1		22.6		9.1		9.1		"OK"	
70		7.28		18.08		7.28		7.28		"OK"	

DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT: **ODOT/EMH&T: HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
SUBJECT: ***Analysis***
Sheet Piling
Prosheet
FILE NAME(s): *PROS_PhaseA&B_Rear.bak*

ODOT PID NO: *77889*
EMH&T JOB NO:
GF JOB NO: 54682
CALC NO.: **HAM562_0026_13R**
REV NO.: **02**
SHEET: 1 OF 60

SUPERSEDES CALC NO: 01 (Stage 3)

CALCULATION DESCRIPTION:
This will analyze the shoring for Phase A&B Construction/Excavation at the rear abutment.

DESIGN BASIS OR REFERENCES:
NS Underpass Design Criteria
AREMA (2014) Chapter 15
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:
Section 2 is the Section of sheeting 10.1' away from RR CL, Section 4 is 16.75' from CL, and Section 5 is the sheeting 10.1' from RR CL, but the cantilever analysis before sheeting is braced to HP pile

Stage 3 Update: Thicker Sections to provide resistance during unbraced period when excavating down to waler elevation

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	SNH	08/20/14	CTM	09/12/14
01	Stage 3 Calculation	SNH	05/27/15	VDT	06/03/15
02	Stage 3 Update	VDT	01/18/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
SNH	05/27/15	VDT	06/01/15	SNH	06/02/15	VDT	06/03/15

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Calc:	SNH	Date:	8/20/2014
Check:		Date:	
Update:		Date:	
Verified:		Date:	

Lateral Pressure from Parallel Strip Loading

Lateral Pressure from Parallel Strip Loading

Calculations as per Norfolk Southern Design Standards

Min. Depth of Resulting Table (Hs_{min}):	1.00 ft	Centerline Track Distance 1, CLT_1:	16.75 ft
Max Depth of Resulting Table (Hs_{max}):	41.00 ft	Centerline Track Distance 2, CLT_2:	16.75 ft
Spacing of Max Axle Load:	5.0 ft	Centerline Track Distance 3, CLT_3:	16.75 ft
Max Axle Load:	80.0 kip	Centerline Track Distance 4, CLT_4:	16.75 ft
Width of Tie (TL):	8.5 ft	Applied Pressure (q):	1.88 ksf

Hs	**β** *(Radians)*				**α** *(Radians)*				*Active Pressure,* **Ps** *(psf)*			
	β_1	β_2	β_3	β_4	α_1	α_2	α_3	α_4	Ps_1	Ps_2	Ps_3	Ps_4
0.00 ft	0.0000	0.0000	0.0000	0.0000	1.5708	1.5708	1.5708	1.5708	0.00	0.00	0.00	0.00
1.00 ft	0.0322	0.0322	0.0322	0.0322	1.5071	1.5071	1.5071	1.5071	76.97	76.97	76.97	76.97
3.00 ft	0.0936	0.0936	0.0936	0.0936	1.3821	1.3821	1.3821	1.3821	216.39	216.39	216.39	216.39
5.00 ft	0.1468	0.1468	0.1468	0.1468	1.2637	1.2637	1.2637	1.2637	319.08	319.08	319.08	319.08
7.00 ft	0.1887	0.1887	0.1887	0.1887	1.1547	1.1547	1.1547	1.1547	377.53	377.53	377.53	377.53
9.00 ft	0.2191	0.2191	0.2191	0.2191	1.0563	1.0563	1.0563	1.0563	396.95	396.95	396.95	396.95
11.00 ft	0.2391	0.2391	0.2391	0.2391	0.9687	0.9687	0.9687	0.9687	388.33	388.33	388.33	388.33
13.00 ft	0.2507	0.2507	0.2507	0.2507	0.8911	0.8911	0.8911	0.8911	362.82	362.82	362.82	362.82
15.00 ft	0.2558	0.2558	0.2558	0.2558	0.8226	0.8226	0.8226	0.8226	329.11	329.11	329.11	329.11
17.00 ft	0.2563	0.2563	0.2563	0.2563	0.7621	0.7621	0.7621	0.7621	292.96	292.96	292.96	292.96
19.00 ft	0.2535	0.2535	0.2535	0.2535	0.7086	0.7086	0.7086	0.7086	257.77	257.77	257.77	257.77
21.00 ft	0.2485	0.2485	0.2485	0.2485	0.6612	0.6612	0.6612	0.6612	225.29	225.29	225.29	225.29
23.00 ft	0.2422	0.2422	0.2422	0.2422	0.6189	0.6189	0.6189	0.6189	196.25	196.25	196.25	196.25
25.00 ft	0.2350	0.2350	0.2350	0.2350	0.5812	0.5812	0.5812	0.5812	170.78	170.78	170.78	170.78
27.00 ft	0.2275	0.2275	0.2275	0.2275	0.5473	0.5473	0.5473	0.5473	148.71	148.71	148.71	148.71
29.00 ft	0.2198	0.2198	0.2198	0.2198	0.5169	0.5169	0.5169	0.5169	129.70	129.70	129.70	129.70
31.00 ft	0.2121	0.2121	0.2121	0.2121	0.4893	0.4893	0.4893	0.4893	113.39	113.39	113.39	113.39
33.00 ft	0.2046	0.2046	0.2046	0.2046	0.4644	0.4644	0.4644	0.4644	99.41	99.41	99.41	99.41
35.00 ft	0.1974	0.1974	0.1974	0.1974	0.4417	0.4417	0.4417	0.4417	87.43	87.43	87.43	87.43
37.00 ft	0.1904	0.1904	0.1904	0.1904	0.4210	0.4210	0.4210	0.4210	77.15	77.15	77.15	77.15
39.00 ft	0.1838	0.1838	0.1838	0.1838	0.4021	0.4021	0.4021	0.4021	68.30	68.30	68.30	68.30
41.00 ft	0.1774	0.1774	0.1774	0.1774	0.3846	0.3846	0.3846	0.3846	60.67	60.67	60.67	60.67

Note: The following two pages contain numerical and graphical representations of these loads over a selected area.

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Calc:	SNH	Date:	8/20/2014
Check:		Date:	
Update:		Date:	
Verified:		Date:	

Numerical Summary of Forces

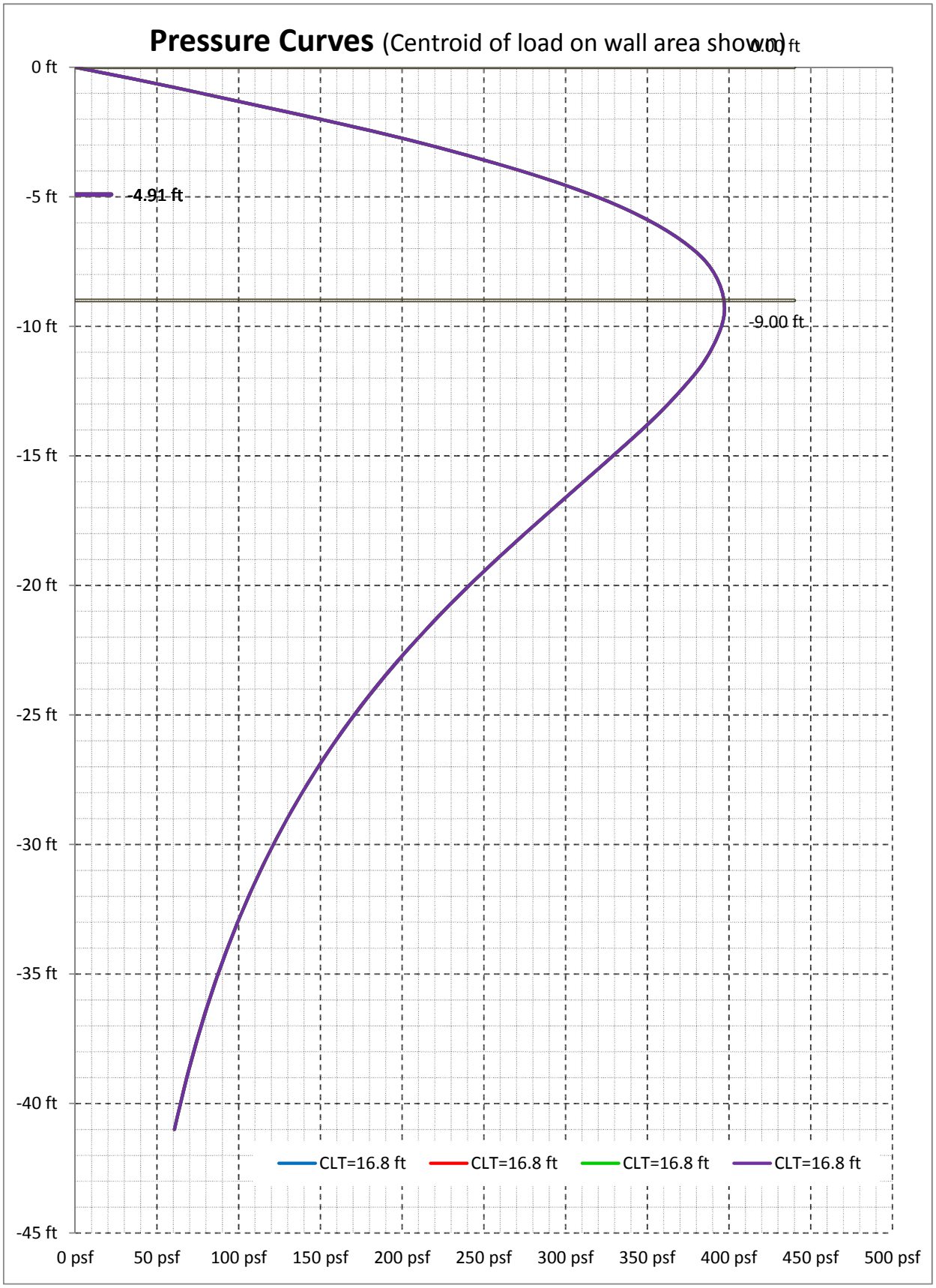
To gain total forces, the area under the graph is required. The area under the graph for the considered depth is divided by the total considered depth to arrive at a uniformly applied lateral pressure on any surface in question. The total lateral force is the total area under the graph. Simpsons Rule is used to arrive at the total area under the graph (median value force over a height is used)

	Values at CLT Distances			
Data Below is intended to give summary values that can be used in the design of walls and surfaces affected by the surcharge. A graphical output is on the next page	CLT=16.8 ft	CLT=16.8 ft	CLT=16.8 ft	CLT=16.8 ft
Top of Wall (Min. Depth Considered): 0.00 ft	.0 psf	.0 psf	.0 psf	.0 psf
Bottom of Wall (Max. Depth Considered): 9.00 ft	396.9 psf	396.9 psf	396.9 psf	396.9 psf

The bottom of the exposed wall face is 9.00 feet below the bottom of the tie. The top of the fill behind the wall (applying lateral pressure) is 0.00 feet below the bottom of the tie. The height of exposed wall face with surcharge pressure applied is 9.00 feet.

Maximum Applied Lateral Pressure on limits of the wall				
Maximum Applied Lateral Pressure	396.9 psf	396.9 psf	396.9 psf	396.9 psf
Total Applied Lateral Pressure on limits of the wall *(as an equivilant point load)*				
Total Lateral Load (Per foot)	2.30 klf	2.30 klf	2.30 klf	2.30 klf
Centroid of Total Lateral Load (Distance down from zero)	4.91 ft	4.91 ft	4.91 ft	4.91 ft
Total Applied Moment due to Surcharge *(assumes fixed at max depth)*	9.4 k-ft	9.4 k-ft	9.4 k-ft	9.4 k-ft
Uniformly Applied Lateral Pressure on limits of the wall (For Lateral Stability) *(Total Applied Lateral Pressure **Thrust Controls;** Total lateral moment is not correct)*				
Uniformly Applied Lateral Load	255.5 psf	255.5 psf	255.5 psf	255.5 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	10.3 k-ft	10.3 k-ft	10.3 k-ft	10.3 k-ft
Difference in moment from that of the Total Point Load	10%	10%	10%	10%
Uniformly Applied Lateral Pressure on limits of the wall (For Moments/Deflectoins) *(Total Applied Lateral Pressure **Moment Controls;** Total lateral thrust is not correct)*				
Uniformly Applied Lateral Load	232.2 psf	232.2 psf	232.2 psf	232.2 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	9.4 k-ft	9.4 k-ft	9.4 k-ft	9.4 k-ft
Difference in moment from that of the Total Point Load	0%	0%	0%	0%
Total of Uniformly Applied Lateral Load	2.09 klf	2.09 klf	2.09 klf	2.09 klf
Difference in Load from that of the Total Point Load	-9%	-9%	-9%	-9%

Total Uniform Load to Approximate Dual Tracks on Wall	**464.3 psf**


Pressure Curves (Centroid of load on wall area shown)
0.00 ft
-4.91 ft
-9.00 ft
0 ft
-5 ft
-10 ft
-15 ft
-20 ft
-25 ft
-30 ft
-35 ft
-40 ft
-45 ft
0 psf
50 psf
100 psf
150 psf
200 psf
250 psf
300 psf
350 psf
400 psf
450 psf
500 psf
CLT=16.8 ft
CLT=16.8 ft
CLT=16.8 ft
CLT=16.8 ft

L-Pile Loads on a 30" Wide Shaft should be entered as follows (depth is inches from pile head)

Shaft Width: 12.0 in
1.000 ft

Depth	Depth	Last CLT column Lateral Load
0.00 ft	0.000 ft	0.000 ksf
1.00 ft	1.000 ft	0.077 ksf
3.00 ft	3.000 ft	0.216 ksf
5.00 ft	5.000 ft	0.319 ksf
7.00 ft	7.000 ft	0.378 ksf
9.00 ft	9.000 ft	0.397 ksf
11.00 ft	11.000 ft	0.388 ksf
15.00 ft	15.000 ft	0.329 ksf
31.00 ft	31.000 ft	0.113 ksf
41.00 ft	41.000 ft	0.061 ksf

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Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

Lateral Pressure from Parallel Strip Loading

Lateral Pressure from Parallel Strip Loading

Calculations as per Norfolk Southern Design Standards

Min. Depth of Resulting Table (Hs_{min}):	1.00 ft	Centerline Track Distance 1, CLT_1:	10.09 ft
Max Depth of Resulting Table (Hs_{max}):	41.00 ft	Centerline Track Distance 2, CLT_2:	10.09 ft
Spacing of Max Axle Load:	5.0 ft	Centerline Track Distance 3, CLT_3:	10.09 ft
Max Axle Load:	80.0 kip	Centerline Track Distance 4, CLT_4:	10.09 ft
Width of Tie (TL):	8.5 ft	Applied Pressure (q):	1.88 ksf

Hs	**β** *(Radians)*				**α** *(Radians)*				*Active Pressure,* **Ps** *(psf)*			
	β_1	β_2	β_3	β_4	α_1	α_2	α_3	α_4	Ps_1	Ps_2	Ps_3	Ps_4
0.00 ft	0.0000	0.0000	0.0000	0.0000	1.5708	1.5708	1.5708	1.5708	0.00	0.00	0.00	0.00
1.00 ft	0.1000	0.1000	0.1000	0.1000	1.4512	1.4512	1.4512	1.4512	235.98	235.98	235.98	235.98
3.00 ft	0.2683	0.2683	0.2683	0.2683	1.2304	1.2304	1.2304	1.2304	568.41	568.41	568.41	568.41
5.00 ft	0.3726	0.3726	0.3726	0.3726	1.0490	1.0490	1.0490	1.0490	665.94	665.94	665.94	665.94
7.00 ft	0.4214	0.4214	0.4214	0.4214	0.9060	0.9060	0.9060	0.9060	622.03	622.03	622.03	622.03
9.00 ft	0.4347	0.4347	0.4347	0.4347	0.7930	0.7930	0.7930	0.7930	528.58	528.58	528.58	528.58
11.00 ft	0.4284	0.4284	0.4284	0.4284	0.7023	0.7023	0.7023	0.7023	430.96	430.96	430.96	430.96
13.00 ft	0.4122	0.4122	0.4122	0.4122	0.6283	0.6283	0.6283	0.6283	345.54	345.54	345.54	345.54
15.00 ft	0.3916	0.3916	0.3916	0.3916	0.5671	0.5671	0.5671	0.5671	275.88	275.88	275.88	275.88
17.00 ft	0.3698	0.3698	0.3698	0.3698	0.5158	0.5158	0.5158	0.5158	220.79	220.79	220.79	220.79
19.00 ft	0.3483	0.3483	0.3483	0.3483	0.4724	0.4724	0.4724	0.4724	177.74	177.74	177.74	177.74
21.00 ft	0.3279	0.3279	0.3279	0.3279	0.4352	0.4352	0.4352	0.4352	144.18	144.18	144.18	144.18
23.00 ft	0.3088	0.3088	0.3088	0.3088	0.4031	0.4031	0.4031	0.4031	117.94	117.94	117.94	117.94
25.00 ft	0.2913	0.2913	0.2913	0.2913	0.3751	0.3751	0.3751	0.3751	97.32	97.32	97.32	97.32
27.00 ft	0.2752	0.2752	0.2752	0.2752	0.3506	0.3506	0.3506	0.3506	80.99	80.99	80.99	80.99
29.00 ft	0.2605	0.2605	0.2605	0.2605	0.3290	0.3290	0.3290	0.3290	67.95	67.95	67.95	67.95
31.00 ft	0.2471	0.2471	0.2471	0.2471	0.3097	0.3097	0.3097	0.3097	57.46	57.46	57.46	57.46
33.00 ft	0.2348	0.2348	0.2348	0.2348	0.2925	0.2925	0.2925	0.2925	48.94	48.94	48.94	48.94
35.00 ft	0.2235	0.2235	0.2235	0.2235	0.2771	0.2771	0.2771	0.2771	41.98	41.98	41.98	41.98
37.00 ft	0.2132	0.2132	0.2132	0.2132	0.2631	0.2631	0.2631	0.2631	36.24	36.24	36.24	36.24
39.00 ft	0.2037	0.2037	0.2037	0.2037	0.2505	0.2505	0.2505	0.2505	31.48	31.48	31.48	31.48
41.00 ft	0.1950	0.1950	0.1950	0.1950	0.2390	0.2390	0.2390	0.2390	27.49	27.49	27.49	27.49

Note: The following two pages contain numerical and graphical representations of these loads over a selected area.

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Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

Numerical Summary of Forces

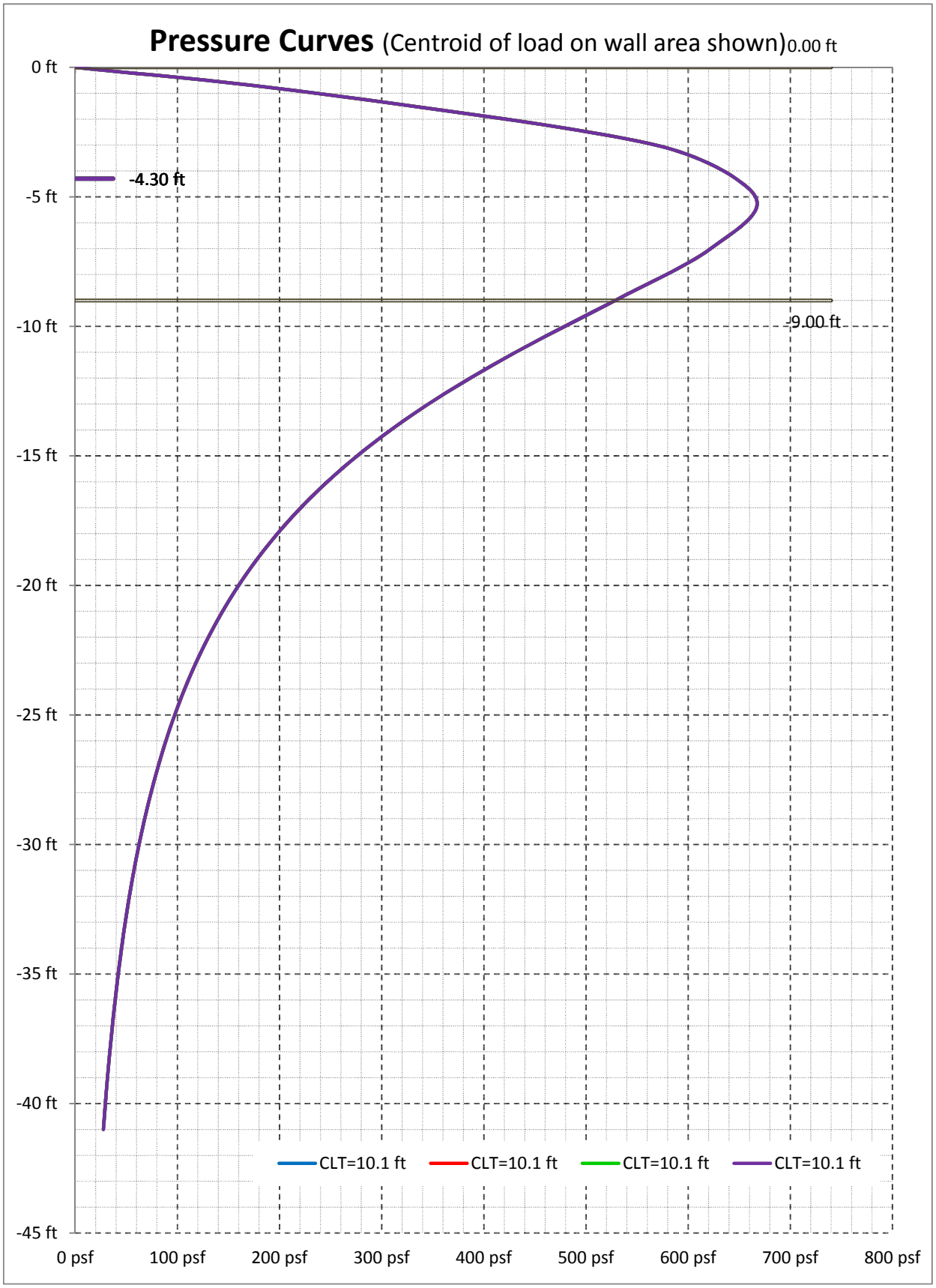
To gain total forces, the area under the graph is required. The area under the graph for the considered depth is divided by the total considered depth to arrive at a uniformly applied lateral pressure on any surface in question. The total lateral force is the total area under the graph. Simpsons Rule is used to arrive at the total area under the graph (median value force over a height is used)

	Values at CLT Distances			
Data Below is intended to give summary values that can be used in the design of walls and surfaces affected by the surcharge. A graphical output is on the next page	CLT=10.1 ft	CLT=10.1 ft	CLT=10.1 ft	CLT=10.1 ft
Top of Wall (Min. Depth Considered): 0.00 ft	.0 psf	.0 psf	.0 psf	.0 psf
Bottom of Wall (Max. Depth Considered): 9.00 ft	528.6 psf	528.6 psf	528.6 psf	528.6 psf

The bottom of the exposed wall face is 9.00 feet below the bottom of the tie. The top of the fill behind the wall (applying lateral pressure) is 0.00 feet below the bottom of the tie. The height of exposed wall face with surcharge pressure applied is 9.00 feet.

Maximum Applied Lateral Pressure on limits of the wall				
Maximum Applied Lateral Pressure	665.9 psf	665.9 psf	665.9 psf	665.9 psf
Total Applied Lateral Pressure on limits of the wall *(as an equivilant point load)*				
Total Lateral Load (Per foot)	4.48 klf	4.48 klf	4.48 klf	4.48 klf
Centroid of Total Lateral Load (Distance down from zero)	4.30 ft	4.30 ft	4.30 ft	4.30 ft
Total Applied Moment due to Surcharge *(assumes fixed at max depth)*	21.1 k-ft	21.1 k-ft	21.1 k-ft	21.1 k-ft
Uniformly Applied Lateral Pressure on limits of the wall (For Lateral Stability) *(Total Applied Lateral Pressure **Thrust Controls;** Total lateral moment is not correct)*				
Uniformly Applied Lateral Load	497.5 psf	497.5 psf	497.5 psf	497.5 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	20.1 k-ft	20.1 k-ft	20.1 k-ft	20.1 k-ft
Difference in moment from that of the Total Point Load	-4%	-4%	-4%	-4%
Uniformly Applied Lateral Pressure on limits of the wall (For Moments/Deflectoins) *(Total Applied Lateral Pressure **Moment Controls;** Total lateral thrust is not correct)*				
Uniformly Applied Lateral Load	520.1 psf	520.1 psf	520.1 psf	520.1 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	21.1 k-ft	21.1 k-ft	21.1 k-ft	21.1 k-ft
Difference in moment from that of the Total Point Load	0%	0%	0%	0%
Total of Uniformly Applied Lateral Load	4.68 klf	4.68 klf	4.68 klf	4.68 klf
Difference in Load from that of the Total Point Load	5%	5%	5%	5%

Total Uniform Load to Approximate Dual Tracks on Wall	**1040.1 psf**


Pressure Curves (Centroid of load on wall area shown)0.00 ft
0 ft
-5 ft
-10 ft
-15 ft
-20 ft
-25 ft
-30 ft
-35 ft
-40 ft
-45 ft
-4.30 ft
-9.00 ft
CLT=10.1 ft
CLT=10.1 ft
CLT=10.1 ft
CLT=10.1 ft
0 psf
100 psf
200 psf
300 psf
400 psf
500 psf
600 psf
700 psf
800 psf

Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

L-Pile Loads on a 30" Wide Shaft should be entered as follows (depth is inches from pile head)

Shaft Width: 12.0 in
1.000 ft

Depth	Depth	Last CLT column Lateral Load
0.00 ft	0.000 ft	0.000 ksf
1.00 ft	1.000 ft	0.236 ksf
3.00 ft	3.000 ft	0.568 ksf
5.00 ft	5.000 ft	0.666 ksf
7.00 ft	7.000 ft	0.622 ksf
9.00 ft	9.000 ft	0.529 ksf
11.00 ft	11.000 ft	0.431 ksf
15.00 ft	15.000 ft	0.276 ksf
31.00 ft	31.000 ft	0.057 ksf
41.00 ft	41.000 ft	0.027 ksf

Sheet Pile Design According to Blum-Method

Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track
Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track
Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track
Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track

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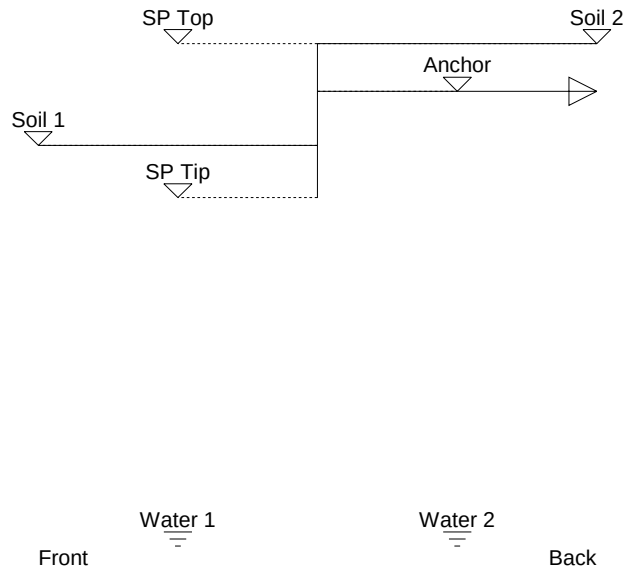
Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	14.511
Soil Level in Front [ft]	9.600
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.500
Water Level in Front [ft]	46.000
Water Level behind [ft]	46.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Free



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Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	50.000	0.125	0.063	3.128	31.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	50.000	0.125	0.063	0.320	31.000	0.000	0.000

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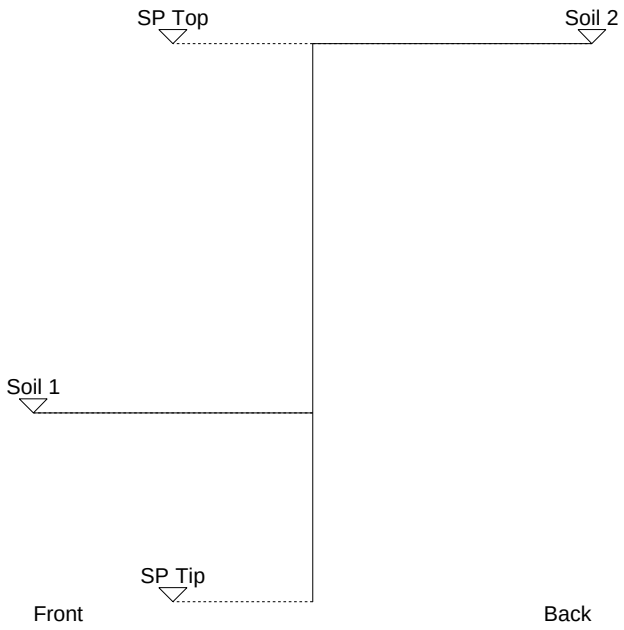
Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]



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Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.077	0.000	1.000
Strip 2	0.077	0.216	1.000	3.000
Strip 3	0.216	0.319	3.000	5.000
Strip 4	0.319	0.378	5.000	7.000
Strip 5	0.378	0.397	7.000	9.000
Strip 6	0.397	0.388	9.000	11.000
Strip 7	0.388	0.329	11.000	15.000
Strip 8	0.329	0.113	15.000	31.000
Strip 9	0.113	0.061	31.000	41.000

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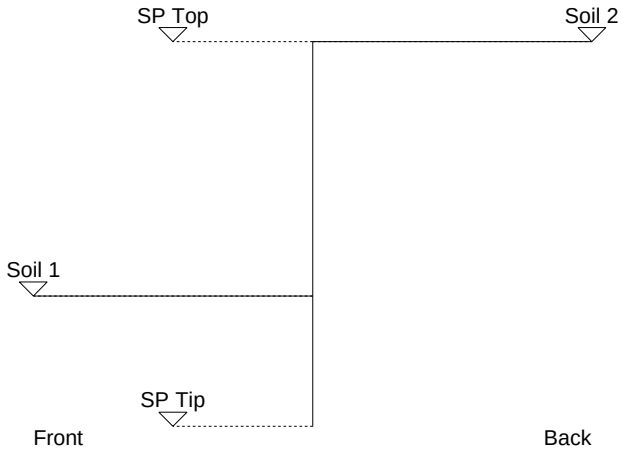
Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



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Pile Section

Name	AZ 36-700N
Inertia [in4/ft]	656.193
Modulus [in3/ft]	66.774
Area [in2/ft]	10.200
Mass [lbs/ft2]	34.716
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

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All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.820	0.000	0.000	0.039	0.011	0.096	0.000	0.033	0.000	0.063
0.820	0.000	0.000	0.039	0.011	0.096	0.000	0.033	0.000	0.063
1.000	0.000	0.000	0.059	0.020	0.117	0.000	0.040	0.000	0.077
1.000	0.000	0.000	0.059	0.020	0.117	0.000	0.040	0.000	0.077
1.820	0.000	0.000	0.191	0.117	0.207	0.000	0.073	0.000	0.134
1.820	0.000	0.000	0.191	0.117	0.207	0.000	0.073	0.000	0.134
2.640	0.000	0.000	0.398	0.353	0.297	0.000	0.106	0.000	0.191
2.640	0.000	0.000	0.398	0.353	0.297	0.000	0.106	0.000	0.191
3.000	0.000	0.000	0.512	0.517	0.336	0.000	0.120	0.000	0.216
3.000	0.000	0.000	0.512	0.517	0.336	0.000	0.120	0.000	0.216
3.820	0.000	0.000	0.818	1.058	0.411	0.000	0.153	0.000	0.258
3.820	0.000	0.000	0.818	1.058	0.411	0.000	0.153	0.000	0.258
4.500	0.000	0.000	1.119	1.713	0.473	0.000	0.180	0.000	0.293
4.500	0.000	0.000	-2.795	1.713	0.473	0.000	0.180	0.000	0.293
5.000	0.000	0.000	-2.547	0.377	0.519	0.000	0.200	0.000	0.319
5.000	0.000	0.000	-2.547	0.377	0.519	0.000	0.200	0.000	0.319
5.820	0.000	0.000	-2.098	-1.531	0.576	0.000	0.233	0.000	0.343
5.820	0.000	0.000	-2.098	-1.531	0.576	0.000	0.233	0.000	0.343
6.640	0.000	0.000	-1.602	-3.052	0.633	0.000	0.266	0.000	0.367
6.640	0.000	0.000	-1.602	-3.052	0.633	0.000	0.266	0.000	0.367
7.000	0.000	0.000	-1.370	-3.587	0.658	0.000	0.280	0.000	0.378
7.000	0.000	0.000	-1.370	-3.587	0.658	0.000	0.280	0.000	0.378
7.820	0.000	0.000	-0.814	-4.484	0.699	0.000	0.313	0.000	0.386
7.820	0.000	0.000	-0.814	-4.484	0.699	0.000	0.313	0.000	0.386
8.640	0.000	0.000	-0.224	-4.912	0.739	0.000	0.346	0.000	0.394
8.640	0.000	0.000	-0.224	-4.912	0.739	0.000	0.346	0.000	0.394
9.000	0.000	0.000	0.045	-4.944	0.757	0.000	0.360	0.000	0.397
9.000	0.000	0.000	0.045	-4.944	0.757	0.000	0.360	0.000	0.397
9.600	0.000	0.000	0.506	-4.780	0.778	0.000	0.384	0.000	0.394
9.600	0.000	0.000	0.506	-4.780	0.778	0.000	0.384	0.000	0.394
10.420	0.000	0.000	1.025	-4.136	0.487	-0.321	0.417	0.000	0.391
10.420	0.000	0.000	1.025	-4.136	0.487	-0.321	0.417	0.000	0.391
11.000	0.000	0.000	1.247	-3.471	0.281	-0.547	0.440	0.000	0.388
11.000	0.000	0.000	1.247	-3.471	0.281	-0.547	0.440	0.000	0.388
11.820	0.000	0.000	1.354	-2.387	-0.019	-0.868	0.473	0.000	0.376
11.820	0.000	0.000	1.354	-2.387	-0.019	-0.868	0.473	0.000	0.376
12.640	0.000	0.000	1.216	-1.317	-0.319	-1.189	0.506	0.000	0.364
12.640	0.000	0.000	1.216	-1.317	-0.319	-1.189	0.506	0.000	0.364
13.461	0.000	0.000	0.831	-0.460	-0.619	-1.510	0.539	0.000	0.352
13.461	0.000	0.000	0.831	-0.460	-0.619	-1.510	0.539	0.000	0.352
14.281	0.000	0.000	0.200	-0.021	-0.919	-1.830	0.571	0.000	0.340
14.281	0.000	0.000	0.200	-0.021	-0.919	-1.830	0.571	0.000	0.340
14.511	0.000	0.000	-0.021	0.000	-1.003	-1.920	0.581	0.000	0.336

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Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	9.000	0.000	0.000	0.000
Cross Force [kip/ft]	4.500	-2.795	11.820	1.354
Moment [kipft/ft]	8.969	-4.945	4.500	1.713

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Pile Check

		Depth [ft]
Name	AZ 36-700N	
Inertia [in4/ft]	656.193	
Modulus [in3/ft]	66.774	
Area [in2/ft]	10.200	
Mass [lbs/ft2]	34.716	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-4.945	8.969
Maxmimal Moment [kipft/ft]	1.713	4.500
Normal Forces at Max. Moment [kip/ft]	0.000	8.969
Normal Forces at Min. Moment [kip/ft]	0.000	4.500
Deflection at Min. Moment [ft]	0.000	8.969
Deflection at Max. Moment [ft]	0.000	4.500
Min. Stress at Min. Moment [lb/in2]	-888.710	8.969
Max. Stress at Min. Moment [lb/in2]	888.710	8.969
Min. Stress at Max. Moment [lb/in2]	-307.901	4.500
Max. Stress at Max. Moment [lb/in2]	307.901	4.500
Safety > Req. Safety = 1.500	43.884	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	14.511	
Sheet Pile Length [ft]	14.511	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	-3.914	

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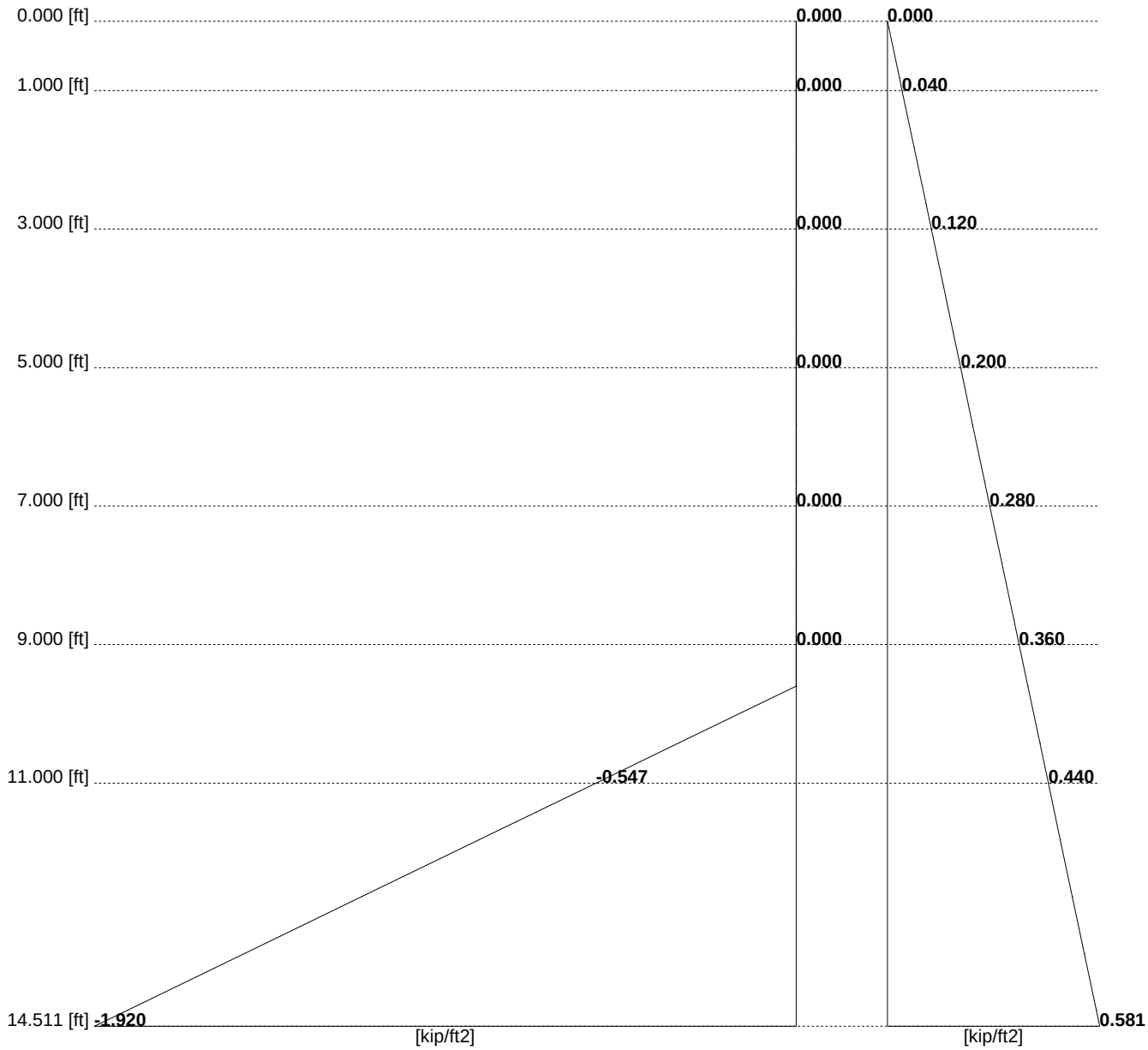
Earth Pressure Diagram



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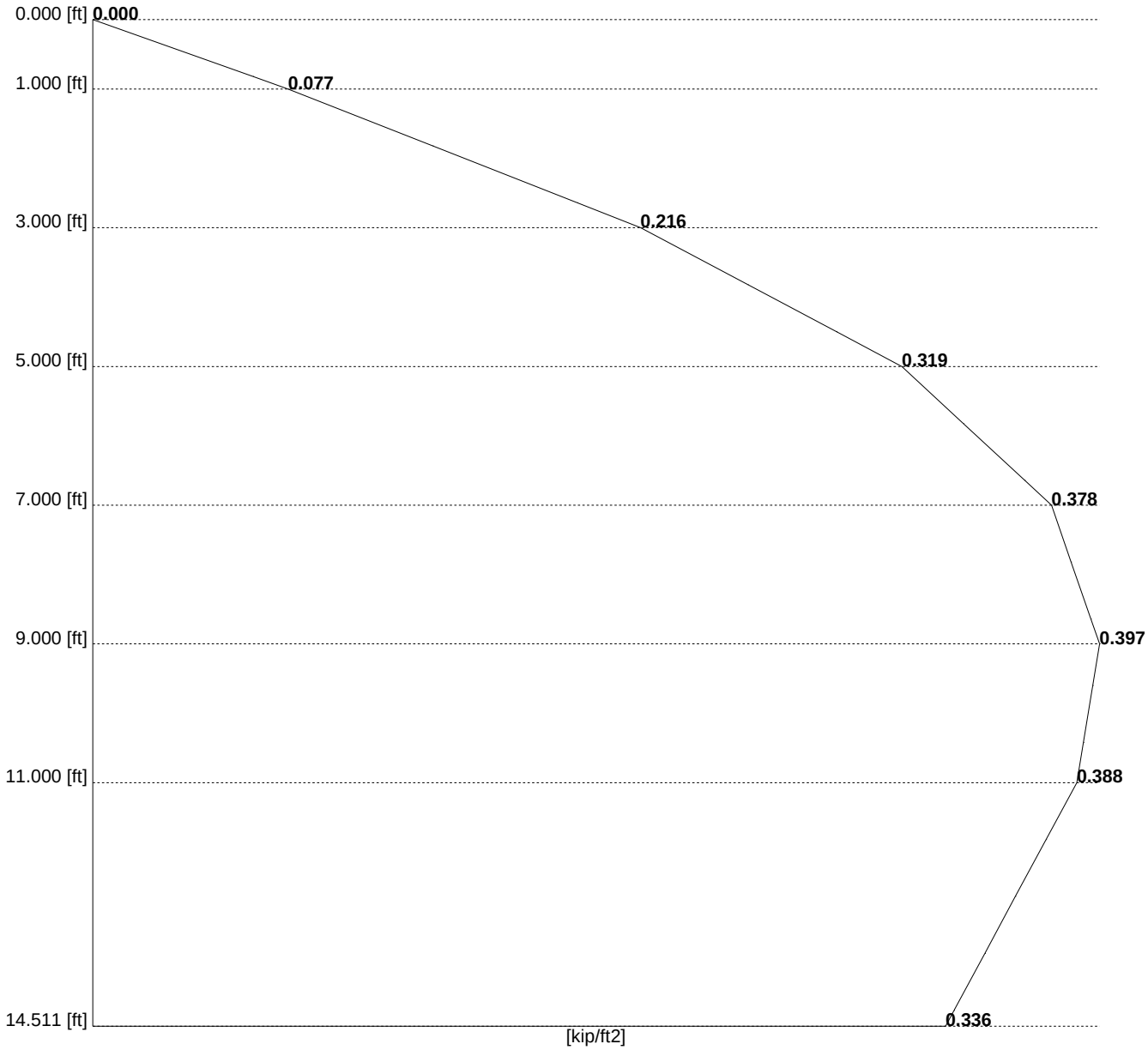
Userdefined Pressure Diagram



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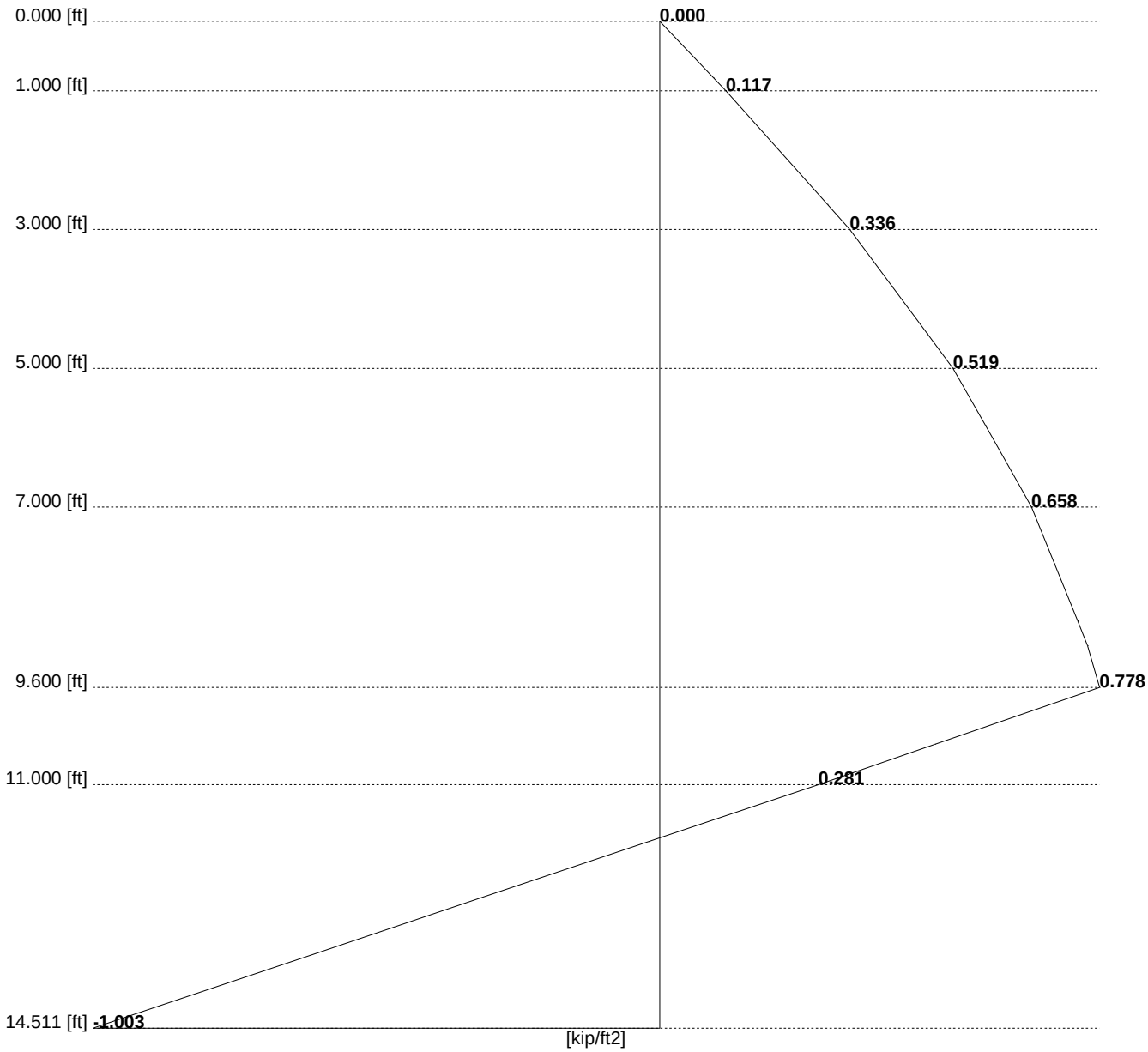
Total Pressure Diagram



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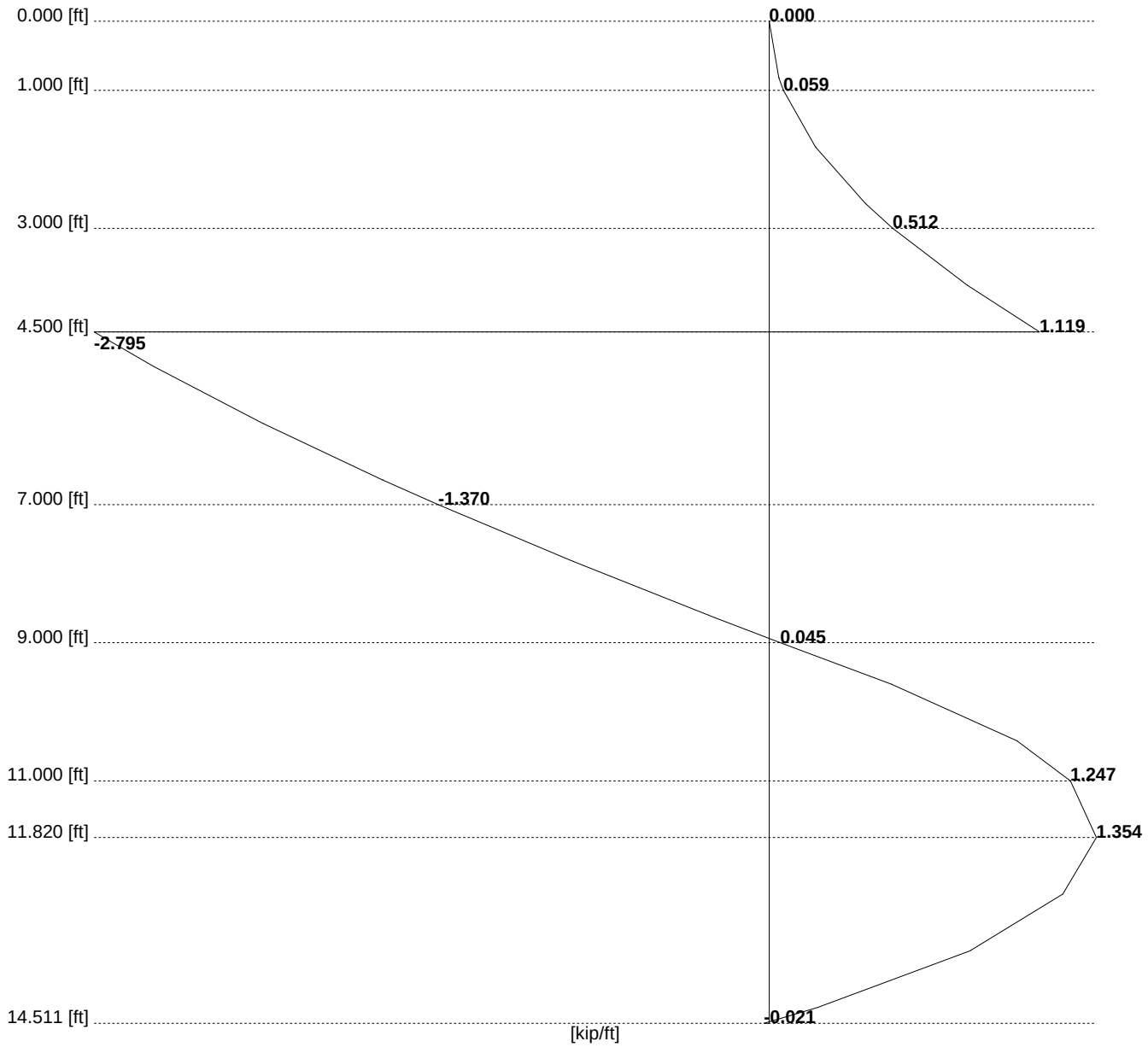
Cross Force Diagram



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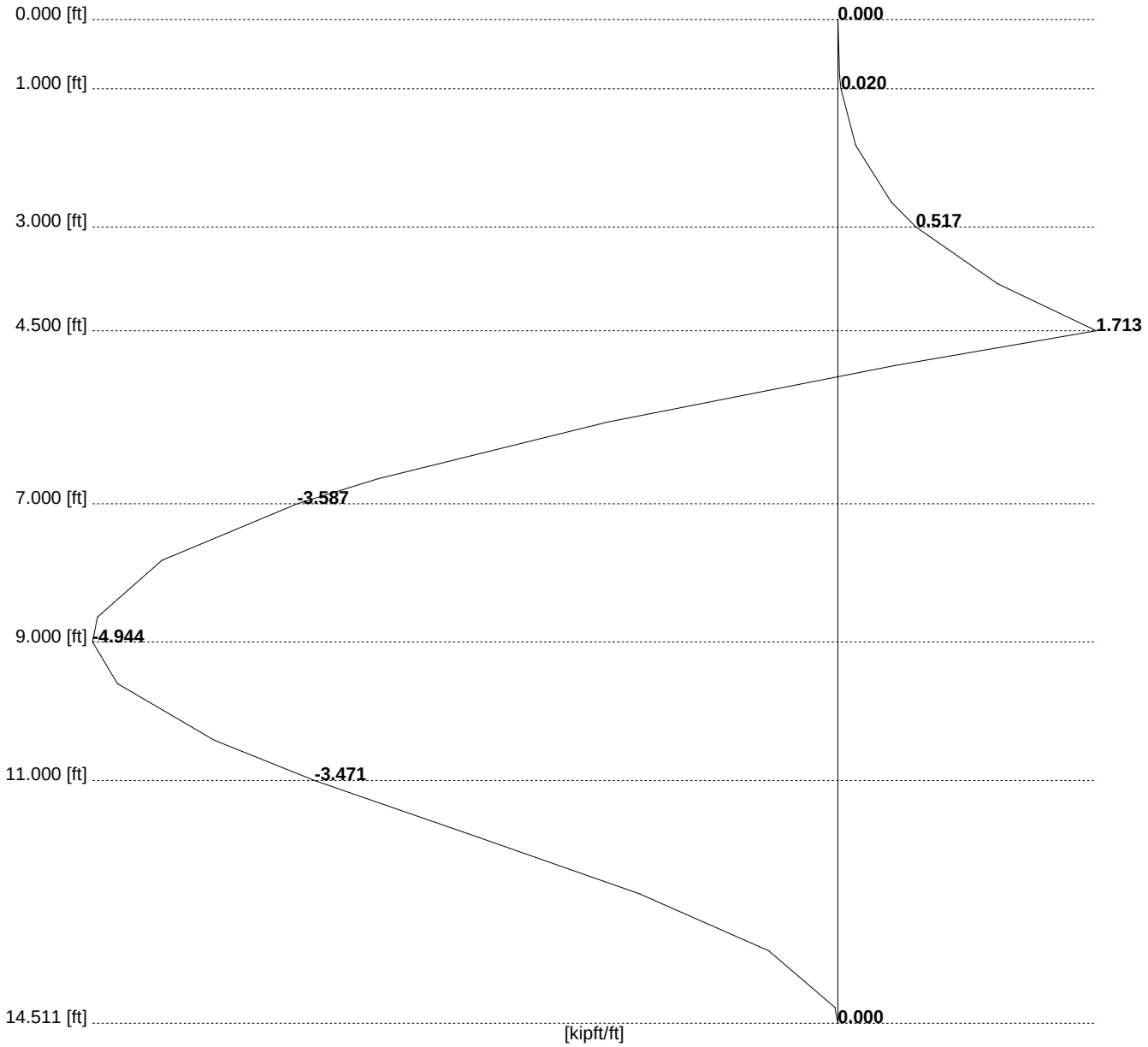
Moment Diagram



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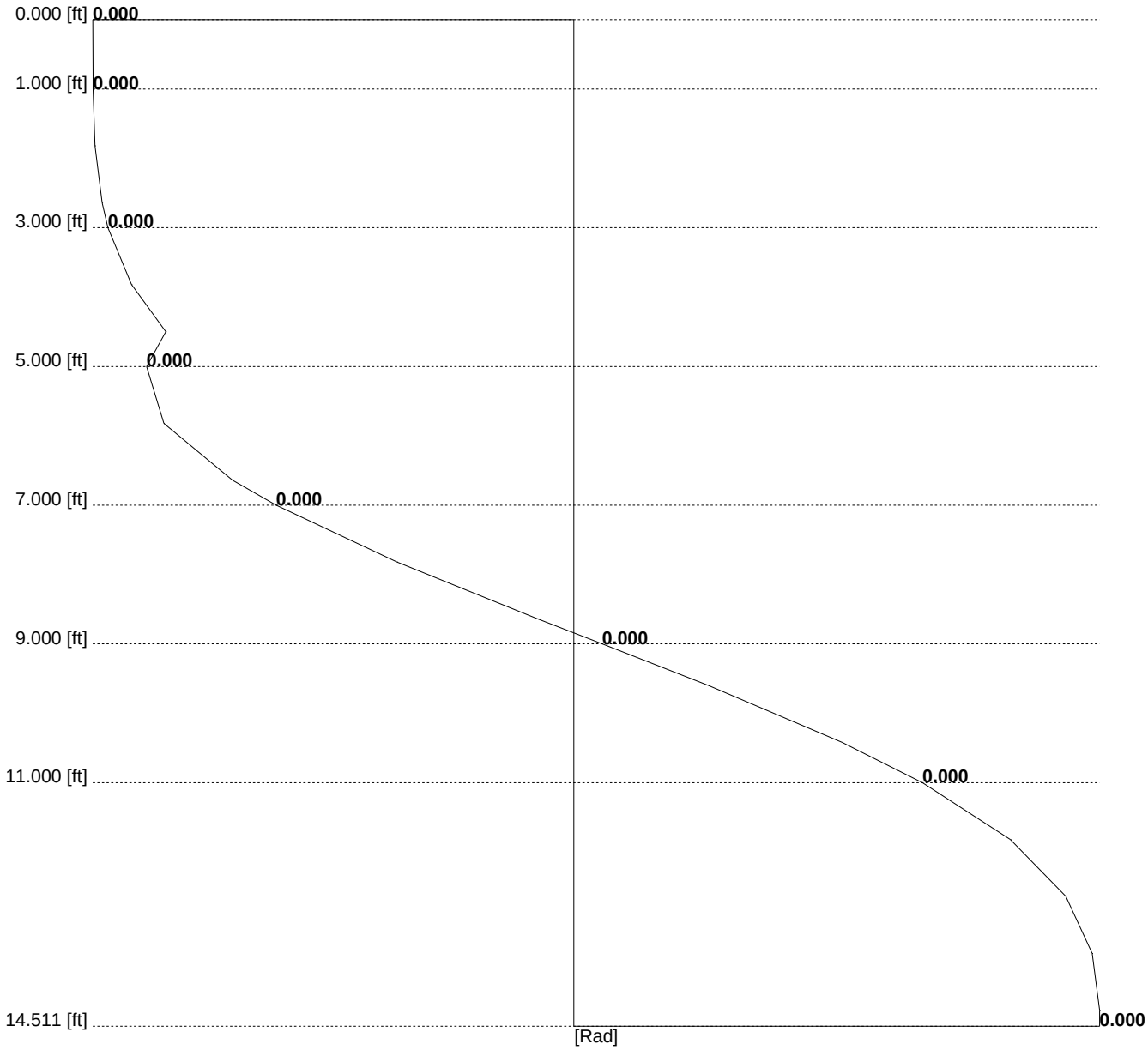
Rotation Diagram



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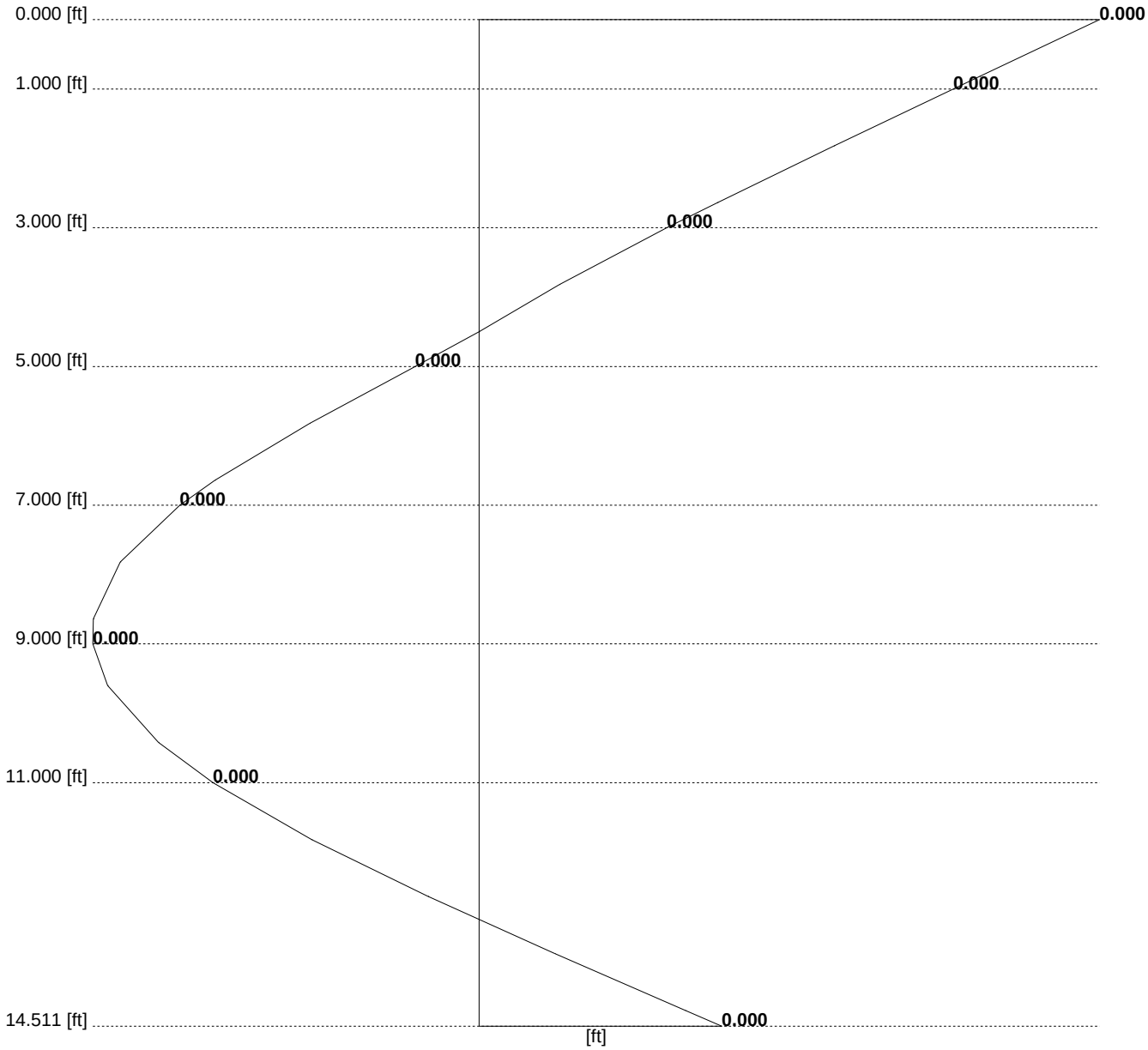
Deflection Diagram



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Sheet Pile Design According to Blum-Method

Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track

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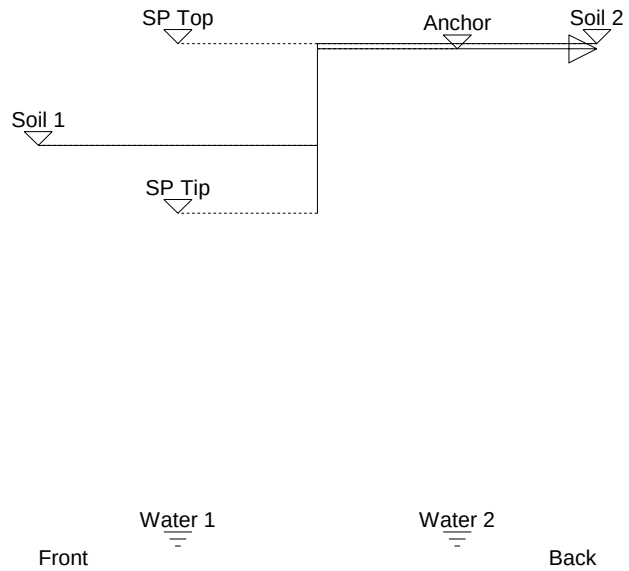
Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	15.984
Soil Level in Front [ft]	9.600
Soil Level behind [ft]	0.000
Anchorlevel [ft]	0.500
Water Level in Front [ft]	46.000
Water Level behind [ft]	46.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Free



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Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	3.120	31.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	0.330	31.000	0.000	0.000

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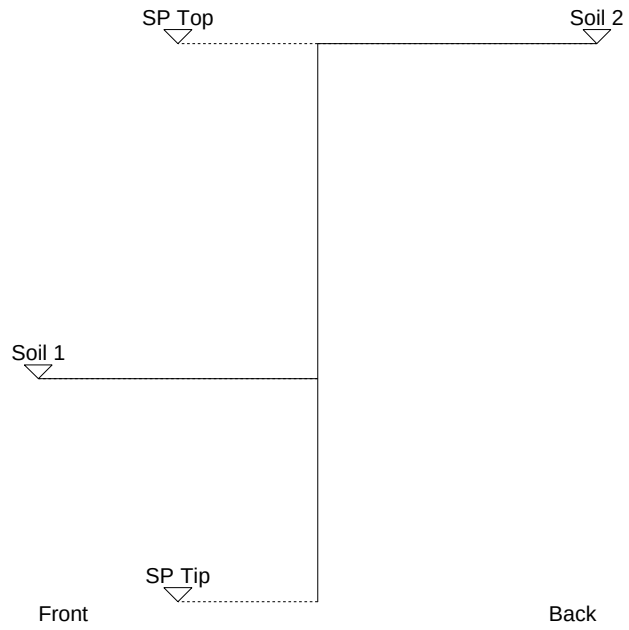
Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]



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Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.236	0.000	1.000
Strip 2	0.236	0.568	1.000	3.000
Strip 3	0.568	0.666	3.000	5.000
Strip 4	0.666	0.622	5.000	7.000
Strip 5	0.622	0.529	7.000	9.000
Strip 6	0.529	0.431	9.000	11.000
Strip 7	0.431	0.276	11.000	15.000
Strip 8	0.276	0.057	15.000	31.000
Strip 9	0.057	0.027	31.000	41.000

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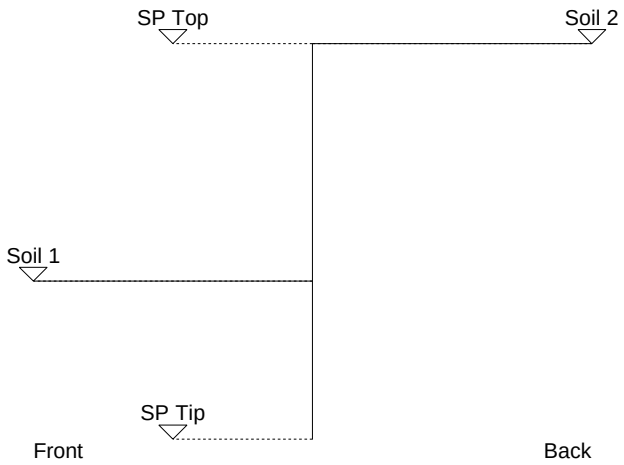
Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



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Pile Section

Name	AZ 36-700N
Inertia [in4/ft]	656.193
Modulus [in3/ft]	66.774
Area [in2/ft]	10.200
Mass [lbs/ft2]	34.716
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

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All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.500	0.000	-0.001	0.035	0.006	0.139	0.000	0.021	0.000	0.118
0.500	0.000	-0.001	-4.569	0.006	0.139	0.000	0.021	0.000	0.118
1.000	0.000	-0.001	-4.465	-2.256	0.277	0.000	0.041	0.000	0.236
1.000	0.000	-0.001	-4.465	-2.256	0.277	0.000	0.041	0.000	0.236
1.820	-0.001	-0.001	-4.168	-5.806	0.447	0.000	0.075	0.000	0.372
1.820	-0.001	-0.001	-4.168	-5.806	0.447	0.000	0.075	0.000	0.372
2.640	-0.001	-0.001	-3.732	-9.055	0.617	0.000	0.109	0.000	0.508
2.640	-0.001	-0.001	-3.732	-9.055	0.617	0.000	0.109	0.000	0.508
3.000	-0.002	-0.001	-3.496	-10.356	0.692	0.000	0.124	0.000	0.568
3.000	-0.002	-0.001	-3.496	-10.356	0.692	0.000	0.124	0.000	0.568
3.820	-0.002	0.000	-2.899	-12.982	0.766	0.000	0.158	0.000	0.608
3.820	-0.002	0.000	-2.899	-12.982	0.766	0.000	0.158	0.000	0.608
4.640	-0.002	0.000	-2.240	-15.094	0.840	0.000	0.191	0.000	0.648
4.640	-0.002	0.000	-2.240	-15.094	0.840	0.000	0.191	0.000	0.648
5.000	-0.002	0.000	-1.932	-15.845	0.872	0.000	0.206	0.000	0.666
5.000	-0.002	0.000	-1.932	-15.845	0.872	0.000	0.206	0.000	0.666
5.820	-0.003	0.000	-1.210	-17.134	0.888	0.000	0.240	0.000	0.648
5.820	-0.003	0.000	-1.210	-17.134	0.888	0.000	0.240	0.000	0.648
6.640	-0.003	0.000	-0.476	-17.827	0.904	0.000	0.274	0.000	0.630
6.640	-0.003	0.000	-0.476	-17.827	0.904	0.000	0.274	0.000	0.630
7.000	-0.003	0.000	-0.149	-17.939	0.911	0.000	0.289	0.000	0.622
7.000	-0.003	0.000	-0.149	-17.939	0.911	0.000	0.289	0.000	0.622
7.820	-0.003	0.000	0.596	-17.756	0.906	0.000	0.323	0.000	0.584
7.820	-0.003	0.000	0.596	-17.756	0.906	0.000	0.323	0.000	0.584
8.640	-0.003	0.000	1.338	-16.963	0.902	0.000	0.356	0.000	0.546
8.640	-0.003	0.000	1.338	-16.963	0.902	0.000	0.356	0.000	0.546
9.000	-0.003	0.000	1.662	-16.423	0.900	0.000	0.371	0.000	0.529
9.000	-0.003	0.000	1.662	-16.423	0.900	0.000	0.371	0.000	0.529
9.600	-0.003	0.000	2.200	-15.265	0.896	0.000	0.396	0.000	0.500
9.600	-0.003	0.000	2.200	-15.265	0.896	0.000	0.396	0.000	0.500
10.420	-0.003	0.000	2.801	-13.195	0.569	-0.320	0.430	0.000	0.459
10.420	-0.003	0.000	2.801	-13.195	0.569	-0.320	0.430	0.000	0.459
11.000	-0.002	0.000	3.064	-11.488	0.339	-0.546	0.454	0.000	0.431
11.000	-0.002	0.000	3.064	-11.488	0.339	-0.546	0.454	0.000	0.431
11.820	-0.002	0.000	3.212	-8.897	0.021	-0.866	0.488	0.000	0.399
11.820	-0.002	0.000	3.212	-8.897	0.021	-0.866	0.488	0.000	0.399
12.640	-0.002	0.000	3.099	-6.291	-0.297	-1.186	0.521	0.000	0.367
12.640	-0.002	0.000	3.099	-6.291	-0.297	-1.186	0.521	0.000	0.367
13.461	-0.001	0.000	2.725	-3.885	-0.615	-1.506	0.555	0.000	0.336
13.461	-0.001	0.000	2.725	-3.885	-0.615	-1.506	0.555	0.000	0.336
14.281	-0.001	0.001	2.090	-1.892	-0.933	-1.826	0.589	0.000	0.304
14.281	-0.001	0.001	2.090	-1.892	-0.933	-1.826	0.589	0.000	0.304
15.000	-0.001	0.001	1.319	-0.654	-1.211	-2.106	0.619	0.000	0.276
15.000	-0.001	0.001	1.319	-0.654	-1.211	-2.106	0.619	0.000	0.276
15.820	0.000	0.001	0.204	-0.013	-1.509	-2.426	0.653	0.000	0.265
15.820	0.000	0.001	0.204	-0.013	-1.509	-2.426	0.653	0.000	0.265
15.984	0.000	0.001	-0.048	0.000	-1.568	-2.490	0.659	0.000	0.263

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Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	7.820	-0.003	0.000	0.000
Cross Force [kip/ft]	0.500	-4.569	11.820	3.212
Moment [kipft/ft]	7.001	-17.939	0.500	0.006

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Pile Check

		Depth [ft]
Name	AZ 36-700N	
Inertia [in4/ft]	656.193	
Modulus [in3/ft]	66.774	
Area [in2/ft]	10.200	
Mass [lbs/ft2]	34.716	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-17.939	7.001
Maxmimal Moment [kipft/ft]	0.006	0.500
Normal Forces at Max. Moment [kip/ft]	0.000	7.001
Normal Forces at Min. Moment [kip/ft]	0.000	0.500
Deflection at Min. Moment [ft]	-0.003	7.001
Deflection at Max. Moment [ft]	0.000	0.500
Min. Stress at Min. Moment [lb/in2]	-3223.763	7.001
Max. Stress at Min. Moment [lb/in2]	3223.763	7.001
Min. Stress at Max. Moment [lb/in2]	-1.038	0.500
Max. Stress at Max. Moment [lb/in2]	1.038	0.500
Safety > Req. Safety = 1.500	12.098	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	15.984	
Sheet Pile Length [ft]	15.984	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	-4.604	

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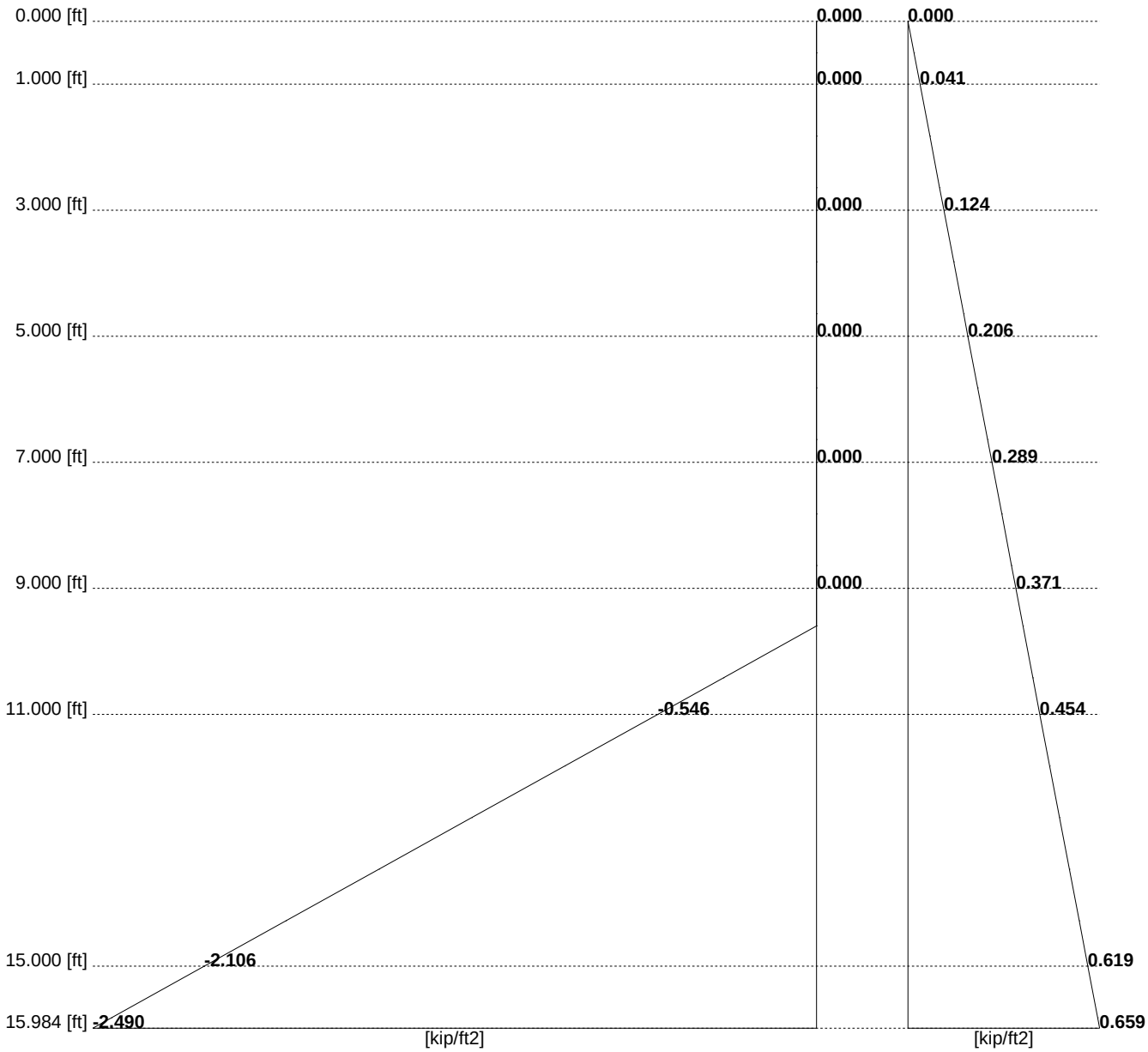
Earth Pressure Diagram



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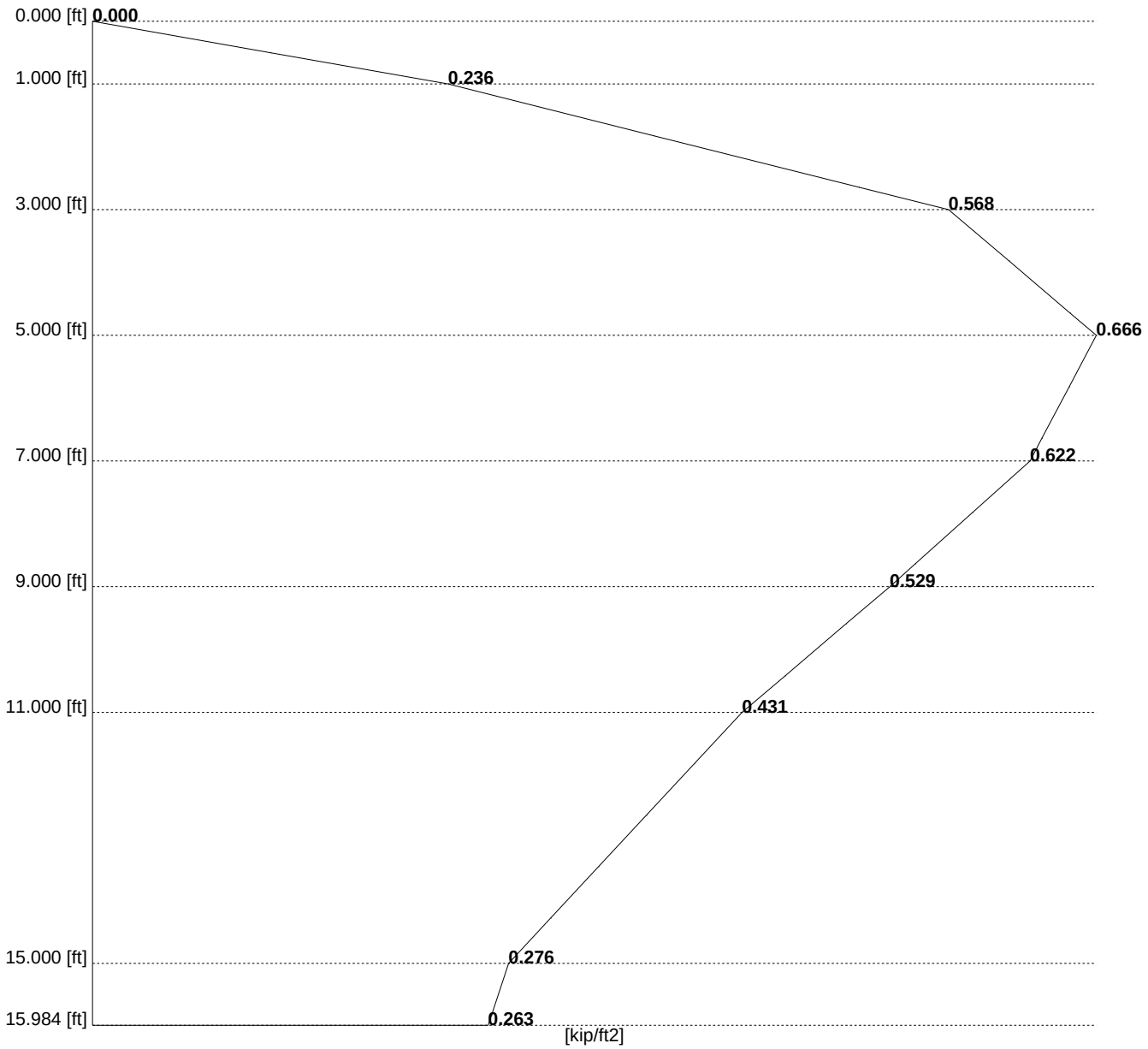
Userdefined Pressure Diagram



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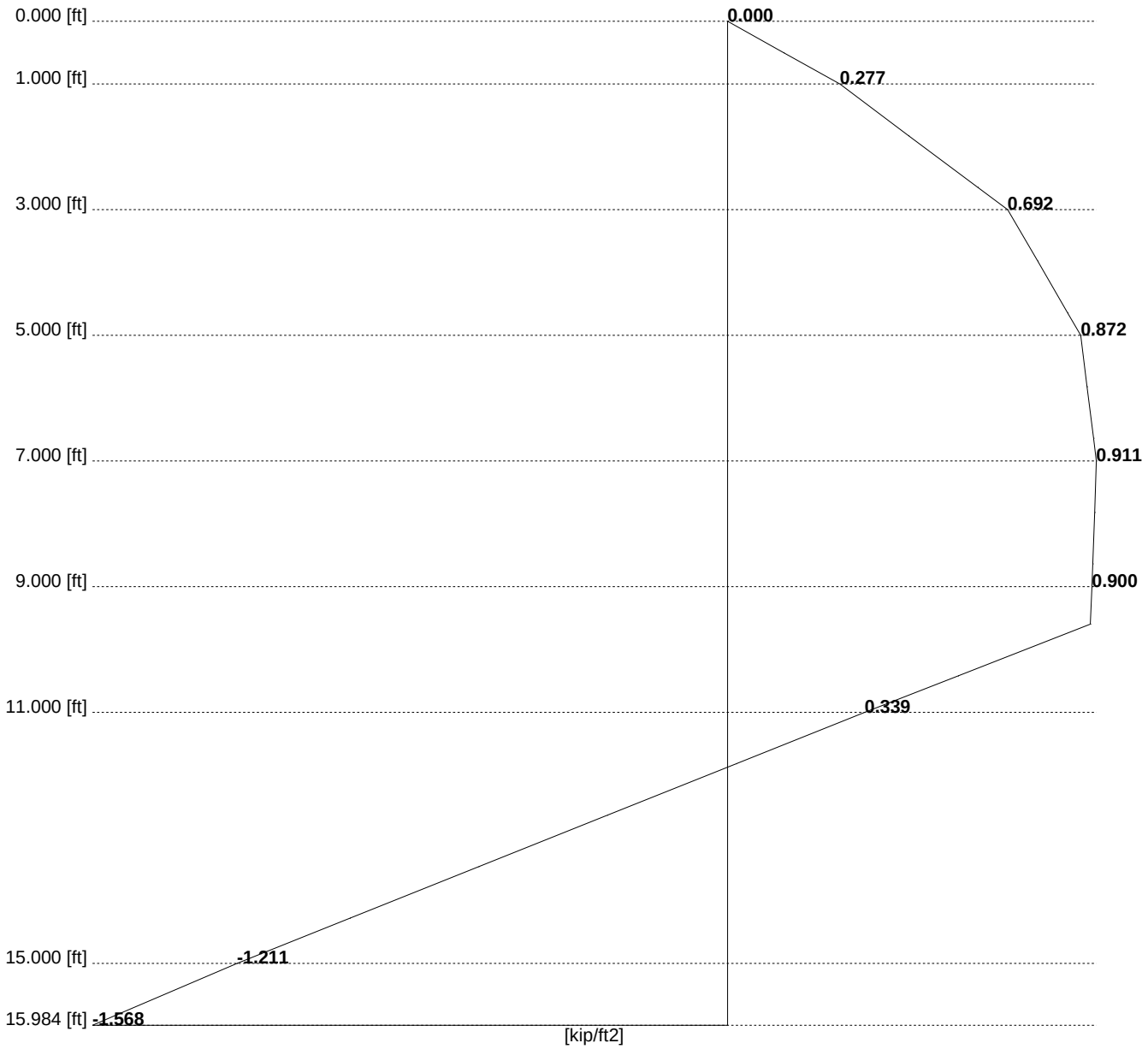
Total Pressure Diagram



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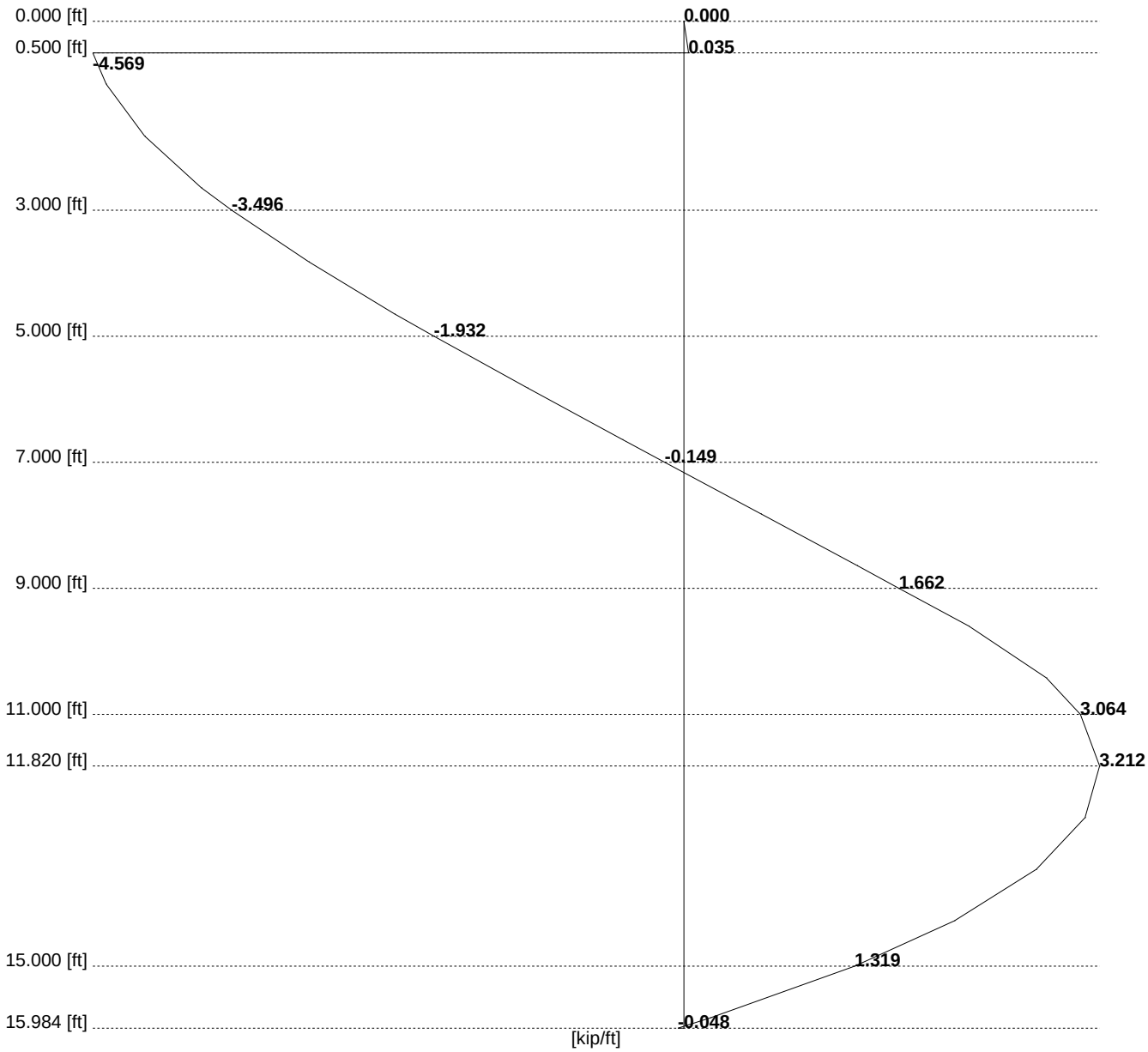
Cross Force Diagram



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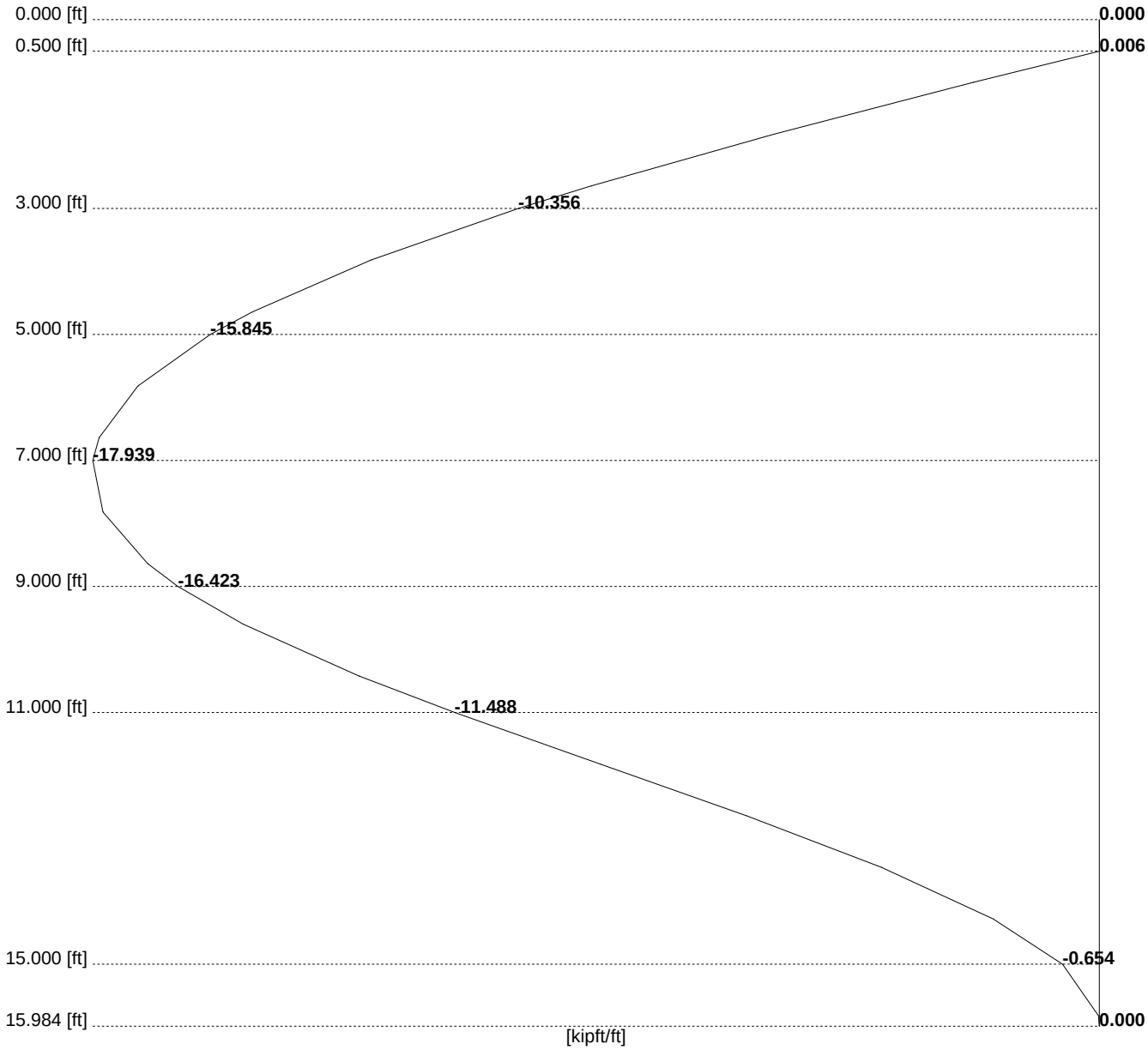
Moment Diagram



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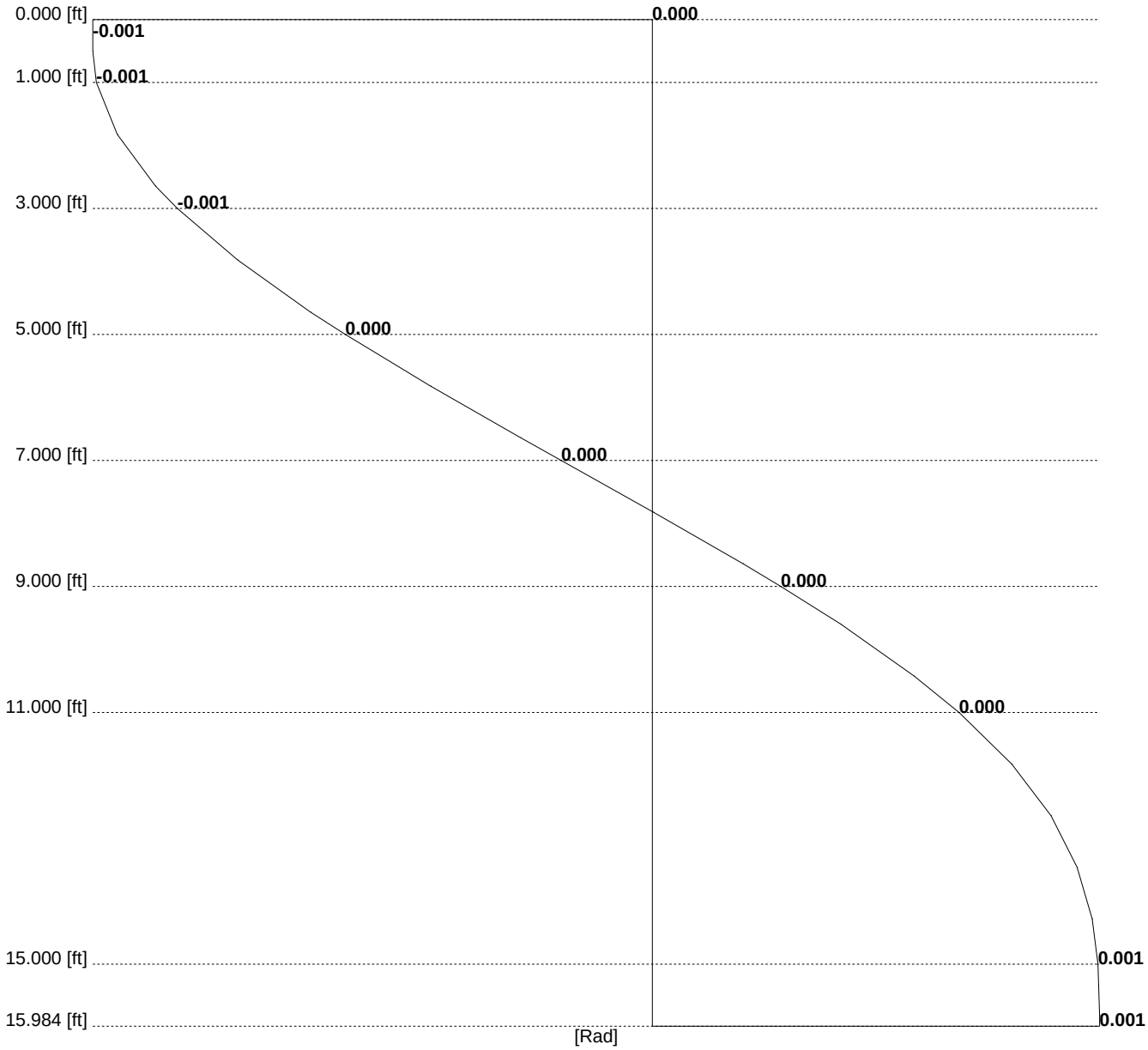
Rotation Diagram



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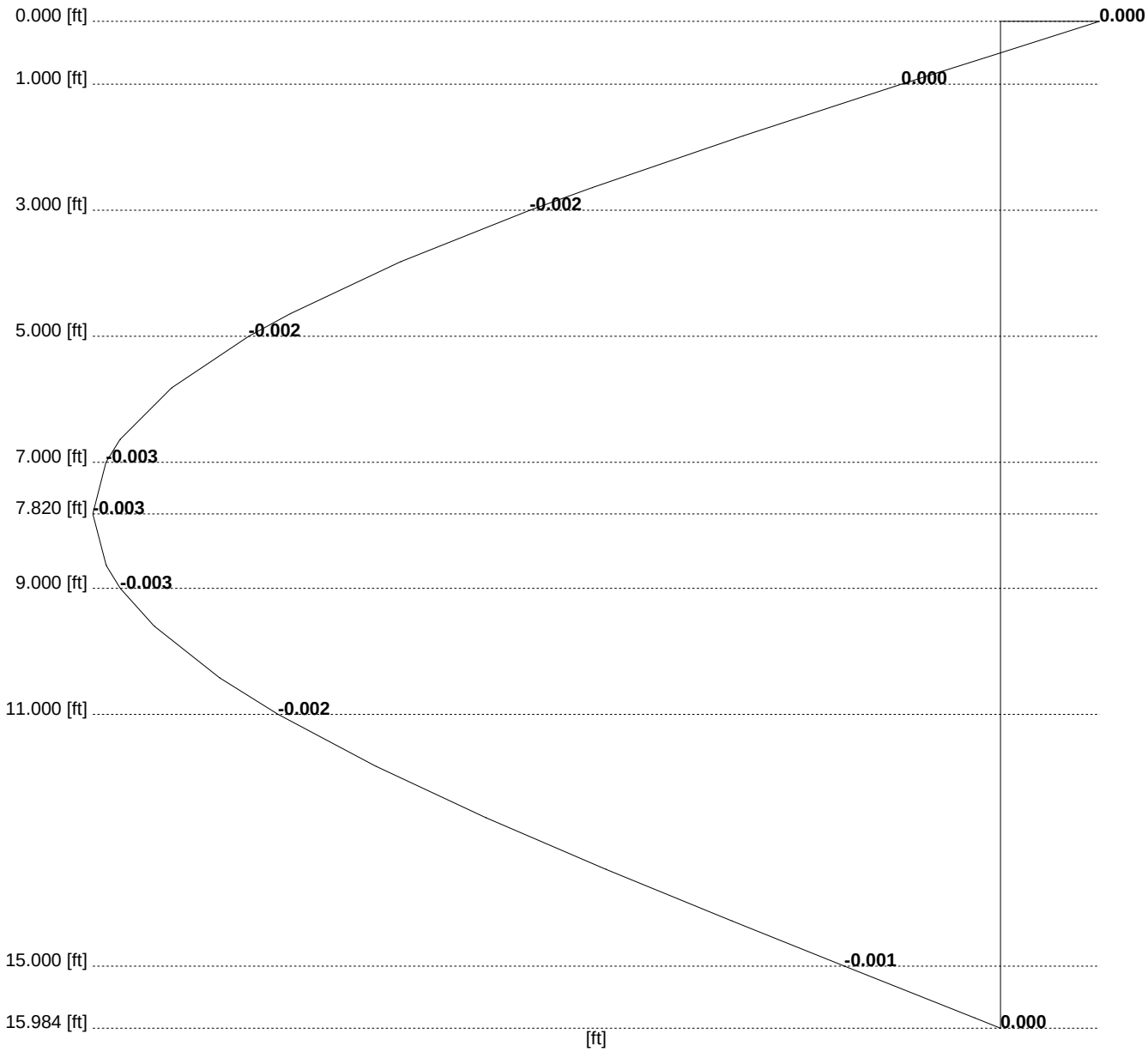
Deflection Diagram



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Sheet Pile Design According to Blum-Method

Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track

Project Name:	HAM562-0026C
Date:	1/20/2016
Author:	SNH
Company:	
Comment:	PHASE AB: Section 2 - Waler Braced @ 16.75' from CL of track, Section 4 - Pile/Waler Braced @ 10.09' from CL of track

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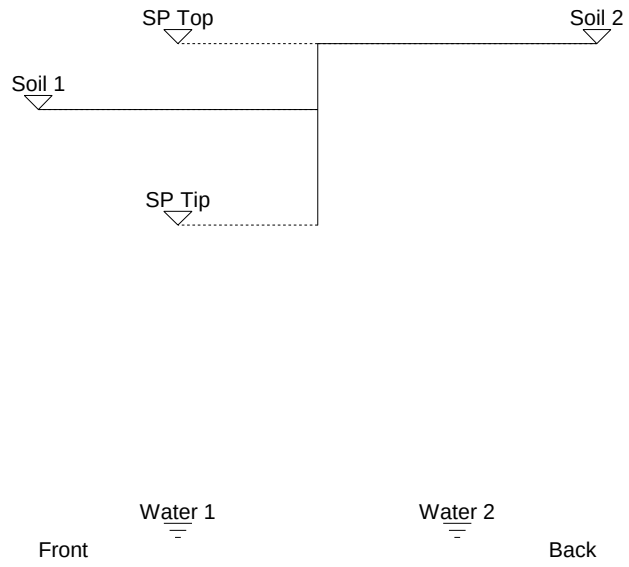
Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	15.137
Soil Level in Front [ft]	5.500
Soil Level behind [ft]	0.000
Anchorlevel [ft]	0.000
Water Level in Front [ft]	40.000
Water Level behind [ft]	40.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



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Soil Layers

Layers in Front

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	3.120	31.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	0.330	31.000	0.000	0.000

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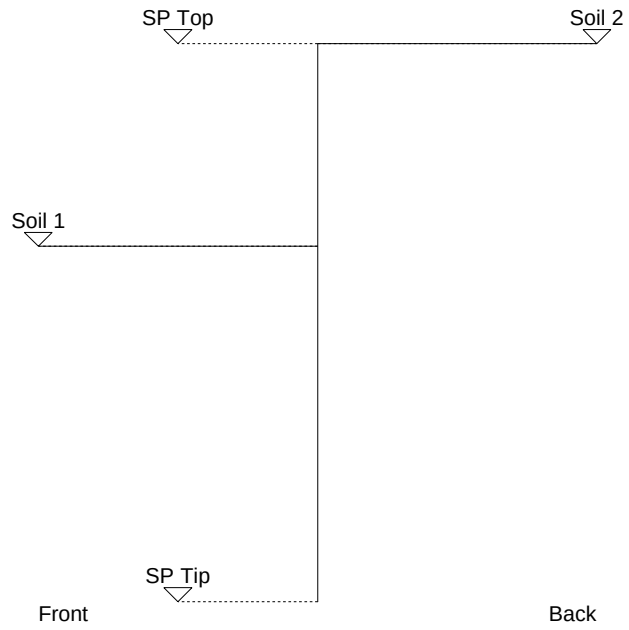
Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]



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Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.077	0.000	1.000
Strip 2	0.077	0.216	1.000	3.000
Strip 3	0.216	0.319	3.000	5.000
Strip 4	0.319	0.378	5.000	7.000
Strip 5	0.378	0.397	7.000	9.000
Strip 6	0.397	0.388	9.000	11.000
Strip 7	0.388	0.329	11.000	15.000
Strip 8	0.329	0.113	15.000	31.000
Strip 9	0.113	0.061	31.000	41.000

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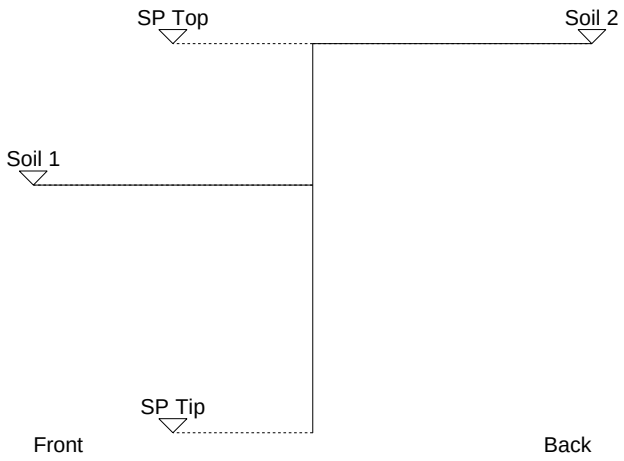
Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



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Pile Section

Name	AZ 36-700N
Inertia [in4/ft]	656.193
Modulus [in3/ft]	66.774
Area [in2/ft]	10.200
Mass [lbs/ft2]	34.716
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

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All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	-0.006	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.820	-0.005	-0.001	0.040	0.011	0.097	0.000	0.034	0.000	0.063
0.820	-0.005	-0.001	0.040	0.011	0.097	0.000	0.034	0.000	0.063
1.000	-0.005	-0.001	0.059	0.020	0.118	0.000	0.041	0.000	0.077
1.000	-0.005	-0.001	0.059	0.020	0.118	0.000	0.041	0.000	0.077
1.820	-0.005	-0.001	0.193	0.118	0.209	0.000	0.075	0.000	0.134
1.820	-0.005	-0.001	0.193	0.118	0.209	0.000	0.075	0.000	0.134
2.640	-0.004	-0.001	0.402	0.357	0.300	0.000	0.109	0.000	0.191
2.640	-0.004	-0.001	0.402	0.357	0.300	0.000	0.109	0.000	0.191
3.000	-0.004	-0.001	0.517	0.522	0.340	0.000	0.124	0.000	0.216
3.000	-0.004	-0.001	0.517	0.522	0.340	0.000	0.124	0.000	0.216
3.820	-0.004	-0.001	0.827	1.069	0.416	0.000	0.158	0.000	0.258
3.820	-0.004	-0.001	0.827	1.069	0.416	0.000	0.158	0.000	0.258
4.640	-0.003	-0.001	1.199	1.896	0.492	0.000	0.191	0.000	0.300
4.640	-0.003	-0.001	1.199	1.896	0.492	0.000	0.191	0.000	0.300
5.000	-0.003	-0.001	1.382	2.360	0.525	0.000	0.206	0.000	0.319
5.000	-0.003	-0.001	1.382	2.360	0.525	0.000	0.206	0.000	0.319
5.500	-0.003	-0.001	1.654	3.118	0.561	0.000	0.227	0.000	0.334
5.500	-0.003	-0.001	1.654	3.118	0.561	0.000	0.227	0.000	0.334
6.320	-0.002	0.000	2.006	4.633	0.299	-0.320	0.261	0.000	0.358
6.320	-0.002	0.000	2.006	4.633	0.299	-0.320	0.261	0.000	0.358
7.000	-0.002	0.000	2.135	6.049	0.082	-0.585	0.289	0.000	0.378
7.000	-0.002	0.000	2.135	6.049	0.082	-0.585	0.289	0.000	0.378
7.820	-0.002	0.000	2.088	7.797	-0.197	-0.905	0.323	0.000	0.386
7.820	-0.002	0.000	2.088	7.797	-0.197	-0.905	0.323	0.000	0.386
8.640	-0.001	0.000	1.813	9.412	-0.475	-1.225	0.356	0.000	0.394
8.640	-0.001	0.000	1.813	9.412	-0.475	-1.225	0.356	0.000	0.394
9.000	-0.001	0.000	1.620	10.031	-0.597	-1.365	0.371	0.000	0.397
9.000	-0.001	0.000	1.620	10.031	-0.597	-1.365	0.371	0.000	0.397
9.820	-0.001	0.000	1.012	11.127	-0.886	-1.685	0.405	0.000	0.393
9.820	-0.001	0.000	1.012	11.127	-0.886	-1.685	0.405	0.000	0.393
10.640	-0.001	0.000	0.166	11.626	-1.176	-2.005	0.439	0.000	0.390
10.640	-0.001	0.000	0.166	11.626	-1.176	-2.005	0.439	0.000	0.390
11.000	0.000	0.000	-0.280	11.607	-1.303	-2.145	0.454	0.000	0.388
11.000	0.000	0.000	-0.280	11.607	-1.303	-2.145	0.454	0.000	0.388
11.820	0.000	0.000	-1.471	10.906	-1.601	-2.465	0.488	0.000	0.376
11.820	0.000	0.000	-1.471	10.906	-1.601	-2.465	0.488	0.000	0.376
12.640	0.000	0.000	-2.907	9.128	-1.900	-2.785	0.521	0.000	0.364
12.640	0.000	0.000	-2.907	9.128	-1.900	-2.785	0.521	0.000	0.364
13.461	0.000	0.000	-4.587	6.071	-2.198	-3.105	0.555	0.000	0.352
13.461	0.000	0.000	-4.587	6.071	-2.198	-3.105	0.555	0.000	0.352
14.281	0.000	0.000	-6.512	1.536	-2.496	-3.425	0.589	0.000	0.340
14.281	0.000	0.000	-6.512	1.536	-2.496	-3.425	0.589	0.000	0.340
14.511	0.000	0.000	-7.094	-0.026	-2.579	-3.514	0.599	0.000	0.336

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Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	0.000	-0.006	14.511	0.000
Cross Force [kip/ft]	14.511	-7.094	7.000	2.135
Moment [kipft/ft]	14.543	-0.260	10.640	11.626

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Pile Check

		Depth [ft]
Name	AZ 36-700N	
Inertia [in4/ft]	656.193	
Modulus [in3/ft]	66.774	
Area [in2/ft]	10.200	
Mass [lbs/ft2]	34.716	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-0.260	14.543
Maxmimal Moment [kipft/ft]	11.626	10.640
Normal Forces at Max. Moment [kip/ft]	0.000	14.543
Normal Forces at Min. Moment [kip/ft]	0.000	10.640
Deflection at Min. Moment [ft]	0.000	14.543
Deflection at Max. Moment [ft]	-0.001	10.640
Min. Stress at Min. Moment [lb/in2]	-46.671	14.543
Max. Stress at Min. Moment [lb/in2]	46.671	14.543
Min. Stress at Max. Moment [lb/in2]	-2089.293	10.640
Max. Stress at Max. Moment [lb/in2]	2089.293	10.640
Safety > Req. Safety = 1.500	18.667	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	15.137	
Sheet Pile Length [ft]	15.137	
Included OverLength [ft]	0.626	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

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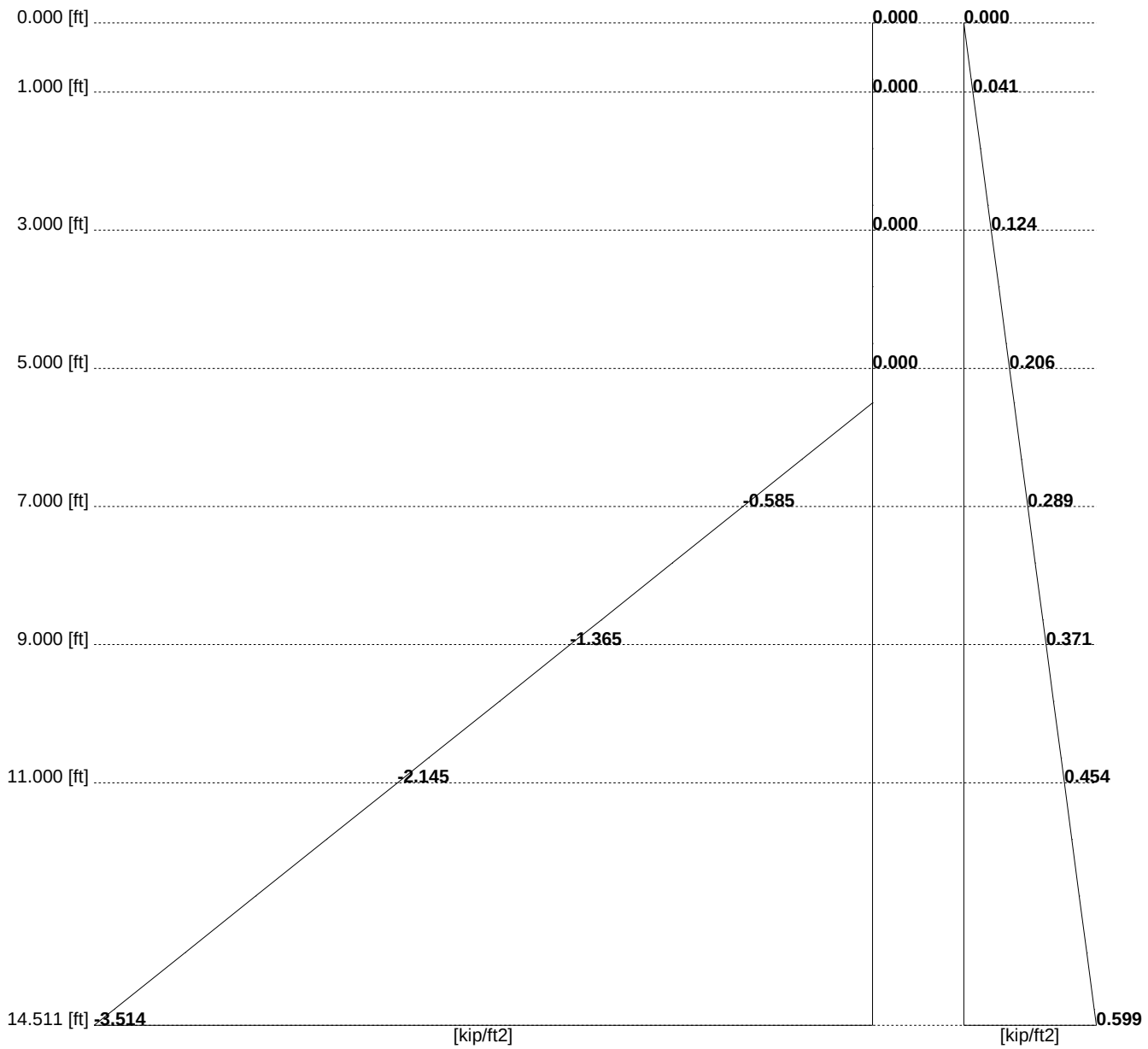
Earth Pressure Diagram



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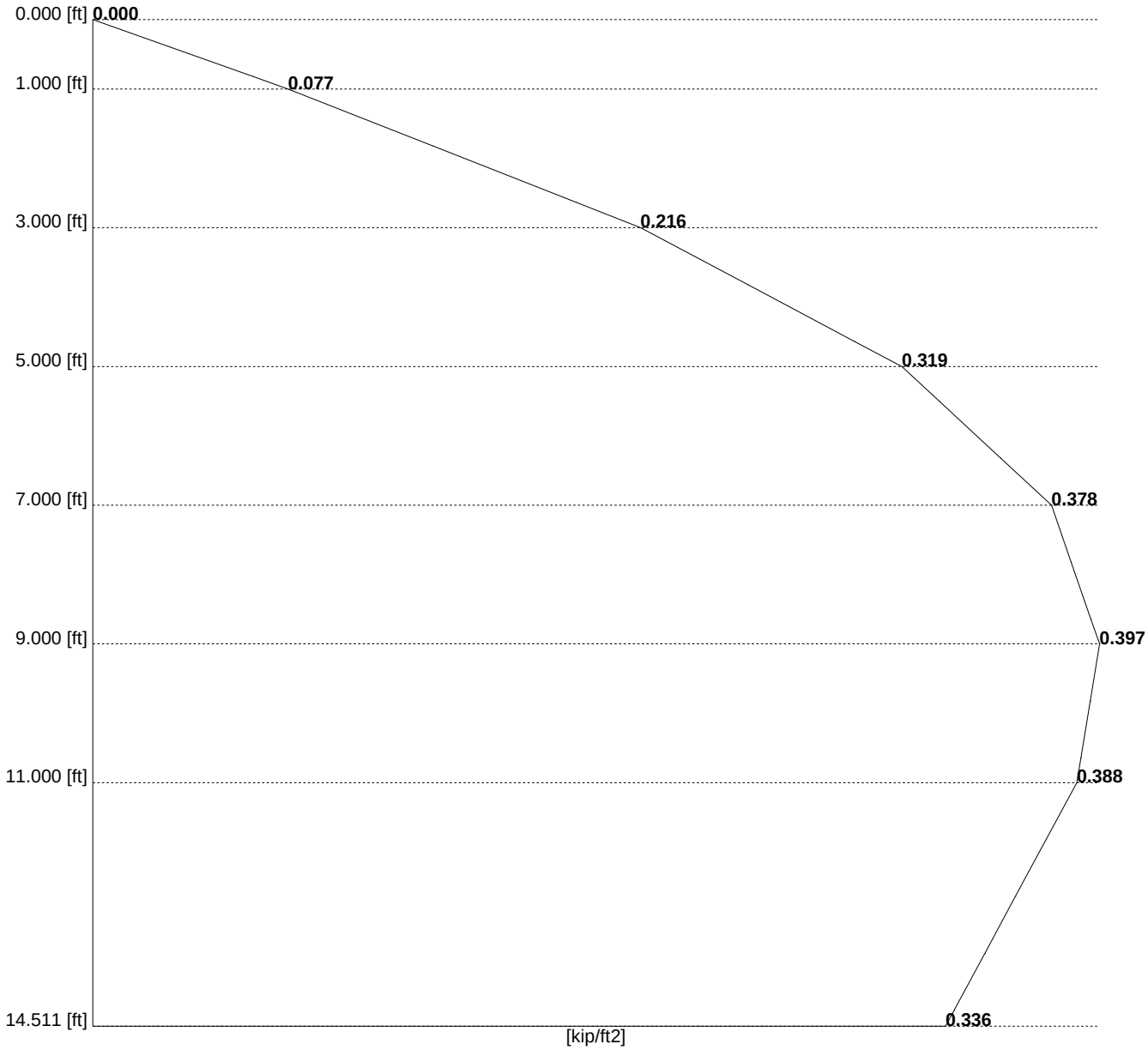
Userdefined Pressure Diagram



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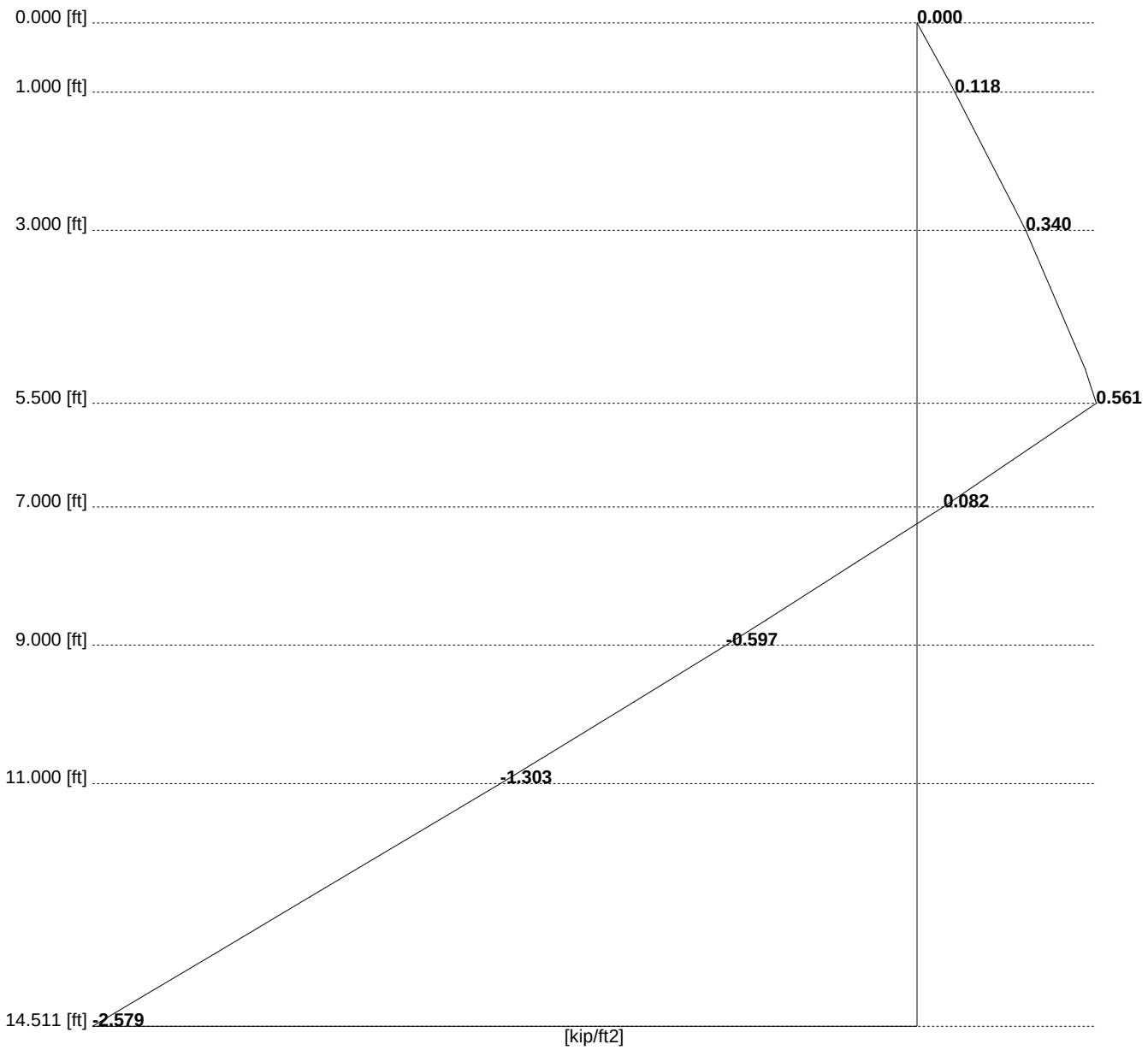
Total Pressure Diagram



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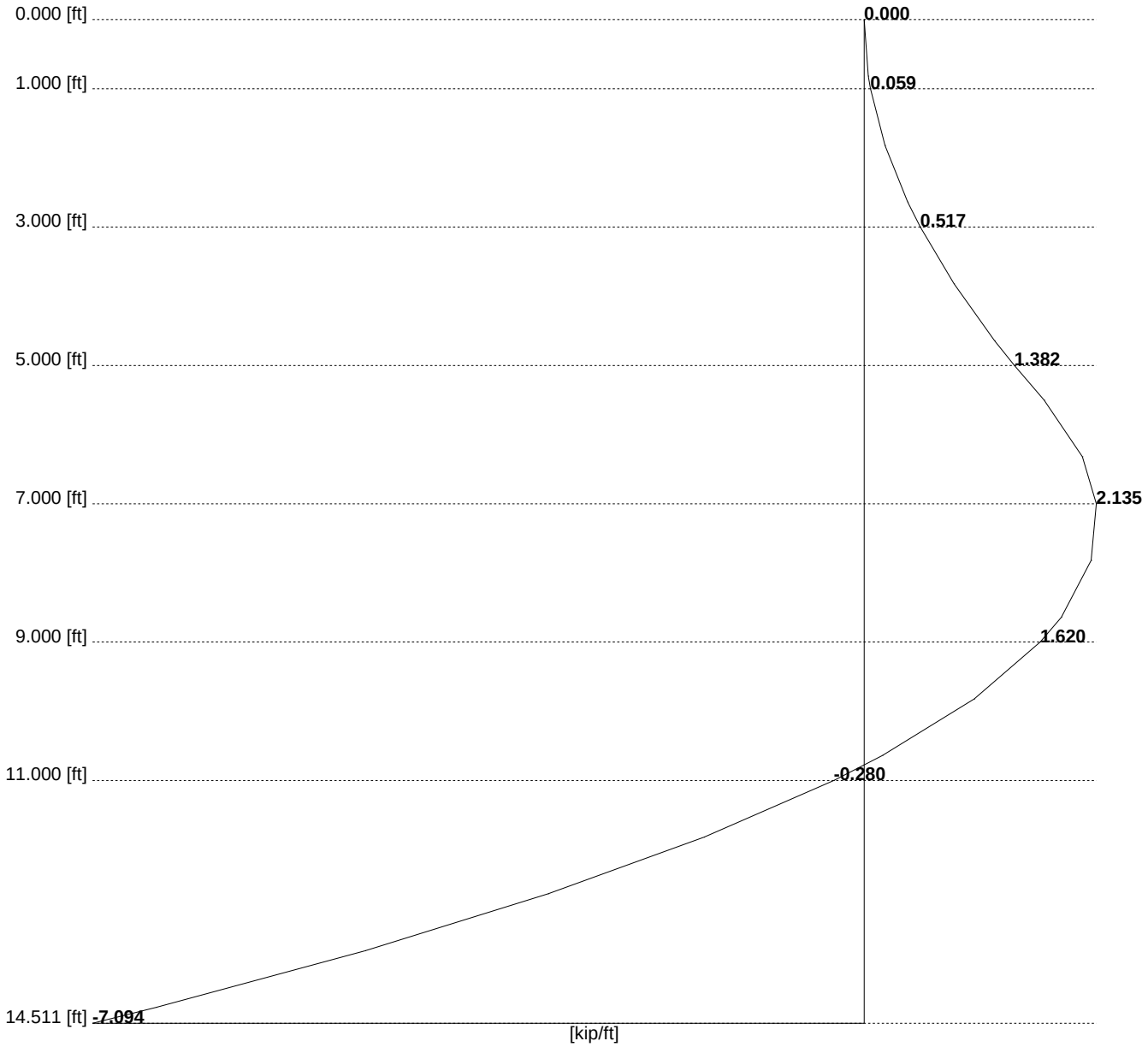
Cross Force Diagram



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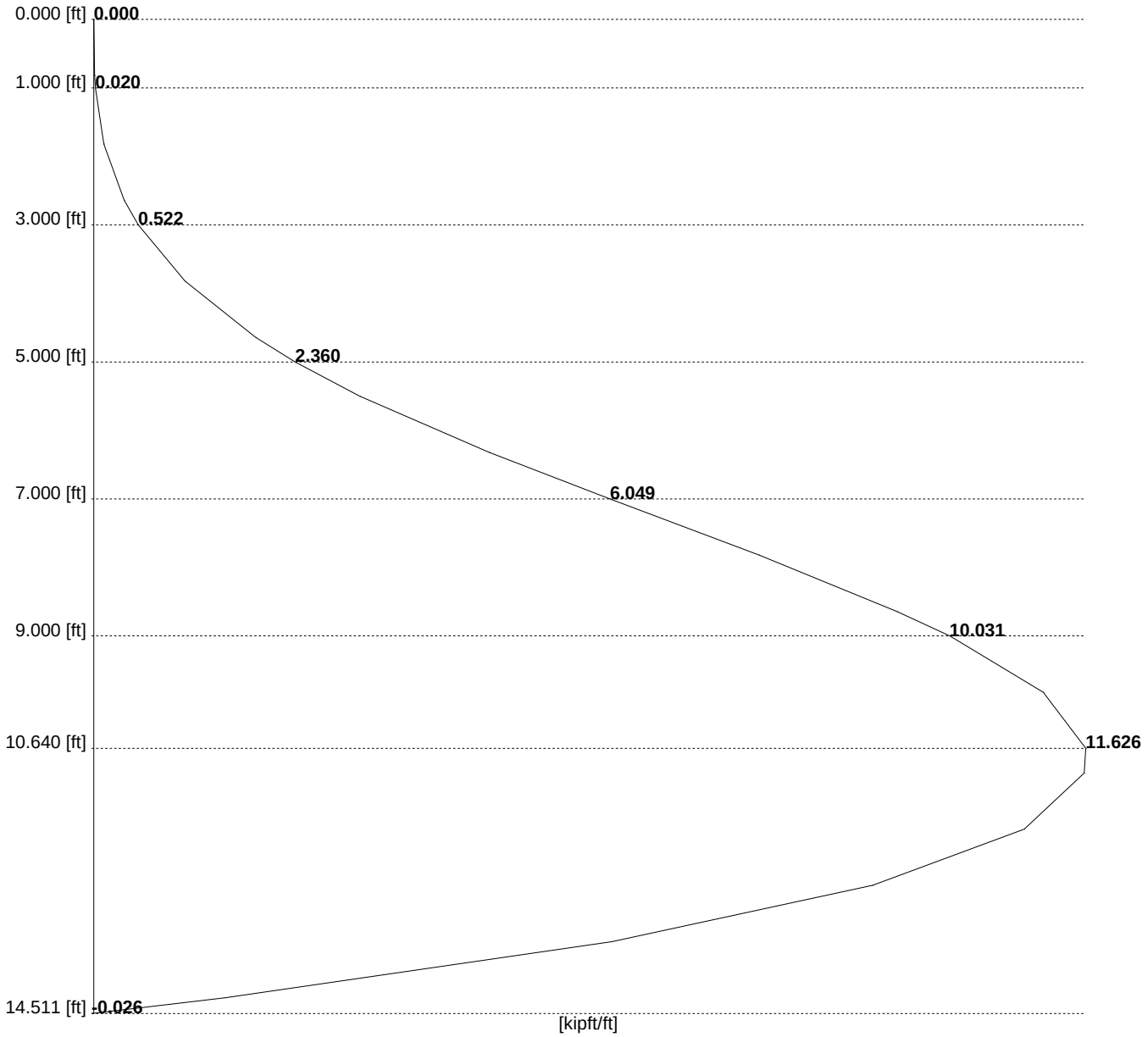
Moment Diagram



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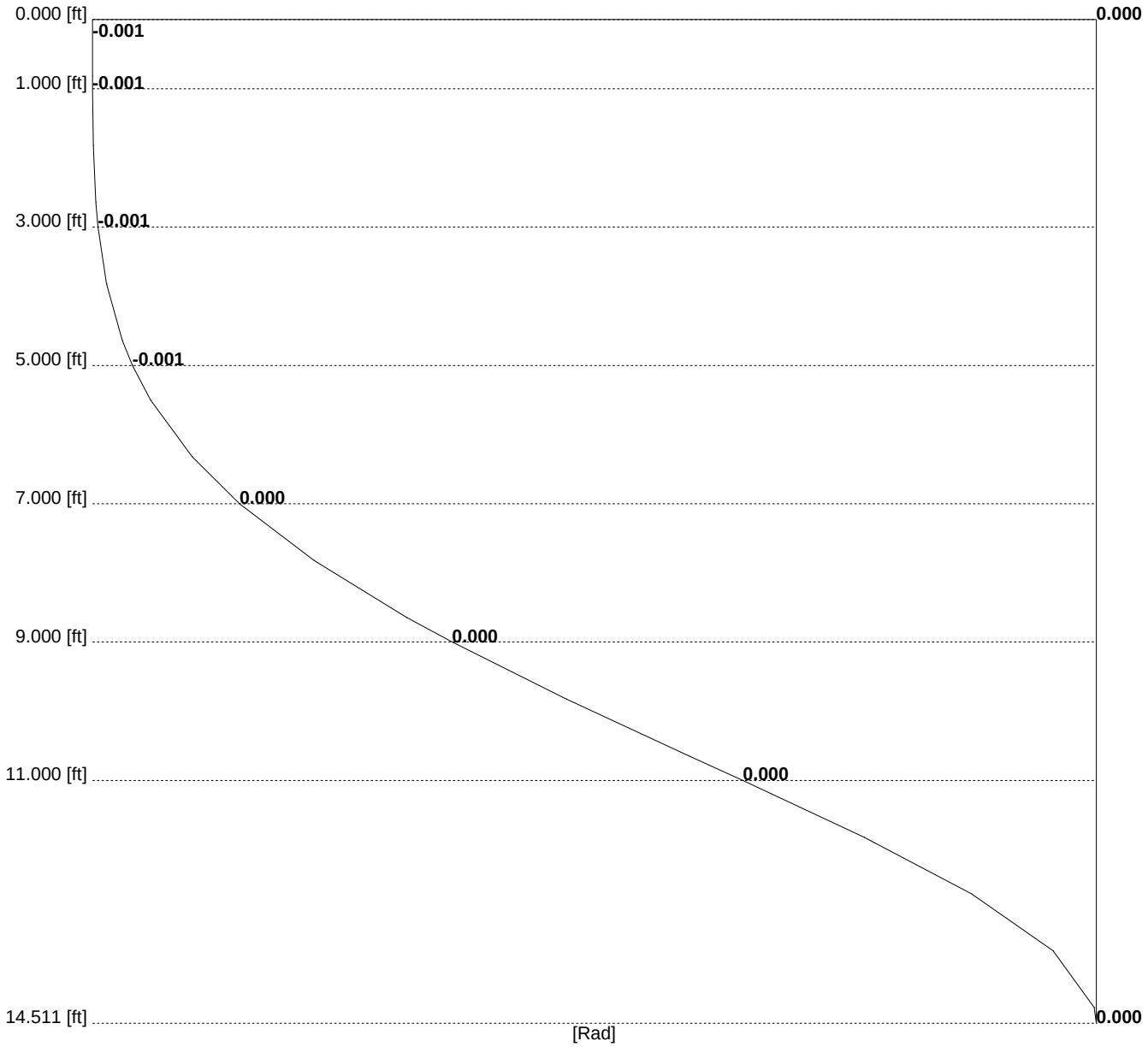
Rotation Diagram



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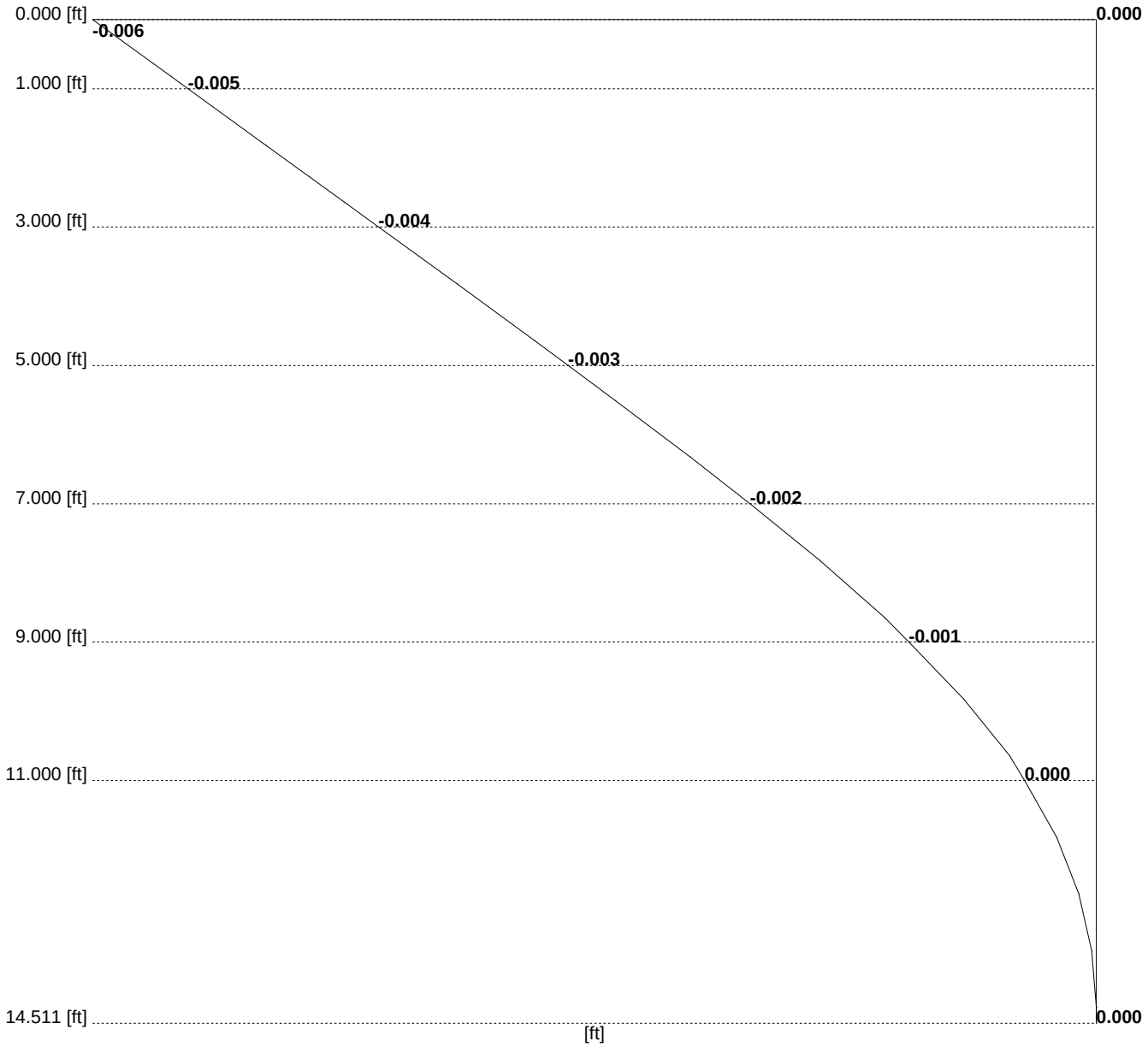
Deflection Diagram



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DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Sheet Piling	CALC NO.:	**HAM562_0026_13F**
	Prosheet	REV NO.:	**00**
FILE NAME(s):	*PROS_PhaseA&B_Forward.bak*	**SHEET:**	**1 OF 24**

SUPERSEDES CALC NO: N/A

CALCULATION DESCRIPTION:

This will analyze the shoring for Phase A&B Construction/Excavation at the forward abutment.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2014) Chapter 15
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	SNH	08/20/14	CTM	09/12/14

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
SNH	08/20/14	CTM	09/11/14	SNH	09/11/14	CTM	09/12/14

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered **As Promised**

Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

Lateral Pressure from Parallel Strip Loading

Lateral Pressure from Parallel Strip Loading

Calculations as per Norfolk Southern Design Standards

Min. Depth of Resulting Table (Hs_{min}):	1.00 ft	Centerline Track Distance 1, CLT_1:	18.40 ft
Max Depth of Resulting Table (Hs_{max}):	41.00 ft	Centerline Track Distance 2, CLT_2:	18.40 ft
Spacing of Max Axle Load:	5.0 ft	Centerline Track Distance 3, CLT_3:	18.40 ft
Max Axle Load:	80.0 kip	Centerline Track Distance 4, CLT_4:	18.40 ft
Width of Tie (TL):	8.5 ft	Applied Pressure (q):	1.88 ksf

Hs	**β** *(Radians)*				**α** *(Radians)*				*Active Pressure,* **Ps** *(psf)*			
	β_1	β_2	β_3	β_4	α_1	α_2	α_3	α_4	Ps_1	Ps_2	Ps_3	Ps_4
0.00 ft	0.0000	0.0000	0.0000	0.0000	1.5708	1.5708	1.5708	1.5708	0.00	0.00	0.00	0.00
1.00 ft	0.0264	0.0264	0.0264	0.0264	1.5135	1.5135	1.5135	1.5135	63.14	63.14	63.14	63.14
3.00 ft	0.0772	0.0772	0.0772	0.0772	1.4005	1.4005	1.4005	1.4005	179.71	179.71	179.71	179.71
5.00 ft	0.1224	0.1224	0.1224	0.1224	1.2923	1.2923	1.2923	1.2923	270.87	270.87	270.87	270.87
7.00 ft	0.1597	0.1597	0.1597	0.1597	1.1912	1.1912	1.1912	1.1912	329.53	329.53	329.53	329.53
9.00 ft	0.1883	0.1883	0.1883	0.1883	1.0984	1.0984	1.0984	1.0984	357.05	357.05	357.05	357.05
11.00 ft	0.2087	0.2087	0.2087	0.2087	1.0143	1.0143	1.0143	1.0143	359.84	359.84	359.84	359.84
13.00 ft	0.2220	0.2220	0.2220	0.2220	0.9387	0.9387	0.9387	0.9387	345.72	345.72	345.72	345.72
15.00 ft	0.2296	0.2296	0.2296	0.2296	0.8711	0.8711	0.8711	0.8711	321.65	321.65	321.65	321.65
17.00 ft	0.2328	0.2328	0.2328	0.2328	0.8106	0.8106	0.8106	0.8106	292.85	292.85	292.85	292.85
19.00 ft	0.2327	0.2327	0.2327	0.2327	0.7565	0.7565	0.7565	0.7565	262.86	262.86	262.86	262.86
21.00 ft	0.2302	0.2302	0.2302	0.2302	0.7081	0.7081	0.7081	0.7081	233.78	233.78	233.78	233.78
23.00 ft	0.2262	0.2262	0.2262	0.2262	0.6646	0.6646	0.6646	0.6646	206.78	206.78	206.78	206.78
25.00 ft	0.2211	0.2211	0.2211	0.2211	0.6256	0.6256	0.6256	0.6256	182.36	182.36	182.36	182.36
27.00 ft	0.2153	0.2153	0.2153	0.2153	0.5904	0.5904	0.5904	0.5904	160.64	160.64	160.64	160.64
29.00 ft	0.2091	0.2091	0.2091	0.2091	0.5585	0.5585	0.5585	0.5585	141.54	141.54	141.54	141.54
31.00 ft	0.2028	0.2028	0.2028	0.2028	0.5296	0.5296	0.5296	0.5296	124.86	124.86	124.86	124.86
33.00 ft	0.1964	0.1964	0.1964	0.1964	0.5033	0.5033	0.5033	0.5033	110.33	110.33	110.33	110.33
35.00 ft	0.1902	0.1902	0.1902	0.1902	0.4793	0.4793	0.4793	0.4793	97.71	97.71	97.71	97.71
37.00 ft	0.1840	0.1840	0.1840	0.1840	0.4573	0.4573	0.4573	0.4573	86.75	86.75	86.75	86.75
39.00 ft	0.1781	0.1781	0.1781	0.1781	0.4371	0.4371	0.4371	0.4371	77.22	77.22	77.22	77.22
41.00 ft	0.1724	0.1724	0.1724	0.1724	0.4185	0.4185	0.4185	0.4185	68.93	68.93	68.93	68.93

Note: The following two pages contain numerical and graphical representations of these loads over a selected area.

Gannett Fleming Engineers and Architects, P.C.
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Numerical Summary of Forces

To gain total forces, the area under the graph is required. The area under the graph for the considered depth is divided by the total considered depth to arrive at a uniformly applied lateral pressure on any surface in question. The total lateral force is the total area under the graph. Simpsons Rule is used to arrive at the total area under the graph (median value force over a height is used)

	Values at CLT Distances			
Data Below is intended to give summary values that can be used in the design of walls and surfaces affected by the surcharge. A graphical output is on the next page	CLT=18.4 ft	CLT=18.4 ft	CLT=18.4 ft	CLT=18.4 ft
Top of Wall (Min. Depth Considered): 0.00 ft	.0 psf	.0 psf	.0 psf	.0 psf
Bottom of Wall (Max. Depth Considered): 9.00 ft	357.1 psf	357.1 psf	357.1 psf	357.1 psf

The bottom of the exposed wall face is 9.00 feet below the bottom of the tie. The top of the fill behind the wall (applying lateral pressure) is 0.00 feet below the bottom of the tie. The height of exposed wall face with surcharge pressure applied is 9.00 feet.

Maximum Applied Lateral Pressure on limits of the wall				
Maximum Applied Lateral Pressure	357.1 psf	357.1 psf	357.1 psf	357.1 psf
Total Applied Lateral Pressure on limits of the wall *(as an equivilant point load)*				
Total Lateral Load (Per foot)	1.98 klf	1.98 klf	1.98 klf	1.98 klf
Centroid of Total Lateral Load (Distance down from zero)	4.99 ft	4.99 ft	4.99 ft	4.99 ft
Total Applied Moment due to Surcharge *(assumes fixed at max depth)*	7.9 k-ft	7.9 k-ft	7.9 k-ft	7.9 k-ft
Uniformly Applied Lateral Pressure on limits of the wall (For Lateral Stability) *(Total Applied Lateral Pressure **Thrust Controls;** Total lateral moment is not correct)*				
Uniformly Applied Lateral Load	220.0 psf	220.0 psf	220.0 psf	220.0 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	8.9 k-ft	8.9 k-ft	8.9 k-ft	8.9 k-ft
Difference in moment from that of the Total Point Load	12%	12%	12%	12%
Uniformly Applied Lateral Pressure on limits of the wall (For Moments/Deflectoins) *(Total Applied Lateral Pressure **Moment Controls;** Total lateral thrust is not correct)*				
Uniformly Applied Lateral Load	196.2 psf	196.2 psf	196.2 psf	196.2 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	7.9 k-ft	7.9 k-ft	7.9 k-ft	7.9 k-ft
Difference in moment from that of the Total Point Load	0%	0%	0%	0%
Total of Uniformly Applied Lateral Load	1.77 klf	1.77 klf	1.77 klf	1.77 klf
Difference in Load from that of the Total Point Load	-11%	-11%	-11%	-11%

Total Uniform Load to Approximate Dual Tracks on Wall	**392.5 psf**

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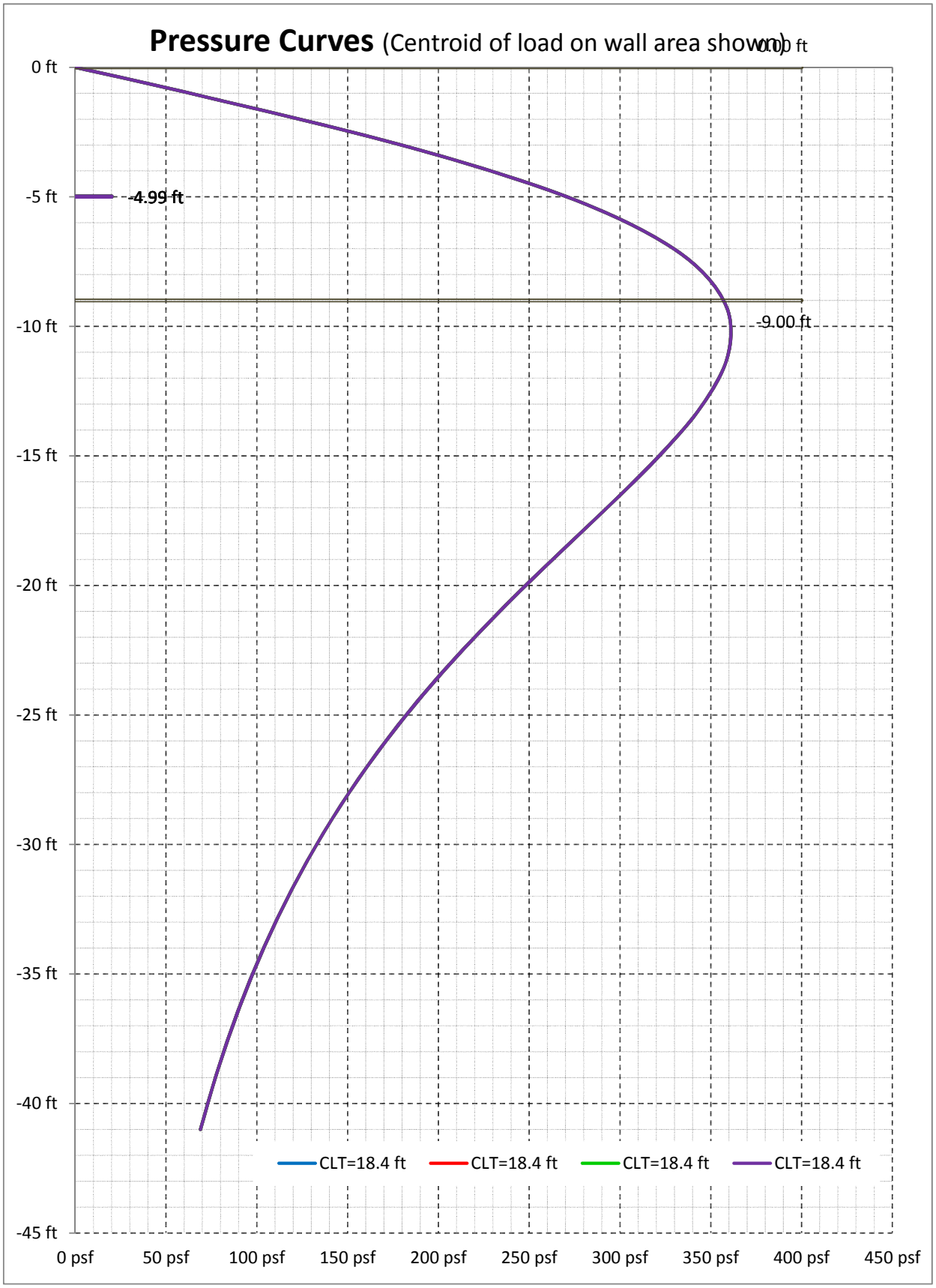

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L-Pile Loads on a 30" Wide Shaft should be entered as follows (depth is inches from pile head)

Shaft Width: 12.0 in
1.000 ft

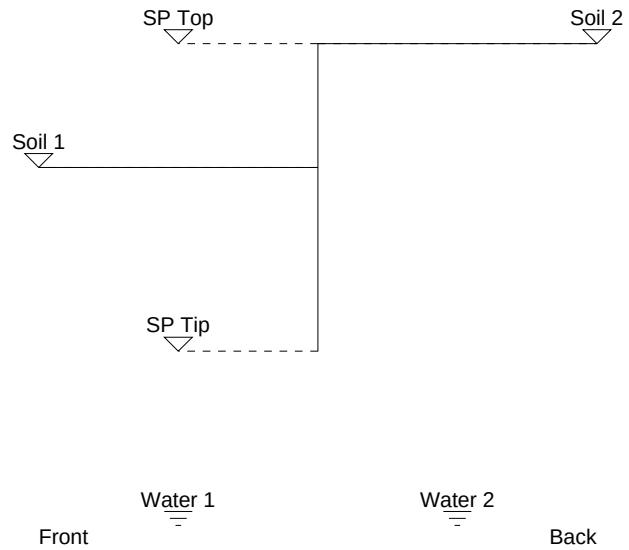
Depth	Depth	Last CLT column Lateral Load
0.00 ft	0.000 ft	0.000 ksf
1.00 ft	1.000 ft	0.063 ksf
3.00 ft	3.000 ft	0.180 ksf
5.00 ft	5.000 ft	0.271 ksf
7.00 ft	7.000 ft	0.330 ksf
9.00 ft	9.000 ft	0.357 ksf
11.00 ft	11.000 ft	0.360 ksf
15.00 ft	15.000 ft	0.322 ksf
31.00 ft	31.000 ft	0.125 ksf
41.00 ft	41.000 ft	0.069 ksf

Sheet Pile Design According to Blum-Method

Project Name:	HAM-532-0026C
Date:	11/11/2014
Author:	SNH
Company:	Gannett Fleming
Comment:	PHASE AB Forward Abutment - Unbraced
Project Name:	HAM-532-0026C
Date:	11/11/2014
Author:	SNH
Company:	Gannett Fleming
Comment:	PHASE AB Forward Abutment - Unbraced

Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	22.350
Soil Level in Front [ft]	9.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	0.000
Water Level in Front [ft]	34.000
Water Level behind [ft]	34.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



Soil Layers

Layers in Front

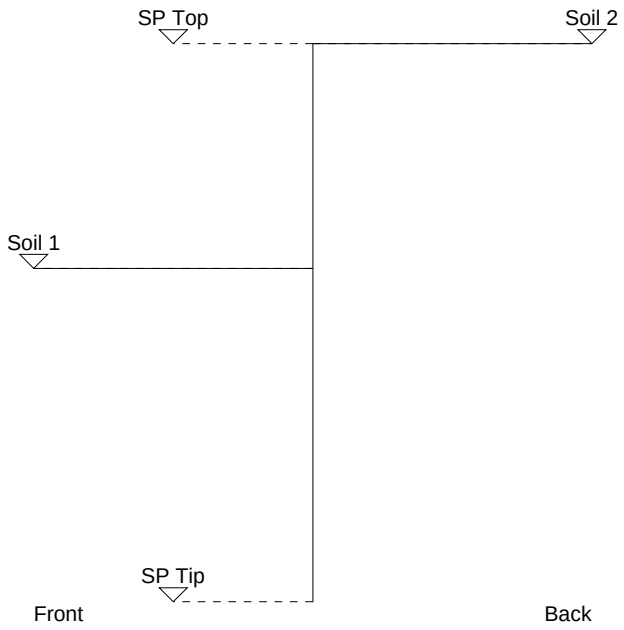
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	3.120	31.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	0.330	31.000	0.000	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]

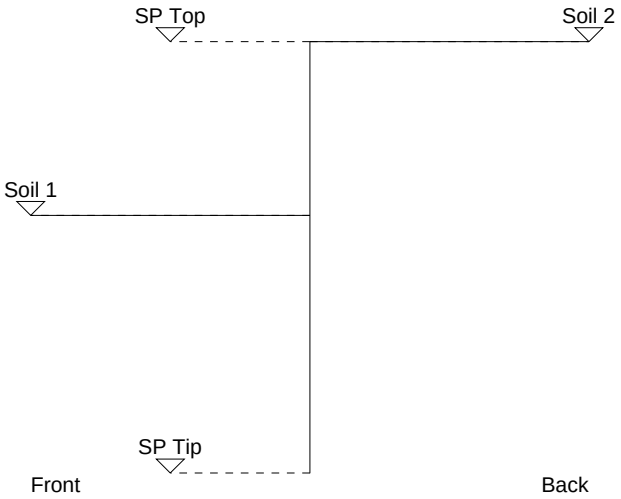


Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.063	0.000	1.000
Strip 2	0.063	0.180	1.000	3.000
Strip 3	0.180	0.271	3.000	5.000
Strip 4	0.271	0.330	5.000	7.000
Strip 5	0.330	0.357	7.000	9.000
Strip 6	0.357	0.360	9.000	11.000
Strip 7	0.360	0.322	11.000	15.000
Strip 8	0.322	0.125	15.000	31.000
Strip 9	0.125	0.069	31.000	41.000

Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



Pile Section

Name	AZ 36-700N
Inertia [in4/ft]	656.193
Modulus [in3/ft]	66.774
Area [in2/ft]	10.200
Mass [lbs/ft2]	34.716
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	-0.037	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.820	-0.035	-0.002	0.035	0.010	0.086	0.000	0.034	0.000	0.052
0.820	-0.035	-0.002	0.035	0.010	0.086	0.000	0.034	0.000	0.052
1.000	-0.035	-0.002	0.052	0.017	0.104	0.000	0.041	0.000	0.063
1.000	-0.035	-0.002	0.052	0.017	0.104	0.000	0.041	0.000	0.063
1.820	-0.033	-0.002	0.171	0.104	0.186	0.000	0.075	0.000	0.111
1.820	-0.033	-0.002	0.171	0.104	0.186	0.000	0.075	0.000	0.111
2.640	-0.031	-0.002	0.357	0.317	0.268	0.000	0.109	0.000	0.159
2.640	-0.031	-0.002	0.357	0.317	0.268	0.000	0.109	0.000	0.159
3.000	-0.030	-0.002	0.460	0.463	0.304	0.000	0.124	0.000	0.180
3.000	-0.030	-0.002	0.460	0.463	0.304	0.000	0.124	0.000	0.180
3.820	-0.028	-0.002	0.738	0.951	0.375	0.000	0.158	0.000	0.217
3.820	-0.028	-0.002	0.738	0.951	0.375	0.000	0.158	0.000	0.217
4.640	-0.026	-0.002	1.075	1.690	0.446	0.000	0.191	0.000	0.255
4.640	-0.026	-0.002	1.075	1.690	0.446	0.000	0.191	0.000	0.255
5.000	-0.025	-0.002	1.241	2.107	0.477	0.000	0.206	0.000	0.271
5.000	-0.025	-0.002	1.241	2.107	0.477	0.000	0.206	0.000	0.271
5.820	-0.023	-0.002	1.656	3.292	0.535	0.000	0.240	0.000	0.295
5.820	-0.023	-0.002	1.656	3.292	0.535	0.000	0.240	0.000	0.295
6.640	-0.021	-0.002	2.119	4.837	0.593	0.000	0.274	0.000	0.319
6.640	-0.021	-0.002	2.119	4.837	0.593	0.000	0.274	0.000	0.319
7.000	-0.020	-0.002	2.337	5.638	0.619	0.000	0.289	0.000	0.330
7.000	-0.020	-0.002	2.337	5.638	0.619	0.000	0.289	0.000	0.330
7.820	-0.018	-0.002	2.863	7.768	0.664	0.000	0.323	0.000	0.341
7.820	-0.018	-0.002	2.863	7.768	0.664	0.000	0.323	0.000	0.341
8.640	-0.016	-0.002	3.426	10.344	0.709	0.000	0.356	0.000	0.352
8.640	-0.016	-0.002	3.426	10.344	0.709	0.000	0.356	0.000	0.352
9.000	-0.016	-0.002	3.684	11.622	0.728	0.000	0.371	0.000	0.357
9.000	-0.016	-0.002	3.684	11.622	0.728	0.000	0.371	0.000	0.357
9.820	-0.014	-0.002	4.165	14.857	0.443	-0.320	0.405	0.000	0.358
9.820	-0.014	-0.002	4.165	14.857	0.443	-0.320	0.405	0.000	0.358
10.640	-0.012	-0.002	4.411	18.390	0.159	-0.640	0.439	0.000	0.359
10.640	-0.012	-0.002	4.411	18.390	0.159	-0.640	0.439	0.000	0.359
11.000	-0.011	-0.002	4.446	19.984	0.034	-0.780	0.454	0.000	0.360
11.000	-0.011	-0.002	4.446	19.984	0.034	-0.780	0.454	0.000	0.360
11.820	-0.010	-0.002	4.353	23.609	-0.260	-1.100	0.488	0.000	0.352
11.820	-0.010	-0.002	4.353	23.609	-0.260	-1.100	0.488	0.000	0.352
12.640	-0.008	-0.002	4.019	27.059	-0.554	-1.420	0.521	0.000	0.344
12.640	-0.008	-0.002	4.019	27.059	-0.554	-1.420	0.521	0.000	0.344
13.461	-0.006	-0.002	3.445	30.137	-0.848	-1.740	0.555	0.000	0.337
13.461	-0.006	-0.002	3.445	30.137	-0.848	-1.740	0.555	0.000	0.337
14.281	-0.005	-0.001	2.629	32.644	-1.142	-2.060	0.589	0.000	0.329
14.281	-0.005	-0.001	2.629	32.644	-1.142	-2.060	0.589	0.000	0.329
15.000	-0.004	-0.001	1.715	34.217	-1.399	-2.340	0.619	0.000	0.322
15.000	-0.004	-0.001	1.715	34.217	-1.399	-2.340	0.619	0.000	0.322
15.820	-0.003	-0.001	0.446	35.120	-1.695	-2.660	0.653	0.000	0.312
15.820	-0.003	-0.001	0.446	35.120	-1.695	-2.660	0.653	0.000	0.312
16.640	-0.002	-0.001	-1.066	34.882	-1.992	-2.980	0.686	0.000	0.302
16.640	-0.002	-0.001	-1.066	34.882	-1.992	-2.980	0.686	0.000	0.302
17.461	-0.001	-0.001	-2.821	33.305	-2.288	-3.300	0.720	0.000	0.292
17.461	-0.001	-0.001	-2.821	33.305	-2.288	-3.300	0.720	0.000	0.292
18.281	-0.001	0.000	-4.819	30.188	-2.584	-3.620	0.754	0.000	0.282
18.281	-0.001	0.000	-4.819	30.188	-2.584	-3.620	0.754	0.000	0.282
19.101	0.000	0.000	-7.059	25.333	-2.880	-3.939	0.788	0.000	0.272
19.101	0.000	0.000	-7.059	25.333	-2.880	-3.939	0.788	0.000	0.272
19.921	0.000	0.000	-9.543	18.541	-3.176	-4.259	0.822	0.000	0.261
19.921	0.000	0.000	-9.543	18.541	-3.176	-4.259	0.822	0.000	0.261
20.742	0.000	0.000	-12.270	9.612	-3.472	-4.579	0.856	0.000	0.251
20.742	0.000	0.000	-12.270	9.612	-3.472	-4.579	0.856	0.000	0.251
21.463	0.000	0.000	-14.870	-0.171	-3.733	-4.861	0.885	0.000	0.242

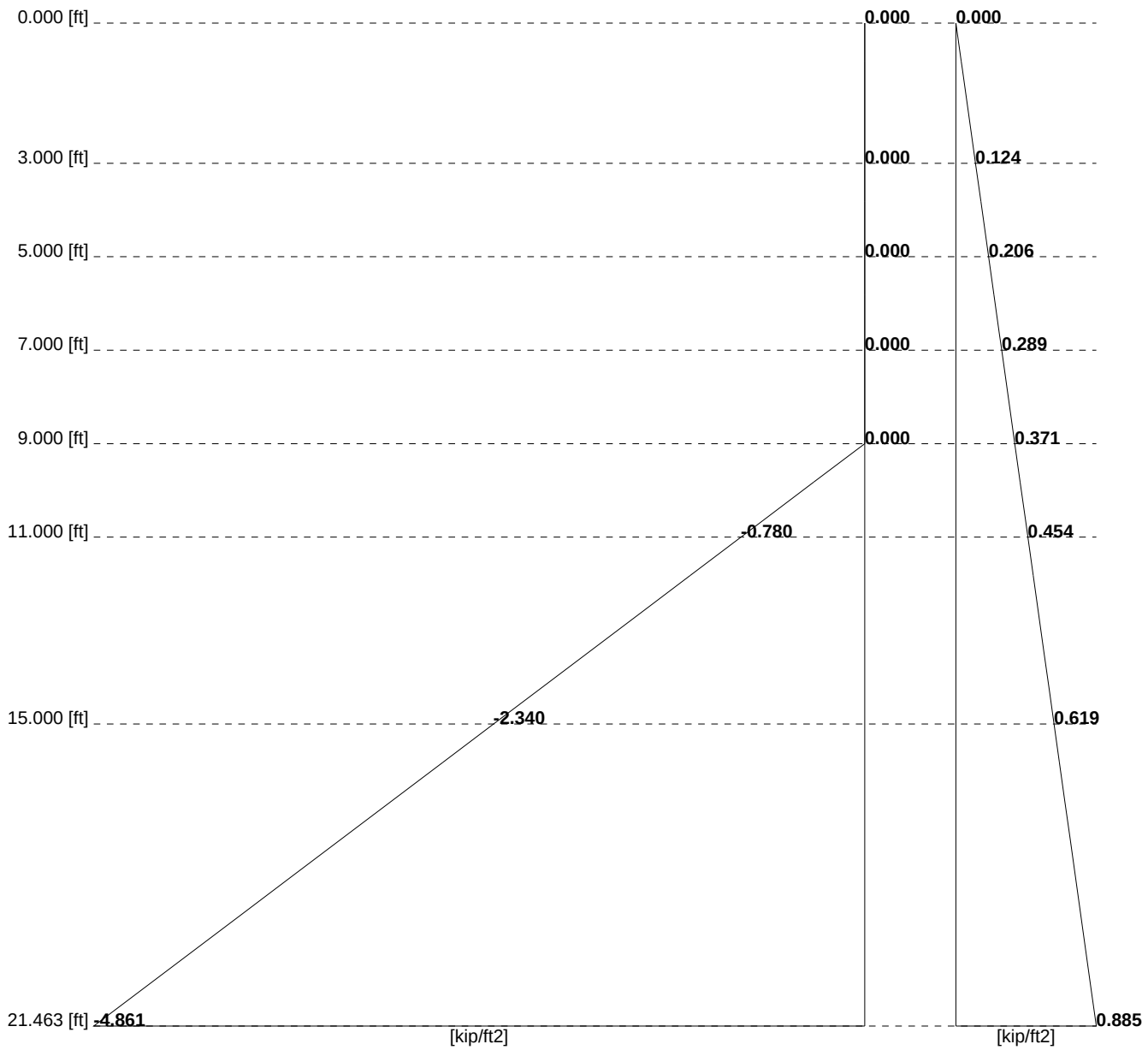
Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	0.000	-0.037	21.463	0.000
Cross Force [kip/ft]	21.463	-14.870	11.000	4.446
Moment [kipft/ft]	21.496	-0.661	15.820	35.120

Pile Check

		Depth [ft]
Name	AZ 36-700N	
Inertia [in4/ft]	656.193	
Modulus [in3/ft]	66.774	
Area [in2/ft]	10.200	
Mass [lbs/ft2]	34.716	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-0.661	21.496
Maxmimal Moment [kipft/ft]	35.120	15.820
Normal Forces at Max. Moment [kip/ft]	0.000	21.496
Normal Forces at Min. Moment [kip/ft]	0.000	15.820
Deflection at Min. Moment [ft]	0.000	21.496
Deflection at Max. Moment [ft]	-0.003	15.820
Min. Stress at Min. Moment [lb/in2]	-118.784	21.496
Max. Stress at Min. Moment [lb/in2]	118.784	21.496
Min. Stress at Max. Moment [lb/in2]	-6311.150	15.820
Max. Stress at Max. Moment [lb/in2]	6311.150	15.820
Safety > Req. Safety = 1.500	6.180	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	22.350	
Sheet Pile Length [ft]	22.350	
Included OverLength [ft]	0.887	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	

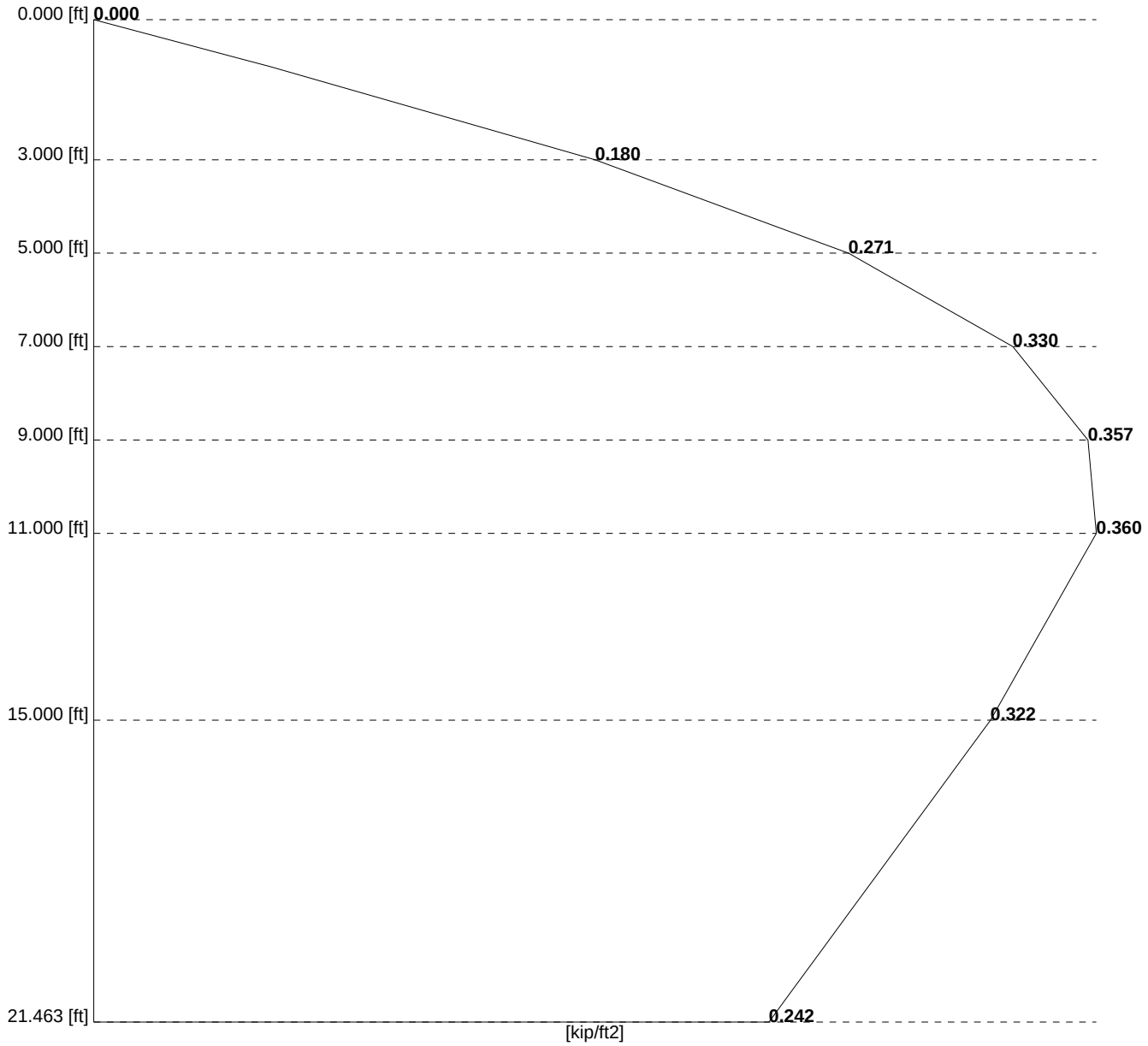
Earth Pressure Diagram



Water Pressure Diagram

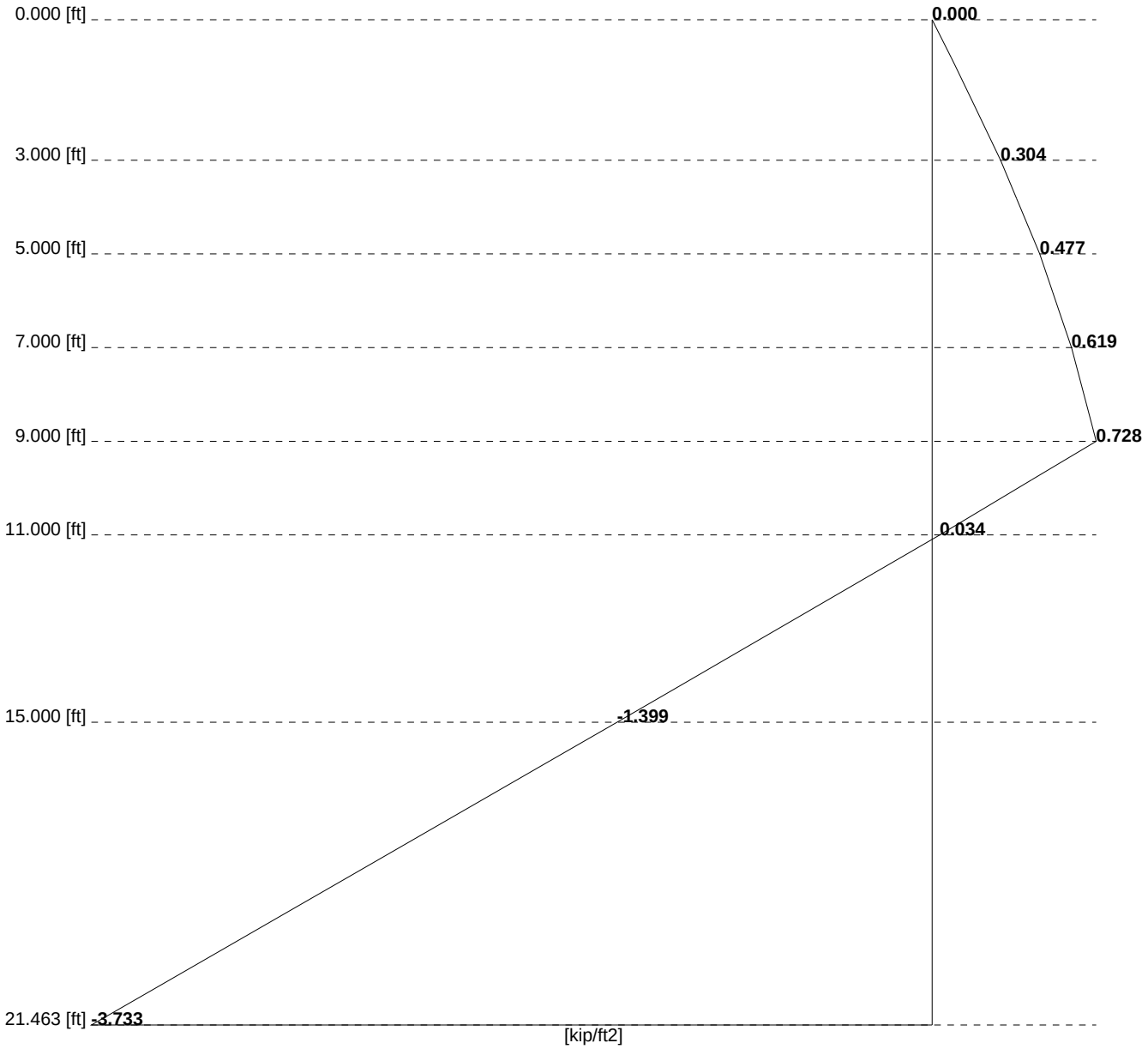
0.000 [ft]	**0.000**
3.000 [ft]	**0.000**
5.000 [ft]	**0.000**
7.000 [ft]	**0.000**
9.000 [ft]	**0.000**
11.000 [ft]	**0.000**
15.000 [ft]	**0.000**
21.463 [ft]	**0.000**
	[kip/ft2]

Userdefined Pressure Diagram

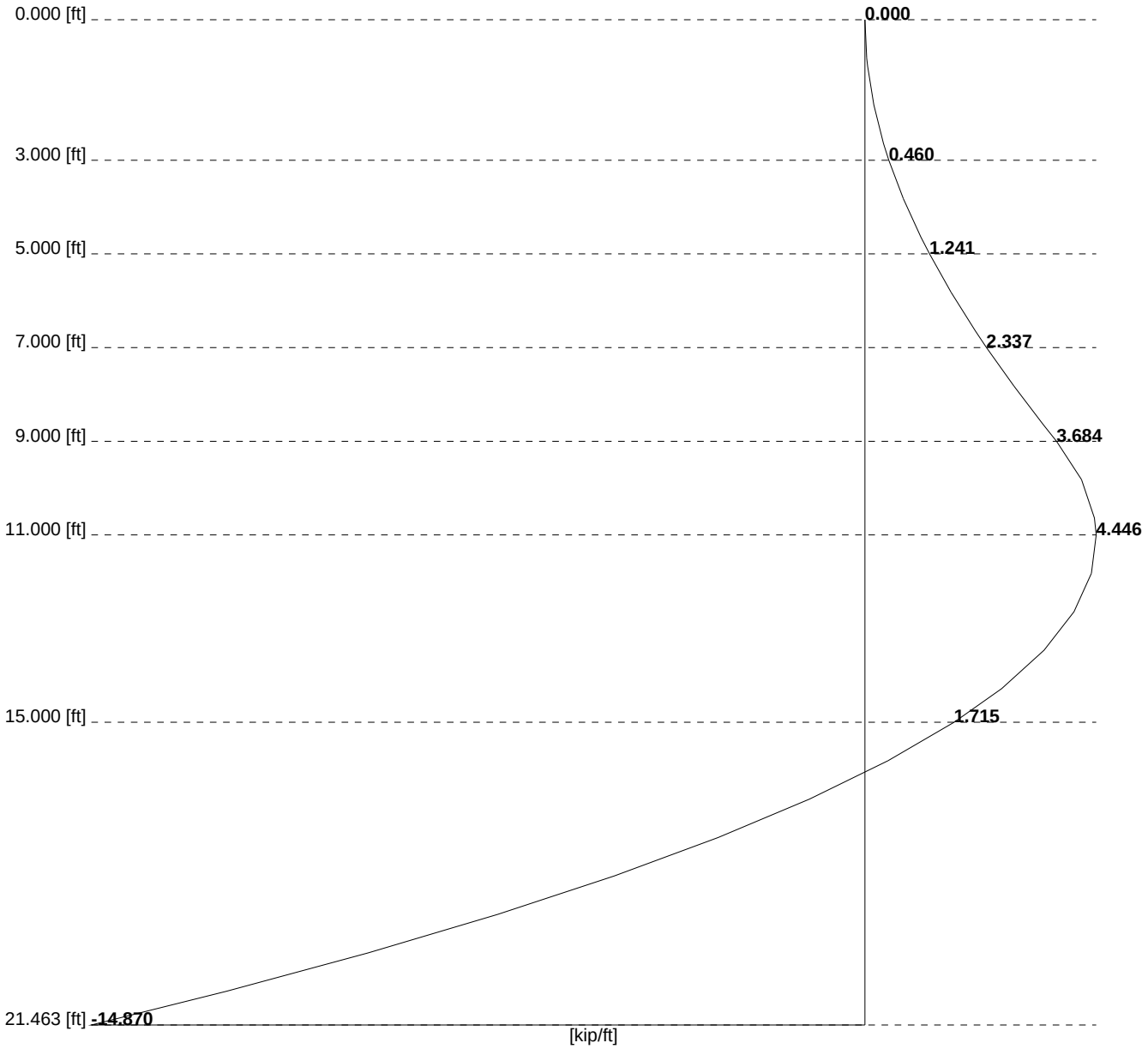


Boussinesq Diagram

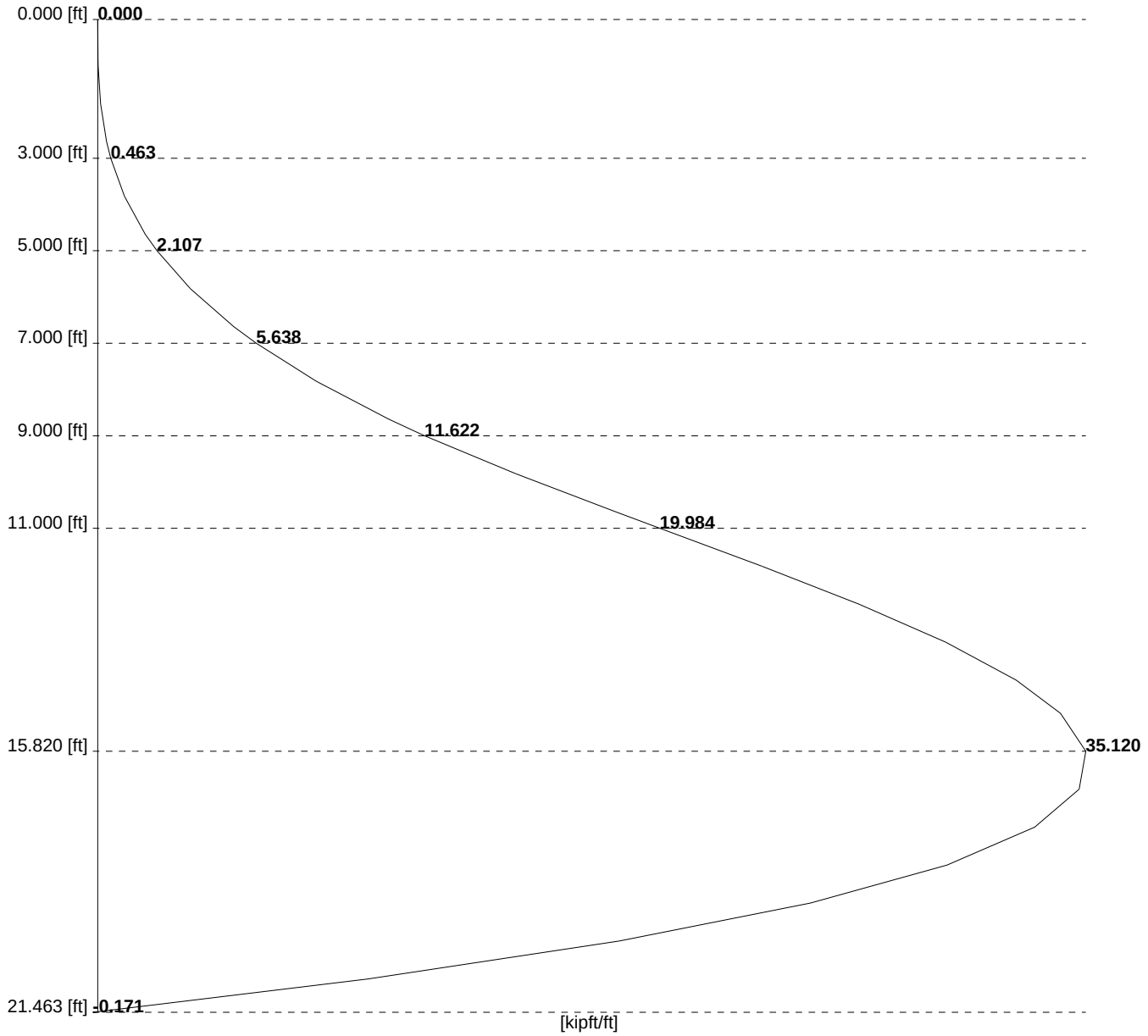
Total Pressure Diagram



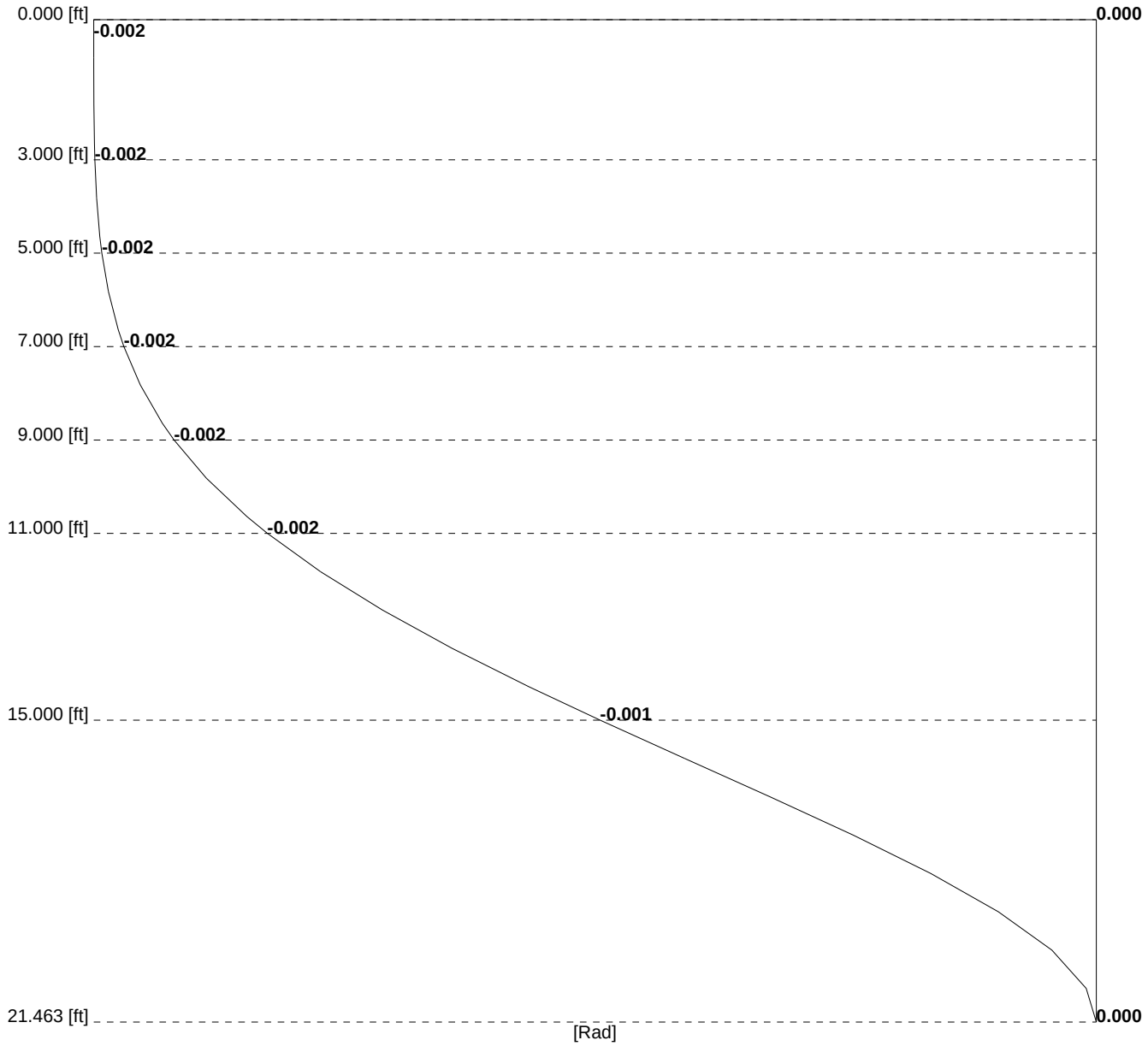
Cross Force Diagram



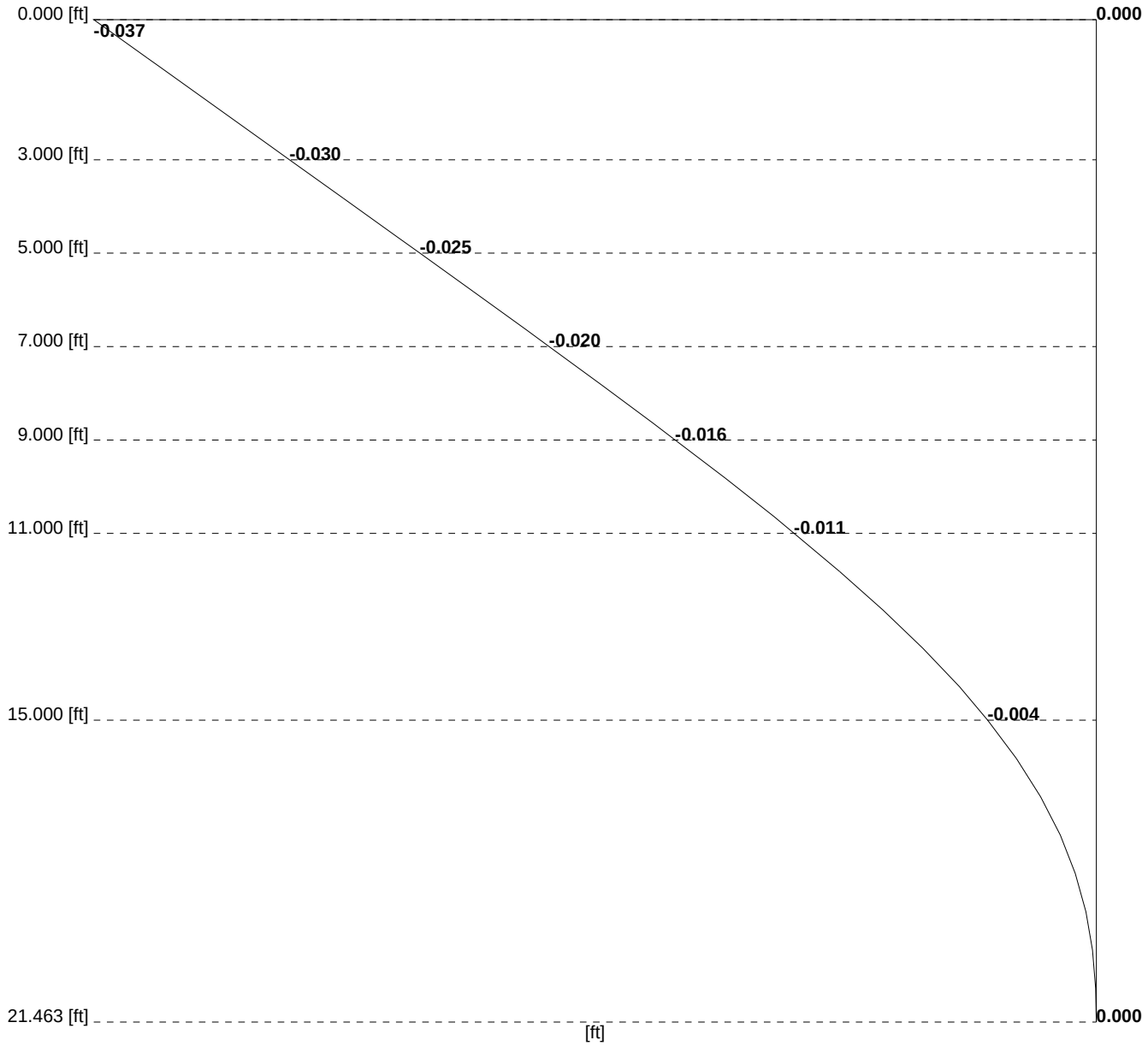
Moment Diagram



Rotation Diagram



Deflection Diagram



DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT: **ODOT/EMH&T: HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
SUBJECT: ***Analysis***
Sheet Piling
Prosheet
FILE NAME(s): *PROS_PhaseC&D_Rear.bak*

ODOT PID NO: *77889*
EMH&T JOB NO:
GF JOB NO: 54682
CALC NO.: **HAM562_0026_14R**
REV NO.: **01**
SHEET: 1 OF 24

SUPERSEDES CALC NO: N/A

CALCULATION DESCRIPTION:

This will analyze the shoring for Phase C&D Construction/Excavation at the rear abutment.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2014) Chapter 15
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	SNH	08/20/14	CTM	09/12/14
01	Stage 3 Calculation	SNH	05/27/15	VDT	06/03/15

RECORD OF CHECK OF CURRENT CALCULATION VERSION

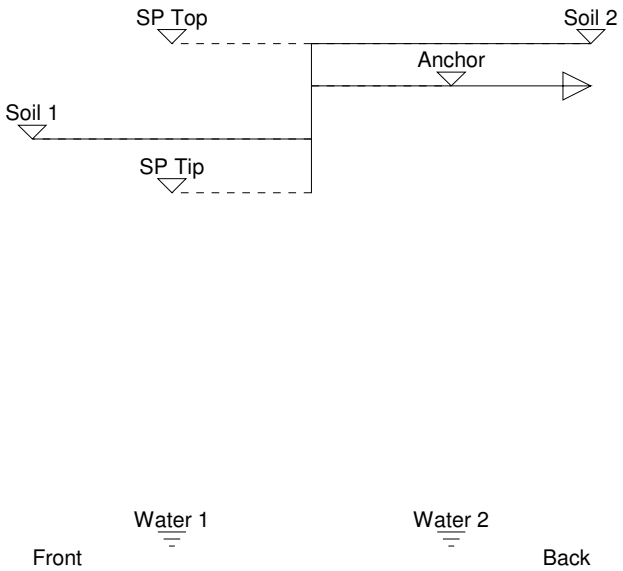
BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
SNH	05/27/15	VDT	06/01/15	SNH	06/02/15	VDT	06/03/15

Sheet Pile Design According to Blum-Method

Project Name:	HAM562-0026C
Date:	9/12/2014
Author:	SNH
Company:	
Comment:	PHASE CD - Rear Abutment: Waler/Raker Braced Sheeting

Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	14.051
Soil Level in Front [ft]	9.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	46.000
Water Level behind [ft]	46.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

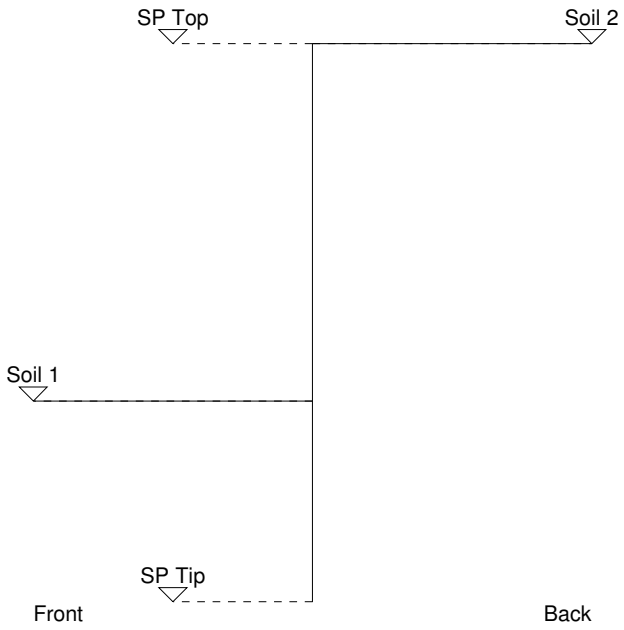
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	3.000	30.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.110	0.048	0.333	30.000	0.000	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]

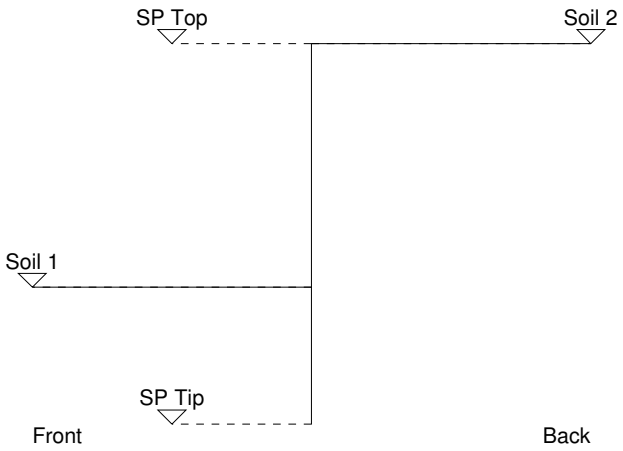


Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.234	0.000	1.000
Strip 2	0.234	0.564	1.000	3.000
Strip 3	0.564	0.663	3.000	5.000
Strip 4	0.663	0.621	5.000	7.000
Strip 5	0.621	0.529	7.000	9.000
Strip 6	0.529	0.431	9.000	11.000
Strip 7	0.431	0.277	11.000	15.000
Strip 8	0.277	0.058	15.000	31.000
Strip 9	0.058	0.028	31.000	41.000

Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



Pile Section

Name	AZ 12-700
Inertia [in4/ft]	138.254
Modulus [in3/ft]	22.413
Area [in2/ft]	5.821
Mass [lbs/ft2]	19.806
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	0.002	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.820	0.001	-0.001	0.091	0.025	0.222	0.000	0.030	0.000	0.192
0.820	0.001	-0.001	0.091	0.025	0.222	0.000	0.030	0.000	0.192
1.000	0.001	-0.001	0.135	0.045	0.271	0.000	0.037	0.000	0.234
1.000	0.001	-0.001	0.135	0.045	0.271	0.000	0.037	0.000	0.234
1.820	0.001	0.000	0.425	0.266	0.436	0.000	0.067	0.000	0.369
1.820	0.001	0.000	0.425	0.266	0.436	0.000	0.067	0.000	0.369
2.640	0.001	0.000	0.851	0.780	0.601	0.000	0.097	0.000	0.505
2.640	0.001	0.000	0.851	0.780	0.601	0.000	0.097	0.000	0.505
3.000	0.000	0.000	1.080	1.126	0.674	0.000	0.110	0.000	0.564
3.000	0.000	0.000	1.080	1.126	0.674	0.000	0.110	0.000	0.564
3.820	0.000	0.000	1.662	2.246	0.745	0.000	0.140	0.000	0.605
3.820	0.000	0.000	1.662	2.246	0.745	0.000	0.140	0.000	0.605
4.000	0.000	0.000	1.797	2.557	0.760	0.000	0.147	0.000	0.613
4.000	0.000	0.000	-3.709	2.557	0.760	0.000	0.147	0.000	0.613
4.820	0.000	0.000	-3.057	-0.222	0.831	0.000	0.177	0.000	0.654
4.820	0.000	0.000	-3.057	-0.222	0.831	0.000	0.177	0.000	0.654
5.000	0.000	0.000	-2.906	-0.758	0.846	0.000	0.183	0.000	0.663
5.000	0.000	0.000	-2.906	-0.758	0.846	0.000	0.183	0.000	0.663
5.820	-0.001	0.000	-2.207	-2.855	0.859	0.000	0.213	0.000	0.646
5.820	-0.001	0.000	-2.207	-2.855	0.859	0.000	0.213	0.000	0.646
6.640	-0.001	0.000	-1.497	-4.375	0.872	0.000	0.243	0.000	0.629
6.640	-0.001	0.000	-1.497	-4.375	0.872	0.000	0.243	0.000	0.629
7.000	-0.001	0.000	-1.183	-4.857	0.877	0.000	0.256	0.000	0.621
7.000	-0.001	0.000	-1.183	-4.857	0.877	0.000	0.256	0.000	0.621
7.820	-0.001	0.000	-0.466	-5.532	0.870	0.000	0.286	0.000	0.583
7.820	-0.001	0.000	-0.466	-5.532	0.870	0.000	0.286	0.000	0.583
8.640	-0.001	0.000	0.244	-5.623	0.862	0.000	0.316	0.000	0.546
8.640	-0.001	0.000	0.244	-5.623	0.862	0.000	0.316	0.000	0.546
9.000	-0.001	0.000	0.554	-5.479	0.859	0.000	0.330	0.000	0.529
9.000	-0.001	0.000	0.554	-5.479	0.859	0.000	0.330	0.000	0.529
9.820	-0.001	0.000	1.128	-4.772	0.541	-0.308	0.360	0.000	0.489
9.820	-0.001	0.000	1.128	-4.772	0.541	-0.308	0.360	0.000	0.489
10.640	-0.001	0.000	1.441	-3.701	0.223	-0.615	0.390	0.000	0.449
10.640	-0.001	0.000	1.441	-3.701	0.223	-0.615	0.390	0.000	0.449
11.000	-0.001	0.000	1.496	-3.172	0.084	-0.750	0.403	0.000	0.431
11.000	-0.001	0.000	1.496	-3.172	0.084	-0.750	0.403	0.000	0.431
11.820	0.000	0.001	1.438	-1.951	-0.225	-1.058	0.433	0.000	0.399
11.820	0.000	0.001	1.438	-1.951	-0.225	-1.058	0.433	0.000	0.399
12.640	0.000	0.001	1.127	-0.882	-0.534	-1.365	0.463	0.000	0.368
12.640	0.000	0.001	1.127	-0.882	-0.534	-1.365	0.463	0.000	0.368
13.461	0.001	0.001	0.562	-0.172	-0.843	-1.673	0.493	0.000	0.336
13.461	0.001	0.001	0.562	-0.172	-0.843	-1.673	0.493	0.000	0.336
14.051	0.001	0.001	-0.002	0.000	-1.066	-1.894	0.515	0.000	0.314

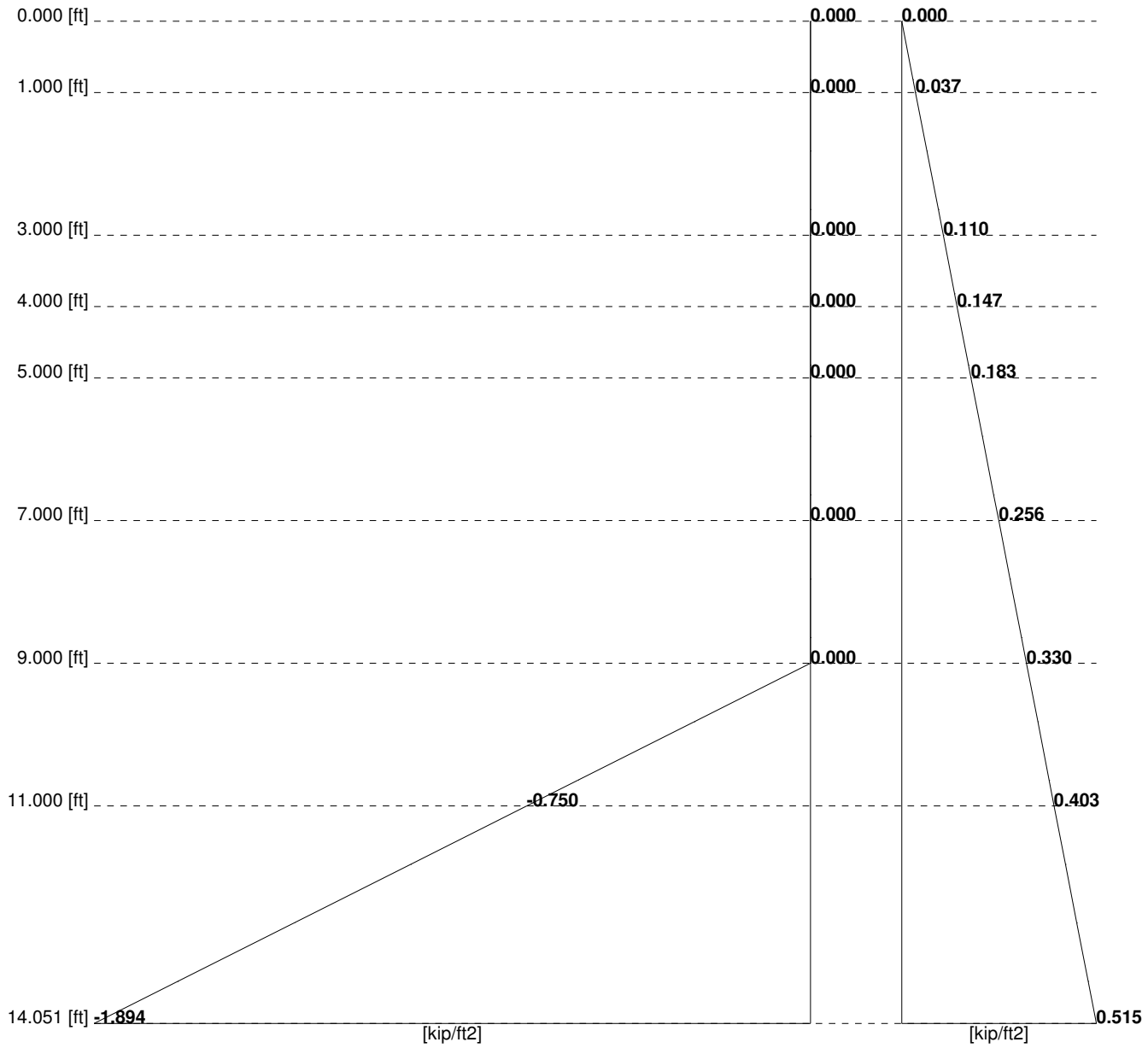
Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	8.640	-0.001	0.000	0.002
Cross Force [kip/ft]	4.000	-3.709	4.000	1.797
Moment [kipft/ft]	8.378	-5.657	4.000	2.557

Pile Check

		Depth [ft]
Name	AZ 12-700	
Inertia [in4/ft]	138.254	
Modulus [in3/ft]	22.413	
Area [in2/ft]	5.821	
Mass [lbs/ft2]	19.806	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-5.657	8.378
Maxmimal Moment [kipft/ft]	2.557	4.000
Normal Forces at Max. Moment [kip/ft]	0.000	8.378
Normal Forces at Min. Moment [kip/ft]	0.000	4.000
Deflection at Min. Moment [ft]	-0.001	8.378
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-3028.825	8.378
Max. Stress at Min. Moment [lb/in2]	3028.825	8.378
Min. Stress at Max. Moment [lb/in2]	-1368.941	4.000
Max. Stress at Max. Moment [lb/in2]	1368.941	4.000
Safety > Req. Safety = 1.500	12.876	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	14.051	
Sheet Pile Length [ft]	14.051	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	-5.506	

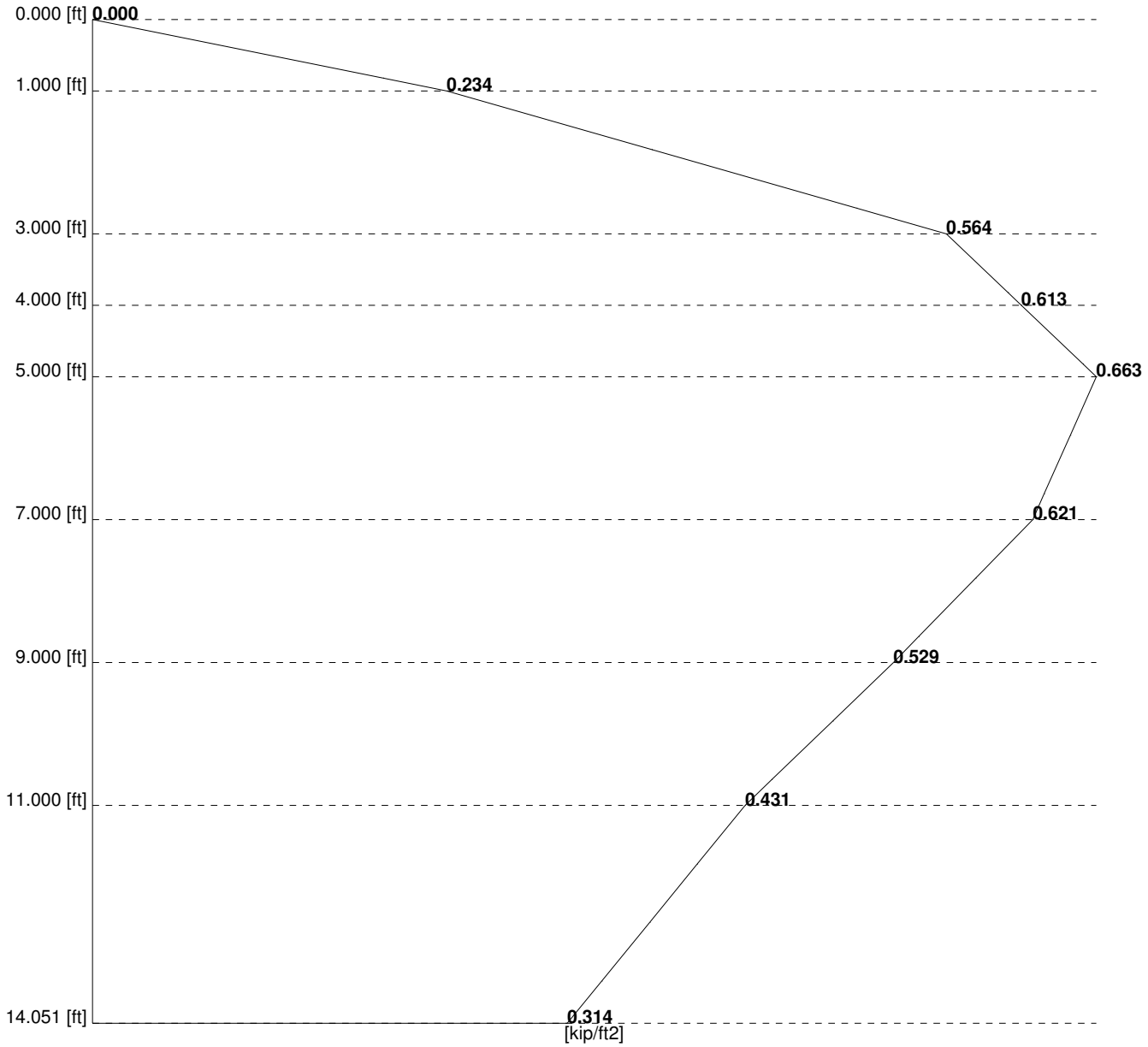
Earth Pressure Diagram



Water Pressure Diagram

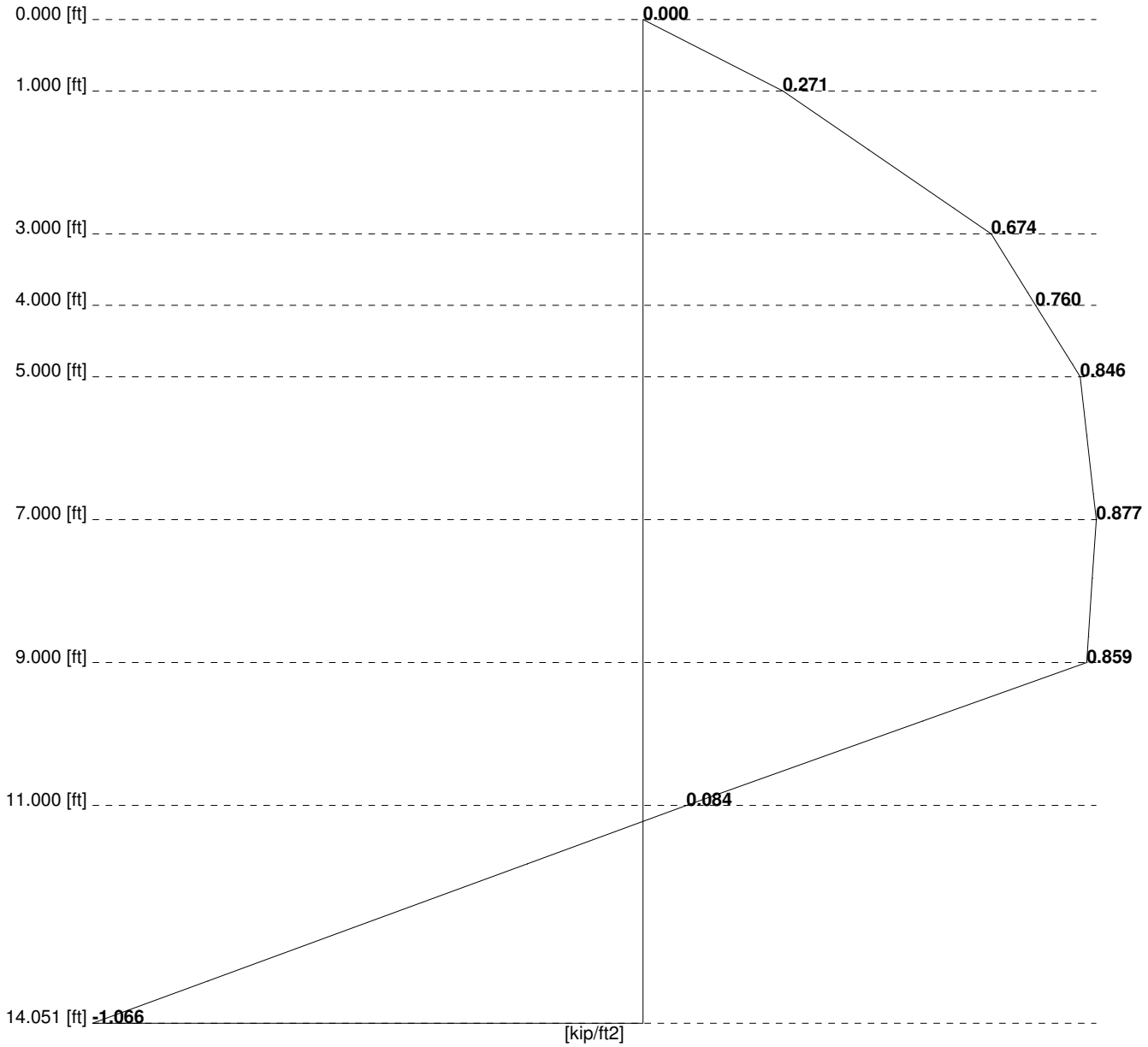
0.000 [ft]	**0.000**
1.000 [ft]	**0.000**
3.000 [ft]	**0.000**
4.000 [ft]	**0.000**
5.000 [ft]	**0.000**
7.000 [ft]	**0.000**
9.000 [ft]	**0.000**
11.000 [ft]	**0.000**
14.051 [ft]	**0.000**
	[kip/ft2]

Userdefined Pressure Diagram

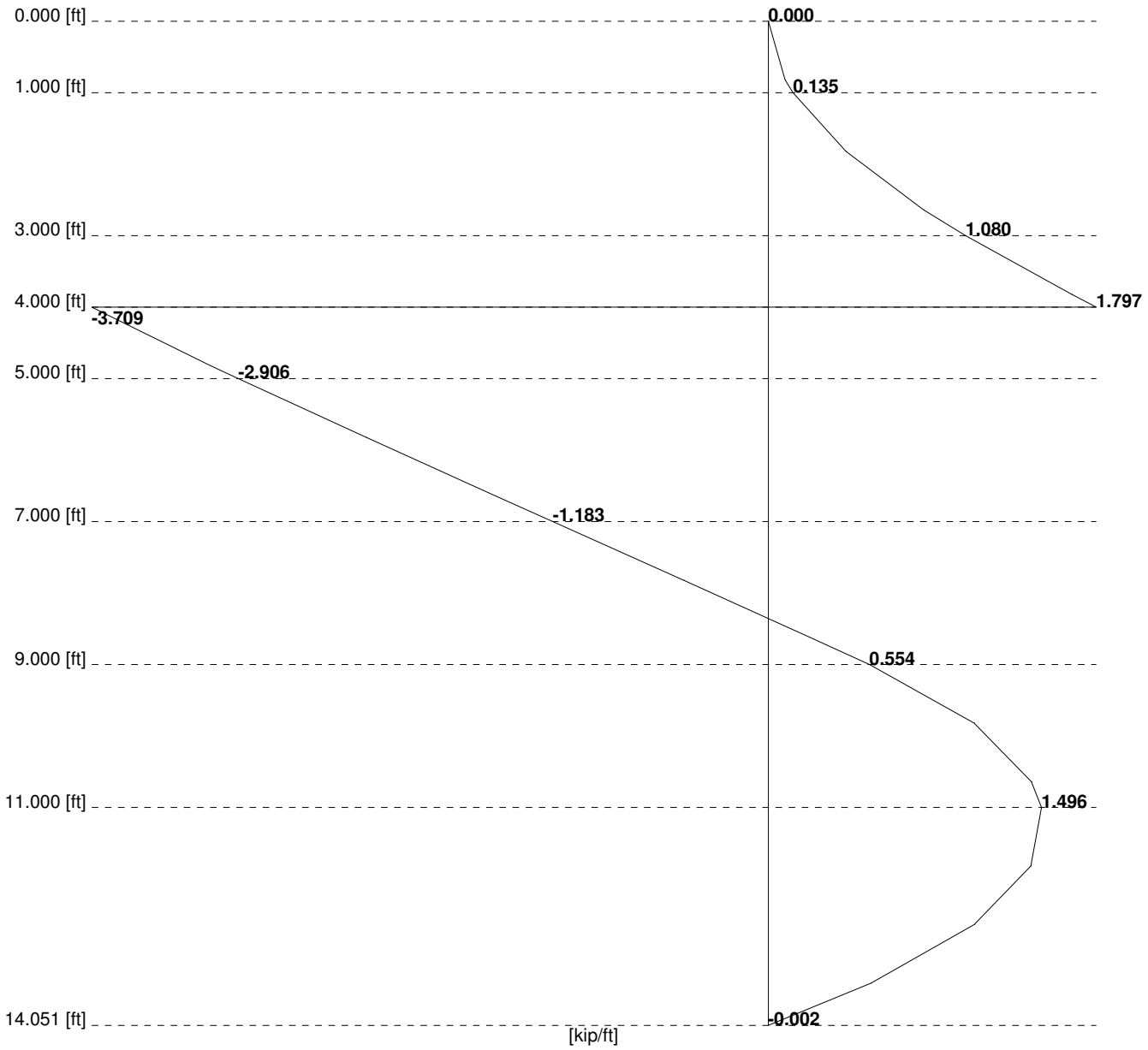


Boussinesq Diagram

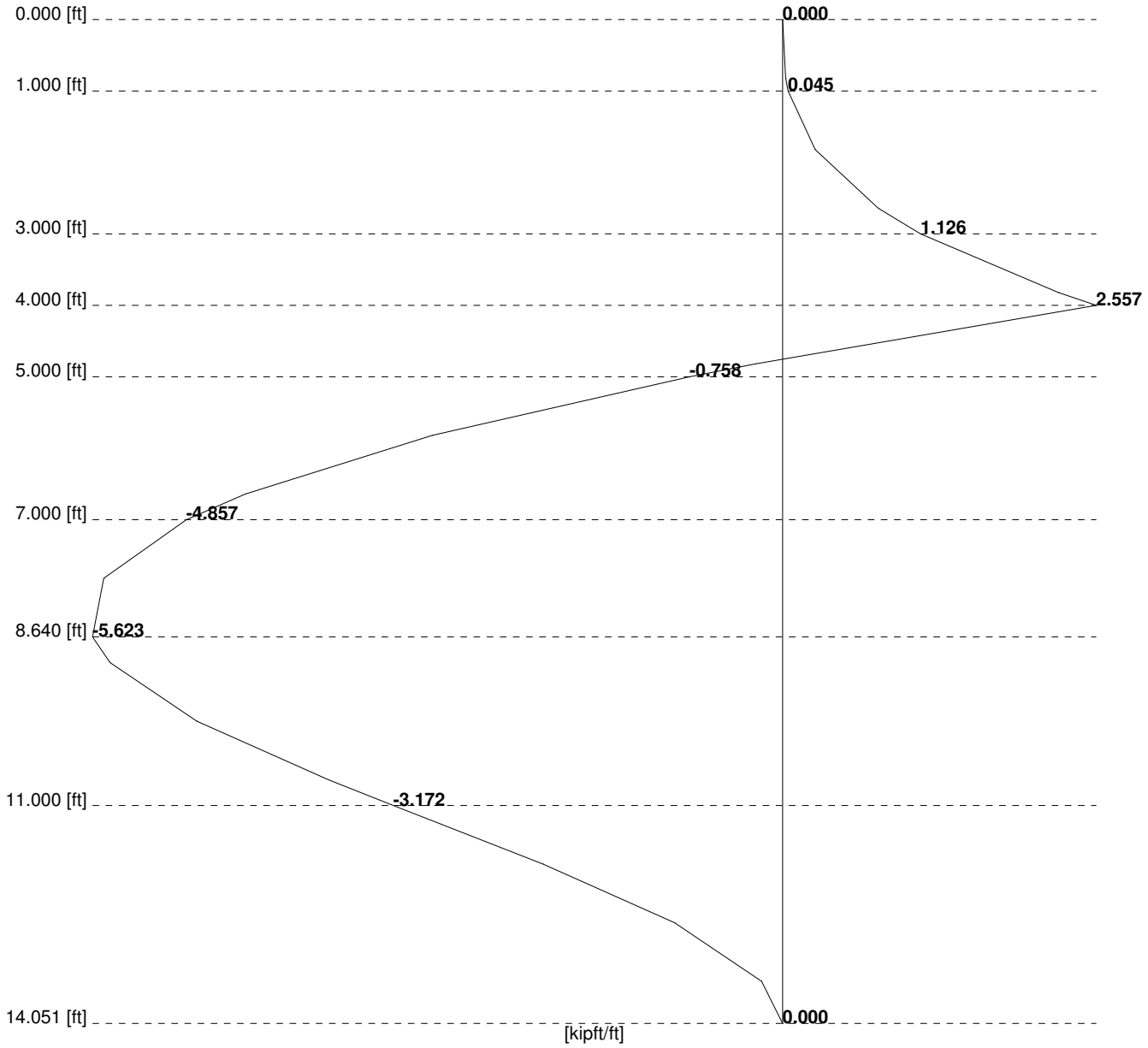
Total Pressure Diagram



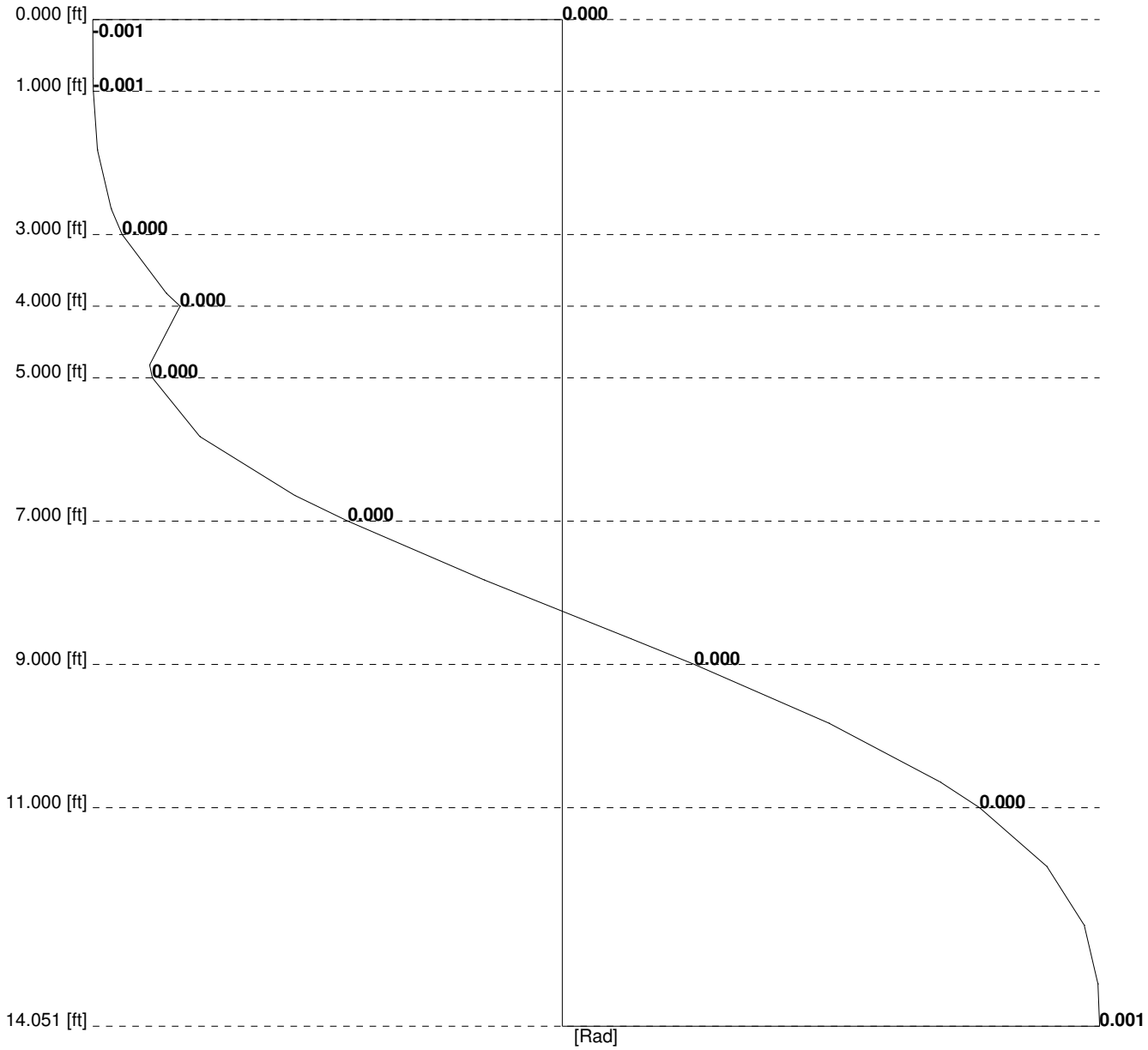
Cross Force Diagram



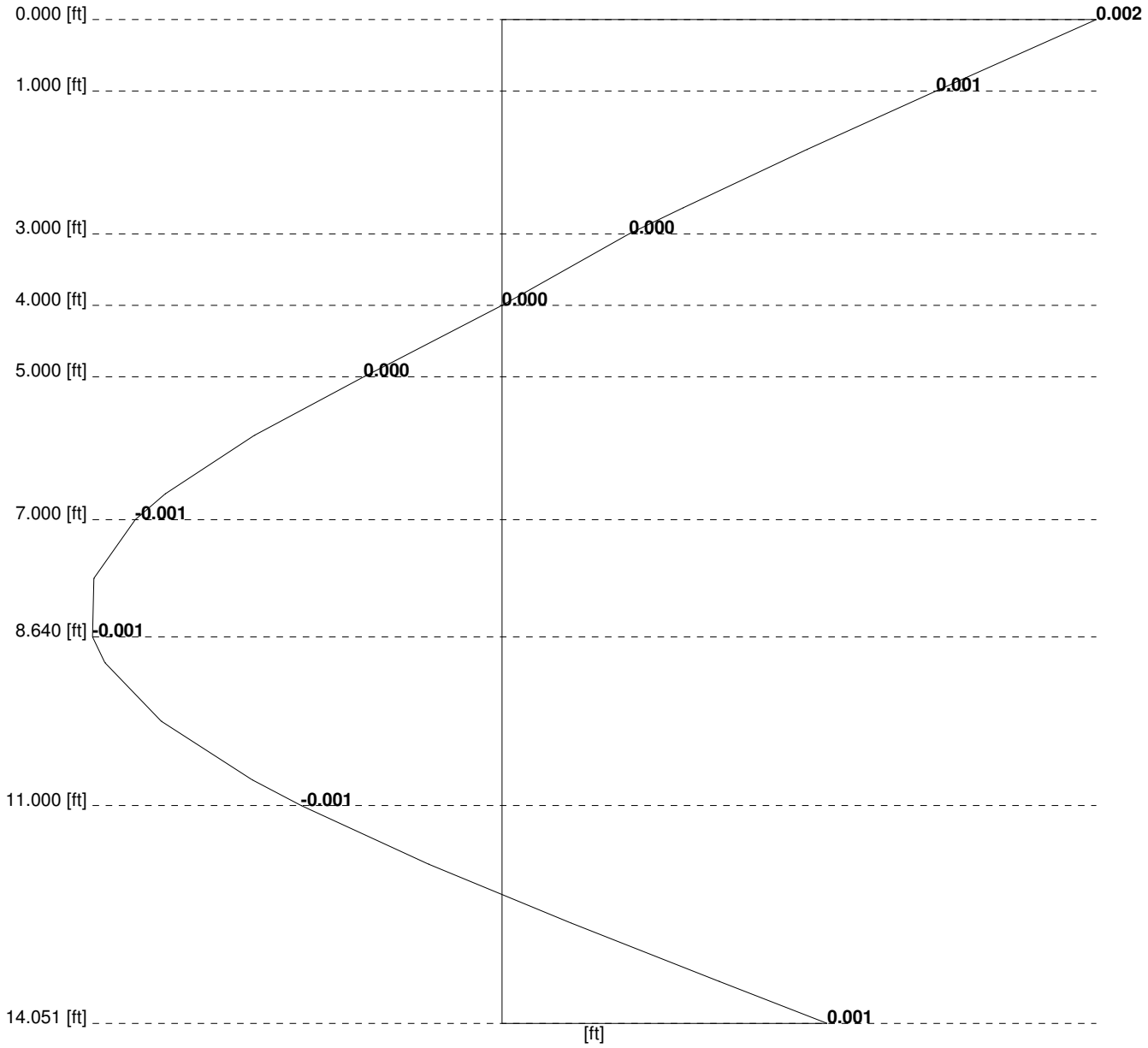
Moment Diagram



Rotation Diagram



Deflection Diagram



DESIGN CALCULATION COVER SHEET

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT: **ODOT/EMH&T: HAM-75-7.85**
BRIDGE NO: **HAM-562-0026**
SUBJECT: ***Analysis***
Sheet Piling
Prosheet
FILE NAME(s): *PROS_PhaseC&D_Forward.bak*

ODOT PID NO: *77889*
EMH&T JOB NO:
GF JOB NO: 54682
CALC NO.: **HAM562_0026_14F**
REV NO.: **00**
SHEET: 1 OF 24

SUPERSEDES CALC NO: N/A

CALCULATION DESCRIPTION:

This will analyze the shoring for Phase C&D Construction/Excavation at the forward abutment.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2014) Chapter 15
AISC Steel Construction Manual, Thirteenth Edition
BDM - ODOT Bridge Design Manual (2004) - Current Edition

MISCELLANEOUS NOTES:

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	SNH	08/20/14	CTM	09/12/14

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
SNH	08/20/14	CTM	09/11/14	SNH	09/11/14	CTM	09/12/14

Gannett Fleming
Engineers and Architects, P.C.
Excellence Delivered **As Promised**

Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

Lateral Pressure from Parallel Strip Loading

Lateral Pressure from Parallel Strip Loading

Calculations as per Norfolk Southern Design Standards

Min. Depth of Resulting Table (Hs_{min}):	1.00 ft	Centerline Track Distance 1, CLT_1:	11.92 ft
Max Depth of Resulting Table (Hs_{max}):	41.00 ft	Centerline Track Distance 2, CLT_2:	11.92 ft
Spacing of Max Axle Load:	5.0 ft	Centerline Track Distance 3, CLT_3:	11.92 ft
Max Axle Load:	80.0 kip	Centerline Track Distance 4, CLT_4:	11.92 ft
Width of Tie (TL):	8.5 ft	Applied Pressure (q):	1.88 ksf

Hs	**β** *(Radians)*				**α** *(Radians)*				*Active Pressure,* **Ps** *(psf)*			
	β_1	β_2	β_3	β_4	α_1	α_2	α_3	α_4	Ps_1	Ps_2	Ps_3	Ps_4
0.00 ft	0.0000	0.0000	0.0000	0.0000	1.5708	1.5708	1.5708	1.5708	0.00	0.00	0.00	0.00
1.00 ft	0.0679	0.0679	0.0679	0.0679	1.4751	1.4751	1.4751	1.4751	161.15	161.15	161.15	161.15
3.00 ft	0.1894	0.1894	0.1894	0.1894	1.2927	1.2927	1.2927	1.2927	418.55	418.55	418.55	418.55
5.00 ft	0.2778	0.2778	0.2778	0.2778	1.1320	1.1320	1.1320	1.1320	542.93	542.93	542.93	542.93
7.00 ft	0.3312	0.3312	0.3312	0.3312	0.9966	0.9966	0.9966	0.9966	556.70	556.70	556.70	556.70
9.00 ft	0.3571	0.3571	0.3571	0.3571	0.8843	0.8843	0.8843	0.8843	510.33	510.33	510.33	510.33
11.00 ft	0.3645	0.3645	0.3645	0.3645	0.7912	0.7912	0.7912	0.7912	441.77	441.77	441.77	441.77
13.00 ft	0.3606	0.3606	0.3606	0.3606	0.7133	0.7133	0.7133	0.7133	371.41	371.41	371.41	371.41
15.00 ft	0.3502	0.3502	0.3502	0.3502	0.6478	0.6478	0.6478	0.6478	307.97	307.97	307.97	307.97
17.00 ft	0.3365	0.3365	0.3365	0.3365	0.5921	0.5921	0.5921	0.5921	254.10	254.10	254.10	254.10
19.00 ft	0.3214	0.3214	0.3214	0.3214	0.5444	0.5444	0.5444	0.5444	209.68	209.68	209.68	209.68
21.00 ft	0.3060	0.3060	0.3060	0.3060	0.5032	0.5032	0.5032	0.5032	173.58	173.58	173.58	173.58
23.00 ft	0.2909	0.2909	0.2909	0.2909	0.4673	0.4673	0.4673	0.4673	144.40	144.40	144.40	144.40
25.00 ft	0.2764	0.2764	0.2764	0.2764	0.4359	0.4359	0.4359	0.4359	120.82	120.82	120.82	120.82
27.00 ft	0.2628	0.2628	0.2628	0.2628	0.4082	0.4082	0.4082	0.4082	101.73	101.73	101.73	101.73
29.00 ft	0.2501	0.2501	0.2501	0.2501	0.3836	0.3836	0.3836	0.3836	86.20	86.20	86.20	86.20
31.00 ft	0.2382	0.2382	0.2382	0.2382	0.3617	0.3617	0.3617	0.3617	73.51	73.51	73.51	73.51
33.00 ft	0.2272	0.2272	0.2272	0.2272	0.3420	0.3420	0.3420	0.3420	63.07	63.07	63.07	63.07
35.00 ft	0.2171	0.2171	0.2171	0.2171	0.3243	0.3243	0.3243	0.3243	54.43	54.43	54.43	54.43
37.00 ft	0.2076	0.2076	0.2076	0.2076	0.3082	0.3082	0.3082	0.3082	47.24	47.24	47.24	47.24
39.00 ft	0.1989	0.1989	0.1989	0.1989	0.2936	0.2936	0.2936	0.2936	41.22	41.22	41.22	41.22
41.00 ft	0.1907	0.1907	0.1907	0.1907	0.2803	0.2803	0.2803	0.2803	36.15	36.15	36.15	36.15

Note: The following two pages contain numerical and graphical representations of these loads over a selected area.

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Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

Numerical Summary of Forces

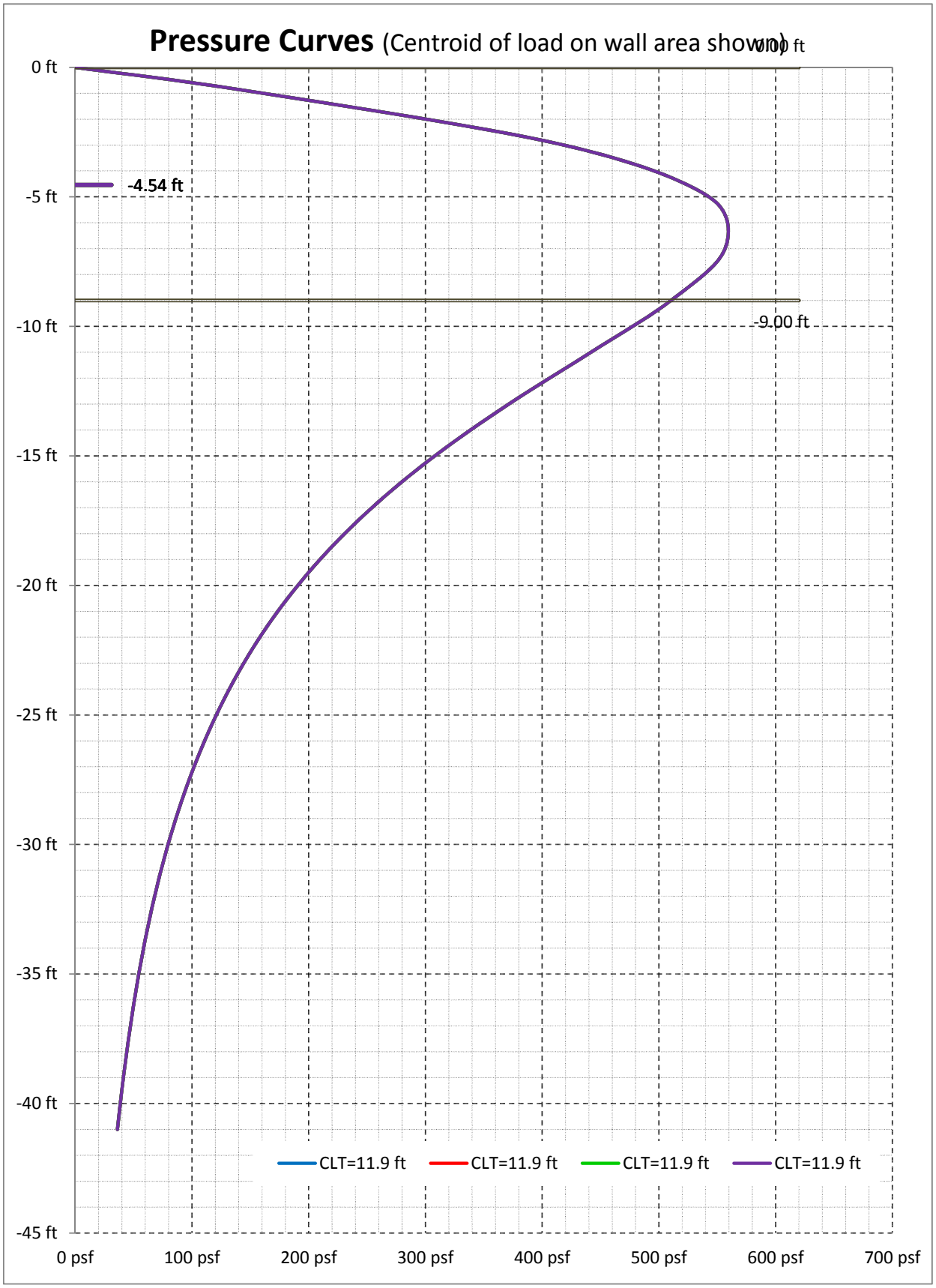
To gain total forces, the area under the graph is required. The area under the graph for the considered depth is divided by the total considered depth to arrive at a uniformly applied lateral pressure on any surface in question. The total lateral force is the total area under the graph. Simpsons Rule is used to arrive at the total area under the graph (median value force over a height is used)

	Values at CLT Distances			
Data Below is intended to give summary values that can be used in the design of walls and surfaces affected by the surcharge. A graphical output is on the next page	CLT=11.9 ft	CLT=11.9 ft	CLT=11.9 ft	CLT=11.9 ft
Top of Wall (Min. Depth Considered): 0.00 ft	.0 psf	.0 psf	.0 psf	.0 psf
Bottom of Wall (Max. Depth Considered): 9.00 ft	510.3 psf	510.3 psf	510.3 psf	510.3 psf

The bottom of the exposed wall face is 9.00 feet below the bottom of the tie. The top of the fill behind the wall (applying lateral pressure) is 0.00 feet below the bottom of the tie. The height of exposed wall face with surcharge pressure applied is 9.00 feet.

Maximum Applied Lateral Pressure on limits of the wall				
Maximum Applied Lateral Pressure	556.7 psf	556.7 psf	556.7 psf	556.7 psf
Total Applied Lateral Pressure on limits of the wall *(as an equivilant point load)*				
Total Lateral Load (Per foot)	3.71 klf	3.71 klf	3.71 klf	3.71 klf
Centroid of Total Lateral Load (Distance down from zero)	4.54 ft	4.54 ft	4.54 ft	4.54 ft
Total Applied Moment due to Surcharge *(assumes fixed at max depth)*	16.5 k-ft	16.5 k-ft	16.5 k-ft	16.5 k-ft
Uniformly Applied Lateral Pressure on limits of the wall (For Lateral Stability) *(Total Applied Lateral Pressure **Thrust Controls;** Total lateral moment is not correct)*				
Uniformly Applied Lateral Load	412.0 psf	412.0 psf	412.0 psf	412.0 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	16.7 k-ft	16.7 k-ft	16.7 k-ft	16.7 k-ft
Difference in moment from that of the Total Point Load	1%	1%	1%	1%
Uniformly Applied Lateral Pressure on limits of the wall (For Moments/Deflectoins) *(Total Applied Lateral Pressure **Moment Controls;** Total lateral thrust is not correct)*				
Uniformly Applied Lateral Load	408.3 psf	408.3 psf	408.3 psf	408.3 psf
Moment due to Uniform Load *(assumes fixed at max depth)*	16.5 k-ft	16.5 k-ft	16.5 k-ft	16.5 k-ft
Difference in moment from that of the Total Point Load	0%	0%	0%	0%
Total of Uniformly Applied Lateral Load	3.67 klf	3.67 klf	3.67 klf	3.67 klf
Difference in Load from that of the Total Point Load	-1%	-1%	-1%	-1%

Total Uniform Load to Approximate Dual Tracks on Wall	**816.7 psf**


Pressure Curves (Centroid of load on wall area shown)
0.00 ft
0 ft
-5 ft
-10 ft
-15 ft
-20 ft
-25 ft
-30 ft
-35 ft
-40 ft
-45 ft
-4.54 ft
-9.00 ft
CLT=11.9 ft
CLT=11.9 ft
CLT=11.9 ft
CLT=11.9 ft
0 psf
100 psf
200 psf
300 psf
400 psf
500 psf
600 psf
700 psf

Calc:	SNH	Date:	8/20/2014
Check:	CTM	Date:	9/11/2014
Update:	SNH	Date:	9/11/2014
Verified:	CTM	Date:	9/12/2014

L-Pile Loads on a 30" Wide Shaft should be entered as follows (depth is inches from pile head)

Shaft Width: 12.0 in
1.000 ft

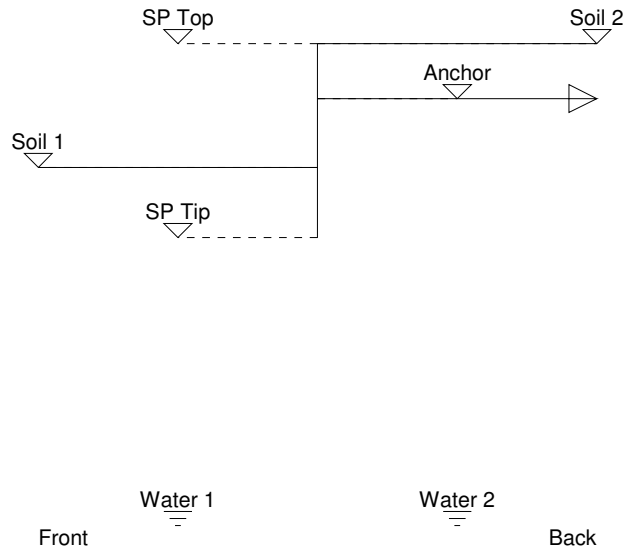
Depth	Depth	Last CLT column Lateral Load
0.00 ft	0.000 ft	0.000 ksf
1.00 ft	1.000 ft	0.161 ksf
3.00 ft	3.000 ft	0.419 ksf
5.00 ft	5.000 ft	0.543 ksf
7.00 ft	7.000 ft	0.557 ksf
9.00 ft	9.000 ft	0.510 ksf
11.00 ft	11.000 ft	0.442 ksf
15.00 ft	15.000 ft	0.308 ksf
31.00 ft	31.000 ft	0.074 ksf
41.00 ft	41.000 ft	0.036 ksf

Sheet Pile Design According to Blum-Method

Project Name:	HAM562-0026C
Date:	9/12/2014
Author:	SNH
Company:	
Comment:	PHASE CD at Forward Abutment: Braced Sheeting

Geodata

	Unit
Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	14.084
Soil Level in Front [ft]	9.000
Soil Level behind [ft]	0.000
Anchorlevel [ft]	4.000
Water Level in Front [ft]	34.000
Water Level behind [ft]	34.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Free



Soil Layers

Layers in Front

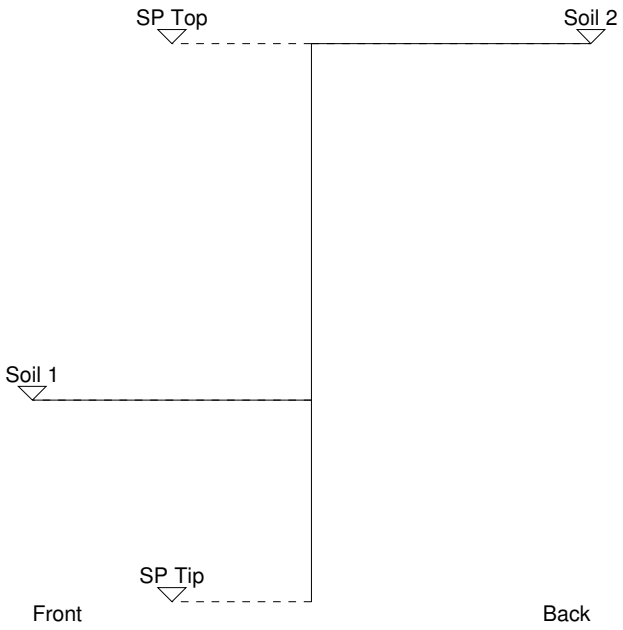
	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.125	0.063	3.000	30.000	0.000	0.000

Layers behind

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	100.000	0.110	0.048	0.333	30.000	0.000	0.000

Boussinesq

	Distance Wall [ft]	Width Surcharge [ft]	Depth Surcharge [ft]	Surcharge [kip/ft2]

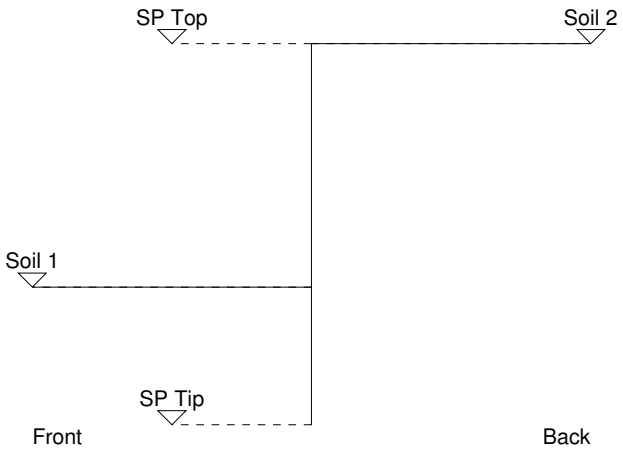


Userdefined Pressures

	Pressure Top [kip/ft2]	Pressure Tip [kip/ft2]	Depth Top [ft]	Depth Tip [ft]
Strip 1	0.000	0.161	0.000	1.000
Strip 2	0.161	0.419	1.000	3.000
Strip 3	0.419	0.543	3.000	5.000
Strip 4	0.543	0.557	5.000	7.000
Strip 5	0.557	0.510	7.000	9.000
Strip 6	0.510	0.442	9.000	11.000
Strip 7	0.442	0.308	11.000	15.000
Strip 8	0.308	0.074	15.000	31.000
Strip 9	0.074	0.036	31.000	41.000

Concentrated Forces

	Horiz. Component [kip/ft]	Vert. Component [kip/ft]	Depth Horiz. Comp. [ft]



Pile Section

Name	AZ 12-700
Inertia [in4/ft]	138.254
Modulus [in3/ft]	22.413
Area [in2/ft]	5.821
Mass [lbs/ft2]	19.806
Steel Grade [lb/in2]	39000.000
Requested Safety	1.500

All Values

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	0.002	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.820	0.002	-0.001	0.066	0.018	0.162	0.000	0.030	0.000	0.132
0.820	0.002	-0.001	0.066	0.018	0.162	0.000	0.030	0.000	0.132
1.000	0.001	-0.001	0.099	0.033	0.198	0.000	0.037	0.000	0.161
1.000	0.001	-0.001	0.099	0.033	0.198	0.000	0.037	0.000	0.161
1.820	0.001	-0.001	0.317	0.196	0.333	0.000	0.067	0.000	0.267
1.820	0.001	-0.001	0.317	0.196	0.333	0.000	0.067	0.000	0.267
2.640	0.001	-0.001	0.646	0.583	0.469	0.000	0.097	0.000	0.373
2.640	0.001	-0.001	0.646	0.583	0.469	0.000	0.097	0.000	0.373
3.000	0.000	-0.001	0.825	0.847	0.529	0.000	0.110	0.000	0.419
3.000	0.000	-0.001	0.825	0.847	0.529	0.000	0.110	0.000	0.419
3.820	0.000	0.000	1.292	1.711	0.610	0.000	0.140	0.000	0.470
3.820	0.000	0.000	1.292	1.711	0.610	0.000	0.140	0.000	0.470
4.000	0.000	0.000	1.404	1.953	0.628	0.000	0.147	0.000	0.481
4.000	0.000	0.000	-3.332	1.953	0.628	0.000	0.147	0.000	0.481
4.820	0.000	0.000	-2.784	-0.560	0.708	0.000	0.177	0.000	0.532
4.820	0.000	0.000	-2.784	-0.560	0.708	0.000	0.177	0.000	0.532
5.000	0.000	0.000	-2.655	-1.048	0.726	0.000	0.183	0.000	0.543
5.000	0.000	0.000	-2.655	-1.048	0.726	0.000	0.183	0.000	0.543
5.820	-0.001	0.000	-2.044	-2.978	0.762	0.000	0.213	0.000	0.549
5.820	-0.001	0.000	-2.044	-2.978	0.762	0.000	0.213	0.000	0.549
6.640	-0.001	0.000	-1.405	-4.394	0.798	0.000	0.243	0.000	0.554
6.640	-0.001	0.000	-1.405	-4.394	0.798	0.000	0.243	0.000	0.554
7.000	-0.001	0.000	-1.115	-4.847	0.813	0.000	0.256	0.000	0.557
7.000	-0.001	0.000	-1.115	-4.847	0.813	0.000	0.256	0.000	0.557
7.820	-0.001	0.000	-0.444	-5.487	0.824	0.000	0.286	0.000	0.538
7.820	-0.001	0.000	-0.444	-5.487	0.824	0.000	0.286	0.000	0.538
8.640	-0.001	0.000	0.237	-5.573	0.835	0.000	0.316	0.000	0.518
8.640	-0.001	0.000	0.237	-5.573	0.835	0.000	0.316	0.000	0.518
9.000	-0.001	0.000	0.538	-5.433	0.840	0.000	0.330	0.000	0.510
9.000	-0.001	0.000	0.538	-5.433	0.840	0.000	0.330	0.000	0.510
9.820	-0.001	0.000	1.101	-4.744	0.534	-0.308	0.360	0.000	0.482
9.820	-0.001	0.000	1.101	-4.744	0.534	-0.308	0.360	0.000	0.482
10.640	-0.001	0.000	1.414	-3.695	0.229	-0.615	0.390	0.000	0.454
10.640	-0.001	0.000	1.414	-3.695	0.229	-0.615	0.390	0.000	0.454
11.000	-0.001	0.000	1.472	-3.175	0.095	-0.750	0.403	0.000	0.442
11.000	-0.001	0.000	1.472	-3.175	0.095	-0.750	0.403	0.000	0.442
11.820	0.000	0.000	1.425	-1.969	-0.210	-1.058	0.433	0.000	0.415
11.820	0.000	0.000	1.425	-1.969	-0.210	-1.058	0.433	0.000	0.415
12.640	0.000	0.001	1.128	-0.905	-0.515	-1.365	0.463	0.000	0.387
12.640	0.000	0.001	1.128	-0.905	-0.515	-1.365	0.463	0.000	0.387
13.461	0.000	0.001	0.580	-0.187	-0.820	-1.673	0.493	0.000	0.360
13.461	0.000	0.001	0.580	-0.187	-0.820	-1.673	0.493	0.000	0.360
14.084	0.001	0.001	-0.003	0.000	-1.052	-1.906	0.516	0.000	0.339

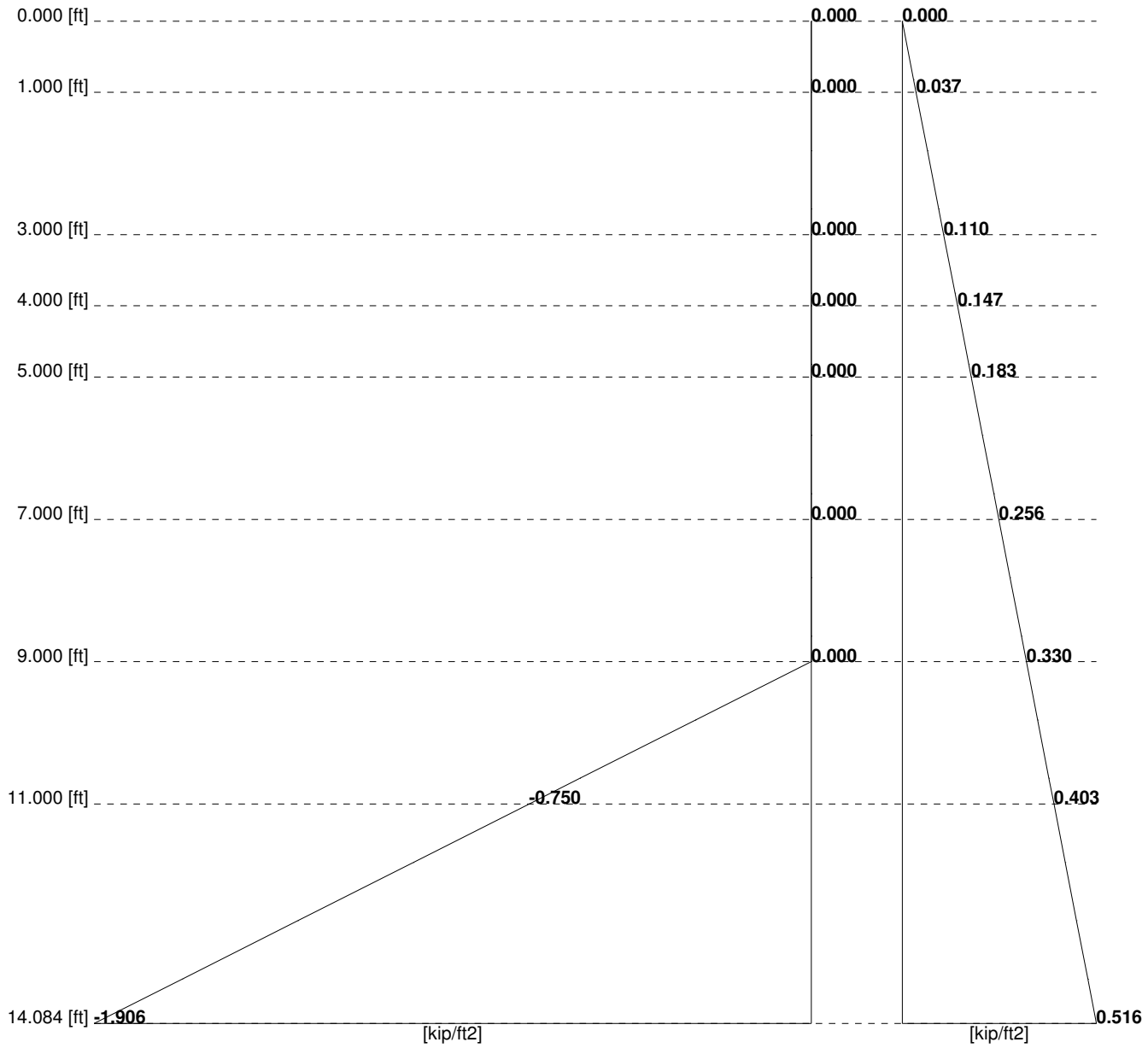
Extremal Values

	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	8.640	-0.001	0.000	0.002
Cross Force [kip/ft]	4.000	-3.332	11.000	1.472
Moment [kipft/ft]	8.378	-5.606	4.000	1.953

Pile Check

		Depth [ft]
Name	AZ 12-700	
Inertia [in4/ft]	138.254	
Modulus [in3/ft]	22.413	
Area [in2/ft]	5.821	
Mass [lbs/ft2]	19.806	
Steel Grade [lb/in2]	39000.000	
Minimal Moment [kipft/ft]	-5.606	8.378
Maxmimal Moment [kipft/ft]	1.953	4.000
Normal Forces at Max. Moment [kip/ft]	0.000	8.378
Normal Forces at Min. Moment [kip/ft]	0.000	4.000
Deflection at Min. Moment [ft]	-0.001	8.378
Deflection at Max. Moment [ft]	0.000	4.000
Min. Stress at Min. Moment [lb/in2]	-3001.384	8.378
Max. Stress at Min. Moment [lb/in2]	3001.384	8.378
Min. Stress at Max. Moment [lb/in2]	-1045.529	4.000
Max. Stress at Max. Moment [lb/in2]	1045.529	4.000
Safety > Req. Safety = 1.500	12.994	
Sheet Pile Top Level [ft]	0.000	
Sheet Pile Tip Level [ft]	14.084	
Sheet Pile Length [ft]	14.084	
Included OverLength [ft]	0.000	
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	-4.735	

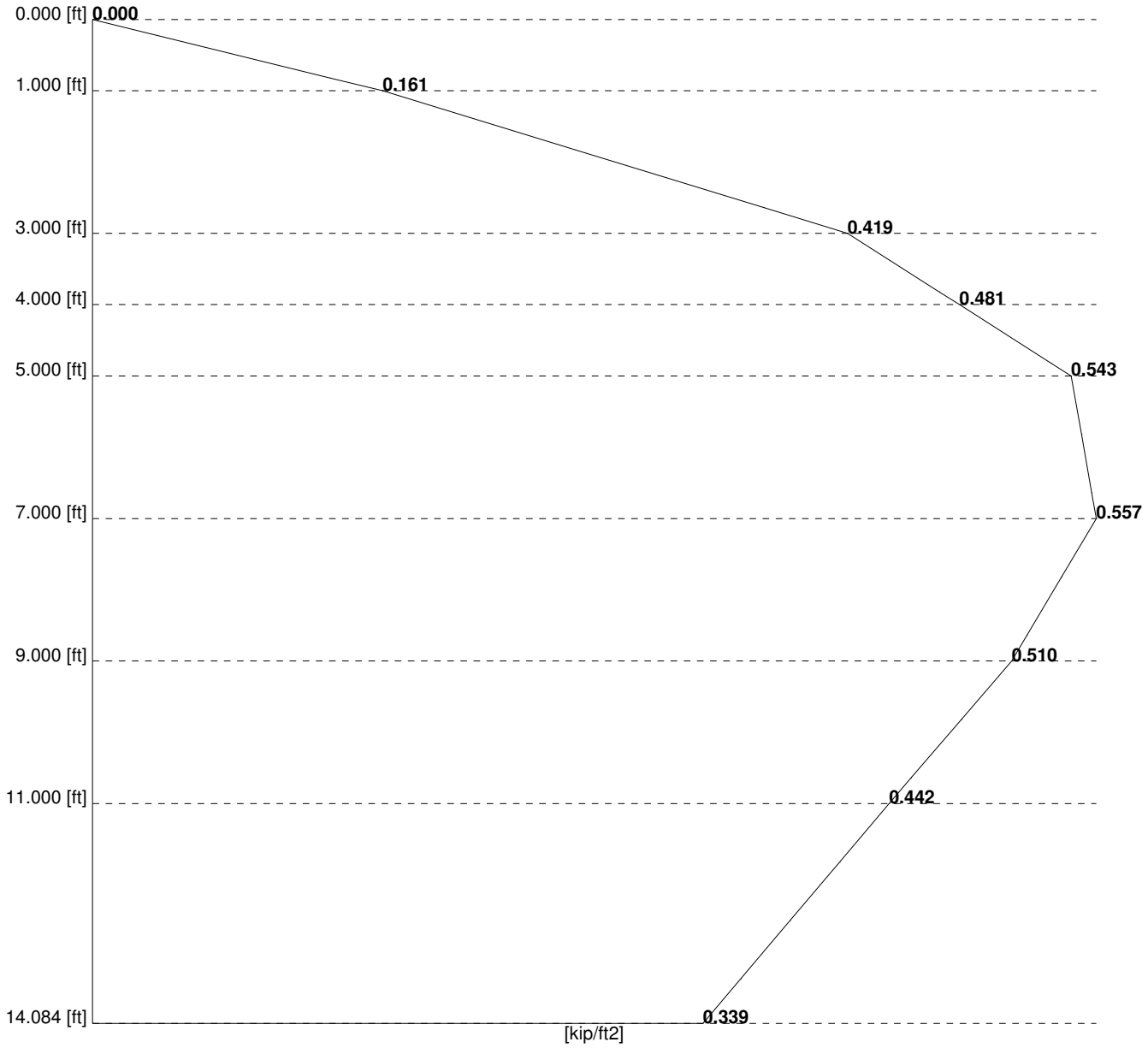
Earth Pressure Diagram



Water Pressure Diagram

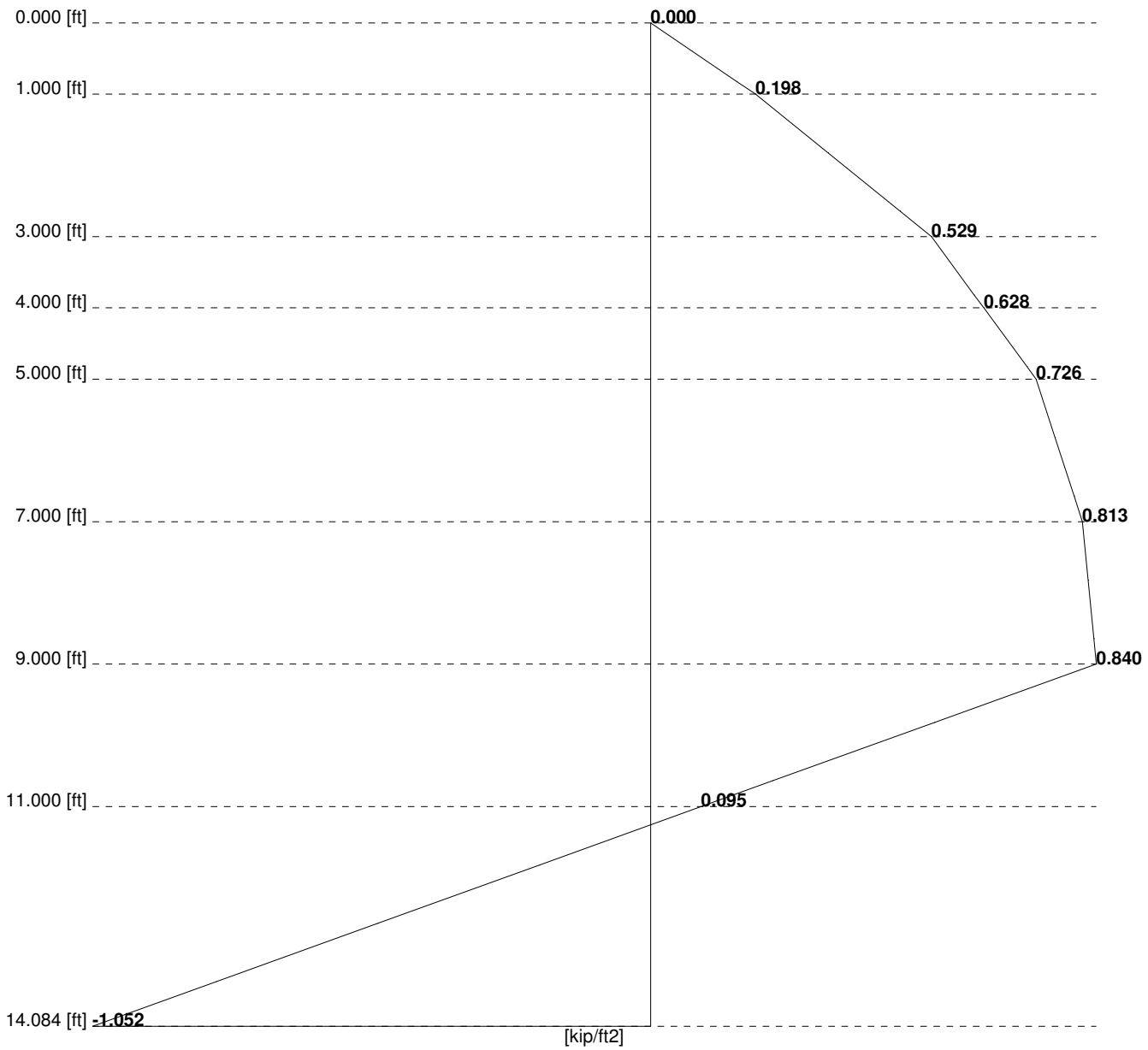
0.000 [ft]	**0.000**
1.000 [ft]	**0.000**
3.000 [ft]	**0.000**
4.000 [ft]	**0.000**
5.000 [ft]	**0.000**
7.000 [ft]	**0.000**
9.000 [ft]	**0.000**
11.000 [ft]	**0.000**
14.084 [ft]	**0.000**
	[kip/ft2]

Userdefined Pressure Diagram

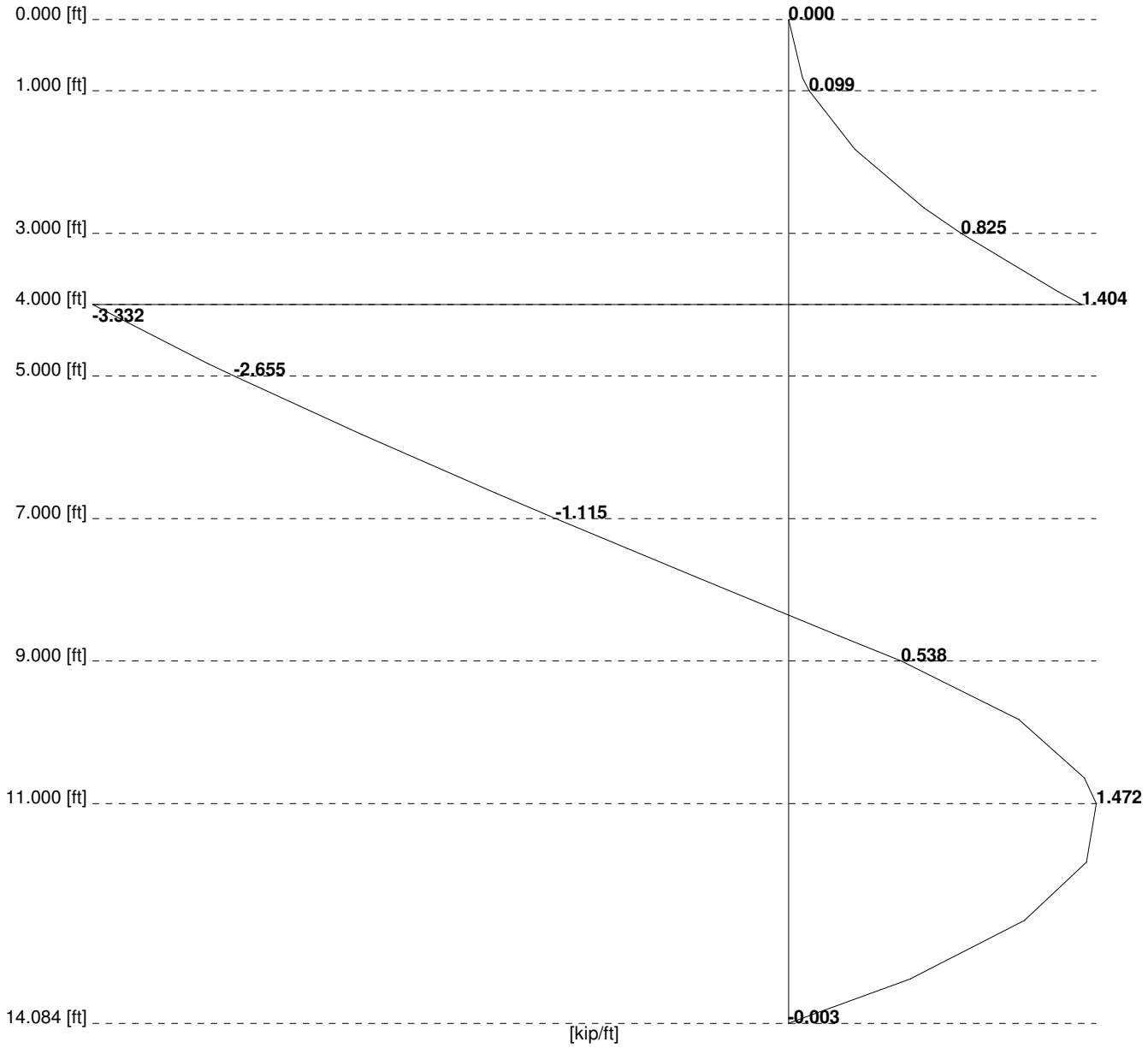


Boussinesq Diagram

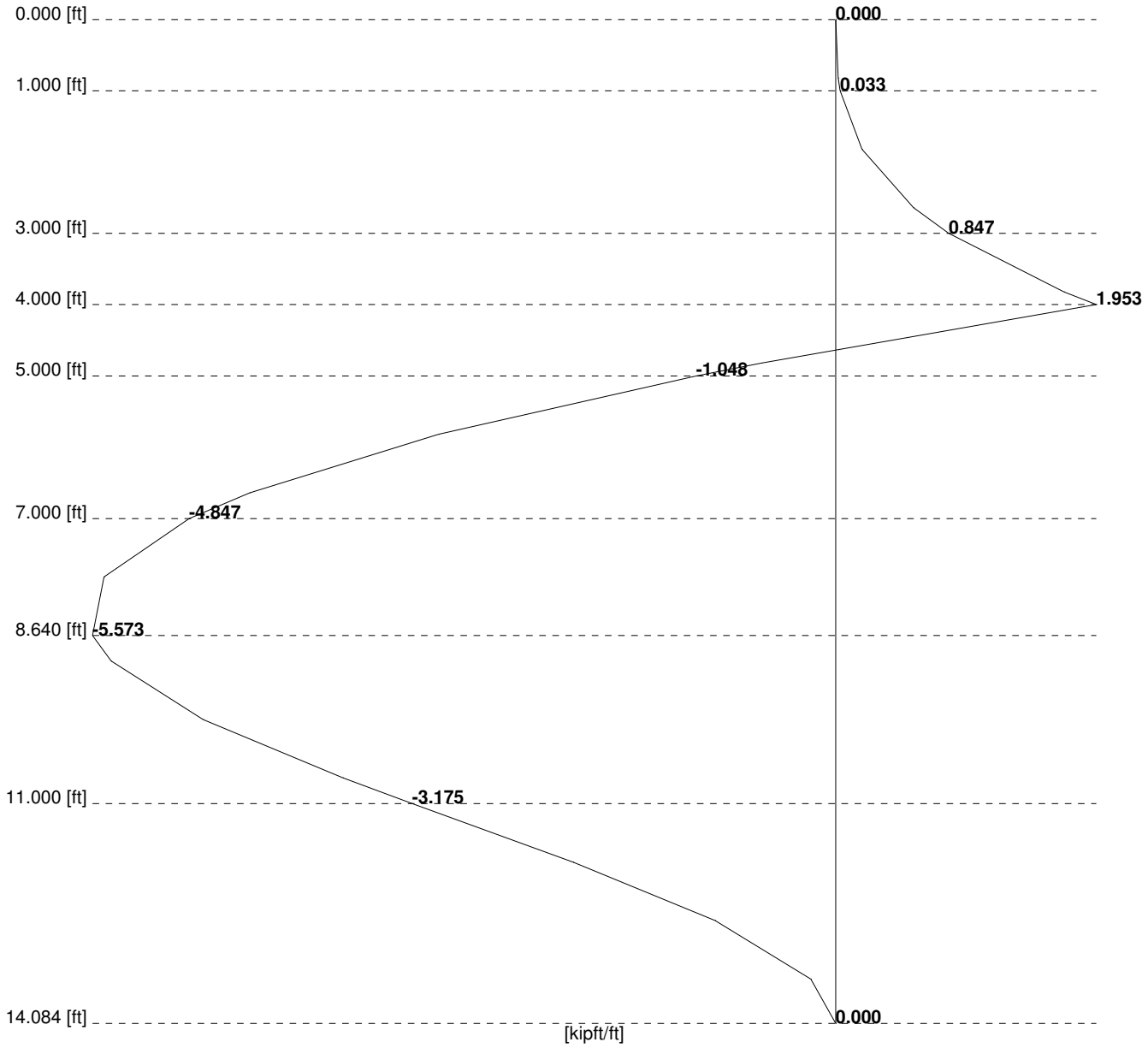
Total Pressure Diagram



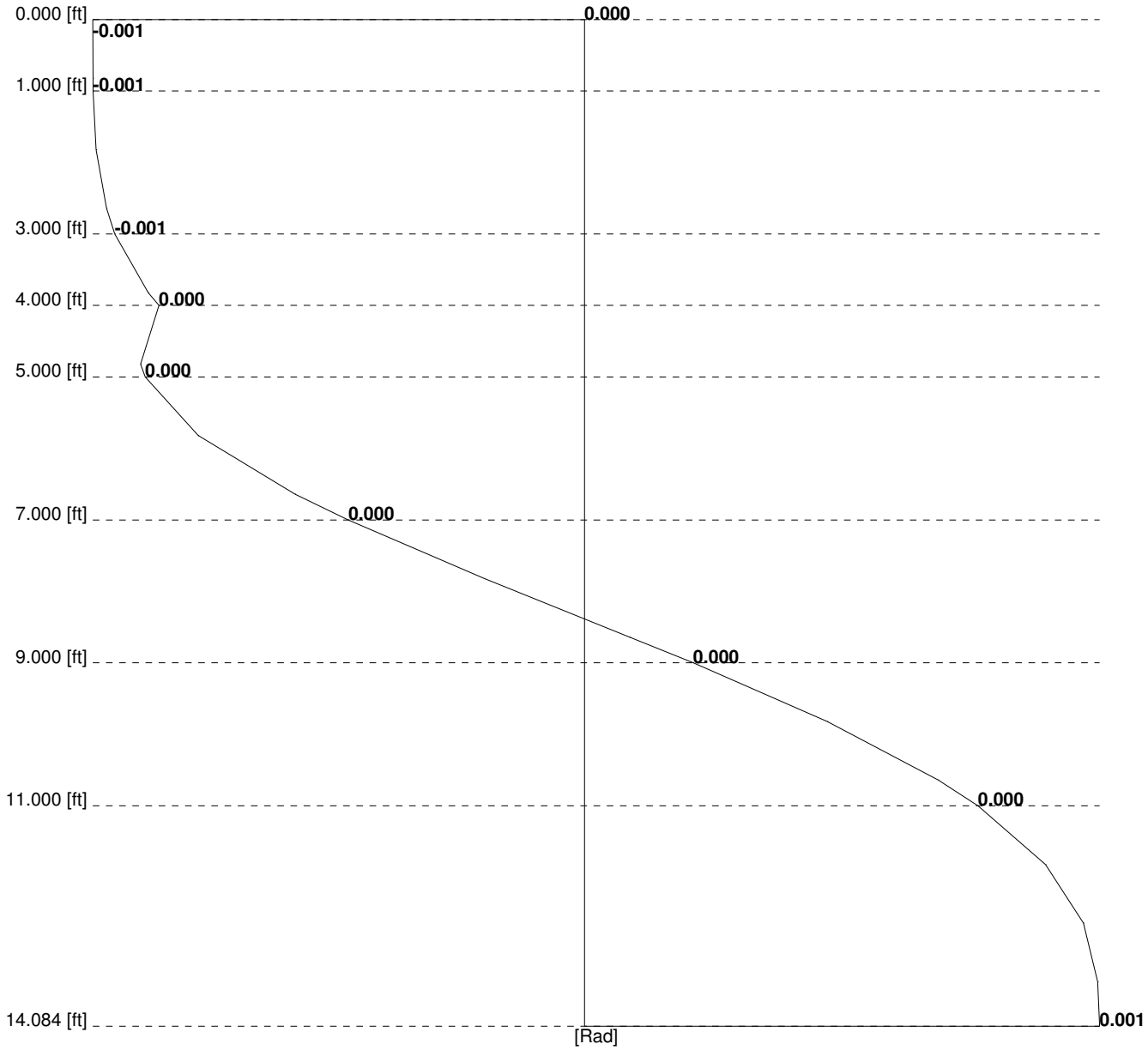
Cross Force Diagram



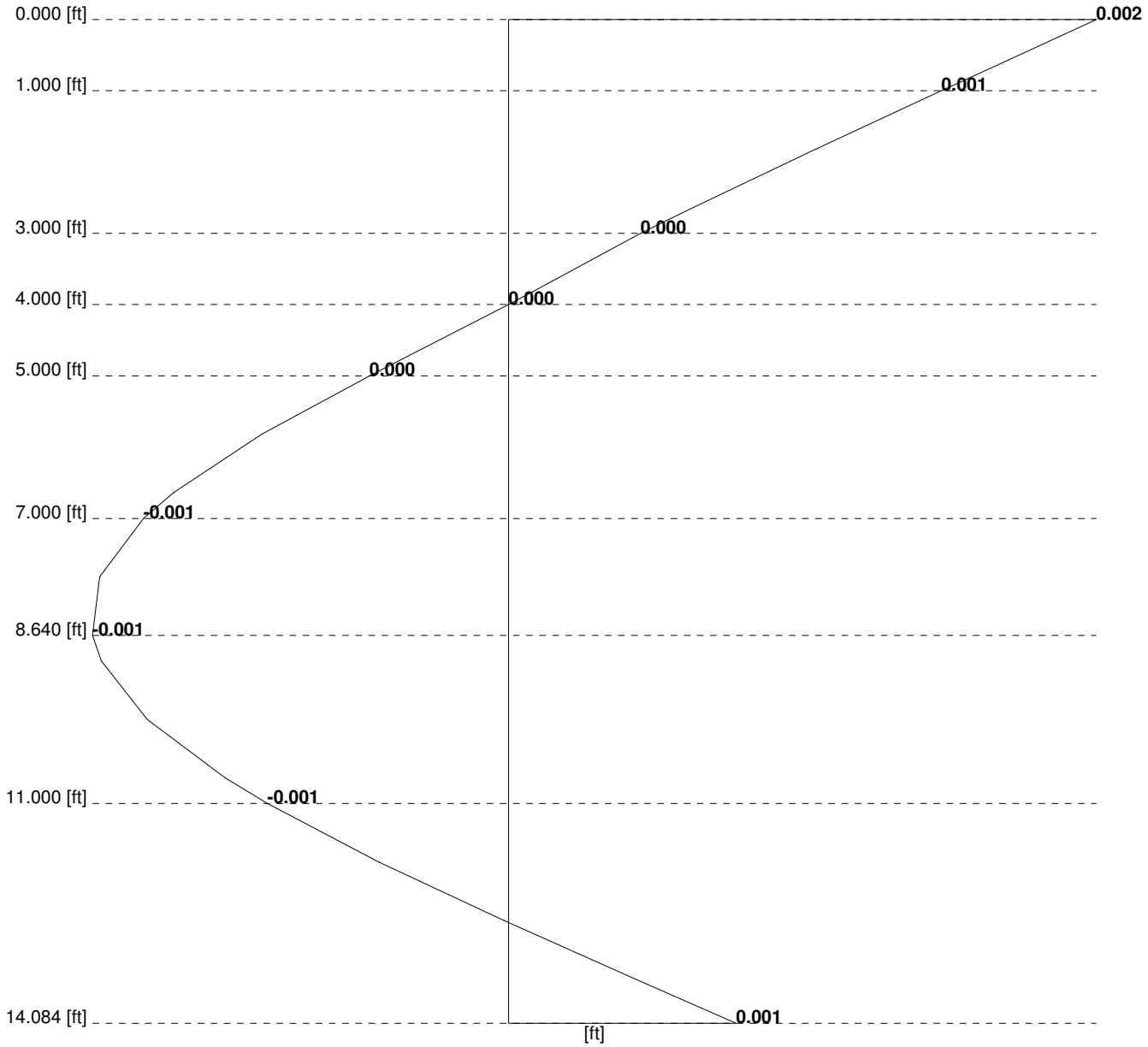
Moment Diagram



Rotation Diagram



Deflection Diagram



DESIGN CALCULATION COVER SHEET

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Excellence Delivered ***As Promised***

ISO 9001:2008 CERTIFIED

PROJECT: **ODOT/EMH&T: HAM-75-7.85**
ODOT PID NO: 77889

BRIDGE NO: **HAM-562-0026**
EMH&T JOB NO:

SUBJECT: ***Analysis***
Pile and Lagging Wall
Mathcad Document
GF JOB NO: 54682

CALC NO.: **HAM562_0026_15**

REV NO.: **00**

FILE NAME(s): *HAM562_0026_15 - Abutment Pile Lagging.xmcd*

SHEET: 1 OF 11

SUPERSEDES CALC NO:

CALCULATION DESCRIPTION:

This will analyze the pile and lagging wall used in front of the abutments for this project.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
CERM-Civil Engineering Reference Manual

MISCELLANEOUS NOTES:

A Coulomb approach was taken when calculating lateral soil pressures behind and in front of the wall.

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 2 Calculation	EFD	07/01/14	VDT	11/06/14

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
EFD	07/01/14	CTM	07/09/14	EFD	11/06/14	VDT	11/06/14

Pile & Lagging Design
(AREMA- ALLOWABLE STRESS DESIGN)

Design notes

- Variables with a box around them require review/user input.
- Code references are made using the following abbreviations:

  - AREMA - American Railway Engineering and Maintenance-of-Way Association
  - SEF - Structural Engineering Formulas (Ilya Mikhelson)
  - AISC - AISC Steel Construction Manual, Thirteenth Edition
  - GB6 - ODOT Office of Geotechnical Engineering: Bulletin 6

- General Design data and assumptions:
  1. The steel pile will be used to reinforce the caisson.
  2. The steel pile will be embedded to the bottom of the caisson.
  3. Calculation based on SEF 11.2

1) GENERAL INPUTS

1.1) Dimensions and Elevations

Retained Soil Elevation: $\boxed{TopSoil := 541.0 \cdot ft}$

Bottom of excavation elevation: $\boxed{BotExc := 525.0 \cdot ft}$

Bottom of Post Elevation: $\boxed{Emb := 502.0 \cdot ft}$

Retained height of wall: $H_{Ret} := TopSoil - BotExc$

$H_{Ret} = 16\,ft$

Effective Embedment below Excav.: $D_{emb} := BotExc - Emb - 1.5 \cdot 30in$

Additional reduction term per AREMA 8-28.5.3.2 a

$D_{emb} = 19.25\,ft$

Spacing: Center-Center of Pile: $\boxed{Pile_{Spa} := 8ft}$

Max Tributary Width of Steel Pile: $\boxed{Pile_{Trib} := 8.0ft}$

Embedded Post Width: $\boxed{b_{emb} := 60in}$

*30" diameter prebored hole * factor of 2*
(per AREMA 8-28.5.3.2 a, for Granular soils
use a factor of 3, we use 2 to be conservative)

Concrete Strength: $\boxed{f_c := 4000psi}$

Concrete Embedment: $\boxed{Conc_{em} := "YES"}$

1.2) Soil Parameter inputs

$\beta := \operatorname{atan}\left(\frac{1}{100}\right)$ (Input - backslope taken perpendicular to shoring)

Fill Angle: $\beta = 0.57 \cdot deg$

Wall Angle: $\theta := 90deg$

Earth Surcharge Load factor (ES): $ES := 1.0$

AREMA Allowable Stress, Passive resistance is reduced in subsequent pages

Taken from Retaining Wall Loads spreadsheet

Passive Resistance Safety Factor: $\Phi_P := 0.66$

AREMA 8-28.5.1.2 Reduction

Table 8-5-2. Properties of Backfill Materials

Type of Backfill	Unit Weight Lb. Per Cu. Ft.	Cohesion "c"	Angle of Internal Friction
1	105	0	33° 42′ (38° for broken stone)
2	110	0	30°
3	125	0	28°
4	100	0	0°
5	120	240	0°

Table 8-5-1. Types of Backfill for Retaining Walls

Backfill Type	Backfill Description
1	Coarse-grained soil without admixture of fine soil particles, very free-draining (sand, gravel or broken stone).
2	Coarse-grained soil of low permeability due to admixture of particles of silt size.
3	Fine silty sand; granular materials with conspicuous clay content; or residual soil with stones.
4	Soft or very soft clay, organic silt; or soft silty clay.
5	Medium or stiff clay that may be placed in such a way that a negligible amount of water will enter the spaces between the chunks during floods or heavy rains.

c. Types 4 and 5 backfill shall be used only with the permission of the Engineer. In all cases the wall design shall be based on the type of backfill used.

	Backfill	Embedment
Unit weight of soil:	$\gamma_{bk} := 125pcf$	$\gamma_{emb} := 125pcf$
Effective Angle of Internal Friction:	$\phi_{bk} := 31deg$	$\phi_{emb} := 31deg$
Friction Angle Between Fill & Wall:	$\delta_{bk} := 15.5deg$	$\delta_{emb} := 15.5deg$

assumed to be 1/2 of internal friction angle

Soil parameters are from Geotechnical Report

1.3) Coefficient of active earth pressure: Coulomb Approach is utilized, AREMA 8-20.3.1

Backfill

$$\Gamma_{abk} := \left[1 + \left(\frac{\sin(\phi_{bk} + \delta_{bk})\cdot\sin(\phi_{bk} - \beta)}{\sin(\theta - \delta_{bk})\sin(\theta + \beta)}\right)^{0.5}\right]^2$$

$\Gamma_{abk} = 2.616$

$$K_{a.bk} := \frac{\sin(\theta + \phi_{bk})^2}{\Gamma_{abk}\cdot\left(\sin(\theta)^2\cdot\sin(\theta - \delta_{bk})\right)}$$

$K_{a.bk} = 0.291$

Embedment

$$\Gamma_{emb} := \left[1 + \left(\frac{\sin(\phi_{emb} + \delta_{emb})\cdot\sin(\phi_{emb})}{\sin(\theta - \delta_{emb})\sin(\theta)}\right)^{0.5}\right]^2$$

$\Gamma_{emb} = 2.633$

$$K_{a.emb} := \frac{\sin(\theta + \phi_{emb})^2}{\Gamma_{emb}\cdot\left(\sin(\theta)^2\cdot\sin(\theta - \delta_{emb})\right)}$$

$K_{a.emb} = 0.290$

1.4) Coefficient of passive earth pressure: Coulomb Approach is utilized, AREMA 8-20.3.4

Backfill

$$\Gamma_{pbk} := \left[1 - \left(\frac{\sin(\phi_{bk} + \delta_{bk})\cdot\sin(\phi_{bk} + \beta)}{\sin(\theta + \delta_{bk})\sin(\theta + \beta)}\right)^{0.5}\right]^2$$

$\Gamma_{pbk} = 0.139$

$$K_{p.bk} := \frac{\sin(\theta - \phi_{bk})^2\cdot\Phi_P}{\Gamma_{pbk}\cdot\left(\sin(\theta)^2\cdot\sin(\theta + \delta_{bk})\right)}$$

$K_{p.bk} = 3.633$

Embedment

$$\Gamma_{embp} := \left[1 - \left(\frac{\sin(\phi_{emb} + \delta_{emb})\cdot\sin(\phi_{emb})}{\sin(\theta + \delta_{emb})\sin(\theta)}\right)^{0.5}\right]^2$$

$\Gamma_{embp} = 0.142$

$$K_{p.emb} := \frac{\sin(\theta - \phi_{emb})^2\cdot\Phi_P}{\Gamma_{embp}\cdot\left(\sin(\theta)^2\cdot\sin(\theta + \delta_{emb})\right)}$$

$K_{p.emb} = 3.534$

1.5) Section Definitions

Type of Steel: ASTM A572 Grade 50 $F_y = 50.0\,ksi$ $F_u = 65.0\,ksi$ $E = 29000\,ksi$

Material = "ASTM A572 Grade 50"

Steel Shape Category: W

Section: W18X143 Confirmation of Shape Selected Selected = "W18X143"

Weight $Wt = 143 \cdot plf$ Area $A_g = 42 \cdot in^2$ Depth $D_y = 19.5 \cdot in$ Flange Width $b_f = 11.2 \cdot in$

Web Th, $t_w = 0.73 \cdot in$ Flange Th. $t_f = 1.32 \cdot in$ Compact Ratio: $bf_2t_f = 4.25$ c/c Flange Dist.: $h_{tw} = 22 \cdot in$

Primary I: $I_x = 2750 \cdot in^4$ Primary S $S_x = 282 \cdot in^3$ Primary X $Z_x = 322 \cdot in^3$ Primary r $r_x = 8.09 \cdot in$

Weak I: $I_y = 311 \cdot in^4$ Weak S $S_y = 55.5 \cdot in^3$ Weak Z $Z_y = 85.4 \cdot in^3$ Weak r $r_y = 2.72 \cdot in$

Compressive flange & 1/3 of web Radius of Gyration $R_{ts} = 3.17 \cdot in$ Torsion J $J_t = 19.2 \cdot in^4$ Torsion Cw $C_w = 25700 \cdot in^6$

Clear distance between flanges: $D_{clear} := D_y - 2 \cdot t_f$ $D_{clear} = 16.86 \cdot in$

Composite Section: Tangent Piles (n=8) (use if pile is embedded in concrete)

$$E_c := 57000 \cdot \sqrt{f_c \cdot psi} \qquad n := round\left(\frac{E}{E_c}\right) \qquad n = 8$$

$$A_c := \pi\left(\frac{b_{emb}}{2}\right)^2 = 2827.43 \cdot in^2 \qquad w_e := \frac{\sqrt{A_c}}{n} = 6.65 \cdot in$$

$$I_{cs} := \left(w_e \cdot \frac{D_{clear}^3}{12}\right) = 2654.59 \cdot in^4$$

$$I_{eff} := if\left(Conc_{em} = \text{"YES"}, I_{cs} + I_x, I_x\right) = 5404.59 \cdot in^4$$

1.6) Timber Input Data

Thickness of Timber Lagging: $t_{tim} := 4.0in$

Type of Timber: Red Oak No. 1

Values from Arema table 7-2-13

Elasticity modulus: $E_{tim} := 1200ksi$

Width (Vertical Height) of Timber Lagging: $w_{tim} := 8in$

Reference stress in bending: $F_{bo} := 1.035ksi$

Timber Bearing Length Tolerance: $tol := 3in$

Per end of the timber

Reference shear stress parallel to grain: $F_{vo} := 0.140ksi$

Strength Factors per AREMA:

Reference compression stress (Perpendicular to grain): $F_{cpo} := 495psi$

$$C_r := if\left[t_{tim} \geq 5in, if\left[w_{tim} \geq 12in, \left(\frac{12in}{w_{tim}}\right)^{\frac{1}{9}}, 1\right], 1\right] = 1$$

Only affects F.bo

Using the following table (AREMA 7-2-13), evaluate the correct size factors based on information given above:

$C_{fb} := 1.3$

$C_{flatb} := 0.74$

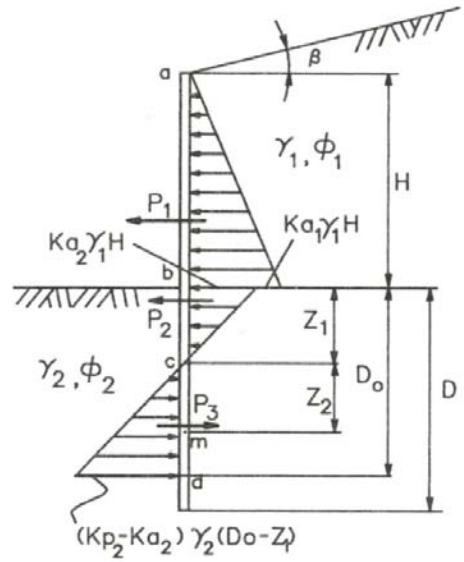
$C_{flatE} := 0.9$

$F_{bof} := F_{bo} \cdot C_r \cdot C_{fb} \cdot C_{flatb} = 0.9957\,ksi$

$E_{timf} := E_{tim} \cdot C_{flatE} = 1080\,ksi$

1.7) Analysis Reference: SEF Figure 11.2 (2) - Cantilever Sheet Piling

2



Earth pressure:

$$P_1 = 0.5K_a\gamma H^2 , \qquad z_1 = \frac{K_a\gamma_1 H}{(K_{p_2} - K_{a_2})\gamma_2}$$

$$P_2 = 0.5K_{a_2}\gamma_1 H \cdot z_1 , \qquad z_2 = \sqrt{\frac{P_1 + P_2}{0.5(K_{p_2} - K_{a_2})\gamma_2}}$$

$$P_3 = 0.5(K_{p_2} - K_{a_2})\gamma_2 (D_0 - z_1)^2$$

Equation to determine D_0: $\sum M_d = 0$

$$P_1\left(\frac{H}{3} + D_0\right) + P_2\left(D_0 - \frac{z_1}{3}\right) - P_3\frac{1}{3}(D_0 - z_1) = 0$$

$D = (1.2 \text{ to } 1.4)D_0$ for factor of safety at 1.5 to 2.0

m = point of zero shear and maximum bending moment

Maximum bending moment

$$M_{max} = P_1\left(\frac{H}{3} + z_1 + z_2\right) + P_2\left(\frac{2}{3}z_1 + z_2\right) - 0.5(K_p - K_a)\gamma z_2^2 \cdot \left(\frac{z_2}{3}\right)$$

2) Steel Post Embedment Check

Earth pressure due to Active soil

$$P_1 := \left[0.5\left(\gamma_{bk} \cdot K_{a.bk} \cdot H_{Ret}^2\right)\right] \cdot Pile_{Trib}$$

$$P_1 = 37.31 \cdot kip$$

z1 depth uses load and resistance factors; conservative for deflection (service) calculations

Earth pressure due to Passive soil

$$z_1 := \frac{ES \cdot \left(K_{a.bk} \cdot \gamma_{bk} \cdot H_{Ret}\right) \cdot Pile_{Trib}}{\left(K_{p.emb} - ES \cdot K_{a.emb}\right)\gamma_{emb} \cdot b_{emb}} = 2.3 \cdot ft$$

$$P_2 := \left(0.5 \cdot K_{a.emb} \cdot \gamma_{bk} \cdot H_{Ret} \cdot z_1\right) \cdot b_{emb} = 3.33 \cdot kip$$

Live load surcharge

$$\boxed{P_{LLS} := 0.35 \cdot 2.0ft \cdot 120pcf \cdot Pile_{Trib} \cdot H_{Ret}}$$

Only 2' of construction surcharge is added. Excavation in front of the wall will not occur until railroad is atop new footing and bridge so there will not be any room for surcharge behind the wall.. the railroad is on its own set of piles.

$$P_{LLS} = 10.75 \cdot kip$$

*Ka x Surcharge Height (Construction) * Density * Height * Width*

$$\boxed{H_{LLS} := H_{Ret} \cdot 0.5}$$

Construction Surcharge (Half of height)

Passive Resistance

$$P_3 := \left[0.5 \cdot \left(K_{p.emb} - K_{a.emb}\right) \cdot \gamma_{emb} \cdot \left(D_{emb} - z_1 - 1.5 \cdot b_f\right)^2\right] \cdot b_{emb}$$

$$P_3 = 245.18 \cdot kip$$

*Embedment depth reduced by 1.5*width of flange per AREMA 8-28.5.3.2 a*

Negative Moment means that the passive (P3) force will tend to rotate the wall towards the filled material.
Positive moments indicate that there is insufficient resisting force.

$$M_D := ES \cdot P_1 \cdot \left(D_{emb} + \frac{H_{Ret}}{3}\right) + ES \cdot P_2 \cdot \left(D_{emb} - \frac{z_1}{3}\right) + ES \cdot P_{LLS} \cdot \left(D_{emb} + H_{LLS}\right) - P_3 \cdot \frac{\left(D_{emb} - z_1\right)}{3}$$

Terms factored as required (Load and Resistance)

$M_D = -113.69\,ft \cdot kip$

$EMBEDMENT_CHECK := if\left(M_D < 0, \text{"OK"}, \text{"INCREASE EMBEDMENT"}\right)$ EMBEDMENT_CHECK = "OK"

3) Steel Post Design (See graphic in section 1.7)

3.1) Required Section Modulus

Zero shear location = m = Point of Max Bending Moment:

$$z_2 := \left[\frac{ES \cdot \left(P_1 + P_2\right)}{0.5\left(K_{p.emb} - ES \cdot K_{a.emb}\right)\gamma_{emb} \cdot b_{emb}}\right]^{0.5}$$

$z_2 = 6.331\,ft$ $\quad z_m := z_1 + z_2 \quad z_m = 8.63\,ft$

Moment at zero shear location

$$M_{m.fact} := ES \cdot P_1 \cdot \left(z_m + \frac{H_{Ret}}{3}\right) + ES \cdot P_2 \cdot \left(\frac{2 \cdot z_1}{3} + z_2\right) \ldots$$
$$+ ES \cdot P_{LLS} \cdot \left(z_m + H_{LLS}\right) - \left[0.5\left(K_{p.emb} - ES \cdot K_{a.emb}\right) \cdot \gamma_{emb} \cdot \left(z_2\right)^2 \cdot \frac{z_2}{3}\right] \cdot b_{emb}$$

$M_{m.fact} = 640.16\,ft \cdot kip$

Required section modulus of steel pile section: $S_{x.req} := \frac{M_{m.fact}}{0.55 \cdot F_y}$ $\quad S_{x.req} = 279.34 \cdot in^3$

$S_x = 282 \cdot in^3$

$SECTION_CHECK := if\left(S_x > S_{x.req}, \text{"OK"}, \text{"INCREASE SECTION"}\right)$ SECTION_CHECK = "OK"

3.2) Calculated Deflection (Unfactored)

Deflection will be calculated assuming the post is fixed at the zero shear (max moment) depth.
The deflections will be calculated by approximating the deflection by each equivalent point load (service) as follows:

Active Deflection

$$\Delta_{p.1} := \frac{\left[P_1 \cdot \left(z_m + \frac{H_{Ret}}{3}\right)^2\right]}{\left(6 \cdot E \cdot I_{eff}\right)} \cdot \left[3 \cdot \left(z_m + H_{Ret}\right) - \left(z_m + \frac{H_{Ret}}{3}\right)\right] = 0.8 \cdot in$$

Surcharge Deflection

$$\Delta_{p.LLS} := \frac{\left[P_{LLS} \cdot \left(z_m + H_{LLS}\right)^2\right]}{\left(6 \cdot E \cdot I_{eff}\right)} \cdot \left[3 \cdot \left(z_m + H_{Ret}\right) - \left(z_m + H_{LLS}\right)\right] = 0.31 \cdot in$$

Embedded Active Deflection

$$\Delta_{p.2} := \frac{\left[P_2 \cdot \left(\frac{2 \cdot z_1}{3} + z_2\right)^2\right]}{\left(6 \cdot E \cdot I_{eff}\right)} \cdot \left[3 \cdot \left(z_m + H_{Ret}\right) - \left(\frac{2 \cdot z_1}{3} + z_2\right)\right] = 0.02 \cdot in$$

Note: P3 Deflection (resisting moment) will not be included. The soil movement, absent a p-y curve, is difficult to estimate.

Deflection at the top of the post: $\Delta_{Top} := \Delta_{p.1} + \Delta_{p.LLS} + \Delta_{p.2}$ $\quad \Delta_{Top} = 1.14 \cdot in$

Deflection Ratio $\Delta_{Ratio} := \frac{H_{Ret}}{\Delta_{Top}}$ $\quad \Delta_{Ratio} = 168.6$

4) Timber Lagging Design

4.1 Timber Properties

Allowable stress in bending: $F_b := F_{bof}$

Allowable stress in shear: $F_v := F_{vo}$ *(All applicable reduction factors = 1)*

Allowable stress in compression: $F_{cp} := F_{cpo}$ *(All applicable reduction factors = 1)*

Thickness: $t_{tim} = 4 \cdot in$

Width: $w_{tim} = 8 \cdot in$

Nominal area of timber unit: $Area_{tim} := t_{tim} \cdot w_{tim}$ $\quad Area_{tim} = 32 \cdot in^2$

Pressure at bottom of excavation due to Live load surcharge: $P_{LLS_tim} := ES \cdot \frac{P_{LLS}}{(Pile_{Trib} \cdot H_{Ret})}$ $\quad P_{LLS_tim} = 84 \cdot psf$

Pressure at bottom of excavation due to retained soil: $P_{1_tim} := ES \cdot (H_{Ret} - 1ft) \cdot K_{a.bk} \cdot \gamma_{bl}$ $\quad P_{1_tim} = 546.46 \cdot psf$

H.ret is reduced by one foot to consider that the timber lagging will not run the full depth of the excavation.

Uniform load on timber unit: $W_{tim} := 0.66 \cdot (P_{1_tim}) \cdot w_{tim}$ $\quad W_{tim} = 240.44 \cdot plf$

1/3 (0.66) reduction per AREMA 8-28.5.3.5(a)

Liveload surcharge is removed due to the presense of the bridge behind the wall, there is no place for live load to be behind the timber lagging wall during excavation.

Lagging Design Span: $L_{tim} := Pile_{Spa} - b_f + 2 \cdot tol$ $\quad L_{tim} = 7.57\,ft$

Timber lagging is designed as a single span beam with a span length equal to the clear distance between the flange tips (plus tolerance)

Moment of inertia of timber unit: $I_{tim} := \frac{w_{tim} \cdot t_{tim}^3}{12}$ $\quad I_{tim} = 42.67 \cdot in^4$

Distance from neutral axis to end fiber: $y_{tim} := \frac{t_{tim}}{2}$ $\quad y_{tim} = 2 \cdot in$

Max Moment: $M_{tim} := \frac{W_{tim} \cdot L_{tim}^2}{8}$ $\quad M_{tim} = 1.72\,ft \cdot kip$

Shear at the support of timber unit: $V_{tim} := \frac{W_{tim} \cdot L_{tim}}{2}$ $\quad V_{tim} = 0.91 \cdot kip$

4.2 Bending Check

Bending stress: $f_b := \frac{M_{tim} \cdot y_{tim}}{I_{tim}}$ $f_b = 967.95 \cdot psi$ $F_{bof} = 995.67 \cdot psi$

BENDING_CHECK := if($f_b < F_{bof}$, "OK" , "MODIFY TIMBER")

BENDING_CHECK = "OK"

4.3 Shear Check

Shear stress: $f_v := \frac{1.5 \cdot V_{tim}}{Area_{tim}}$ $f_v = 42.64 \cdot psi$ $F_v = 140 \cdot psi$

SHEAR_CHECK := if($f_v < F_v$, "OK" , "MODIFY TIMBER")

SHEAR_CHECK = "OK"

4.4 Bearing Check

Length of bearing of timber unit on steel flange: $L_{brg} := \frac{b_f - t_w}{2} - tol$ $L_{brg} = 2.23 \cdot in$

Compression stress: $f_{cp} := \frac{V_{tim}}{(L_{brg} \cdot w_{tim})}$ $f_{cp} = 50.88 \cdot psi$ $F_{cp} = 495 \cdot psi$

BEARING_CHECK := if($f_{cp} < F_{cp}$, "OK" , "MODIFY SECTION")

BEARING_CHECK = "OK"

4.5 Deflection Check

Live load surcharge (uniformly distributed): $W_{LLS} := P_{LLS_tim} \cdot w_{tim}$ $W_{LLS} = 56 \cdot plf$

Active Pressure (uniformly distributed): $W_{1_tim} := P_{1_tim} \cdot w_{tim}$ $W_{1_tim} = 364.31 \cdot plf$

Live load deflection: $\Delta_{LLS} := \frac{5 \cdot (W_{LLS}) \cdot L_{tim}^4}{384 \cdot E_{tim} \cdot I_{tim}}$ $\Delta_{LLS} = 0.08 \cdot in$

Allowable live load deflection: $\Delta_{allow} := \frac{L_{tim}}{240}$ $\Delta_{allow} = 0.38 \cdot in$

DEFLECTION_CHECK := if($\Delta_{LLS} > \Delta_{allow}$, "EXCESS DEFLECTION" , "OK") DEFLECTION_CHECK = "OK"

Gannett Fleming Engineers and Architects, P.C. — Excellence Delivered As Promised	Calculation	Stage 3 Quantities: Norfolk Southern Railroad Bridges
	Description	HAM-562-0026, NSRR over S.R. 562 (Phase B Construction)

GF Job No:	Bridge SFN	Calculated	Checked	Updated	Verified	Level 2 Review
• 054682	• XXXXXXX	• CTM, 11/4/14	• SNH, 11/12/14	• CTM, 11/17/14 • VDT, 06/05/15	• SNH, 11/18/14 • SNH, 06/09/15	•

This calculation will use ODOT Bid Elements. Reinforcing ratios will be used to determine reinforcing until the Stage 3 reinforcing calculations are complete.
Framing is normal to the chord for each span, with end diapragms being placed along the skew angle at bearing locations.

INPUT: Superstructure

General Data

Minimum Concrete Deck Thickness:	9.000 in	Curb Thickness:	1.000 ft
Total Number of Girder Lines:	9 Girders	Curb Height:	2.000 ft
Girder Spacing, Cent-Cent:	3.500 ft	No. of Lines of Diaphragms with Holes:	2 lines
		Bays containing LLB:	0 bays
		LLB Member Weight (L4x4x3/8):	0.00 plf
		LLB Paint Perimeter:	16.0 in
Int. Diaphragm Web Length:	38.250 in	Int. Diaphragm Flange Length:	29.000 in
Int. Diaphragm Web Depth:	30.500 in	Int. Diaphragm Flange Thickness:	0.500 in
Int. Diaphragm Web Thickness:	0.500 in	Int. Diaphragm Flange Width:	6.000 in
Int. Diaphragm Drain Hole Area:	178.5 SqIn	Int. Diaphragm Paint Area	3126 SqIn
End Diaphragm Web Length:	33.000 in	End Diaphragm Flange Length:	22.000 in
End Diaphragm Web Depth:	30.500 in	End Diaphragm Flange Thickness:	0.500 in
End Diaphragm Web Thickness:	0.500 in	End Diaphragm Flange Width:	6.000 in
End Diaphragm Hole Area:	311.7 SqIn	End Diaphragm Paint Area	1995 SqIn
Int Dphrm Connex/Bot Flange Connex	7.500 in	Length	
Int Dphrm Connex/Bot Flange Connex	4.000 in	Width	
Int Dphrm Connex/Bot Flange Connex	0.500 in	Thickness	

CIP Deck Reinforcing Ratio:	270 lb/cy	Abutment & W.W. Reinforcing Ratio:	120 lb/cy
Pier Cap Reinforcing Ratio:	200 lb/cy	Footing Reinforcing Ratio:	140 lb/cy
Pier Wall & Abutment Backwall Reinforcing Ratio:	300 lb/cy	Parapet/Curb Reinforcing Ratio:	170 lb/cy

Span #1 Specific Data

Design Girder (Chord) Length:	69.500 ft	C/C Bearing	Total Concrete Deck Length:	72.677 ft	Parallel to Chord
Length of Girder Overhangs (Total):	2.500 ft	1'-3" Each End	Deck Width, Out-Out:	31.750 ft	Normal to Chord
			Span #1 Skew:	16.833 deg	0.29379 rad
Intermediate Dprm Connx Plate Height:	34.500 in				
Intermediate Dprm Connx Plate Thickness:	0.500 in		Girder Flange Width:	21.000 in	
Intermediate Dprm Connx Plate Width:	5.000 in		Girder Flange Thickness:	3.000 in	
Intermediate Dprm Connx Plate Paint Area	380 SqIn		Girder Web Depth:	35.000 in	
Intermediate Dprm Connx Spacing:	12.000 ft		Girder Web Thickness:	0.750 in	
Bearing Stiffener Thickness:	1.000 in		Girder Paint Perimeter	137.5 in	Excl. Top of Flng
Bearing Stiffener Width:	9.500 in		Typical Stiffener Clip	1.830 in	
Bearing Stiffener Paint Area	735 SqIn				
Typical Diaphragm Spacing:	12.00 ft	NSRR Max is 12'			
Jacking Stiffener Thickness:	0.750 in				
Jacking Stiffener Height:	30.500 in				
Jacking Stiffener Width:	2.750 in				
Jacking Stiffener Paint Area	214 SqIn				

Span #2 Specific Data

Design Girder (Chord) Length:	69.500 ft	C/C Bearing	Total Concrete Deck Length:	72.677 ft	Parallel to Chord
Length of Girder Overhangs (Total):	2.500 ft	1'-3" Each End	Deck Width, Out-Out:	31.750 ft	Normal to Chord
			Span #2 Skew:	16.833 deg	0.29379 rad
Intermediate Dprm Connx Plate Height:	34.500 in				
Intermediate Dprm Connx Plate Thickness:	0.500 in		Girder Flange Width:	21.000 in	
Intermediate Dprm Connx Plate Width:	5.000 in		Girder Flange Thickness:	3.000 in	
Intermediate Dprm Connx Plate Paint Area	380 SqIn		Girder Web Depth:	35.000 in	
Intermediate Dprm Connx Spacing:	12.000 ft		Girder Web Thickness:	0.750 in	
Bearing Stiffener Thickness:	1.000 in		Girder Paint Perimeter	137.5 in	Excl. Top of Flng
Bearing/Jacking Stiffener Width:	9.500 in		Typical Stiffener Clip	1.830 in	
Bearing Stiffener Paint Area	735 SqIn				
Typical Diaphragm Spacing:	12.00 ft	NSRR Max is 12'			
Jacking Stiffener Thickness:	0.750 in				
Jacking Stiffener Height:	30.500 in				
Jacking Stiffener Width:	2.750 in				
Jacking Stiffener Paint Area	214 SqIn				

INPUT: Substructure

Rear (South) Abutment

Bottom of Abutment Footing Elevation:	540.40		Footing Length:	38.000 ft	
Top of Stem Elevation:	544.34		Footing Width:	16.500 ft	
Top of Backwall Shoulder Elevation:	551.03	Top of Curb	Footing Thickness:	3.000 ft	
Median Top of Backwall Elevation:	549.11	Between Curbs			
Pile Tip Elevation:	451.65		Pile Embedment into Footing:	1.250 ft	
Finished Ground Elevation:	527.75	Toe of Barrier	Wingwall Footing Thickness	0.000 ft	
			Backwall Length (Along Skew):	33.210 ft	Betwn Curbs
Stem Thickness:	5.500 ft		Stem Length:	34.000 ft	Total
Backwall Thickness:	1.500 ft		Backwall Extension Plan Area:	32.84 SqFt	
Pile Row #1 Batter:	6.0 on 1	109.84%	Pile Row #2 Batter:	6.0 on 1	100.75%
Pile Row #1 Piles:	11 ea		Pile Row #2 Piles:	11 ea	
Pile Row #3 Batter:	6.0 on 1	111.88%	Pile Row #4 Batter:	6.0 on 1	101.38%
Pile Row #3 Piles:	9 ea		Pile Row #4 Piles:	1 ea	
Length of Soldier Pile/Lagging Wall:	91.500 ft				
Height of Soldier Pile/Lagging Wall Cap:	2.500 ft				
Width of Soldier Pile/Lagging Wall Cap:	2.500 ft				
Facing Area of Soldier Pile/Lagging Wall:	1,192 sf	CADD area			

Rear Wingwall Data

West Wingwall			East Wingwall		
Total Wingwall Length:	0.000 ft		Total Wingwall Length:	17.200 ft	
Wingwall Shoulder Length:	0.000 ft		Wingwall Shoulder Length:	3.700 ft	
Wingwall Shoulder Elevation:	0.00		Wingwall Shoulder Elevation:	551.03	
Wingwall Lowest Elevation:	0.00		Wingwall Lowest Elevation:	550.03	
Wingwall Thickness:	0.000 ft		Wingwall Thickness:	1.500 ft	
Wingwall Footing Length #1:	0.000 ft		Wingwall Footing Length #1:	0.000 ft	
Wingwall Footing Width #1:	0.000 ft		Wingwall Footing Width #1:	0.000 ft	
Wingwall Footing Length #2:	0.000 ft		Wingwall Footing Length #2:	0.000 ft	
Wingwall Footing Width #2:	0.000 ft		Wingwall Footing Width #2:	0.000 ft	
Battered Piles - Average Batter:	Vertical	100.00%	Battered Piles - Average Batter:	Vertical	100.00%
Battered Piles - Total Number:	0 batt		Battered Piles - Total Number:	0 batt	
Vertical Piles - Total Number:	0 Vert		Vertical Piles - Total Number:	0 Vert	

Forward (North) Abutment

Bottom of Footing Elevation:	540.60		Footing Length:	45.250 ft	
Top of Stem Elevation:	544.59		Footing Width:	16.500 ft	
Top of Backwall Shoulder Elevation:	551.29	Top of Curb	Footing Thickness:	3.000 ft	
Median Top of Backwall Elevation:	549.37	Betwn Curbs			
Pile Tip Elevation:	466.85		Pile Embedment into Footing:	1.250 ft	
Finished Ground Elevation:	527.50	Edge of Pvmt	Wingwall Footing Thickness	0.000 ft	
			Backwall Length (Along Skew):	34.790 ft	Betwn Curbs
Stem Thickness:	5.500 ft		Stem Length:	37.250 ft	Total
Backwall Thickness:	1.500 ft		Backwall Extension Plan Area:	13.76 SqFt	
Pile Row #1 Batter:	6.0 on 1	100.75%	Pile Row #2 Batter:	6.0 on 1	100.75%
Pile Row #1 Piles:	11 ea		Pile Row #2 Piles:	11 ea	
Pile Row #3 Batter:	6.0 on 1	100.75%	Pile Row #4 Batter:	6.0 on 1	101.38%
Pile Row #3 Piles:	11 ea		Pile Row #4 Piles:	1 ea	
Length of Soldier Pile/Lagging Wall:	78.000 ft				
Height of Soldier Pile/Lagging Wall Cap:	2.500 ft				
Width of Soldier Pile/Lagging Wall Cap:	2.500 ft				
Facing Area of Soldier Pile/Lagging Wall:	1,023 sf	CADD area			

Forward Wingwall Data

West Wingwall			East Wingwall		
Total Wingwall Length:	0.000 ft		Total Wingwall Length:	18.461 ft	
Wingwall Shoulder Length:	0.000 ft		Wingwall Shoulder Length:	5.961 ft	
Wingwall Shoulder Elevation:	0.00		Wingwall Shoulder Elevation:	551.29	
Wingwall Lowest Elevation:	0.00		Wingwall Lowest Elevation:	547.29	
Wingwall Thickness:	0.000 ft		Wingwall Thickness:	1.500 ft	
Wingwall Footing Length #1:	0.000 ft		Wingwall Footing Length #1:	0.000 ft	
Wingwall Footing Width #1:	0.000 ft		Wingwall Footing Width #1:	0.000 ft	
Wingwall Footing Length #2:	0.000 ft		Wingwall Footing Length #2:	0.000 ft	
Wingwall Footing Width #2:	0.000 ft		Wingwall Footing Width #2:	0.000 ft	
Battered Piles - Average Batter:	Vertical	100.00%	Battered Piles - Average Batter:	Vertical	100.00%
Battered Piles - Total Number:	0 batt		Battered Piles - Total Number:	0 batt	
Vertical Piles - Total Number:	0 Vert		Vertical Piles - Total Number:	0 Vert	

Pier

Bottom of Footing Elevation:	521.70		Footing Length:	40.000 ft
Top of Cap Elevation:	544.62		Footing Width:	19.333 ft
Pile Tip Elevation:	453.20		Footing Thickness:	4.000 ft
Finished Ground Elevation:	527.75	Toe of Barrier	Pile Embedment into Footing:	1.500 ft
Cap Length:	34.750 ft			
Cap Height:	5.000 ft		Wall Thickness:	4.000 ft
Cap Width:	6.833 ft		Wall Length:	35.25 ft
Pile Row #1 Batter:	Vertical	100.14%	Pile Row #2 Batter:	Vertical	100.14%
Pile Row #1 Piles:	10 ea		Pile Row #2 Piles:	10 ea	

Quantities

202E 11003	STRUCTURE REMOVED, OVER 20 FOOT SPAN, AS PER PLAN							(LS) =		0
Super Removed	(Assume $200,000, 74'x100'x$80/sf = $600,000 - 1/3 Phase B, 2/3 Phase D)									
503E 11101	COFFERDAMS AND EXCAVATION BRACING, AS PER PLAN							(LS) =		0
	(Assume $100,000)									
503E 21101	UNCLASSIFIED EXCAVATION, AS PER PLAN							(CY) =	1,020.0	(CHECK UNIT OF MEASURE)
Rear Abutment Plan:	40.0 ft (Length)	X	18.5 ft (Width)	X	9.6 ft (Ave. depth below EX Grade)	/ 27	=	263 cy		
Rear Abutment Cut Behind:	40.0 ft (Length)	X	9.6 ft (Width)	X	9.6 ft (Depth below EX Grade)	/ 27 / 2	=	68 cy		
FWD Abutment Plan:	47.3 ft (Length)	X	18.5 ft (Width)	X	9.4 ft (Ave. depth below EX Grade)	/ 27	=	304 cy		
FWD Abutment Cut Behind:	47.3 ft (Length)	X	9.4 ft (Width)	X	9.4 ft (Depth below EX Grade)	/ 27 / 2	=	77 cy		
Pier Plan:	42.0 ft (Length)	X	21.0 ft (Width (between sheet piles))	X	9.3 ft (Ave. depth below EX Grade)	/ 27	=	304 cy		
505E 11100	PILE DRIVING EQUIPMENT MOBILIZATION							(LS) =		0
Super and Sub Removed	(Assume $10,000, This is a small part of a much larger mobilization)									
507E 00400	STEEL PILES, MISC.: SOLDIER PILES							(FT) =	830	(ADD SUPPLEMENTAL DESCRIPTION)
Rear Abutment, Lagging Wall Piles	12 ea (Number)	X	37.5 ft (Average Length)				=	450.0 Feet		
Fwd Abutment, Lagging Wall Piles	10 ea (Number)	X	37.6 ft (Average Length)				=	376.0 Feet		
507E 00601	14" CAST-IN-PLACE REINFORCED CONCRETE PILES, DRIVEN, AS PER PLAN							(FT) =	5,430	0
Rear Abutment	90.0 ft (Estimated Length)	X	32 piles				=	2,880 lf		Rounded up to Nearest Foot/Pile
Rear Abutment, Additional	0.0 ft (Estimated Length)	X	0 piles				=	0 lf		
Forward Abutment	75.0 ft (Estimated Length)	X	34 piles				=	2,550 lf		
507E 00651	14" CAST-IN-PLACE REINFORCED CONCRETE PILES, FURNISHED, AS PER PLAN							(FT) =	5,760	0
5' Additional Per Pile	5,430 ft (Driven Length)	+	66 piles (Total Piles)	X	5 ft/pile		=	5,760 lf		
507E 00701	16" CAST-IN-PLACE REINFORCED CONCRETE PILES, DRIVEN, AS PER PLAN							(FT) =	1,400	0
Pier	70.0 ft (Estimated Length)	X	20 piles				=	1,400 lf		Rounded up to Nearest Foot/Pile
507E 00751	16" CAST-IN-PLACE REINFORCED CONCRETE PILES, FURNISHED, AS PER PLAN							(FT) =	1,500	0
5' Additional Per Pile	1,400 ft (Driven Length)	+	20 piles (Total Piles)	X	5 ft/pile		=	1,500 lf		

509E 10000	EPOXY COATED REINFORCING STEEL						(LB) = 78,750	()
Superstructure	(36,706 lb (Volume))						=	36,706 lb
Footing	(7,816 lb (Rear)	+	16,163 lb (Pier)	+	8,324 lb (Forward)	)	=	32,303 lb
Abutment & Wingwalls	(3,289 lb (Rear)	+	3,027 lb (Forward)	)			=	6,316 lb
Pier	(3,417 lb (Pier))						=	3,417 lb

511E 34447	CLASS QC2 CONCRETE WITH QC/QA, BRIDGE DECK, AS PER PLAN						(CY) = 161	(CHECK UNIT OF MEASURE)
Span 1, Deck - Above Flange	72.68 ft (Length)	X	31.75 ft (Width)	X	9.0 in (Thickness)	/	(27 cf/cy)) =	64.1 CU YD
Span 1, Deck - Between Flanges	72.68 ft (Length)	X	16.00 ft (Width)	X	3.0 in (Thickness)	/	(27 cf/cy)) =	10.8 CU YD
Span 1, Deck - Crown	72.68 ft (Length)	X	1.92 sf (Area)			/	(27 cf/cy)) =	5.2 CU YD
Span 2, Deck - Above Flange	72.68 ft (Length)	X	31.75 ft (Width)	X	9.0 in (Thickness)	/	(27 cf/cy)) =	64.1 CU YD
Span 2, Deck - Between Flanges	72.68 ft (Length)	X	16.00 ft (Width)	X	3.0 in (Thickness)	/	(27 cf/cy)) =	10.8 CU YD
Span 2, Deck - Crown	72.68 ft (Length)	X	1.92 sf (Area)			/	(27 cf/cy)) =	5.2 CU YD
511E 34451	**CLASS QC2 CONCRETE WITH QC/QA, BRIDGE DECK (PARAPET), AS PER PLAN**						**(CY) = 22**	*(CHECK UNIT OF MEASURE)*
Span 1, Curb/Parapet	72.68 ft (Length)	X 2 X	1.00 ft (Thickness)	X	2.00 ft (Height)	/	(27 cf/cy)) =	10.8 CU YD
Span 2, Curb/Parapet	72.68 ft (Length)	X 2 X	1.00 ft (Thickness)	X	2.00 ft (Height)	/	(27 cf/cy)) =	10.8 CU YD
511E 40513	**CLASS QC1 CONCRETE WITH QC/QA, PIER ABOVE FOOTINGS, AS PER PLAN**						**(CY) = 115**	*(WALLS)*
Pier Wall	35.25 ft (Length)	X	4.00 ft (Thickness)	X	13.92 ft (Height)	/	(27 cf/cy)) =	72.7 CU YD
Pier Cap	34.75 ft (Length)	X	6.83 ft (Width)	X	5.00 ft (Height)	/	(27 cf/cy)) =	44.0 CU YD
Pier Cap, Chamfer	34.75 ft (Length)	X	1.42 ft (Width)	X	-1.42 ft (Height)	/	(27 cf/cy)) =	-2.6 CU YD
511E 45513	**CLASS QC1 CONCRETE WITH QC/QA, ABUTMENT, AS PER PLAN**						**(CY) = 47**	*(MISC. NEW CONSTRUCTION)*
Rear, Stem	34.00 ft (Length)	X	0.94 ft (Height)	X	5.50 ft (Width)	/	(27 cf/cy)) =	6.5 CU YD
Rear, Backwall Between Curbs	33.21 ft (Length)	X	4.77 ft (Height)	X	1.50 ft (Thickness)	/	(27 cf/cy)) =	8.8 CU YD
Rear, Backwall/Wingwall Shldr	3.70 ft (Length)	X	7.63 ft (Height)	X	1.50 ft (Thickness)	/	(27 cf/cy)) =	1.6 CU YD
Rear, Backwall Extension	32.84 sf (Plan Area)	X	5.71 ft (Height)		/ (27 cf/cy))		=	6.9 CU YD
Forward, Stem	37.25 ft (Length)	X	0.99 ft (Height)	X	5.50 ft (Width)	/	(27 cf/cy)) =	7.5 CU YD
Forward, Backwall Between Curbs	34.79 ft (Length)	X	4.78 ft (Height)	X	1.50 ft (Thickness)	/	(27 cf/cy)) =	9.2 CU YD
Forward, Backwall/Wingwall Shldr	5.96 ft (Length)	X	7.69 ft (Height)	X	1.50 ft (Thickness)	/	(27 cf/cy)) =	2.5 CU YD
Forward, Backwall Extension	13.76 sf (Plan Area)	X	5.77 ft (Height)		/ (27 cf/cy))		=	2.9 CU YD

511E 46013	**CLASS QC1 CONCRETE WITH QC/QA, AS PER PLAN**						**(CY) = 10**		*(RET WALL/WINGWALL, ABVE FOOTN)*
Rear Wingwall, West	0.00 ft *Length*	**X**	-543.40 ft *Height (Assumes WW T/Ftg EL = Abutment T/Ftg)*	**X**	0.00 ft *Thickness*		**/ (27 cf/cy)) =**	**0.0** *CU YD*	
Rear Wingwall, West - Slope	0.00 ft *Length*	**X**	0.00 ft *Height*	**X**	0.00 ft *Thickness*		**/ (27 cf/cy)) =**	**0.0** *CU YD*	
Rear Wingwall, East	13.50 ft *Length*	**X**	6.63 ft *Height (Assumes WW T/Ftg EL = Abutment T/Ftg)*	**X**	1.50 ft *Thickness*		**/ (27 cf/cy)) =**	**5.0** *CU YD*	
Rear Wingwall, East - Slope	13.50 ft *Length*	**X**	1.00 ft *Height*	**X**	1.50 ft *Thickness*	**/ 2**	**/ (27 cf/cy)) =**	**0.4** *CU YD*	
Forward Wingwall, West	0.00 ft *Length*	**X**	-543.60 ft *Height (Assumes WW T/Ftg EL = Abutment T/Ftg)*	**X**	0.00 ft *Thickness*		**/ (27 cf/cy)) =**	**0.0** *CU YD*	
Forward Wingwall, West - Slope	0.00 ft *Length*	**X**	0.00 ft *Height*	**X**	0.00 ft *Thickness*		**/ (27 cf/cy)) =**	**0.0** *CU YD*	
Forward Wingwall, East	12.50 ft *Length*	**X**	3.69 ft *Height (Assumes WW T/Ftg EL = Abutment T/Ftg)*	**X**	1.50 ft *Thickness*		**/ (27 cf/cy)) =**	**2.6** *CU YD*	
Forward Wingwall, East - Slope	12.50 ft *Length*	**X**	4.00 ft *Height*	**X**	1.50 ft *Thickness*	**/ 2**	**/ (27 cf/cy)) =**	**1.4** *CU YD*	
511E 46511	**CLASS QC1 CONCRETE, FOOTING, AS PER PLAN**						**(CY) = 307**		*()*
Rear Abutment	38.00 ft *Length*	**X**	16.50 ft *Width*	**X**	3.00 ft *Thickness*		**/ (27 cf/cy)) =**	**69.7** *CU YD*	
Rear Abutment, Wall Cap	91.50 ft *Length*	**X**	2.50 ft *Height*	**X**	2.50 ft *Width*		**/ (27 cf/cy)) =**	**21.2** *CU YD*	
Pier	40.00 ft *Length*	**X**	19.33 ft *Width*	**X**	4.00 ft *Thickness*		**/ (27 cf/cy)) =**	**114.6** *CU YD*	
Forward Abutment	45.25 ft *Length*	**X**	16.50 ft *Width*	**X**	3.00 ft *Thickness*		**/ (27 cf/cy)) =**	**83.0** *CU YD*	
Forward Abutment, Wall Cap	78.00 ft *Length*	**X**	2.50 ft *Height*	**X**	2.50 ft *Width*		**/ (27 cf/cy)) =**	**18.1** *CU YD*	
511E 71200	**CONCRETE, MISC.: FACING OF CANTILEVER WALLS**						**(SF) = 2,215**		*()*
Rear Abutment	1,192 sf *CADD Area*							**1,192** *SqFt*	
Forward Abutment	1,023 sf *CADD Area*							**1,023** *SqFt*	

512E 10100	**SEALING OF CONCRETE SURFACES (EPOXY-URETHANE)**							(SY) = 719	0
Curb and Deck Underside	145.4 ft (Total Length)	X	5.42 ft (Curb/Paraper perimeter)				/(9 sf/sy) =	87 SqYd	
Rear Abutment, Wall Facing	1,192 sf (CADD Area)						/(9 sf/sy) =	132 SqYd	
Rear Abutment, Wall Cap	91.5 ft (Length)	X	5.0 ft (Perimeter)	/	(9 sf/sy)		=	50.8 SqYd	
Rear Abutment Backwall	189.00 sf (CADD Area)						/(9 sf/sy) =	21 SqYd	
Rear, West Wingwall - Front	0.00 sf (CADD Area)						/(9 sf/sy) =	0 SqYd	
Rear, West Wingwall - Top/Behind	0.0 ft (Length)	X	2.0 ft (Perimeter)	/	(9 sf/sy)		=	0.0 SqYd	
Rear, East Wingwall - Front	55.00 sf (CADD Area)						/(9 sf/sy) =	6 SqYd	
Rear, East Wingwall - Top/Behind	17.20 ft (Length)	X	2.0 ft (Perimeter)	/	(9 sf/sy)		=	3.8 SqYd	
Rear Abutment Stem	7.94 ft (Height (includes seat))	X	34.00 ft (Length)	/	(9 sf/sy)		=	30.0 SqYd	
Forward Abutment, Wall Facing	1,023 sf (CADD Area)						/(9 sf/sy) =	114 SqYd	
Forward Abutment, Wall Cap	78.0 ft (Length)	X	5.0 ft (Perimeter)	/	(9 sf/sy)		=	43.3 SqYd	
FWD Abutment Backwall	218.00 sf (CADD Area)						/(9 sf/sy) =	24 SqYd	
FWD, West Wingwall - Front	0.00 sf (CADD Area)						/(9 sf/sy) =	0 SqYd	
FWD, West Wingwall - Top/Behind	0.0 ft (Length)	X	2.0 ft (Perimeter)	/	(9 sf/sy)		=	0.0 SqYd	
FWD, East Wingwall - Front	63.00 sf (CADD Area)						/(9 sf/sy) =	7 SqYd	
FWD, East Wingwall - Top/Behind	18.46 ft (Length)	X	2.0 ft (Perimeter)	/	(9 sf/sy)		=	4.1 SqYd	
FWD Abutment Stem	7.99 ft (Height (includes seat))	X	37.25 ft (Length)	/	(9 sf/sy)		=	33.1 SqYd	
Pier Wall	13.92 ft (Height)	X	35.25 ft (Length)	X	2 Sides		/(9 sf/sy) =	109 SqYd	
Pier Ends	79.20 sf (Length)	X	1 (Sides)	/	(9 sf/sy)		=	9 SqYd	
Pier Cap, Excluding Top	34.75 ft (Length)	X	11.17 ft (Perimeter)	/	(9 sf/sy)		=	43 SqYd	
512E 10001	**SEALING OF CONCRETE SURFACES, AS PER PLAN**						(SY) = 631		(PERMANENT GRAFFITI PROTECTION)
Rear Abutment	244 SqYd						=	244 SqYd	
Forward Abutment	225 SqYd						=	225 SqYd	
Pier	161 SqYd						=	161 SqYd	
512E 44451	**TYPE E WATERPROOFING, AS PER PLAN**						(SY) = 500		#N/A
Span 1	(29.92 ft (Deck Width)	+	1.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	250 SqYd
Span 2	(29.92 ft (Deck Width)	+	1.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	250 SqYd
512E 56100	**SPECIAL - BUTYL RUBBER MEMBRANE WATERPROOFING**						(SY) = 97		0
Span 1	(6.00 ft (Deck Width)	+	0.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	48 SqYd
Span 2	(6.00 ft (Deck Width)	+	0.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	48 SqYd
512E 56202	**SPECIAL - ASPHALTIC PANEL**						(SY) = 500		0
Span 1	(29.92 ft (Deck Width)	+	1.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	250 SqYd
Span 2	(29.92 ft (Deck Width)	+	1.0 ft (Up Curb))	X	72.68 ft (Length)		/(9 sf/sy)	=	250 SqYd
512E 67400	**SPECIAL - WATERPROOFING, MISC.: DAMPPROOFING OF RAILROAD STRUCTURES**						(SF) = 633		0

Rear Abutment	312.00 sf *CADD Area*	=	**312 SqFt**
Forward Abutment	321.00 sf *CADD Area*	=	**321 SqFt**

513E 10321 STRUCTURAL STEEL MEMBERS, LEVEL 6, AS PER PLAN | **(LB) = 682,735** | *(CHECK UNIT OF MEASURE)*

Span 1, Girder Volume	(	26.25 sq.in *Web Area*	+ 2 x	126.0 sq.in *Total Flange Area*	)	/	(144 si/sf)	1.0573 sf/ Ft		
Span 1, Total Girder Weight		72.0 ft *Length*	X	1.06 sf/Ft *Number Girders*	X		9 girder(s) *Number Girders*	X 490 lb/CF	=	**335,711.3** *Pounds*
Span 1, Int. Dprm Connex Volume	(	171.7 si *Elevation Area*	X	0.500 in *Thickness*	)	/	(1728 ci/cf)	0.0497 cf/ea		
Span 1, Int. Dprm Connex Weight		0.050 cf/ea *Volume/Each*	X	6 / Girder *Diaphragms per Girder*	X		17 faces *Girder Faces (None on Exterior)*	X 490 lb/CF	=	**2,482.4** *Pounds*
Span 1, Bearing Stiffener Volume	(	329.2 si *Elevation Area*	X	1.000 in *Thickness*	)	/	(1728 ci/cf)	0.1905 cf/ea		
Span 1, Bearing Stiffener Weight		0.190 cf/ea *Volume/Each*	X	2 / Girder *Brg Stiff per Girder*	X		17 faces *Girder Faces (None on Exterior)*	X 490 lb/CF	=	**3,173.4** *Pounds*
Span 2, Girder Volume	(	26.25 sq.in *Web Area*	+ 2 x	126.0 sq.in *Total Flange Area*	)	/	(144 si/sf)	1.0573 sf/ Ft		
Span 2, Total Girder Weight		72.0 ft *Length*	X	1.06 sf/Ft *Number Girders*	X		9 girder(s) *Number Girders*	X 490 lb/CF	=	**335,711.3** *Pounds*
Span 2, Int. Dprm Connex Volume	(	171.7 si *Elevation Area*	X	0.500 in *Thickness*	)	/	(1728 ci/cf)	0.0497 cf/ea		
Span 2, Int. Dprm Connex Weight		0.050 cf/ea *Volume/Each*	X	6 / Girder *Diaphragms per Girder*	X		17 faces *Girder Faces (None on Exterior)*	X 490 lb/CF	=	**2,482.4** *Pounds*
Span 2, Bearing Stiffener Volume	(	329.2 si *Elevation Area*	X	1.000 in *Thickness*	)	/	(1728 ci/cf)	0.1905 cf/ea		
Span 2, Bearing Stiffener Weight		0.190 cf/ea *Volume/Each*	X	2 / Girder *Brg Stiff per Girder*	X		17 faces *Girder Faces (None on Exterior)*	X 490 lb/CF	=	**3,173.4** *Pounds*

513E 10221	STRUCTURAL STEEL MEMBERS, LEVEL 1, AS PER PLAN							(LB) = 27,420	(CHECK UNIT OF MEASURE)
Span 1, Jack Stiff. Volume (	80.5 si Elevation Area	X	0.750 in Thickness	) /	(1728 ci/cf)	0.0350 cf/ea			
Span 1, Jack Stiff. Weight	0.035 cf/ea Volume/Each	X	8 / Bay Jack Stiff per Bay	X	8 Bays	X 490 lb/CF	=	1,096.0	Pounds
Span 1, End Dphrgm Web Volume (	1,006.5 si Elevation Area	X	0.500 in Thickness	) /	(1728 ci/cf)	0.2912 cf/ea			
Span 1, End Dphrgm Web Weight	0.291 cf/ea Volume/Each	X	2 / Bay Webs per Bay	X	8 Bays	X 490 lb/CF	=	2,283.3	Pounds
Span 1, End Dphrgm Flange Vol (	132.0 si Elevation Area	X	0.500 in Thickness	) /	(1728 ci/cf)	0.0382 cf/ea			
Span 1, End Dphrgm Flange Weight	0.038 cf/ea Volume/Each	X	4 / Bay Flanges per Bay	X	8 Bays	X 490 lb/CF	=	598.9	Pounds
Span 1, End Dphrgm Holes	-0.090 cf/ea Volume/Each	X	2 / Bay Holes per Bay	X	8 Bays	X 490 lb/CF	=	-707.1	Pounds
Span 1, Int. Dphrgm Web Volume (	1,166.6 si Elevation Area	X	0.500 in Thickness	) /	(1728 ci/cf)	0.3376 cf/ea			
Span 1, Int Dphrgm Web Weight	0.338 cf/ea Volume/Each	X	6 / Bay Webs per Bay	X	8 Bays	X 490 lb/CF	=	7,939.5	Pounds
Span 1, Int. Dphrgm Flange Vol (	174.0 si Elevation Area	X	0.500 in Thickness	) /	(1728 ci/cf)	0.0503 cf/ea			
Span 1, Int. Dphrgm Flange Weight	0.050 cf/ea Volume/Each	X	12 / Bay Flanges per Bay	X	8 Bays	X 490 lb/CF	=	2,368.3	Pounds
Span 1, Int Dphrgm Holes	-0.052 cf/ea Volume/Each	X	6 / Bay Holes per Bay	X	2 Bays	X 490 lb/CF	=	-303.8	Pounds
Span 1, Int Dphrm Connex/Bot Flange Connex Volume (	30.0 si Plan Area	X	0.500 in Thickness	) /	(1728 ci/cf)	0.0087 cf/ea			
Span 1, Int Dphrm Connex/Bot Flange Connex Weight	0.009 cf/ea Volume/Each	X	6 / Girder Diaphragms per Girder	X	17 faces Girder Faces (None on Exterior)	X 490 lb/CF	=	433.9	Pounds
Span 1, Total LLB Weight	6 / Bay pan/Spa	X 0 bays Bays * Span/Spa	X	12.50 ft/ea Typical Member Length Btwn Diaphragms	X	0.00 plf Member Weight	=	0.0	Pounds

Span 2, Jack Stiff. Volume (	80.5 si	X	0.750 in	)	/	(1728 ci/cf)	0.0350 cf/ea			
	Elevation Area		*Thickness*							
Span 2, Jack Stiff. Weight	0.035 cf/ea	X	8 / Bay		X	8 Bays	X 490 lb/CF	=	**1,096.0**	*Pounds*
	Volume/Each		*Jack Stiff per Bay*							
Span 2, End Dphrgm Web Volume (	1,006.5 si	X	0.500 in	)	/	(1728 ci/cf)	0.2912 cf/ea			
	Elevation Area		*Thickness*							
Span 2, End Dphrgm Web Weight	0.291 cf/ea	X	2 / Bay		X	8 Bays	X 490 lb/CF	=	**2,283.3**	*Pounds*
	Volume/Each		*Webs per Bay*							
Span 2, End Dphrgm Flange Vol (	132.0 si	X	0.500 in	)	/	(1728 ci/cf)	0.0382 cf/ea			
	Elevation Area		*Thickness*							
Span 2, End Dphrgm Flange Weight	0.038 cf/ea	X	4 / Bay		X	8 Bays	X 490 lb/CF	=	**598.9**	*Pounds*
	Volume/Each		*Flanges per Bay*							
Span 2, End Dphrgm Holes	-0.090 cf/ea	X	2 / Bay		X	8 Bays	X 490 lb/CF	=	**-707.1**	*Pounds*
	Volume/Each		*Holes per Bay*							
Span 2, Int. Dphrgm Web Volume (	1,166.6 si	X	0.500 in	)	/	(1728 ci/cf)	0.3376 cf/ea			
	Elevation Area		*Thickness*							
Span 2, Int Dphrgm Web Weight	0.338 cf/ea	X	6 / Bay		X	8 Bays	X 490 lb/CF	=	**7,939.5**	*Pounds*
	Volume/Each		*Webs per Bay*							
Span 2, Int. Dphrgm Flange Vol (	174.0 si	X	0.500 in	)	/	(1728 ci/cf)	0.0503 cf/ea			
	Elevation Area		*Thickness*							
Span 2, Int. Dphrgm Flange Weight	0.050 cf/ea	X	12 / Bay		X	8 Bays	X 490 lb/CF	=	**2,368.3**	*Pounds*
	Volume/Each		*Flanges per Bay*							
Span 2, Int Dphrgm Holes	-0.052 cf/ea	X	6 / Bay		X	2 Bays	X 490 lb/CF	=	**-303.8**	*Pounds*
	Volume/Each		*Holes per Bay*							
Span 2, Int Dphrm Connex/Bot Flange Connex Volume (	30.0 si	X	0.500 in	)	/	(1728 ci/cf)	0.0087 cf/ea			
	Plan Area		*Thickness*							
Span 2, Int Dphrm Connex/Bot Flange Connex Weight	0.009 cf/ea	X	6 / Girder		X	17 faces	X 490 lb/CF	=	**433.9**	*Pounds*
	Volume/Each		*Diaphragms per Girder*			*Girder Faces (None on Exterior)*				
Span 2, Total LLB Weight	6 / Bay	X 0 bays	X	12.50 ft/ea	X	0.00 plf		=	**0.0**	*Pounds*
	pan/Spa	*Bays * Span/Spa*		*Typical Member Length Btwn Diaphragms*		*Member Weight*				
513E 20000	**WELDED STUD SHEAR CONNECTORS**					**(EACH) = 2,664**			*0*	
Studs	296	X	9 Girders					=	**2,664.0**	*Each*
	Studs/Girdet		*Total Flange Area*							

514E 80020	**SPECIAL - SHOP PAINTING AND FIELD TOUCH-UP OF STRUCTURAL STEEL**								**(SF) =**	**18,395**	0
Span 1, Girder Painting	72.0 ft *Length*	X	9 gird *Girders*	X	(	137.50 in *Perimeter*	/	(12 in/ft)) =		**7,425.0** *Sq. Ft.*	
Span 2, Girder Painting	72.0 ft *Length*	X	9 gird *Girders*	X	(	137.50 in *Perimeter*	/	(12 in/ft)) =		**7,425.0** *Sq. Ft.*	
Span 1, End Diaphragms	2 /bay *Ends*	X	8 bays *Bays*	X	(	1994.57 si *Average Surface Area*	/	(144 si/sf)) =		**221.6** *Sq. Ft.*	
Span 2, End Diaphragms	2 /bay *Ends*	X	8 bays *Bays*	X	(	1994.57 si *Average Surface Area*	/	(144 si/sf)) =		**221.6** *Sq. Ft.*	
Span 1, Int. Diaphragms, No Drain	6 /bay *Diaphragms per Bay*	X	6 bays *Bays*	X	(	3125.50 si *Average Surface Area*	/	(144 si/sf)) =		**781.4** *Sq. Ft.*	
Span 2, Int. Diaphragms, No Drain	6 /bay *Diaphragms per Bay*	X	6 bays *Bays*	X	(	3125.50 si *Average Surface Area*	/	(144 si/sf)) =		**781.4** *Sq. Ft.*	
Span 1, Int. Diaphragms, With Drain	6 /bay *Diaphragms per Bay*	X	2 bays *Bays*	X	(	2768.42 si *Average Surface Area*	/	(144 si/sf)) =		**230.7** *Sq. Ft.*	
Span 2, Int. Diaphragms, With Drain	6 /bay *Diaphragms per Bay*	X	2 bays *Bays*	X	(	2768.42 si *Average Surface Area*	/	(144 si/sf)) =		**230.7** *Sq. Ft.*	
Span 1, Int. Dprm Connex Plate	6 / Girder *Diaphragms per Girder*	X	17 faces *Girder Faces (None on Exterior)*	X	(	379.50 si *Average Surface Area*	/	(144 si/sf)) =		**268.8** *Sq. Ft.*	
Span 2, Int. Dprm Connex Plate	6 / Girder *Diaphragms per Girder*	X	17 faces *Girder Faces (None on Exterior)*	X	(	379.50 si *Average Surface Area*	/	(144 si/sf)) =		**268.8** *Sq. Ft.*	
Span 1, Bearing Stiffener	2 / Girder *Brg Stiff per Girder*	X	17 faces *Girder Faces (None on Exterior)*	X	(	735.00 si *Average Surface Area*	/	(144 si/sf)) =		**173.5** *Sq. Ft.*	
Span 2, Bearing Stiffener	2 / Girder *Brg Stiff per Girder*	X	17 faces *Girder Faces (None on Exterior)*	X	(	735.00 si *Average Surface Area*	/	(144 si/sf)) =		**173.5** *Sq. Ft.*	
Span 1, Jacking Stiffener	8 / Bay *Jack Stiff per Bay*	X	8 Bays	X	(	213.50 si *Average Surface Area*	/	(144 si/sf)) =		**94.9** *Sq. Ft.*	
Span 2, Jacking Stiffener	8 / Bay *Jack Stiff per Bay*	X	8 Bays	X	(	213.50 si *Average Surface Area*	/	(144 si/sf)) =		**94.9** *Sq. Ft.*	
LLB Members	0 each	X	12.5 ft *Length*	X	(	16.00 in *Perimeter*	/	(12 in/ft)) =		**0.0** *Sq. Ft.*	
516E 12201	**STRUCTURAL STEEL EXPANSION JOINT, AS PER PLAN**								**(FT) =**	**67**	0
Rear Abutment	33.171 ft								=	**33.2** *Feet*	
Forward Abutment	33.171 ft								=	**33.2** *Feet*	
516E 13600	**1" PREFORMED EXPANSION JOINT FILLER**								**(SF) =**	**12**	0
Forward Abutment, East Wingwall	1.500 ft *Width*	X	7.690 ft *Height*						=	**11.5** *Sq. Ft.*	
516E 44401	**ELASTOMERIC BEARING WITH INTERNAL LAMINATES AND LOAD PLATE (NEOPRENE), AS PER PLAN**								**(EACH) =**	**36**	*(5" & OVER, SPECIFY DIMENSIONS)*
5-6" Thickness	36 each	**Elastomeric is used due to skew and lateral bending considerations**								**36.0** *Each*	
517E 73101	**TEMPORARY BRIDGE RAILING, AS PER PLAN**								**(FT) =**	**356**	0
Temporary Railing, On New Deck	(77.7 ft *Span 1*	+	77.7 ft *Span 2*	)	X	1 *Sides*			=	**155.4** *Feet*	
Temporary Railing, On Ex Deck	(100.0 ft *Span 1*	+	100.0 ft *Span 2*	)	X	1 *Sides*			=	**200.0** *Feet*	
517E 75001	**RAILING, ALUMINUM, AS PER PLAN**								**(FT) =**	**37**	0
NSRR Railing	(18.0 ft *Rear Abutment*	+	19.0 ft *Forward Abutment*	)					=	**37.0** *Feet*	
517E 76300	**RAILING, MISC.: NSRR ALUMINUM HANDRAIL WITH VANDAL PROTECTION FENCE**								**(FT) =**	**146**	*(ADD SUPPLEMENTAL DESCRIPTION)*
NSRR Railing	(72.7 ft *Length*	+	72.7 ft *Sides*	)	X	1 *Sides*			=	**145.4** *Feet*	
518E 21200	**POROUS BACKFILL WITH FILTER FABRIC**								**(CY) =**	**47**	*(CHECK UNIT OF MEASURE)*
Rear Abutment	312.00 sf *CADD Area*	X	2.0 ft *Thickness*		/	(27 cf/cy)) =				**23.1** *CU YD*	
Forward Abutment	321.00 sf *CADD Area*	X	2.0 ft *Thickness*		/	(27 cf/cy)) =				**23.8** *CU YD*	
518E 40012	**6" NON-PERFORATED CORRUGATED PLASTIC PIPE**								**(FT) =**	**180**	0
Length	96.0 ft *Rear Abutment*	+	84.0 ft *Forward Abutment*			=				**180.0** *Feet*	

518E 42201	8" PERFORATED CORRUGATED STEEL PIPE, 707.01, AS PER PLAN				(FT) =	100	0
Length (No perf. 5' from ends)	45.0 ft (Rear Abutment)	+	55.0 ft (Forward Abutment)	=			100.0 Feet
518E 42301	8" NON-PERFORATED CORRUGATED STEEL PIPE, INCLUDING SPECIALS, 707.01, AS PER PLAN				(FT) =	365	0
Length (End 5')	185.0 ft (Rear Abutment)	+	180.0 ft (Forward Abutment)				365.0 Feet
518E 63300	STRUCTURE DRAINAGE, MISC.: SUPERSTRUCTURE DRAINAGE SYSTEM				(LS) =	1	(ADD SUPPLEMENTAL DESCRIPTION)
Superstructure Drainage	(Assume $20,000)						
523E 20000	DYNAMIC LOAD TESTING				(EACH) =	6	0
See Specifications:	(Spec requires a minimum of two piles, this number is for two piles per substructure)						6.0 Each
523E 20500	RESTRIKE				(EACH) =	6	0
See Specifications:	(Spec requires a minimum of two piles, this number is for two piles per substructure)						6.0 Each
524E 94603	DRILLED SHAFTS, 30" DIAMETER, ABOVE BEDROCK, AS PER PLAN				(FT) =	804	0
Rear Abutment, Lagging Wall	12 ea (Number)	X	36.5 ft (Average Length)			=	438.0 Feet
Forward Abutment, Lagging Wall	10 ea (Number)	X	36.6 ft (Average Length)			=	366.0 Feet
530E 00200	SPECIAL - STRUCTURE, MISC.: SURVEY AND MONITORING OF TRACK AND TEMPORARY SHORING				(LS) =	1	(ADD SUPPLEMENTAL DESCRIPTION)
	(Assume $25,000)						
530E 13000	SPECIAL - FORM LINER				(SF) =	2,215	0
Rear Abutment, Lagging Wall	1,192.0 sf (CADD Area)					=	1,192.0 SQ FT
Forward Abutment, Lagging Wall	1,023.0 sf (CADD Area)					=	1,023.0 SQ FT
610E 50010a	SPECIAL - RETAINING WALL, MISC.: PREFABRICATED GEOCOMPOSITE DRAIN				(SF) =	2,215	(ADD SUPPLEMENTAL DESCRIPTION)
Rear Abutment, Lagging Wall	1,192.0 sf (CADD Area)					=	1,192.0 Each
Forward Abutment, Lagging Wall	1,023.0 sf (CADD Area)					=	1,023.0 Each
610E 50010b	SPECIAL - RETAINING WALL, MISC.: TEMPORARY HARDWOOD LAGGING				(SF) =	2,215	(ADD SUPPLEMENTAL DESCRIPTION)
Rear Abutment, Lagging Wall	1,192.0 sf (CADD Area)					=	1,192.0 SQ FT
Forward Abutment, Lagging Wall	1,023.0 sf (CADD Area)					=	1,023.0 SQ FT
611E 01907	8" CONDUIT, TYPE B, DUCTILE IRON PIPE ANSI CLASS 52, MECHANICAL JOINTS AND FITTINGS, AS PER PLAN				(FT) =	0	(FOR SANITARY)
Length (No perf. 5' from ends)	0.0 ft (Rear Abutment)	+	0.0 ft (Forward Abutment)	=			0.0 Feet
625E 25604	CONDUIT, 4", 725.051				(FT) =	154	0
	76.7 ft (Span Length +4'-0")	X	2 (Sides)	=			153.4 Feet

DESIGN CALCULATION COVER SHEET

Gannett Fleming
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PROJECT:	**ODOT/EMH&T: HAM-75-7.85**	*ODOT PID NO:*	*77889*
BRIDGE NO:	**HAM-562-0026**	*EMH&T JOB NO:*	
SUBJECT:	***Analysis***	**GF JOB NO:**	**54682**
	Concrete Deck	CALC NO.:	**HAM562_0026_17**
	MATHCAD	REV NO.:	**01**
FILE NAME(s):	*NSRR Standard Concrete Deck Design*	**SHEET: 1 OF 13**	

SUPERSEDES CALC NO:

CALCULATION DESCRIPTION:

This will analyze the concrete deck to be used on the bridge. The design looks at a 12" strip for the calculations and then applies this to the entire bridge.

DESIGN BASIS OR REFERENCES:

NS Underpass Design Criteria
AREMA (2008) Chapter 8, Section 5
BDM-ODOT LFD Bridge Design Manual (2004) - Current Edition
AISC Steel Construction Manual, Thirteenth Edition
Stage 1 Plans and Comments

MISCELLANEOUS NOTES:

Minimum 8" ballast used for worst case lateral live load distribution

Maximum (9"+6" future wearing surface) ballast used for worst case dead load applied

Maximum projected overhang used for all designs(rounded up

Minimum top flange used for all designs

Stage 3: Deck increased due to Derail Load being increased.

RECORD OF ISSUES:

REV	DESCRIPTION	BY	DATE	VERIF'D	DATE
00	Stage 1 Calculation	VDK	03/26/14	VDK	05/30/14
01	Stage 3 Update	VDT	01/14/16		

RECORD OF CHECK OF CURRENT CALCULATION VERSION

BY	DATE	CHKD	DATE	UPD.	DATE	VERIF'D	DATE
VDT	01/14/16						

Reinforced Deck Slab Design

(AREMA/NSRR LFD Deck Design)

Design notes

- Variables with a box around them require review/user input.
- Code references are made using the following abbreviations:
  - AREMA -AREMA Chapter 8 - Current Edition
  - NS - Norfolk Southern Public Policy Manual - Current Edition
  - BDM - ODOT LFD Bridge Design Manual (2004) - Current Edition
  - AA - AASHTO LFD
  - AISC - AISC Steel Construction Manual, Thirteenth Edition

- General Design data and assumptions:
  - A 12" wide strip is designed
  - Minimum (8") ballast is used for a worst-case lateral live load distribution
  - Maximum (9" + 6" future) ballast is used for worst-case dead load applied
  - Maximum project overhang is used for all designs (rounded up)
  - Minimum top flange width (rounded down) is used for all designs
  - Norfolk Southern derailed loads are assumed

1.0 INPUT:

1.1 SECTION PROPERTIES:

Girder Spacing $Spa := 3.5 \cdot ft$ **Minimum Girder Flange Width** $b_f := 21 \cdot in$

Minimum Girder Flange Thickness $t_f := 3 \cdot in$ **Min. Gider Span:** $Sp := 69.5 \cdot ft$

Effective Deck Span Length $Len := Spa - 0.5 \cdot b_f$ $Len = 2.63 \cdot ft$ **AREMA 8-2.23.6.c(2)**

Clear Cover (AREMA Table 8-2.7) **Top of Slab:** $Ct := 2.0 \cdot in$ **Bottom of Slab:** $Cb := 1.0 \cdot in$ *cover to the flange... knowing an additional Tf is below that*

Thickness of Slab for Negative Bending $h_n := 9in$ *minimum deck thickness is considered for conservative purposes. In reality, at the negative bending section, the deck will always be thicker due to cross-slope*

Thickness of Slab for Positive Bending $h_p := h_n + t_f = 12 \cdot in$

Max. Deck Overhang $Ovh := 36 \cdot in$ **Parapet Width** $Parp_W := 12 \cdot in$ **Slab Design Width** $b := 12 \cdot in$

1.2 REINFORCING BAR PROPERTIES:

TRANSVERSE BARS: Bar 1 - Positive bending (BOTTOM); Bar 2 - Negative bending (TOP)
LONGITUDINAL BARS: Bar 3 (BOTTOM) and Bar 4 (TOP)

BAR 1:	#5 Bar	$d_{b1} := 0.625 \cdot in$	$A_{b1} := 0.31 \cdot in^2$	$S1 := 9 \cdot in$	$A_{s1} := A_{b1} \cdot \frac{b}{S1}$	$A_{s1} = 0.41 \cdot in^2$
BAR 2:	#5 Bar	$d_{b2} := .625 \cdot in$	$A_{b2} := .31 \cdot in^2$	$S2 := 9 \cdot in$	$A_{s2} := A_{b2} \cdot \frac{b}{S2}$	$A_{s2} = 0.41 \cdot in^2$
BAR 3:	#5 Bar	$d_{b3} := 0.625 \cdot in$	$A_{b3} := 0.31 \cdot in^2$	$S3 := 9 \cdot in$	$A_{s3} := A_{b3} \cdot \frac{b}{S3}$	$A_{s3} = 0.41 \cdot in^2$
BAR 4:	#5 Bar	$d_{b4} := 0.625 \cdot in$	$A_{b4} := 0.31 \cdot in^2$	$S4 := 9 \cdot in$	$A_{s4} := A_{b4} \cdot \frac{b}{S4}$	$A_{s4} = 0.41 \cdot in^2$

1.3 MATERIAL PROPERTIES:

CONCRETE: $f'_c := 4500 \cdot psi$ $\quad \varepsilon_c := 0.003$ $\quad w_{conc} := 150 \cdot \frac{lbf}{ft^3}$ $\quad f_r := 7.5 \cdot \sqrt{f'_c \, psi}$ $\quad E_c := 57000 \cdot \sqrt{f'_c \cdot psi}$

$$\beta_1 := if\left[f'_c \le 4000 \cdot psi, 0.85, 0.85 - 0.05 \cdot \left(\frac{f'_c - 4000 \cdot psi}{1000 \cdot psi}\right)\right] \quad \beta_1 := if\left(\beta_1 \le 0.65, 0.65, \beta_1\right) \quad \beta_1 = 0.83$$

REINFORCING STEEL: $f_y := 60000 \cdot psi$ $\quad E_s := 29000000 \cdot psi$ $\quad n := round\left(\frac{E_s}{E_c}\right)$ $\quad n = 8$

Resistance Factors **Flexure:** $\phi_f := 0.9$

Shear: $\phi_s := 0.85$ AREMA 8-2.52

2.0 LOADS AND FORCES

- *Loads are calculated over a 12" wide strip (transverse to the beams).*
- *Positive and Negative Moment is calculated assuming 3 spans (4 supports/girders) with uniform loading. This is conservative because generally, a railroad bridge will have more than 4 girders; meaning moments and shears are slightly reduced*
- *Negative moment for the exterior deck*

2.1 DEAD & LIVE LOADS APPLIED

Max Live Load Axle (E-80 @ 5'-0" Max Spa) $LL := 80kip$ AREMA Figure 8.2-1

Minimum Ballast $W_{Bal.Min} := 8in \cdot (120pcf) = 80 \cdot psf$ *(Superelevated)*

Maximum Ballast $W_{Bal.Max} := (9 + 6)in \cdot (120pcf) = 150 \cdot psf$ *(Non-Super + Future)* NS H-2.6.D.6

Concrete Deck $W_{Deck} := h_p \cdot (150pcf) = 150 \cdot psf$

Concrete Parapet & Handrail (overhang) $W_{Parp} := (Parp_W)(30in + 6in + 12in) \cdot w_{conc} = 600 \cdot plf$

Conservative height, it is assumed that the extra 6 inches of concrete height covers the weight of the handrail and fence and the extra 12" accounts for the deck under the parapet

Track $W_{track} := 200plf$ AREMA 8-2.2.3.b (2)

2.2 TRACK DISTRIBUTION, IMPACT FACTOR & CENTRIFUGAL FORCE

Track Distribution Width: $Dist_W := 8.5ft + 8in = 9.17\,ft$ AREMA 8-2.2.3.c (3)

Track Distribution Length: $Dist_L := \min\left(3.0ft + 8in + 2 \cdot \min\left(h_p - Cb, h_n - Ct\right), 5ft\right) = 4.83\,ft$

AREMA 8-2.2.3.c (2); Assumes worst-case effective slab depth

Typical E-80 Live Load Impact Factor: $LL_{Imp} := 1 + \frac{2.25}{\sqrt{\frac{Sp}{ft}}} = 1.27$

AREMA 8-2.2.3.d (1): Span between 14' & 127'

NSRR DL over Derail Limits

NS Appendix H.2.6.E.1

$$DL_{DR.min} := [(7.5ft)\cdot(5ft)]\cdot\left(W_{Bal.Min} + W_{Deck}\right) \ldots + (5ft)\cdot W_{track} = 9.62\cdot kip$$

NSRR E-80 Derail Impact Load: $LL_{Derail} := \frac{LL\cdot LL}{LL + DL_{DR.min}} = 71.41\cdot kip$

NS Appendix H.2.6.E.1

Note: A maximum overhang of 3'-3" and a 12" parapet width would mean that the 7'-6" wide derail load would always extend past the second beam in from the outside on a standard NSRR bridge. Due to this, the negative overhang moment will be calculated using the maximum allowable overhang and will assume it is a uniformly loaded beam on two supports (at 3.5' spacing) and a 3.25' overhang. The negative overhang moment will be multiplied by 0.75 to reflect the fact that a 25% overstress is allowed. The worst negative moment (interior under live load + impact or overhang under live load + derail load) will be used for the design of the top mat of steel consistently throughout the project.

Centrifugal Force (% of LL) $LL_{cent} := 0.00117\cdot 20^2\cdot 10 = 4.68$

AREMA 8-2.2.3.e (4) (S = 20mph, D = 10)

2.3 DEAD LOADS & LIVE LOADS ON THE DESIGN WIDTH OF DECK

Uniform Dead Load $DL_{typ} := b\cdot\left[\left(W_{Bal.Max} + W_{Deck}\right) + \left(\frac{W_{track}}{Dist_W}\right)\right] = 321.82\cdot plf$

Interior Uniform LL+Impact $LL_{typ} := b\cdot\left(\frac{LL}{Dist_W\cdot Dist_L}\right)\cdot LL_{Imp} = 2292.97\cdot plf$

Interior Centrifugal Force $LL_{cf} := \frac{LL_{cent}}{100}\cdot LL_{typ} = 107.31\cdot plf$

Exterior Uniform LL+Derail $LL_{ext} := b\cdot\left[\frac{LL + LL_{Derail}}{(5.0ft)\cdot(7.5ft)}\right] = 4037.56\cdot plf$

NS 6.E Derail Area

2.4 DESIGN MOMENTS

Interior Max Positive DL $M_{int.DL.p} := 0.08\cdot DL_{typ}\cdot Len^2 = 177.4\cdot lbf\cdot ft$

Interior Max Negative DL $M_{int.DL.n} := 0.10\cdot DL_{typ}\cdot Len^2 = 221.75\cdot lbf\cdot ft$

Interior Max Positive LL+I $M_{int.LL.p} := 0.08\cdot LL_{typ}\cdot Len^2 = 1264\cdot lbf\cdot ft$

Interior Max Negative LL+I $M_{int.LL.n} := 0.10\cdot LL_{typ}\cdot Len^2 = 1580\cdot lbf\cdot ft$

Interior Max Positive CF $M_{int.CF.p} := 0.08\cdot LL_{cf}\cdot Len^2 = 59.16\cdot lbf\cdot ft$

Interior Max Negative CF $M_{int.CF.n} := 0.10\cdot LL_{cf}\cdot Len^2 = 73.94\cdot lbf\cdot ft$

Exterior Parapet Moment $M_{ext.parapet} := b \cdot \left[W_{Parp} \cdot \left(Ovh - 0.5 \cdot Parp_W - 0.25 \cdot b_f\right)\right] = 1237.5 \cdot lbf \cdot ft$ *at face of support*

Exterior Negative DL $M_{ext.DL.n} := 0.5 \cdot DL_{typ} \cdot \left(Ovh - Parp_W - 0.25 \cdot b_f\right)^2 + M_{ext.parapet} = 1630.34 \cdot lbf \cdot ft$

Exterior Negative LL $M_{ext.LL.n} := 0.5 \cdot LL_{ext} \cdot \left(Ovh - Parp_W - 0.25 \cdot b_f\right)^2 = 4928.67 \cdot lbf \cdot ft$

2.5 DESIGN SHEARS

Internal reduction for Shear at critical section 75% of "d" away from edge of flange (conservative)

$$Int_{VRed} := \frac{Len - 0.75\left(h_p - Cb - t_f\right)}{Len} = 0.8095$$

Reduction is to account for the fact that the maximum shear calculated below is for that of the girder edge of the flange. In actuality, the shear can be taken at a location "d" away from the support (edge of flange). In this case, to be conservative, the critical section shear will be calculated at a distance d/2 from the support.

External Reduction for Shear at critical section 75% of "d" away from edge of flange

$$Ext_{VRed} := \frac{Ovh - 0.25 \cdot b_f - 0.75\left(h_p - Cb - t_f\right)}{Ovh - 0.25 \cdot b_f} = 0.8049$$

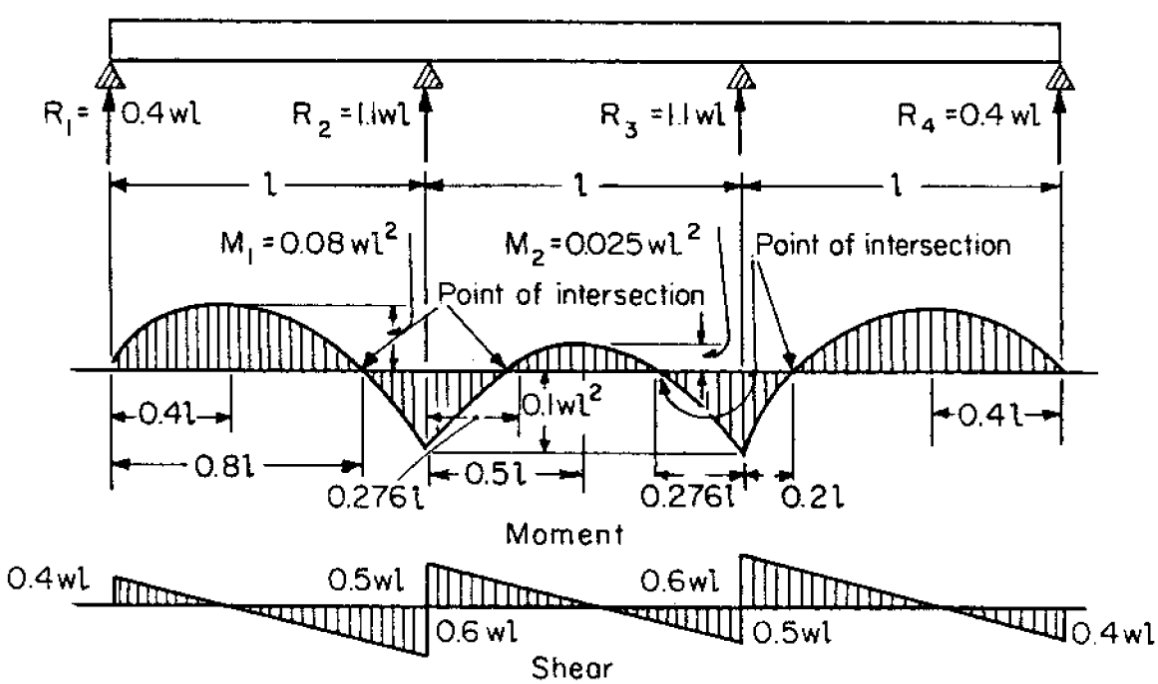
Interior DL $V_{int.DL} := 0.60 \cdot DL_{typ} \cdot Len \cdot Int_{VRed} = 410.32 \cdot lbf$

Interior LL+I $V_{int.LL} := 0.60 \cdot LL_{typ} \cdot Len \cdot Int_{VRed} = 2923.54 \cdot lbf$

Interior CF $V_{int.CF} := 0.60 \cdot LL_{cf} \cdot Len \cdot Int_{VRed} = 136.82 \cdot lbf$

Exterior DL $V_{ext.DL} := Ext_{VRed} \cdot \left[DL_{typ} \cdot \left(Ovh - Parp_W - 0.25 \cdot b_f\right) + \left(W_{Parp} \cdot b\right)\right] = 887.65 \cdot lbf$

Exterior LL $V_{ext.LL} := LL_{ext} \cdot \left(Ovh - Parp_W - 0.25 \cdot b_f\right) \cdot Ext_{VRed} = 5077.73 \cdot lbf$



3.0 LOAD COMBINATIONS TO BE RESISTED

3.1 SERVICE MOMENTS (AREMA TABLE 8-2.4)

Interior Negative $M_{n.int} := M_{int.DL.n} + M_{int.LL.n} + M_{int.CF.n}$ $M_{n.int} = 1.88 \cdot kip \cdot ft$

Exterior Negative $M_{n.ext} := \left(M_{ext.DL.n} + M_{ext.LL.n}\right) \cdot 0.80$ $M_{n.ext} = 5.25 \cdot kip \cdot ft$

Multiplied by 0.80 to account for the fact that this derail load allows for a 25% overstress

Design Negative Moment: $M_n := \max\left(M_{n.int}, M_{n.ext}\right)$ $M_n = 5.25 \cdot kip \cdot ft$

Interior Positive $M_p := M_{int.DL.p} + M_{int.LL.p} + M_{int.CF.p}$ $M_p = 1.5 \cdot kip \cdot ft$

3.2 FACTORED (ULTIMATE) LOADS (AREMA TABLE 8-2.5)

Interior Negative $M_{un.int} := 1.4\left(M_{int.DL.n} + \frac{5}{3} \cdot M_{int.LL.n} + M_{int.CF.n}\right)$ $M_{un.int} = 4.10 \cdot kip \cdot ft$

Exterior Negative $M_{un.ext} := 1.4\left(M_{ext.DL.n} + \frac{5}{3} \cdot M_{ext.LL.n}\right) \cdot 0.80$ $M_{un.ext} = 11.03 \cdot kip \cdot ft$

Multiplied by 0.80 to account for the fact that this derail load allows for a 25% overstress

Design Negative Moment: $M_{un} := \max\left(M_{un.int}, M_{un.ext}\right)$ $M_{un} = 11.03 \cdot kip \cdot ft$

Interior Positive $M_{up} := 1.4\left(M_{int.DL.p} + \frac{5}{3} \cdot M_{int.LL.p} + M_{int.CF.p}\right)$ $M_{up} = 3.28 \cdot kip \cdot ft$

3.3 SERVICE SHEAR (AREMA TABLE 8-2.4)

Interior $V_{s.int} := V_{int.DL} + V_{int.LL} + V_{int.CF}$ $V_{s.int} = 3.47 \cdot kip$

Exterior $V_{s.ext} := \left(V_{ext.DL} + V_{ext.LL}\right) \cdot 0.80$ $V_{s.ext} = 4.77 \cdot kip$

Multiplied by 0.80 to account for the fact that this derail load allows for a 25% overstress

Design Shear $V_s := \max\left(V_{s.int}, V_{s.ext}\right)$ $V_s = 4.77 \cdot kip$

3.4 FACTORED (ULTIMATE) SHEAR (AREMA TABLE 8-2.5)

Interior $V_{u.int} := 1.4\left(V_{int.DL} + \frac{5}{3} \cdot V_{int.LL} + V_{int.CF}\right)$ $V_{u.int} = 7.59 \cdot kip$

Exterior $V_{u..ext} := 1.4\left(V_{ext.DL} + \frac{5}{3} \cdot V_{ext.LL}\right) \cdot 0.80$ $V_{u..ext} = 10.47 \cdot kip$

Multiplied by 0.80 to account for the fact that this derail load allows for a 25% overstress

Design Shear $V_u := \max\left(V_{u.int}, V_{u..ext}\right)$ $V_u = 10.47 \cdot kip$

4.0 CHECK ADEQUACY OF POSITIVE BENDING

Distance to tension steel from top fiber $d_p := h_p - Cb - t_f - 0.5 \cdot d_{b1}$ $d_p = 7.69 \cdot in$

Depth of concrete in compression *(assumed rectangular stress block)* $a_p := \frac{A_{s1} \cdot f_y}{0.85 \cdot f'_c \cdot b}$ $a_p = 0.54 \cdot in$

Design moment capacity $M_{rp} := \phi_f \cdot A_{s1} \cdot f_y \cdot \left(d_p - \frac{a_p}{2}\right)$ $M_{rp} = 13.80 \cdot kip \cdot ft$

Actual Moment $M_{up} = 3.28 \cdot kip \cdot ft$

$Chk_{bend_p} := if\left(M_{rp} \geq M_{up}, "OK", "NO\ GOOD"\right)$ $Chk_{bend_p} = "OK"$

4.1 CHECK THE MINIMUM REINFORCEMENT (AREMA SECTION 8-2.7)

Section Modulus $S_{x.p} := \frac{d_p^2}{6} \cdot b$ $S_{x.p} = 118 \cdot in^3$

Modulus of rupture $f_r = 503.12 \cdot psi$ $M_{rp} = 13.8\ ft \cdot kip$

Cracking moment $M_{cr} := f_r \cdot S_{x.p}$ $M_{cr} = 4.96 \cdot kip \cdot ft$

$Chk_{min_p} := if\left(M_{rp} \geq 1.2 \cdot M_{cr}, "OK", "NO\ GOOD"\right)$ $Chk_{min_p} = "OK"$

4.2 CHECK THE MAXIMUM REINFORCEMENT (AREMA SECTION 8-2.32)

Strain in bottom steel $\varepsilon_{sb} := \frac{f_y}{E_s}$ $\varepsilon_{sb} = 2.07 \times 10^{-3}$

Depth of neutral axis $c_b := \frac{\varepsilon_c \cdot d_p}{\left(\varepsilon_c + \varepsilon_{sb}\right)}$ $c_b = 4.55 \cdot in$

$a_b := c_b \cdot \beta_1$ $a_b = 3.75 \cdot in$

Balanced reinforcement ratio $\rho_b := \frac{a_b \cdot .85 \cdot f'_c}{d_p \cdot f_y}$ $\rho_b = 0.0311$

Provided reinforcement ratio $\rho := \frac{a_p \cdot .85 \cdot f'_c}{d_p \cdot f_y}$ $\rho = 0.0045$

$Chk_{max_p} := if\left(\rho \leq 0.75 \cdot \rho_b, "OK", "NO\ GOOD"\right)$ $Chk_{max_p} = "OK"$

4.3 CHECK THE SPACING OF THE REINFORCEMENT (AREMA SECTION 8-2.5)

Maximum spacing $s_{max.p} := \min(18 \cdot in, 1.5 \cdot h_p)$ $s_{max.p} = 18 \cdot in$

Minimum spacing $s_{min.p} := \max(1.5 \cdot in, 1.5 \cdot d_{b1})$ $s_{min.p} = 1.5 \cdot in$

$Chk_{Spacing_p} := \text{if}(S1 \le s_{max.p} \wedge S1 \ge s_{min.p}, \text{"OK"}, \text{"NO GOOD"})$ $Chk_{Spacing_p} = \text{"OK"}$

4.4 CHECK DISTRIBUTION OF FLEXURAL STEEL (AREMA SECTION 8-2.39)

$Z := 130 \cdot \frac{kip}{in}$ *Based on severe exposure conditions*

Thickness of concrete cover from extreme tension fiber to center of bar $d_{c.p} := \min\left(2in + \frac{d_{b1}}{2}, t_f + Cb + \frac{d_{b1}}{2}\right)$ $d_{c.p} = 2.31 \cdot in$

Effective tension area of concrete surrounding main bar $A_{s.p} := 2 \cdot d_{c.p} \cdot S1$ $A_{s.p} = 41.63 \cdot in^2$

Allowable stress in reinforcement steel $f_{s_allow.p} := \min\left(0.5 \cdot f_y, \frac{Z}{\sqrt[3]{d_{c.p} \cdot A_{s.p}}}\right)$ $f_{s_allow.p} = 28.37 \cdot ksi$

Reinforcement ratio $\rho_p := \frac{A_{s1}}{d_p \cdot b}$ $\rho_p = 0.0045$

Position of neutral axis $K_p := \sqrt{(\rho_p \cdot n)^2 + 2 \cdot \rho_p \cdot n} - \rho_p \cdot n$ $K_p = 0.23$

$K_p \cdot d_p = 1.8 \cdot in$

Distance from C.G. to extreme tension fiber $c_p := d_p - K_p \cdot d_p$ $c_p = 5.89 \cdot in$

Effective Moment of Inertia of section
Assumes zero compression reinforcement (Conservative)
$I_p := \frac{b \cdot (K_p \cdot d_p)^3}{3} + n \cdot A_{s1} \cdot c_p^2$ $I_p = 137.95 \cdot in^4$

Actual stress in reinforcement
at service load
$f_{s_act.p} := \frac{n \cdot M_p \cdot c_p}{I_p}$ $f_{s_act.p} = 6.15 \cdot ksi$

$Chk_{flex_p} := \text{if}(f_{s_act.p} \le f_{s_allow.p}, \text{"OK"}, \text{"NO GOOD"})$ $Chk_{flex_p} = \text{"OK"}$

4.5 CHECK OVERALL DESIGN FOR POSITIVE BENDING:

$Chk_{positive} := \text{if}(Chk_{bend_p} = \text{"OK"} \wedge Chk_{min_p} = \text{"OK"} \wedge Chk_{max_p} = \text{"OK"} \wedge Chk_{flex_p} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"})$

$Chk_{positive} = \text{"OK"}$

5.0 DETERMINE THE MOMENT CAPACITY OF THE SLAB IN NEGATIVE BENDING

Distance to tension steel from bottom fiber $d_n := h_n - Ct - 0.5 \cdot d_{b2}$ $d_n = 6.69 \cdot in$

Depth of concrete in compression (assumed rectangular stress block) $a_n := \frac{A_{s2} \cdot f_y}{0.85 \cdot f'_c \cdot b}$ $a_n = 0.54 \cdot in$

Design moment capacity $M_{rn} := \phi_f \cdot A_{s2} \cdot f_y \cdot \left(d_n - \frac{a_n}{2}\right)$ $M_{rn} = 11.94 \cdot kip \cdot ft$

Actual Moment $M_{un} = 11.03 \cdot kip \cdot ft$

$Chk_{bend_n} := if\left(M_{rn} \geq M_{un}, "OK", "NO\ GOOD"\right)$ $Chk_{bend_n} = "OK"$

5.1 CHECK THE MINIMUM REINFORCEMENT (AREMA SECTION 8-2.7)

Section Modulus $S_{x.n} := \frac{d_n^2}{6} \cdot b$ $S_{x.n} = 89 \cdot in^3$

Modulus of rupture $f_r = 503.12 \cdot psi$ $M_{rn} = 11.94\ ft \cdot kip$

Cracking moment $M_{cr.n} := f_r \cdot S_{x.n}$ $M_{cr.n} = 3.75 \cdot kip \cdot ft$

$Chk_{min_n} := if\left(M_{rn} \geq 1.2 \cdot M_{cr.n}, "OK", "NO\ GOOD"\right)$ $Chk_{min_n} = "OK"$

5.2 CHECK THE MAXIMUM REINFORCEMENT (AREMA SECTION 8-2.32)

Strain in the steel reinforcement $\varepsilon_{sb} = 2.07 \times 10^{-3}$

Strain in the concrete $\varepsilon_c = 3 \times 10^{-3}$

Depth of neutral axis $c_{b.n} := \frac{\varepsilon_c \cdot d_n}{(\varepsilon_c + \varepsilon_{sb})}$ $c_{b.n} = 3.96 \cdot in$

$a_{b.n} := c_{b.n} \cdot \beta_1$ $a_{b.n} = 3.27 \cdot in$

Balanced reinforcement ratio $\rho_{b.n} := \frac{a_{b.n} \cdot .85 \cdot f'_c}{d_n \cdot f_y}$ $\rho_{b.n} = 0.0311$

Provided reinforcement ratio $\rho_n := \frac{a_n \cdot .85 \cdot f'_c}{d_n \cdot f_y}$ $\rho_n = 0.0052$

$Chk_{max_n} := if\left(\rho_n \leq 0.75 \cdot \rho_{b.n}, "OK", "NO\ GOOD"\right)$ $Chk_{max_n} = "OK"$

5.3 CHECK THE SPACING OF THE REINFORCEMENT (AREMA SECTION 8-2.5)

Maximum Spacing $s_{max.n} := \min(18 \cdot in, 1.5 \cdot h_n)$ $s_{max.n} = 13.5 \cdot in$

Minimum Spacing $s_{min.n} := \max(1.5 \cdot in, 1.5 \cdot d_{b2})$ $s_{min.n} = 1.5 \cdot in$

$Chk_{Spacing_n} := \text{if}(S1 \le s_{max.n} \wedge S1 \ge s_{min.n}, \text{"OK"}, \text{"NO GOOD"})$ $Chk_{Spacing_n} = \text{"OK"}$

5.4 CHECK DISTRIBUTION OF FLEXURAL STEEL (AREMA SECTION 8-2.39)

$Z := 130 \cdot \frac{kip}{in}$ *Based on severe exposure conditions*

Thickness of concrete cover from extreme tension fiber to center of bar $d_{c.n} := \min\left(2in + \frac{d_{b2}}{2}, Ct + \frac{d_{b2}}{2}\right)$ $d_{c.n} = 2.31 \cdot in$

Effective tension area of concrete surrounding main bar $A_{s.n} := 2 \cdot d_{c.n} \cdot S2$ $A_{s.n} = 41.63 \cdot in^2$

Allowable stress in reinforcement steel $f_{s_allow.n} := \min\left(0.5 \cdot f_y, \frac{Z}{\sqrt[3]{d_{c.n} \cdot A_{s.n}}}\right)$ $f_{s_allow.n} = 28.37 \cdot ksi$

Reinforcement ratio $\rho_p := \frac{A_{s2}}{d_n \cdot b}$ $\rho_p = 0.0045$

Position of neutral axis $K_n := \sqrt{(\rho_n \cdot n)^2 + 2 \cdot \rho_n \cdot n} - \rho_n \cdot n$ $K_n = 0.25$

$K_n \cdot d_n = 1.66 \cdot in$

Distance from C.G. to extreme tension fiber $c_n := d_n - K_n \cdot d_n$ $c_n = 5.02 \cdot in$

Effective Moment of Inertia of section
Assumes zero compression reinforcement (Conservative)
$I_n := \frac{b \cdot (K_n \cdot d_n)^3}{3} + n \cdot A_{s2} \cdot c_n^2$ $I_n = 101.88 \cdot in^4$

Actual stress in reinforcement
at service load
$f_{s_act.n} := \frac{n \cdot M_n \cdot c_n}{I_n}$ $f_{s_act.n} = 24.84 \cdot ksi$

$Chk_{flex_n} := \text{if}(f_{s_act.n} \le f_{s_allow.n}, \text{"OK"}, \text{"NO GOOD"})$ $Chk_{flex_n} = \text{"OK"}$

5.5 CHECK OVERALL DESIGN FOR NEGATIVE BENDING:

$Chk_{negative} := \text{if}(Chk_{bend_n} = \text{"OK"} \wedge Chk_{min_n} = \text{"OK"} \wedge Chk_{max_n} = \text{"OK"} \wedge Chk_{flex_n} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"})$

$Chk_{negative} = \text{"OK"}$

6.0 DETERMINE THE REQUIRED LONGITUDINAL (DISTRIBUTION) REINFORCEMENT AND SPACING:

6.1 CHECK REQUIRED DISTRIBUTION REINFORCEMENT PER AASHTO 9.7.3.2:

$$A_{Distrib} := \min\left(\frac{67}{100}, \frac{220 \cdot in}{\sqrt{Len \cdot in}}\right) \cdot A_{s1}$$

$$A_{Distrib} = 0.28 \cdot in^2$$

$$Chk_{AASHTO} := if\left(A_{s3} \geq A_{Distrib} \wedge A_{s4} \geq A_{Distrib}, \text{"OK"}, \text{"NO GOOD"}\right)$$

$$Chk_{AASHTO} = \text{"OK"}$$

6.2 CHECK REQUIRED SHIRINKAGE & TEMPERATURE REINFORCEMENT PER AREMA SECTION 8-2.12:

$$A_{ShrnkTemp} := 0.25 \cdot in^2$$

$$Chk_{A_AREMA} := if\left(A_{s3} \geq A_{ShrnkTemp} \wedge A_{s4} \geq A_{ShrnkTemp}, \text{"OK"}, \text{"NO GOOD"}\right)$$

$$Chk_{A_AREMA} = \text{"OK"}$$

$$S_{ShrnkTemp} := \min\left(18 \cdot in, 3 \cdot h_n\right)$$

$$S_{ShrnkTemp} = 18 \cdot in$$

$$Chk_{S_AREMA} := if\left(S3 \leq S_{ShrnkTemp} \wedge S4 \leq S_{ShrnkTemp}, \text{"OK"}, \text{"NO GOOD"}\right)$$

$$Chk_{S_AREMA} = \text{"OK"}$$

$$Chk_{Distrib} := if\left(Chk_{AASHTO} = \text{"OK"} \wedge Chk_{A_AREMA} = \text{"OK"} \wedge Chk_{S_AREMA} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"}\right)$$

$$Chk_{Distrib} = \text{"OK"}$$

7.0 CHECK SHEAR CAPACITY:

7.1 DETERMINE SHEAR CAPACITY OF THE SLAB (AREMA SECTION (8-2.35)

In most designs with average overhangs, the negative moment section will control the shear capacity at the overhang under the NSRR derail condition.

$\lambda := 1$ *(Normal Weight Concrete)*

Shear stress carried by concrete shall not exceed $V_{c.max} := 2 \cdot \lambda \sqrt{f'_c \cdot psi}$ $V_{c.max} = 134.16 \cdot psi$

Ratio of reinforcement $\rho_v := \frac{A_{s2}}{b \cdot d_p} = 0.0045$ $d_p = 7.69 \cdot in$

Shear stress that can be carried by concrete sections subject to shear & flexure only $V_{c.max.alt} := 1.9 \cdot \lambda \sqrt{f'_c \cdot psi} + 2500psi \cdot \rho_v \cdot min\left(1, \frac{V_u \cdot d_p}{M_{un}}\right)$

$V_u = 10.47 \cdot kip$ $V_{c.max.alt} = 134.27 \cdot psi$

Factored Shear stress $V_{u.max} := \frac{V_u}{\phi_s \cdot b \cdot d_p}$ $V_{u.max} = 133.56 \cdot psi$

$Chk_{Vc} := if\left(max\left(V_{c.max.alt}, V_{c.max}\right) \geq V_{u.max}, "OK", "NO\ GOOD"\right)$ $Chk_{Vc} = "OK"$

NO SHEAR REINFORCEMENT REQUIRED IN SLABS PER AREMA CHAPTER 8 SECTION 2.10.1.a

7.2 CHECK PUNCHING SHEAR

As there is no reference of Rail contact area in AREMA,
Train wheel estimated as 6" x 12" contact area.

$A_{pll} := 6 \cdot in$ $A_{perp} := 12 \cdot in$ $V_{ps} := 60kip$

(1/2 of Rail Axle Load)

$AREA := A_{pll} \cdot A_{perp}$ $AREA = 72 \cdot in^2$

$D := h_p - Cb - .5 \cdot d_{b1}$ $D = 10.69 \cdot in$

Critical Area Located D/2 from Contact Area
AREMA 8-2.35.6 a

$CA_{pll} := A_{pll} + D$ $CA_{pll} = 16.69 \cdot in$

$CA_{perp} := A_{perp} + D$ $CA_{perp} = 22.69 \cdot in$

Ratio of long side to short side $\beta_c := \frac{CA_{perp}}{CA_{pll}}$ $\beta_c = 1.36$

Interior Reaction Area $\alpha_s := 40$

Perimeter of the critical section $b_o := 2(CA_{pll} + CA_{perp})$ $b_o = 6.56 \cdot ft$

Allowable shear force

$$V_{ps_c} := \min\left[4 \cdot \lambda \sqrt{f'_c \cdot psi} \cdot b_o \cdot D, \left(2 + \frac{4}{\beta_c}\right) \cdot \lambda \sqrt{f'_c \cdot psi} \cdot b_o \cdot D, \left(2 + \frac{\alpha_s \cdot D}{b_o}\right) \cdot \lambda \sqrt{f'_c \cdot psi} \cdot b_o \cdot D\right] \qquad V_{ps_c} = 225.84 \cdot kip$$

$Chk_{V_ps} := \text{if}\left(V_{ps} \le \phi_s \cdot V_{ps_c}, \text{"OK"}, \text{"NO GOOD"}\right)$ $Chk_{V_ps} = \text{"OK"}$

7.3 CHECK OVERALL DESIGN FOR SHEAR

$Chk_V := \text{if}\left(Chk_{Vc} = \text{"OK"} \wedge Chk_{V_ps} = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"}\right)$ $Chk_V = \text{"OK"}$

8.0 CHECK FULL DESIGN:

$DESIGN := \text{if}\left(Chk_{positive} = \text{"OK"} \wedge Chk_{negative} = \text{"OK"} \wedge Chk_{Distrib} = \text{"OK"} \wedge Chk_V = \text{"OK"}, \text{"OK"}, \text{"NO GOOD"}\right)$

$DESIGN = \text{"OK"}$

Similar to H-Piles, Pipe Piles are also designed to transfer structural loads through the foundation to soils below. Where H-Piles are typically classified as poi
effi
sub
wit
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Pip
wit
and
exc
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L.B
DS
We
size
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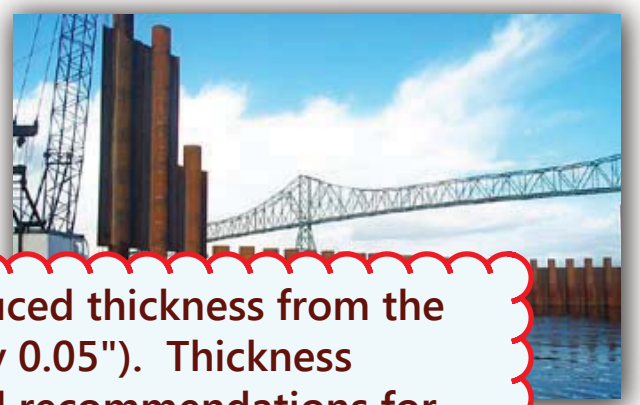
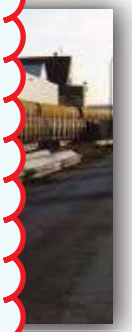
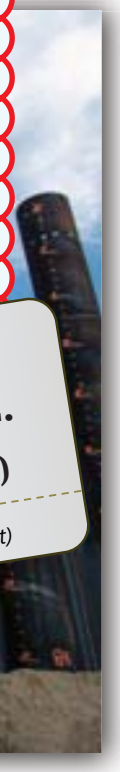
complete pipe pile solutions.







Calculations will assume 0.05" of reduced thickness from the outside of the pile (O.D. is reduced by 0.05"). Thickness reduction is from SkylineSteel manual recommendations for 100 years.

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3/8" and 7/16" minimum pile wall thicknesses are being specified.

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12.6ksi allowable stress per AREMA 8-4.4.4.6(b)

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Capacity = 12.6 * Pi/4 * { (OD-2*0.05)^2 - (OD - 2*Twall)^2 }

.

12" Capacity (0.375" wall): 148 kips
14" Capacity (0.437" wall): 207 kips
16" Capacity (0.437" wall): 237 kips

Gannett Fleming Login
edues
Calculated
By: Eric Dues, P.E., S.E.
Date: 07/17/2014 (Thu, am)
(Note Result) (Note Input)

Gannett Fleming Login
vtraini
Check
By: Vincent Traini
Date: 07/17/2014 (Thu, am)
(Agree) (Disagree) (Discuss)

LBFoster Piling

Electric Resistance Weld

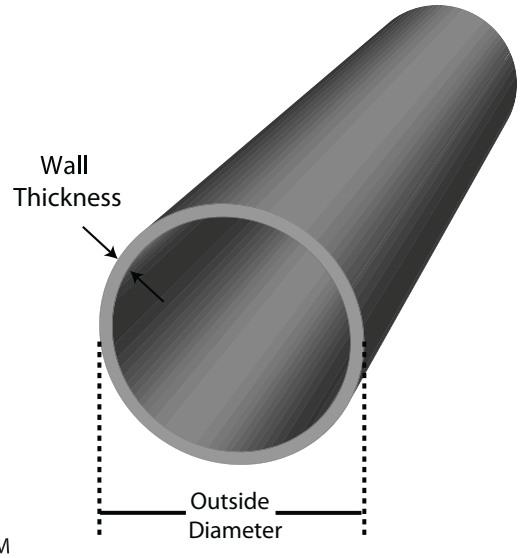
3/8" wall

7/16" wall

ERW	Wall Thickness (in.)							
Outside Diameter (in.) / lbs / ft	0.219	0.250	0.312	0.375	0.438	0.500	0.625	0.750
8.625	19.68	22.38	27.73	33.07	38.33	43.43		
10.75	24.65	28.06	34.81	41.59	48.28	54.79		
12	27.58	31.40	38.98	46.60	54.14	61.47	76.00	
12.75	29.34	33.41	41.48	49.61	57.65	65.48	81.01	
14	32.26	36.75	45.65	54.62	63.50	72.16	89.36	
16	36.95	42.09	52.32	62.64	72.86	82.85	102.72	
18	41.63	47.44	58.99	70.65	82.23	93.54	116.09	
20		52.78	65.66	78.67	91.59	104.23	129.45	
24		63.47	79.01	94.71	110.32	125.61	156.17	186.41

ERW is able to be produced to pipe specifications: A252, A500, A53 and API 5L

Pipe can be produced to the above specifications utilizing other grades of steel (A36, A572, A588 etc.)



Pipe Weight Calculation:

LB / FT = (OD-WT) WT × 10.69

OD = Outside Diameter
WT = Wall Thickness

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skylinesteel
a NUCOR company

Pipe

we are driving through undisturbed natural soils

Loss of Thickness Due to Corrosion for Piles in Soil with or without Groundwater

Required design working life	5 Years	25 Years	50 Years	75 Years	100 Years
	in / mm				
Undisturbed natural soils (sand, clay, schist, ...)	0.000 0.00	0.012 0.30	0.024 0.60	0.035 0.90	0.047 1.20
Polluted natural soils and industrial grounds	0.006 0.15	0.030 0.75	0.059 1.50	0.089 2.25	0.118 3.00
Aggressive natural soils (swamp, marsh, peat, ...)	0.008 0.20	0.039 1.00	0.069 1.75	0.098 2.50	0.128 3.25
Non-compacted and non-aggressive fills (clay, schist, sand, silt, ...)	0.007 0.18	0.028 0.70	0.047 1.20	0.067 1.70	0.087 2.20
Non-compacted and aggressive fills (ashes, slag, ...)	0.020 0.50	0.079 2.00	0.128 3.25	0.177 4.50	0.226 5.75

Notes:
1. Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills, the figures in the table should be divided by two.
2. The values given are only for guidance. Local conditions should be considered because they may affect the actual corrosion rate, which can be lower or higher than the average value given in the table.
3. The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

Loss of Thickness Due to Corrosion for Piles in Fresh Water or in Sea Water

Required design working life	5 Years	25 Years	50 Years	75 Years	100 Years
	in / mm				
Common fresh water (river, ship canal, ...) in the zone of high attack (water line)	0.006 0.15	0.022 0.55	0.035 0.90	0.045 1.15	0.055 1.40
Very polluted fresh water (sewage, industrial effluent, ...) in the zone of high attack (water line)	0.012 0.30	0.051 1.30	0.091 2.30	0.130 3.30	0.169 4.30
Sea water in temperate climate in the zone of high attack (low water and splash zones)	0.022 0.55	0.074 1.90	0.148 3.75	0.220 5.60	0.295 7.50
Sea water in temperate climate in the zone of permanent immersion or in the intertidal zone	0.010 0.25	0.035 0.90	0.069 1.75	0.102 2.60	0.138 3.50

Notes:
1. The highest corrosion rate is usually found at the splash zone or at the low water level in tidal waters. However, in most cases, the highest stresses are in the permanent immersion zone.
2. The values given are only for guidance. Local conditions should be considered because they may affect the actual corrosion rate, which can be lower or higher than the average value given in the table.
3. The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.