WELCOME RAMP, INC.

STRUCTURAL ANALYSIS

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Ramp System Design Criteria and Analysis

1) Reference Design Criteria:
   a) International Building Code, 2018 Edition
2) Site Specific Criteria:
   a) Building Occupancy Classifications: II
   b) Vertical Loading: 100 psf for Landings, 300 lbs. concentrated loads for steps
   c) Horizontal Loading:
      i) Wind Loads: 135 mph(ultimate), Exposure B, Kz=0.85, Kzt=1.0; Design Wind Pressure = 30 psf (At less than 15 feet above grade, IBC 2012, 1609.6.2) w/ 5' effective width = 30 lbs/leg
      ii) Seismic Loads: Sds = 1.50, S1=0.50, I=1.0, R=3.25, Ωo=2, Cd=3.25, Cs=0.462, w/62.5#DL/leg*0.462*2 = 58#/leg
      iii) Pedestrian Traffic Load: 5'effective*100psf*1/12*1.5 = 63#/leg
   d) Soil Bearing: 1,500 psf, unless verified by Geotechnical Report or Building Official
3) Material Specifications:
   a) Aluminum:
      i) Handrail ASTM 6063-T5, 16 ksi, minimum yield strength
      ii) Structural ASTM 6061-T5, 35 ksi, minimum yield strength
   b) Density 170 lbs. per cubic foot
4) Connectors:
   a) Bolts Grade 5 zinc-coated (Design), ASTM A-325 may be substituted.
   b) Screws #10x1.25" zinc plated Self-Tapping Screw (STS)
   c) Welding Per AWS D1.2 and size as shown on the drawings
   d) Sleeves Length of snug-fitting sleeves designed resist moment and shear of sleeved connection.
5) Design Basis:
   a) Each side of the assembly is a framed made rigid by either welding or assembling parts together in sleeves to resist movement. Base connections are a pinned condition.
   b) Each frame is connected together with landing or ramp frames and planking to distribute dead and live loads to the frames. Railing is added to the frame assembly.
   c) Landing Platforms are attached to buildings with Lag-bolts or SDS Screws.
   d) Basic Dead Load is 5 psf for frame, ramp & landing surfaces. 2 psf is added for railing.
   e) A 300 lb. lateral load is used in the design to simulate seismic, wind and pedestrian lateral loading for each frame (2 frames per unit, 600# per assembly). This results in an effective Design

Cs for a 30-foot ramp and 5x10 platform of 0.5 and a design wind load of 30 psf without consideration for stress duration. Seismic and wind loads do not govern lateral loading for standard configurations. Standard platform lateral loading will be resisted by connections of platform to building. (3) SDS25300 (OR 3/8”Ø x 3” lag-bolts= 900# for each 5’ platform section. Lateral loads of ramps and stair assemblies attached to the platforms will be resisted by the platforms.

f) Anchorage for Asphalt and Concrete Substrate: Where requested by the Owner, anchorage of ramps and stairs to asphalt and concrete substrates will be done with drilled anchors. Asphalt substrate conditions will use (1) ‘Bolt-Hold’ SP-10 at each bottom bearing plate of last section of ramp and bottom of stair. Concrete substrate conditions will use (1) ‘Simpson’ Titen HD ¼“Øx3”.

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Ramp System Design

Member Data

Member Label	I Joint	J Joint	Rotate (degrees)	Shape / Section Set	Material Set	Phys Memb	TOM	End Releases I-End AVM	End Releases J-End AVM	End Offsets I-End (in)	End Offsets J-End (in)	Inactive Code	Length (ft)
M1	N1	N10		SEC1	AL	Y		PIN					4.768
M2	N10	N11		SEC1	AL	Y			PIN				4.768
M3	N11	N9		SEC1	AL	Y							4.768
M4	N9	N6		SEC1	AL	Y			PIN				5.012
M5	N6	N8		SEC2	AL	Y							5
M6	N7	N8		SEC3	AL	Y							1.599
M7	N5	N6		SEC3	AL	Y							1.599
M8	N4	N9		SEC3	AL	Y							1.25
M9	N3	N11		SEC3	AL	Y							.833
M10	N2	N10		SEC3	AL	Y							.417

Sections

Section Label	Database Shape	Material Label	Area (in)^2	SA (0,180)	SA (90,270)	I (90,270) (in^4)	I (0,180) (in^4)	T/C Only
SEC1	Welcome Ramp	AL	1.438	1.2	1.2	.421	2.02	
SEC2	Welcome Deck	AL	1.438	1.2	1.2	.421	1.378	
SEC3	TU2X2X2	AL	.897	1.2	1.2	.513	.513	

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Gravity X	Gravity Y	Load Type Totals Joint	Point	Direct Dist.
1	w1 - Dead Load	DL	Dead Load		-1			5
2	w2 -Pedestrian Load	LLS	Live Load Special (public as..			1		5

Member Direct Distributed Loads, Category : DL, BLC 1 : w1 - Dead Load

Member Label	Direction	Start Magnitude (k/ft, F)	End Magnitude (k/ft, F)	Start Location (ft or %)	End Location (ft or %)
M1	Y	-.014	-.014	0	0
M2	Y	-.014	-.014	0	0
M3	Y	-.014	-.014	0	0
M4	Y	-.014	-.014	0	0
M5	Y	-.018	-.018	0	0

Member Direct Distributed Loads, Category : LLS, BLC 2 : w2 -Pedestrian Load

Member Label	Direction	Start Magnitude (k/ft, F)	End Magnitude (k/ft, F)	Start Location (ft or %)	End Location (ft or %)
M1	Y	-.2	-.2	0	0
M2	Y	-.2	-.2	0	0
M3	Y	-.2	-.2	0	0
M4	Y	-.2	-.2	0	0
M5	Y	-.25	-.25	0	0

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL + Ped. Load	y				1	1	1	2	1				
2	Ped. Load Only	y				1	2	1						

Load Combinations (continued)

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
3						1								
4						1								
5						1								

Envelope Member Stresses

Member Label	Section		Axial (ksi)	Lc	Shear (ksi)	Lc	Bending top (ksi)	Lc	Bending bot (ksi)	Lc
M1	1	max	.023	1	.319	1	0	1	0	1
		min	.022	2	.299	2	0	1	0	1
	2	max	.003	1	.036	1	4.933	1	-2.906	2
		min	.003	2	.034	2	4.625	2	-3.1	1
	3	max	-.017	2	-.23	2	2.009	1	-1.197	2
		min	-.018	1	-.247	1	1.906	2	-1.262	1
	4	max	-.036	2	-.494	2	-8.157	2	5.513	1
		min	-.039	1	-.53	1	-8.774	1	5.125	2
M2	1	max	.059	2	.531	1	-8.355	2	5.589	1
		min	.053	1	.497	2	-8.895	1	5.25	2
	2	max	.04	2	.248	1	1.928	1	-1.114	2
		min	.032	1	.232	2	1.773	2	-1.211	1
	3	max	.02	2	-.032	2	4.893	1	-2.864	2
		min	.011	1	-.035	1	4.558	2	-3.074	1
	4	max	.001	2	-.296	2	0	1	0	1
		min	-.009	1	-.318	1	0	1	0	1
M3	1	max	.2	1	.359	1	-2.64	2	1.752	1
		min	.199	2	.337	2	-2.789	1	1.659	2
	2	max	.18	2	.077	1	3.268	1	-1.91	2
		min	.18	1	.072	2	3.039	2	-2.053	1
	3	max	.16	2	-.192	2	1.467	1	-.864	2
		min	.159	1	-.206	1	1.375	2	-.922	1
	4	max	.141	2	-.456	2	-7.633	2	5.147	1
		min	.138	1	-.489	1	-8.192	1	4.796	2
M4	1	max	.029	1	.55	1	-8.455	2	5.68	1
		min	.026	2	.514	2	-9.04	1	5.313	2
	2	max	.012	1	.252	1	2.667	1	-1.564	2
		min	.01	2	.236	2	2.489	2	-1.676	1
	3	max	-.006	1	-.043	2	5.681	1	-3.334	2
		min	-.006	2	-.046	1	5.307	2	-3.569	1
	4	max	-.022	2	-.321	2	0	1	0	1
		min	-.023	1	-.343	1	0	1	0	1
M5	1	max	.152	1	.56	1	-5.456	2	6.538	1
		min	.141	2	.523	2	-5.832	1	6.116	2
	2	max	.152	1	.188	1	6.427	1	-6.715	2
		min	.141	2	.175	2	5.99	2	-7.205	1
	3	max	.152	1	-.173	2	6.464	1	-6.765	2
		min	.141	2	-.185	1	6.035	2	-7.246	1
	4	max	.152	1	-.52	2	-5.322	2	6.414	1
		min	.141	2	-.558	1	-5.721	1	5.966	2
M6	1	max	.745	1	.523	1	0	1	0	1
		min	.695	2	.487	2	0	1	0	1
	2	max	.745	1	.523	1	2.717	1	-2.527	2

Envelope Member Stresses, (continued)

Member Label	Section		Axial (ksi)	Lc	Shear (ksi)	Lc	Bending top (ksi)	Lc	Bending bot (ksi)	Lc
		min	.695	2	.487	2	2.527	2	-2.717	1
	3	max	.745	1	.523	1	5.435	1	-5.055	2
		min	.695	2	.487	2	5.055	2	-5.435	1
	4	max	.745	1	.523	1	8.152	1	-7.582	2
		min	.695	2	.487	2	7.582	2	-8.152	1
M7	1	max	1.208	1	-.499	2	0	1	0	1
		min	1.129	2	-.533	1	0	1	0	1
	2	max	1.208	1	-.499	2	-2.591	2	2.77	1
		min	1.129	2	-.533	1	-2.77	1	2.591	2
	3	max	1.208	1	-.499	2	-5.182	2	5.54	1
		min	1.129	2	-.533	1	-5.54	1	5.182	2
	4	max	1.208	1	-.499	2	-7.774	2	8.31	1
		min	1.129	2	-.533	1	-8.31	1	7.774	2
M8	1	max	1.367	1	-.108	2	0	1	0	1
		min	1.275	2	-.112	1	0	1	0	1
	2	max	1.367	1	-.108	2	-.44	2	.454	1
		min	1.275	2	-.112	1	-.454	1	.44	2
	3	max	1.367	1	-.108	2	-.879	2	.907	1
		min	1.275	2	-.112	1	-.907	1	.879	2
	4	max	1.367	1	-.108	2	-1.319	2	1.361	1
		min	1.275	2	-.112	1	-1.361	1	1.319	2
M9	1	max	.93	1	-.521	2	0	1	0	1
		min	.87	2	-.55	1	0	1	0	1
	2	max	.93	1	-.521	2	-1.411	2	1.49	1
		min	.87	2	-.55	1	-1.49	1	1.411	2
	3	max	.93	1	-.521	2	-2.822	2	2.98	1
		min	.87	2	-.55	1	-2.98	1	2.822	2
	4	max	.93	1	-.521	2	-4.233	2	4.471	1
		min	.87	2	-.55	1	-4.471	1	4.233	2
M10	1	max	1.424	1	-.048	1	0	1	0	1
		min	1.332	2	-.078	2	0	1	0	1
	2	max	1.424	1	-.048	1	-.065	1	.106	2
		min	1.332	2	-.078	2	-.106	2	.065	1
	3	max	1.424	1	-.048	1	-.129	1	.212	2
		min	1.332	2	-.078	2	-.212	2	.129	1
	4	max	1.424	1	-.048	1	-.194	1	.318	2
		min	1.332	2	-.078	2	-.318	2	.194	1

Envelope Member Section Forces

Member Label	Section		Axial (k)	Lc	Shear (k)	Lc	Moment (k)	Lc
M1	1	max	.034	1	.382	1	0	1
		min	.031	2	.358	2	0	1
	2	max	.004	1	.043	1	-.317	2
		min	.004	2	.041	2	-.338	1
	3	max	-.024	2	-.276	2	-.131	2
		min	-.026	1	-.296	1	-.138	1
	4	max	-.052	2	-.592	2	.601	1
		min	-.056	1	-.634	1	.559	2
M2	1	max	.085	2	.636	1	.61	1
		min	.076	1	.595	2	.573	2
	2	max	.057	2	.297	1	-.122	2

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (k)	Lc	Shear (k)	Lc	Moment (k)	Lc
		min	.046	1	.278	2	-.132	1
	3	max	.029	2	-.038	2	-.312	2
		min	.016	1	-.042	1	-.335	1
	4	max	.002	2	-.355	2	0	1
		min	-.013	1	-.38	1	0	1
M3	1	max	.288	1	.431	1	.191	1
		min	.286	2	.403	2	.181	2
	2	max	.258	2	.092	1	-.208	2
		min	.258	1	.087	2	-.224	1
	3	max	.231	2	-.23	2	-.094	2
		min	.229	1	-.247	1	-.101	1
	4	max	.203	2	-.547	2	.561	1
		min	.199	1	-.586	1	.523	2
M4	1	max	.042	1	.659	1	.62	1
		min	.038	2	.616	2	.58	2
	2	max	.017	1	.302	1	-.171	2
		min	.015	2	.282	2	-.183	1
	3	max	-.008	1	-.051	2	-.364	2
		min	-.009	2	-.055	1	-.389	1
	4	max	-.032	2	-.384	2	0	1
		min	-.033	1	-.411	1	0	1
M5	1	max	.218	1	.671	1	.355	1
		min	.203	2	.627	2	.332	2
	2	max	.218	1	.225	1	-.365	2
		min	.203	2	.21	2	-.391	1
	3	max	.218	1	-.207	2	-.368	2
		min	.203	2	-.222	1	-.394	1
	4	max	.218	1	-.623	2	.348	1
		min	.203	2	-.669	1	.324	2
M6	1	max	.669	1	.218	1	0	1
		min	.623	2	.203	2	0	1
	2	max	.669	1	.218	1	-.108	2
		min	.623	2	.203	2	-.116	1
	3	max	.669	1	.218	1	-.216	2
		min	.623	2	.203	2	-.232	1
	4	max	.669	1	.218	1	-.324	2
		min	.623	2	.203	2	-.348	1
M7	1	max	1.084	1	-.208	2	0	1
		min	1.012	2	-.222	1	0	1
	2	max	1.084	1	-.208	2	.118	1
		min	1.012	2	-.222	1	.111	2
	3	max	1.084	1	-.208	2	.237	1
		min	1.012	2	-.222	1	.222	2
	4	max	1.084	1	-.208	2	.355	1
		min	1.012	2	-.222	1	.332	2
M8	1	max	1.226	1	-.045	2	0	1
		min	1.144	2	-.047	1	0	1
	2	max	1.226	1	-.045	2	.019	1
		min	1.144	2	-.047	1	.019	2
	3	max	1.226	1	-.045	2	.039	1
		min	1.144	2	-.047	1	.038	2
	4	max	1.226	1	-.045	2	.058	1
		min	1.144	2	-.047	1	.056	2

Envelope Member Section Forces, (continued)

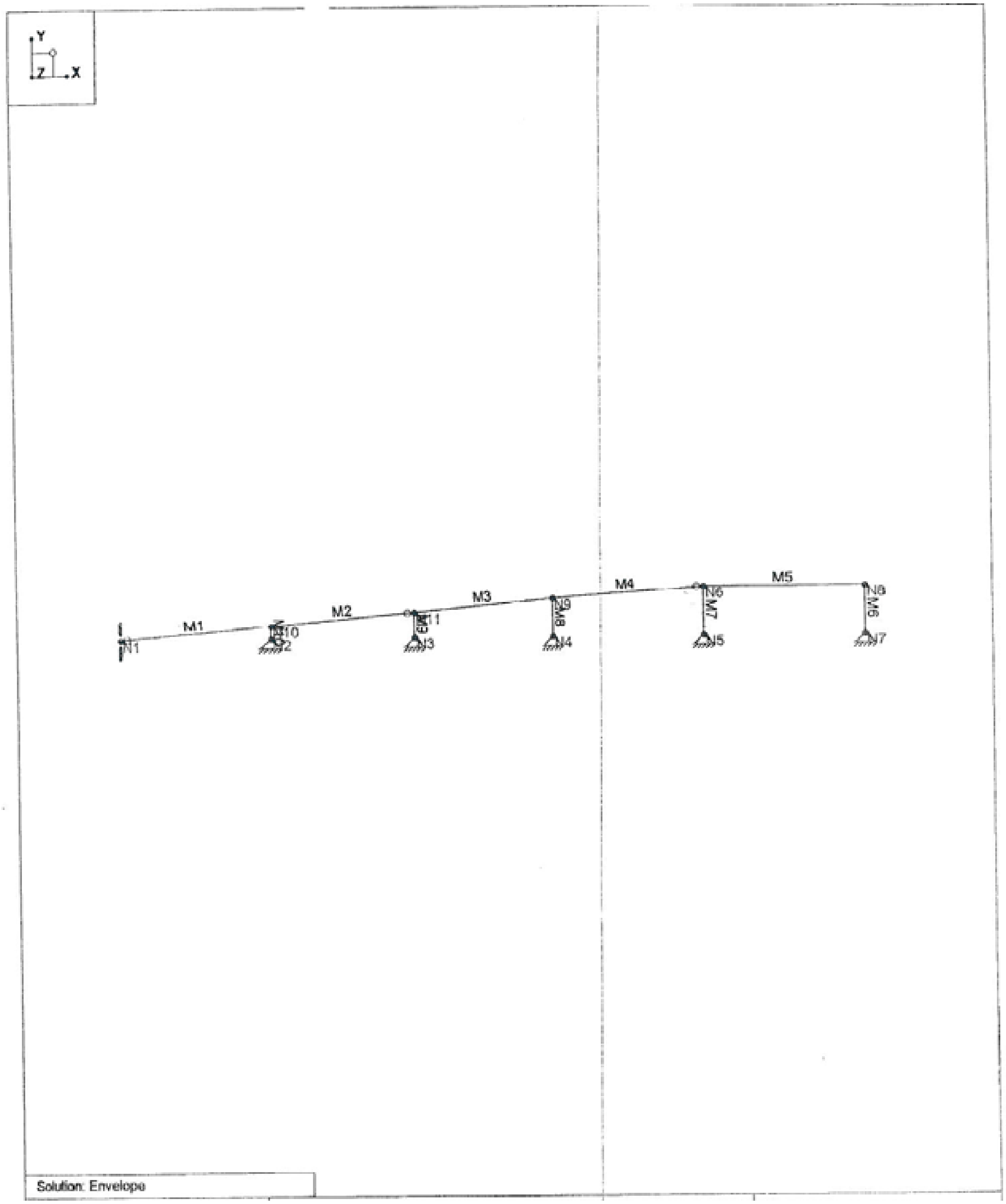
Member Label	Section		Axial (k)	Lc	Shear (k)	Lc	Moment (k)	Lc
M9	1	max	.834	1	-.217	2	0	1
		min	.78	2	-.229	1	0	1
	2	max	.834	1	-.217	2	.064	1
		min	.78	2	-.229	1	.06	2
	3	max	.834	1	-.217	2	.127	1
		min	.78	2	-.229	1	.121	2
	4	max	.834	1	-.217	2	.191	1
		min	.78	2	-.229	1	.181	2
M10	1	max	1.277	1	-.02	1	0	1
		min	1.195	2	-.033	2	0	1
	2	max	1.277	1	-.02	1	.005	2
		min	1.195	2	-.033	2	.003	1
	3	max	1.277	1	-.02	1	.009	2
		min	1.195	2	-.033	2	.006	1
	4	max	1.277	1	-.02	1	.014	2
		min	1.195	2	-.033	2	.008	1

Envelope Member Deflections

Member Label	Section		x-Translate (in)	Lc	y-Translate (in)	Lc	(n) L/y Ratio	Lc
M1	1	max	0	1	0	2	NC	
		min	0	2	0	1	NC	
	2	max	0	1	-.046	2	1243.875	2
		min	0	2	-.049	1	1169.664	1
	3	max	0	1	-.033	2	1756.299	2
		min	0	2	-.035	1	1659.338	1
	4	max	0	1	0	2	NC	
		min	0	2	0	1	NC	
M2	1	max	0	1	0	2	NC	
		min	0	2	0	1	NC	
	2	max	0	1	-.032	2	1848.986	2
		min	0	2	-.034	1	1708.638	1
	3	max	0	1	-.045	2	1280.237	2
		min	0	2	-.049	1	1189.011	1
	4	max	0	1	0	2	NC	
		min	0	2	0	1	NC	
M3	1	max	0	1	0	2	NC	
		min	0	2	0	1	NC	
	2	max	0	1	-.029	2	2063.401	2
		min	-.001	2	-.031	1	1919.616	1
	3	max	-.001	1	-.021	2	2931.998	2
		min	-.002	2	-.022	1	2735.504	1
	4	max	-.002	1	-.002	2	NC	
		min	-.002	2	-.002	1	NC	
M4	1	max	-.002	1	-.002	2	NC	
		min	-.002	2	-.002	1	NC	
	2	max	-.002	1	-.047	2	1336.222	2
		min	-.002	2	-.05	1	1247.236	1
	3	max	-.002	1	-.062	2	996.057	2
		min	-.002	2	-.067	1	930.197	1
	4	max	-.002	1	-.002	2	NC	
		min	-.002	2	-.002	1	NC	

Envelope Member Deflections, (continued)

Member Label	Section		x-Translate (in)	Lc	y-Translate (in)	Lc	(n) L/y Ratio	Lc
M5	1	max	-.001	1	-.002	2	NC	
		min	-.002	2	-.002	1	NC	
	2	max	-.002	1	-.109	2	559.623	2
		min	-.002	2	-.117	1	521.856	1
	3	max	-.002	1	-.109	2	557.976	2
		min	-.002	2	-.117	1	520.674	1
	4	max	-.002	1	-.001	2	NC	
		min	-.003	2	-.001	1	NC	
M6	1	max	0	1	0	1	NC	
		min	0	1	0	1	NC	
	2	max	0	2	-.013	2	1392.207	2
		min	0	1	-.014	1	1294.941	1
	3	max	0	2	-.016	2	1113.766	2
		min	0	1	-.017	1	1035.953	1
	4	max	-.001	2	.003	2	NC	
		min	-.001	1	.002	1	NC	
M7	1	max	0	1	0	1	NC	
		min	0	1	0	1	NC	
	2	max	0	2	.016	1	1270.353	1
		min	0	1	.015	2	1357.948	2
	3	max	-.001	2	.02	1	1016.282	1
		min	-.002	1	.019	2	1086.359	2
	4	max	-.002	2	.002	2	NC	
		min	-.002	1	.001	1	NC	
M8	1	max	0	1	0	1	NC	
		min	0	1	0	1	NC	
	2	max	0	2	.002	2	NC	
		min	0	1	.002	1	9920.451	1
	3	max	-.001	2	.003	2	8189.633	2
		min	-.001	1	.003	1	7936.361	1
	4	max	-.002	2	.002	2	NC	
		min	-.002	1	.001	1	NC	
M9	1	max	0	1	0	1	NC	
		min	0	1	0	1	NC	
	2	max	0	2	.002	1	4529.485	1
		min	0	1	.002	2	4784.344	2
	3	max	0	2	.003	2	3827.475	2
		min	0	1	.003	1	3623.588	1
	4	max	0	2	0	2	NC	
		min	0	1	0	1	NC	
M10	1	max	0	1	0	1	NC	
		min	0	1	0	1	NC	
	2	max	0	2	0	2	NC	
		min	0	1	0	1	NC	
	3	max	0	2	0	2	NC	
		min	0	1	0	1	NC	
	4	max	0	2	0	2	NC	
		min	0	1	0	1	NC	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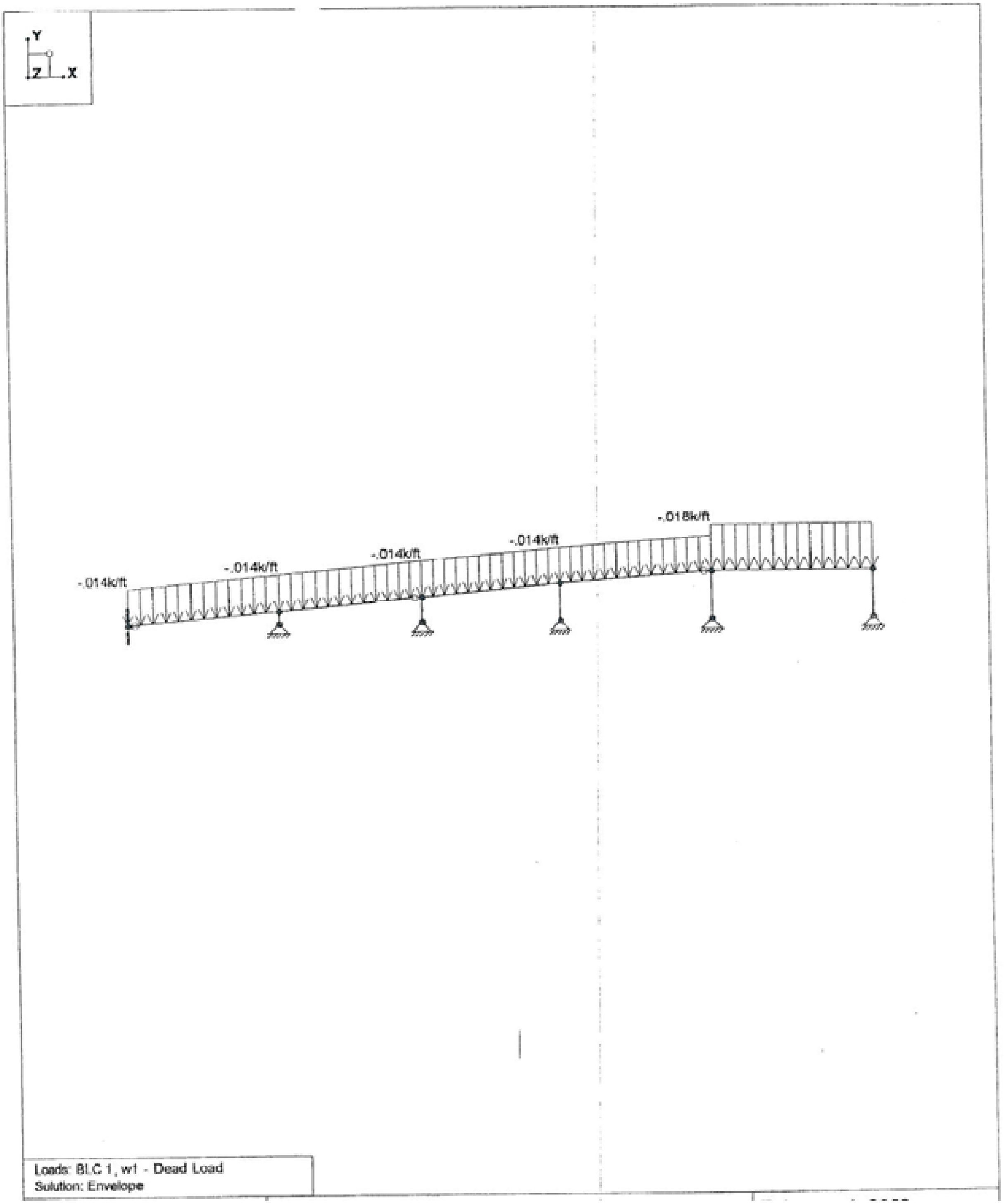
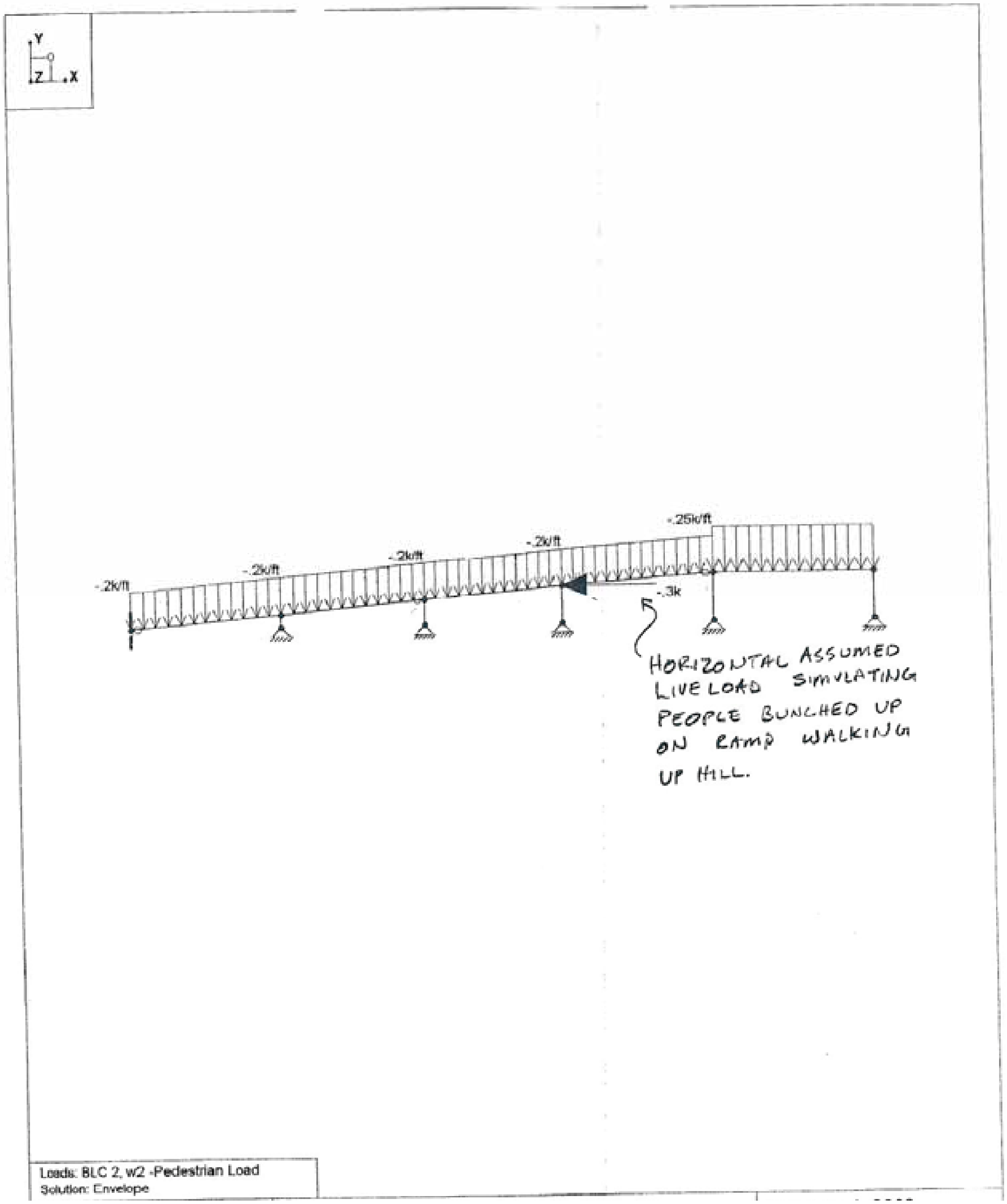
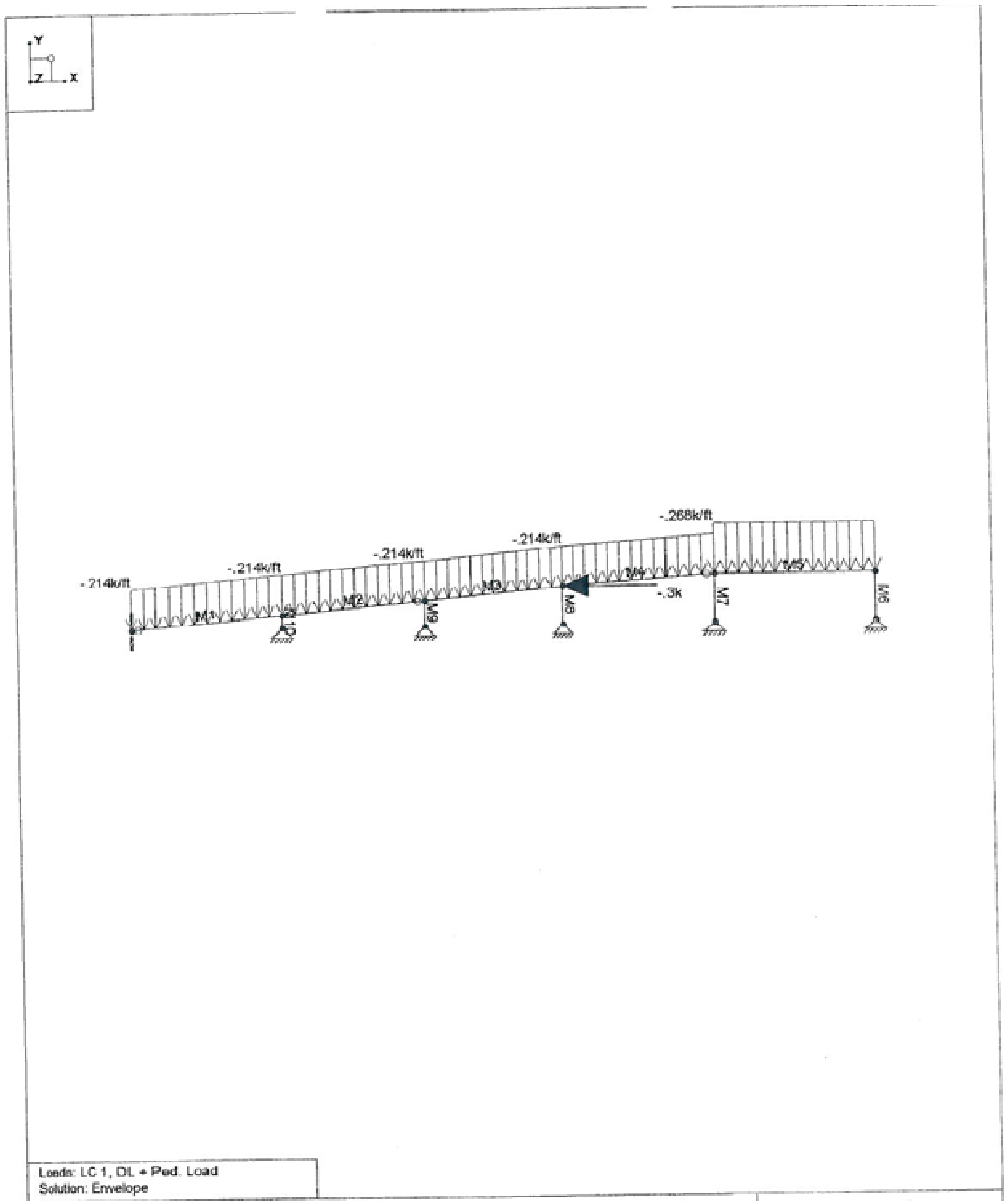
Z
X
M1
M2
M3
M4
M5
N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
M6
M7
M8
Solution: Envelope


Y
Z
X
-.014k/ft
-.014k/ft
-.014k/ft
-.014k/ft
-.018k/ft
Loads: BLC 1, w1 - Dead Load
Solution: Envelope



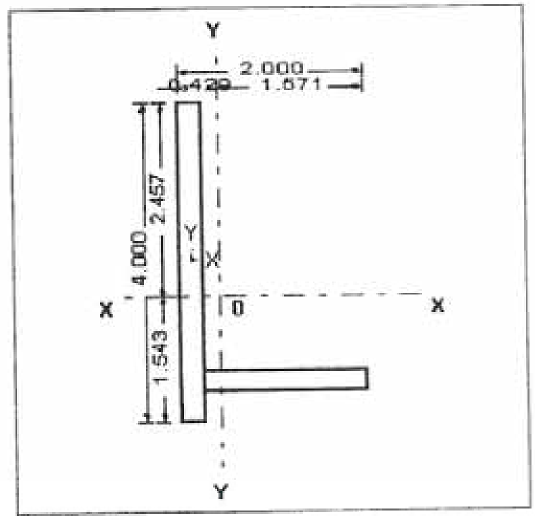
Y
Z
X
-.2k/ft
-.2k/ft
-.2k/ft
-.2k/ft
-.25k/ft
-.3k
HORIZONTAL ASSUMED LIVE LOAD SIMULATING PEOPLE BUNCHED UP ON RAMP WALKING UP HILL.
Loads: BLC 2, w2 -Pedestrian Load
Solution: Envelope


Y
Z
X
-.214k/ft
-.214k/ft
-.214k/ft
-.214k/ft
-.268k/ft
M1
M2
M3
M4
M5
M6
M7
M8
M9
-.3k
Loads: LC 1, DL + Ped. Load
Solution: Envelope

Section:Welcome Ramp

Section Properties:

Number of Shapes	= 2	
Total Width	= 2.00	in
Total Height	= 4.00	in
Center, Xo	= 0.304	in
Center, Yo	= -0.457	in
X-bar (Right)	= 1.571	in
X-bar (Left)	= 0.429	in
Y-bar (Top)	= 2.457	in
Y-bar (Bot)	= 1.543	in
Equivalent Properties:		
Area, Ax	= 1.438	in^2
Inertia, Ixx	= 2.02	in^4
Inertia, Iyy	= 0.4212	in^4
Inertia, Ixy	= -0.4565	in^4
Torsional, J	= 0.0299	in^4
Modulus, Sx(Top)	= 0.8225	in^3
Modulus, Sx(Bot)	= 1.309	in^3
Modulus, Sy(Left)	= 0.981	in^3
Modulus, Sy(Right)	= 0.2682	in^3
Plastic Modulus, Zx	= 1.4921	in^3
Plastic Modulus, Zy	= 0.4852	in^3
Radius, rx	= 1.186	in
Radius, ry	= 0.541	in



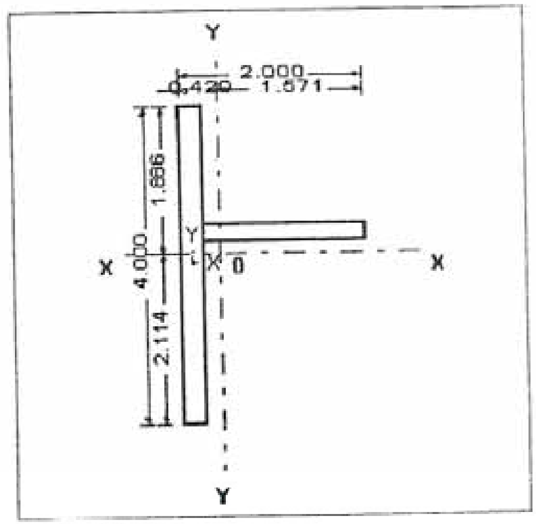
Section Diagram

Summary of Section Properties

Sh. No.	Section	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	Welcome Ramp	2.00	4.00	0.304	-0.457	1.438	2.02	0.4212

Section:Welcome Deck

Section Properties:



Section Diagram

Number of Shapes	= 2	
Total Width	= 2.00	in
Total Height	= 4.00	in
Center, Xo	= 0.304	in
Center, Yo	= 0.114	in
X-bar (Right)	= 1.571	in
X-bar (Left)	= 0.429	in
Y-bar (Top)	= 1.886	in
Y-bar (Bot)	= 2.114	in
Equivalent Properties:		
Area, Ax	= 1.438	in^2
Inertia, Ixx	= 1.378	in^4
Inertia, Iyy	= 0.4212	in^4
Inertia, Ixy	= 0.1141	in^4
Torsional, J	= 0.0299	in^4
Modulus, Sx(Top)	= 0.7309	in^3
Modulus, Sx(Bot)	= 0.652	in^3
Modulus, Sy(Left)	= 0.981	in^3
Modulus, Sy(Right)	= 0.2682	in^3
Plastic Modulus, Zx	= 1.0532	in^3
Plastic Modulus, Zy	= 0.4852	in^3
Radius, rx	= 0.9792	in
Radius, ry	= 0.5413	in

Summary of Section Properties

Sh. No.	Section	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	Welcome Deck	2.00	4.00	0.304	0.114	1.438	1.378	0.4212

Member Stress Results

Access the **Member Section Stresses** spreadsheet by selecting the **Results** menu and then selecting **Members** ▸ **Stresses.**

These are the member stresses calculated along each active member. The number of sections for which stresses are reported is controlled by the **Number Of Sections** specified on the Global window. The actual number of segments is this **Number Of Sections** minus 1. The incremental length of each segment is the same. For example, if you specify 5 sections, the member is divided into 4 equal pieces, and the stresses are reported for each piece.

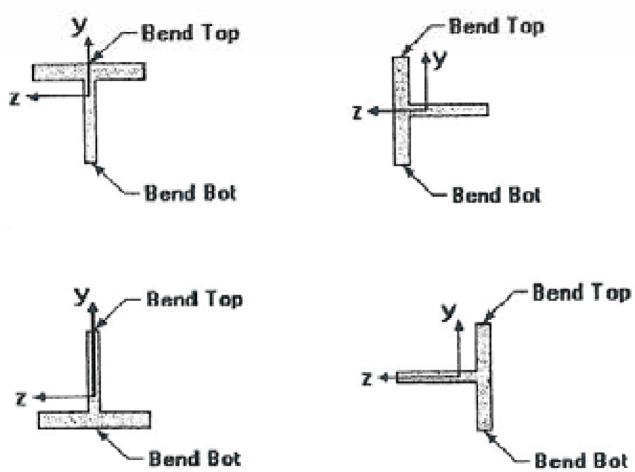
There will be four stress values listed for each section location along the member taking into account any member offsets. The units for the stresses are shown at the top of each column. As for the sign convention, the signs of these results correspond to the signs of the forces. These line up as positive or negative according to the member local axis directions.

The axial stress is the ratio P/A, where P is the section axial force. A positive stress is compressive, since the sign of the stress follows the sign of the force.

The shear stress is calculated as V/S.A., where S.A. is the effective shear area. For members not defined with a section set a value of 1.2 is used for the shear area coefficient S.A.

The bending stresses are calculated using the familiar equation M * c / I, where "M" is the bending moment, "c" is the distance from the neutral axis to the extreme fiber and "I" is the moment of inertia. The stress for the section's extreme edge is listed with respect to the positive and negative directions of the local y and z axes. A positive stress is compressive and a negative stress is tensile.

Some shapes are not symmetrical about both local axes. For example Tee and Channel shapes. Thus the stress at the positive and negative edges may not be the same. The locations for the calculated stresses are illustrated in this diagram:



So, the y-top location is the extreme fiber of the shape in the positive local y direction, y-bot is the extreme fiber in the negative local y direction, etc. The y-top,bot stresses are calculated using Mz.

For enveloped results the maximum and minimum value at each location is listed. The load combination producing the maximum or minimum is also listed, in the "lc" column. To include a particular Load Combination in the envelope analysis, open the **Load Combinations** spreadsheet and check the box in the "Env" column.

Note

- A special case is bending stress calculations for single angles. The bending stresses for single angles are reported for bending about the principal axes.
- To view the results for a particular member, use the Find option. To view the maximums and minimums, use the Sort option.

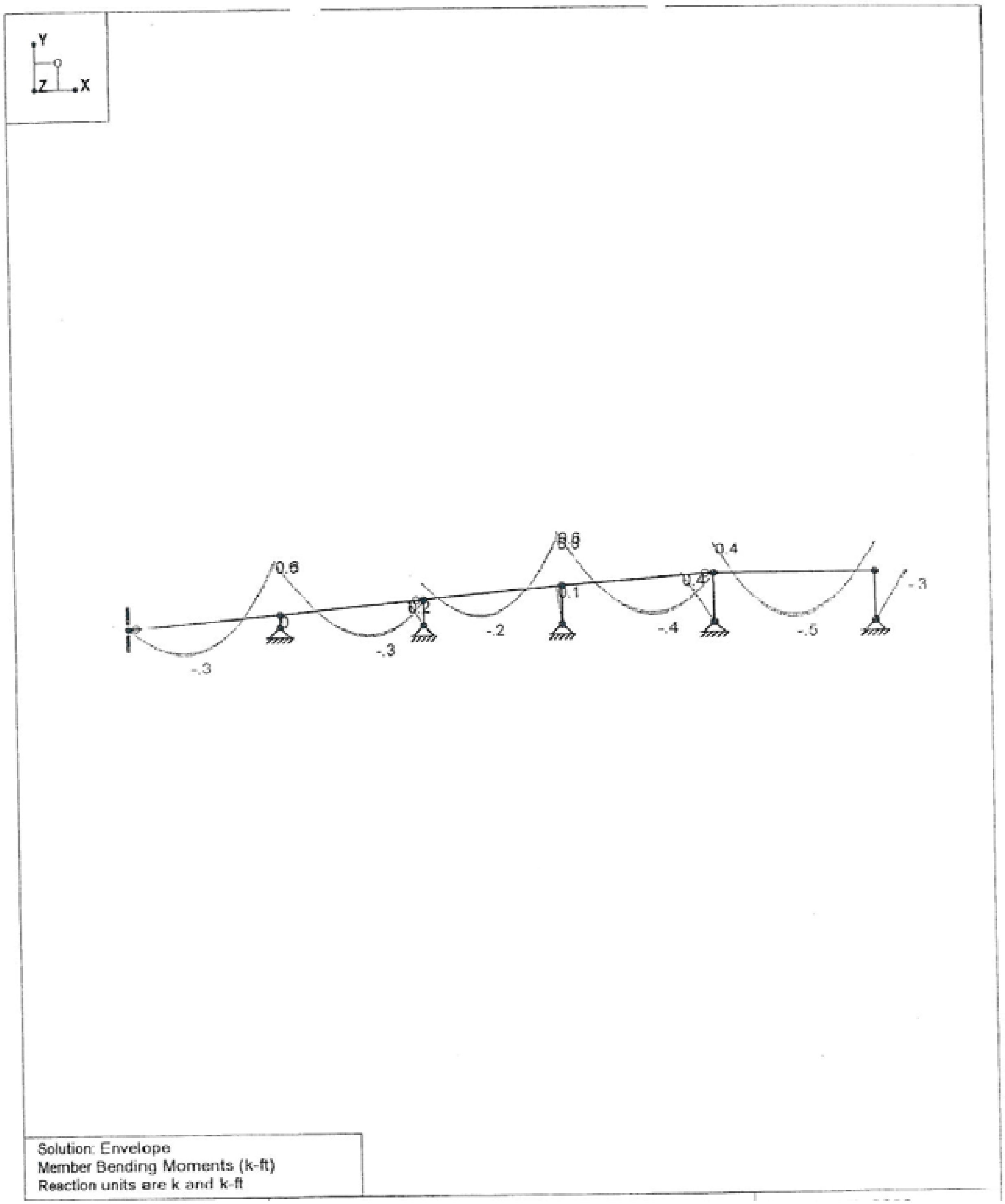

Y
Z
X
0.6
-.3
-.3
-.2
0.1
0.4
-.4
-.5
-.3
Solution: Envelope
Member Bending Moments (k-ft)
Reaction units are k and k-ft

TABLE 20-II-A—MINIMUM MECHANICAL PROPERTIES FOR ALUMINUM ALLOYS—(Continued)
Values Are Given in Units of ksi (1,000 lb/in²)

ALLOY AND TEMPER	PRODUCT[1]	THICKNESS RANGE[1] (inch)	TENSION F_{tu}[2] ksi	TENSION F_{ty}[2] ksi	COMPRESSION F_{cy} ksi	SHEAR F_{su} ksi	SHEAR F_{sy} ksi	BEARING F_{bu} ksi	BEARING F_{by} ksi	COMPRESSIVE MODULUS OF ELASTICITY[3] E ksi
		× 25.4 for mm	× 6.89 for MPa							
5086-H111	Extrusions	up to 0.500	36	21	18	21	12	70	36	10,400
-H111	Extrusions	0.501 and over	36	21	18	21	12	70	34	10,400
-H112	Plate	0.250-0.499	36	18	17	22	10	72	31	10,400
-H112	Plate	0.500-1.000	35	16	16	21	9	70	28	10,400
-H112	Plate	1.001-2.000	35	14	15	21	8	70	28	10,400
-H112	Plate	2.001-3.000	34	14	15	21	8	68	28	10,400
-H32	Sheet and plate	All	40	28	26	24	16	78	48	10,400
-H34	Drawn tube.	All	44	34	32	26	20	84	58	10,400
5154-H38	Sheet	0.006-0.128	45	35	33	24	20	81	56	10,300
5454-H111	Extrusions	up to 0.500	33	19	16	20	11	64	32	10,400
H111	Extrusions	0.501 and over	33	19	16	19	11	64	30	10,400
-H112	Extrusions	up to 5.000	31	12	13	19	7	62	24	10,400
-H32	Sheet and plate	0.020-2.000	36	26	24	21	15	70	44	10,400
-H34	Sheet and plate	0.020-1.000	39	29	27	23	17	74	49	10,400
5456-H111	Extrusions	up to 0.500	42	26	22	25	15	82	44	10,400
-H111	Extrusions	0.501 and over	42	26	22	24	15	82	42	10,400
-H112	Extrusions	up to 5.000	41	19	20	24	11	82	38	10,400
-H321	Sheet and plate	0.188-1.250	46	33	27	27	19	87	56	10,400
-H321	Plate	1.251-1.500	44	31	25	25	18	84	53	10,400
-H321	Plate	1.501-3.000	41	29	25	25	17	82	49	10,400
-H323	Sheet	0.051-0.249	48	36	34	28	21	94	61	10,400
-H343	Sheet	0.051-0.249	53	41	39	31	24	101	70	10,400
6005-T5	Extrusions	up to 0.500	38	35	35	24	20	80	56	10,100
6061-T6, -T651	Sheet and plate	0.010-4.000	42	35	35	27	20	88	58	10,100
-T6, -T6510[1]	Extrusions	up to 3.000	38	35	35	24	20	80	56	10,100
-T6, -T651	Rolled rod and bar	up to 8.000	42	35	35	27	20	88	56	10,100
-T6	Drawn tube	0.025-0.500	42	35	35	27	20	88	56	10,100
-T6	Pipe	up to 0.999	42	35	35	27	20	88	56	10,100
-T6	Pipe	over 0.999	38	35	35	24	20	80	56	10,100

MAIN RAILS

HAND RAILS

6063-T5	Extrusions	up to 0.500	22	16	16	13	9	46	26	10,100
-T5	Extrusions	over 0.500	21	15	15	12	8.5	44	24	10,100
-T6	Extrusions Pipe	All	30	25	25	19	14	63	40	10,100
6351-T5	Extrusions	up to 1.00	38	35	35	24	20	80	56	10,100

[1]Values also apply to -T6511 temper.
[2]F_{tu} and F_{ty} are minimum specified values (except for Alclad 3004-H14, -H16 and F_{ty} for Alclad 3003-H18). Other strength properties are corresponding minimum expected values.
[3]For deflection calculations an average modulus of elasticity is used; numerically this is 100 ksi (689 MPa) lower than the values in this column.

TABLE 20-II-B—MINIMUM MECHANICAL PROPERTIES FOR WELDED ALUMINUM ALLOYS[1]
(Gas Tungsten Arc or Gas Metal Arc Welding with No Postweld Heat Treatment)

ALLOY AND TEMPER	PRODUCT AND THICKNESS RANGE (inch)	TENSION F_{tuw}[1] ksi	TENSION F_{tyw}[2] ksi	COMPRESSION F_{cyw}[2] ksi	SHEAR F_{suw} ksi	SHEAR F_{syw} ksi	BEARING F_{buw} ksi	BEARING F_{byw} ksi
	× 25.4 for mm	× 6.89 for MPa						
1100-H12, -H14	All	11	4.5	4.5	8	2.5	23	8
3003-H12, -H14, -H16, -H18	All	14	7	7	10	4	30	12
Alclad 3003-H12, -H14, -H16, -H18	All	13	6	6	10	3.5	30	11
3004-H32, -H34, -H36	All	22	11	11	14	6.5	46	20
Alclad 3004-H32, -H34, -H14, -H16	All	21	11	11	13	6.5	44	19
3005-H25	Sheet 0.013-0.050	17	9	9	12	5	36	15
5005-H12, -H14, -H32, -H34	All	14	7	7	9	4	28	10

15

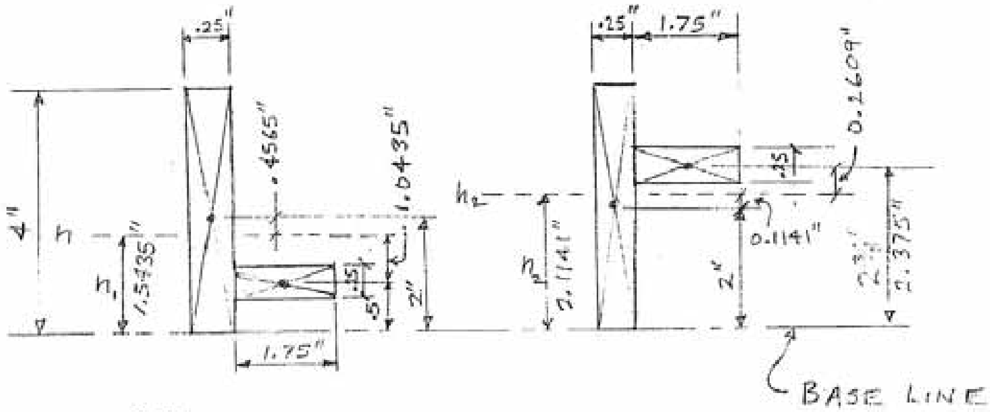
F_{byw} = bearing yield strength within 1.0 inch (25.4 mm) of a weld, ksi (MPa).
F_c = allowable compressive stress, ksi (MPa).
F_{cy} = compressive yield strength, ksi (MPa).
F_{cyw} = compressive yield strength across a butt weld (0.2 percent offset in 10-inch (254 mm) gage length), ksi (MPa).
F_{ec} = $\pi^2 E/[n_u(l/r)^2]$, where l/r is slenderness ratio for member considered as a column tending to fail in the plane of the applied bending moments, ksi (MPa).
F_n = allowable stress for cross section 1.0 inch (25.4 mm) or more from weld, ksi (MPa).
F_{pw} = allowable stress on cross section, part of whose area lies within 1.0 (25.4 mm) inch of a weld, ksi (MPa).
F_s = allowable shear stress for members subjected only to torsion or shear, ksi (MPa).
F_{su} = shear ultimate strength, ksi (MPa).
F_{suw} = shear ultimate strength within 1.0 inch (25.4 mm) of a weld, ksi (MPa).
F_{sy} = shear yield strength, ksi (MPa).
F_{syw} = shear yield strength within 1.0 inch (25.4 mm) of a weld, ksi (MPa).
F_{tu} = tensile ultimate strength, ksi (MPa).
F_{tuw} = tensile ultimate strength across a butt weld, ksi (MPa).
F_{ty} = tensile yield strength, ksi (MPa).
F_{tyw} = tensile yield strength across a butt weld [0.2 percent offset in 10-inch (254 mm) gage length], ksi (MPa).
F_y = either F_{ty} or F_{cy}, whichever is smaller, ksi (MPa).
f = calculated stress, ksi (MPa).
f_a = average compressive stress on cross section of member produced by axial compressive load, ksi (MPa).
f_b = maximum bending stress (compressive) caused by transverse loads or end moments, ksi (MPa).
f_s = shear stress caused by torsion or transverse shear, ksi (MPa).
G = modulus of elasticity in shear, ksi (MPa).
g = spacing of rivet or bolt holes perpendicular to direction of load, inches (mm).
h = clear height of shear web, inches (mm).
I = moment of inertia, inches^4 (mm^4).
I_h = moment of inertia of horizontal stiffener, inches^4 (mm^4).
I_s = moment of inertia of transverse stiffener to resist shear buckling, inches^4 (mm^4).
I_x = moment of inertia of a beam about axis perpendicular to web, inches^4 (mm^4).
I_y = moment of inertia of a beam about axis parallel to web, inches^4 (mm^4).
I_{yc} = moment of inertia of compression element about axis parallel to vertical web, inches^4 (mm^4).
J = torsion constant, inches^4 (mm^4).
k_1 = coefficient for determining slenderness limit S_2 for sections for which the allowable compressive stress is based on crippling strength.
k_2 = coefficient for determining allowable compressive stress in sections with slenderness ratio above S_2 for which the allowable compressive stress is based on crippling strength.
k_c = coefficient for compression members.
k_t = coefficient for tension members.
L = length of compression member between points of lateral support, or twice the length of a cantilever column (except where analysis shows that a shorter length can be used), inches (mm).

2–272

L_b = length of beam between points at which the compression flange is sup al movement, or length of cantilever beam from free end to point at sion flange is supported against lateral movement, inches (mm).
L_t = total length of portion of column lying within 1.0 inch (25.4 mm) o welds at ends of columns that are supported at both ends), inches (m
L_w = increased length to be substituted in column formula to determine welded column, inches (mm).
l/r = slenderness ratio for columns.
M = bending moment, inch-kips (kN·m).
M_c = bending moment at center of span resulting from applied bendin (kN·m).
M_m = maximum bending moment in span resulting from applied bendin (kN·m).
M_1, M_2 = bending moments at two ends of a beam, inch-kips (kN·m).
N = length of bearing at reaction or concentrated load, inches (mm).
n_a = factor of safety on appearance of buckling.
n_u = factor of safety on ultimate strength.
n_y = factor of safety on yield strength.
P = local load concentration on bearing stiffener, kips (kN).
P_c = allowable reaction or concentrated load per web, kips (kN).
P_t = allowable tensile load per fastener, sheet to purlin or girt, kips (kN).
R = outside radius of round tube or maximum outside radius for an oval t
R_b = radius of curvature of tubular members, inches (mm).
R_t = transition radius, the radius of an attachment of the weld detail.
r = least radius of gyration of a column, inches (mm).
r_L = radius of gyration of lip or bulb about face of flange from which lip proj
r_y = radius of gyration of a beam (about axis parallel to web), inches (mm). (unsymmetrical about the horizontal axis, r_y should be calculated as th were the same as the compression flange.)
S_c = section modulus of a beam, compression side, inches^3 (mm^3).
SR = stress ratio, the ratio of minimum stress to maximum stress.
S_t = section modulus of a beam, tension side, inches^3 (mm^3).
S_1, S_2 = slenderness limits.
s = spacing of transverse stiffeners (clear distance between stiffeners for sti of a pair of members, one on each side of the web, center-to-center distar eners consisting of a member on one side of the web only), inches (mm or bolt holes parallel to direction of load, inches (mm).
t = thickness of flange, plate, web or tube, inches (mm). (For tapered flange thickness.)
V = shear force on web at stiffener location, kips (kN).
α = a factor equal to unity for a stiffener consisting of equal members on bot and equal to 3.5 for a stiffener consisting of a member on one side onl
θ = angle between plane of web and plane of bearing surface ($\theta \le 90$), deg

2001.4 Identification. Aluminum for structural elements shall at all times be seg wise handled in the fabricator's plant so that the separate alloys and tempers are p

(1.) CALC. I_{xx} FOR TWO AL. SECTIONS.



$$h = \frac{\Sigma M}{\Sigma A}$$

$$h_1 = \frac{(2'')(.25)(4.0) + (.5)(.25)(1.75)}{(.25)(4.0) + (.25)(1.75)} = \frac{2.2186}{1.4375} = 1.5435''$$

$$h_2 = \frac{(2'')(.25)(4.0) + (2.375)(.25)(1.75)}{(.25)(4.0) + (.25)(1.75)} = \frac{3.0391}{1.4375} = 2.1141''$$

$$I_i = I + Ad^2 + I + Ad_n^2 = \frac{bd^3}{3} + bd(d_n^2) + \ldots$$

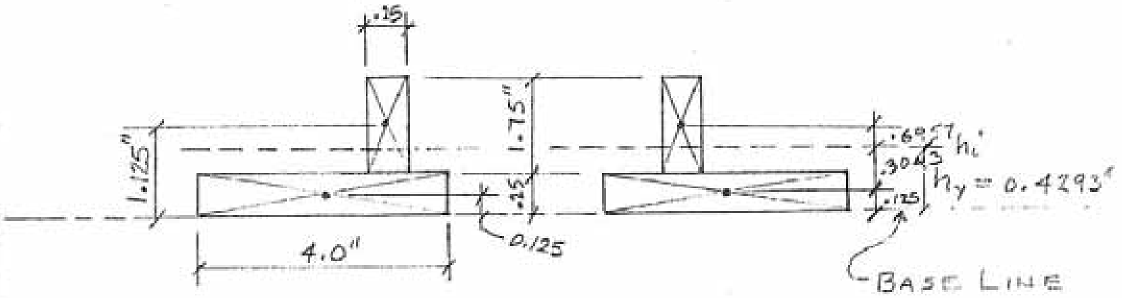
$$I_1 = \frac{.25(4)^3}{12} + .25(4)(.4565)^2 + \frac{1.75(.25)^3}{12} + 1.75(.25)(1.0435)^2$$

$$I_1 = 1.333 + 0.2084 + 0.0023 + 0.4764 = \underline{\underline{2.0201\ in^4}}$$

$$I_2 = \frac{.25(4^3)}{12} + .25(4)(0.1141)^2 + \frac{1.75(.25)^3}{12} + 1.75(.25)(0.2609)^2$$

$$I_2 = 1.333 + 0.0130 + 0.0023 + 0.0298 = \underline{\underline{1.3784\ in^4}}$$

(2.) CALC. I_{yy} FOR TWO AL. SECTIONS.



$$h = \frac{\Sigma M}{\Sigma A} \qquad I_1 = I_y$$

$$h_y = \frac{(0.125)(0.25)(4.0) + (1.125)(.25)(1.75)}{.25(4.0) + .25(1.75)} = 0.4293"$$

$$I_1 = I + Ad^2 + I + Ad^2 = \frac{bd^3}{3} + bd(d_h^2) + \ldots\ldots$$

$$I_1 = \frac{4.0(.25)^3}{12} + 4.0(.25)(0.3043)^2 + \frac{.25(1.75)^3}{12} + .25(1.75)(.6957)^2$$

$$I_1 = 0.0052 + 0.0926 + 0.1117 + 0.2117 = \underline{\underline{0.4212\ in^4}}$$

(3.) CALC. RAMP:
(USING RISA-2D)

$A_{1\&2} = .25(4) + 1.75(.25) = 1.4375\ in^2$

$I_1 = 2.0201\ in^4$

$I_2 = 1.3784\ in^4$

6061-T6 AL, $F_y = 35^{\underline{KSI}}$

I_1 = RAMP

I_2 = PLATFORM

DEAD LOAD = $7^{\underline{PSF}}$

LIVE LOAD = $100^{\underline{PSF}}$

PEDESTRIAN WALK = (UBC TABLE 16-A)

RAMP BEAM DL $= 7(\frac{4}{2}) = 14^{\underline{PLF}}$

RAMP BEAM LL $= 100(\frac{4}{2}) = 200^{\underline{PLF}}$

PLATFORM DL $= 7(\frac{5}{2}) = 17.5^{PLF}$

PLATFORM LL $= 100(\frac{5}{2}) = 250^{\underline{PLF}}$

STRUCTURAL ANALYSIS

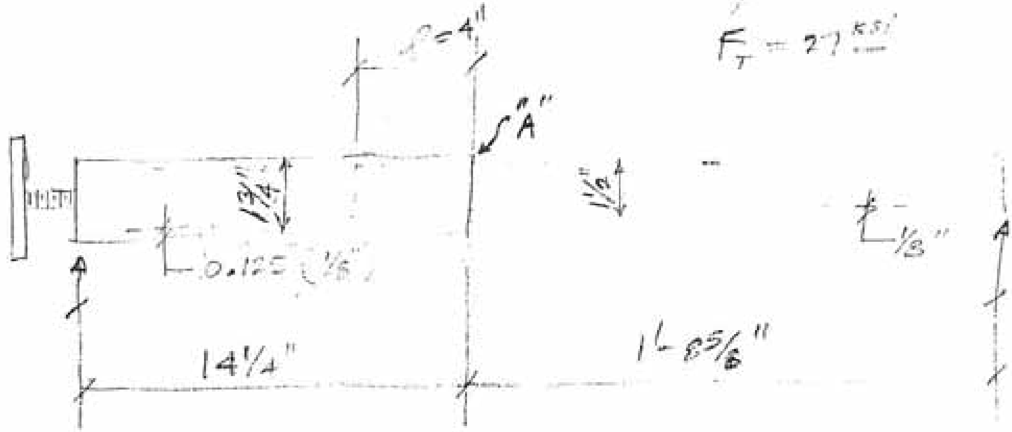
Adjustable Leg Design

425-754-4108
(client)

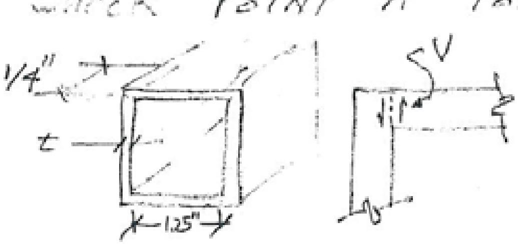
ASSUME:
6063-T5 Al (ASTM B 221)

$F_y = 21^{\text{ksi}}$

$F_T = 27^{\text{ksi}}$



(1.) Check POINT "A" FOR MAX. V OF WALL'S



ASSUME 1/4" BEARING IN SHEAR = V
(IGNORE BENDING OF 1/4" SECT.)
$t = 0.125"$

ASSUME 1^{st} 1/4" OF SHEAR = V

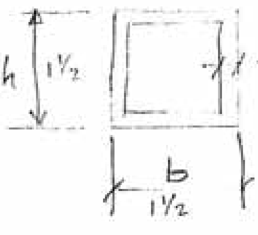
$F_T = 27^{\text{ksi}}$ ∴ $V = 3/4\,F_T = 20.25^{\text{ksi}}$ (ASSUMED)

$0.125"(0.25")(2 \text{ sides})(20.25^{\text{ksi}}) = 1.2656^{k} = 1{,}265^{lb}$ MAX.

(2.) Check POINT "A" FOR MAX. BENDING OF 1½" ☐.

$F_b = 2/3\,F_y = 2/3(21) = 14^{\text{ksi}}$

(2.) CONT.



$$S = \frac{bh^3 - b'h'^3}{6h} = \frac{1.5(1.5)^3 - 1.25(1.25)^3}{6(1.5)}$$

$$S = 0.2912\ in^3$$

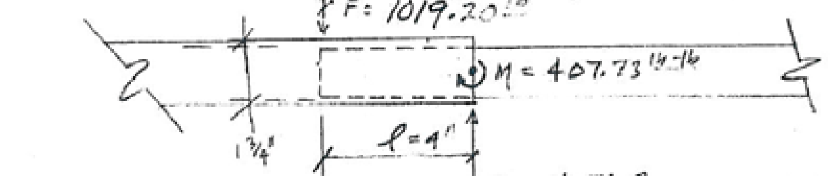
$$S = \frac{M_{max}}{F_b}$$

$$M_{max} = (.2912\ in^3)(14\ k/in^2)(1000) = 4076.80\ in\cdot lb$$

∴ THE MAX. BENDING OF THE 1½" x 1½" = 4076.80 in·lb

BUT THE ABILITY OF THE 1¾" x 1¾" at POINT "A" TO ACCEPT SHEAR IS 1,265 lb.

(3.) NEXT, CALC. MAX. FORCE APPLIED BY 1½" x 1½" & COMPAIR.



$$F = \frac{4076.8}{4"} = 1019.20\ lb$$

$$\therefore 1{,}019.20\ lb < 1{,}265\ lb \quad ok!$$

THEREFOR, THE POST WILL FAIL IN BENDING PRIOR TO FAILING IN SHEAR AT POINT "A." $\ell = 4$ IS THE MINIMUM ALLOWABLE LEG OVERLAP FOR ANY LEG OF THE PREVIOUS DESIGNS [illegible]

WELCOME RAMP, INC.

STRUCTURAL ANALYSIS

Alternate 7-foot Landing Design

• INCLUDED IS THE NEW DESIGN FOR A 7' SECTION PLATFORM.

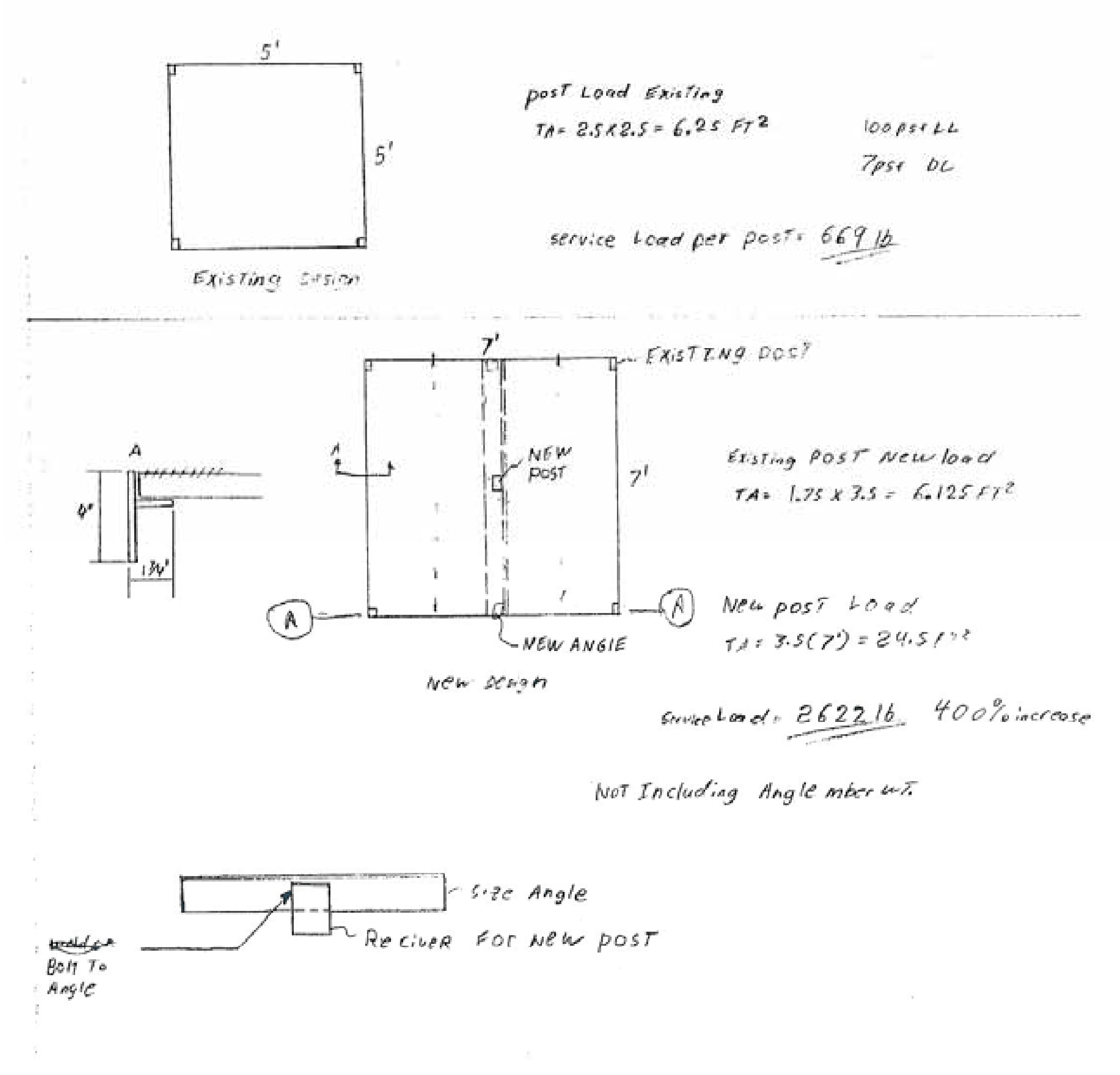
1) FOR A SINGLE POST AND DOUBLE ANGLE BEAM.
2) FOR A DOUBLE POST AND DOUBLE BOX BEAM CONFIGURATION.

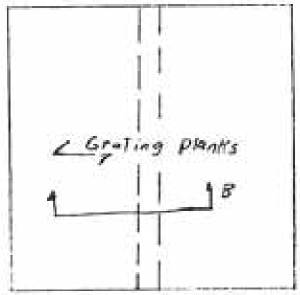
- THIS CHECKS ONLY WHAT HAS BEEN CHANGED FOR THE 7'-0" PLATFORM. ASSUMES TREADS ARE ADEQUATE ON STAIRS TO SPAN 7'-0".

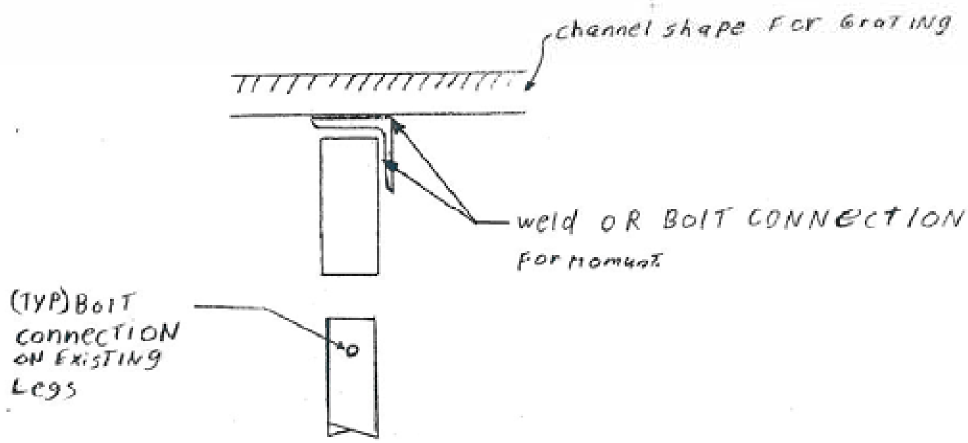
SUMMARY

use current post IN CENTER.
post will be placed on a 16"x16" FOOTING.
New Double Angle For Beam section is a 4x2x3/16 angle placed Back To Back.

DESIGN OF 7' SECTION USING SINGLE POST IN CENTER OF NEW DOUBLE ANGLE BEAM.


5'
5'
Existing Design
post Load Existing
TA= 2.5x2.5 = 6.25 FT²
100 psf LL
7psf DL
service Load per post= 669 lb
7'
EXISTING POST
A
4"
1¾"
NEW POST
7'
Existing POST New load
TA= 1.75 x 3.5 = 6.125 FT²
A
A
NEW ANGLE
New post Load
TA= 3.5(7') = 24.5 ft²
New Design
Service Load= 2622 lb
400% increase
Not Including Angle mber wT.
Size Angle
Reciver For New post
Bolt To Angle


Grating planks
B


channel shape For GraTING
weld OR BolT CONNECTION
For moment
(TYP) BolT connecTION on EXisTING Legs

Typical Post Calculations.

TABLE 20-II-A Pg 2-296

PIPING = 6061 - T6 EXTRUSIONS

Tension F_{tu} = 38 ksi F_{ty} = 35 ksi

compression F_{cy} = 35 ksi

Shear = F_{su} = 24 ksi F_{sy} = 20 ksi

Bearing , F_{bu} = 80 ksi F_{by} = 56 ksi

E = 10,100 ksi

Square structural tubing pg 111 section 1

Leg material = 1½" sq X .12" AL. Tubing WT per FT: 2.252 [illegible]

ITEM I. BUCKLING LOAD

Fcr Buckling assuming 48" with NO Eccentricitie

$$F_{cr} = \frac{\pi^2 E}{(K\ell/r)^2} \qquad r = \sqrt{I/A} = \sqrt{\frac{.2118}{.6624}} = .5655 \qquad K = 1$$

$$= \frac{\pi^2 (10{,}100\text{ ksi})}{\left(1 \cdot 48''/.5655\right)^2} = 13.84\text{ Kips} < 2622\text{ lb}$$

service load

ITEM 2. AXIAL LOAD

AXIAL BEARING P/A_g = service Load = $\frac{2622}{.6624}$ = 3958 PSI

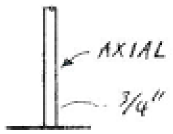
ITEM 3. BEARING. Allow Comp = 35 ksi

Bolt Bearing - Alluminum will Fail Befor Bolt Bearing

Tube Thickness = .12 in Bolt size = 3/8 = .375 F_{bu} = 80 ksi

F_b = (.375(.12))2 x 80 ksi = 7.2 Kips < 2.6 K

ITEM 4. AXIAL Load on Rod AT BASE



Area= $\pi r^2 = \pi(.375^2) = .4418\ in^2$

Load $= \frac{2622\ lb}{.4418\ in^2} = \underline{5934}\ psi < Fcy = 35\ Ksi$ OK

ITEM 5. Base PlATE Bering

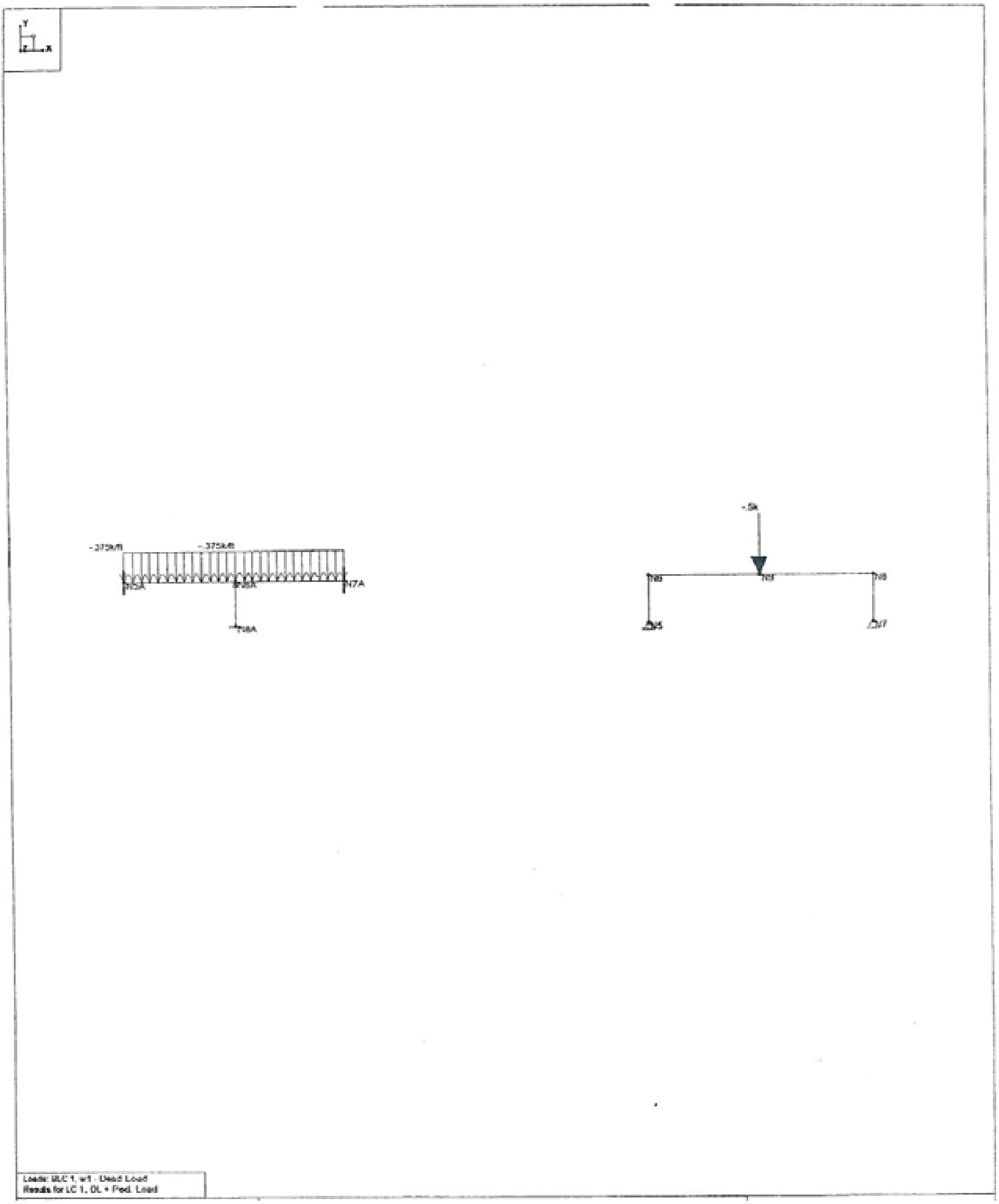
Base plate = 2"x2"

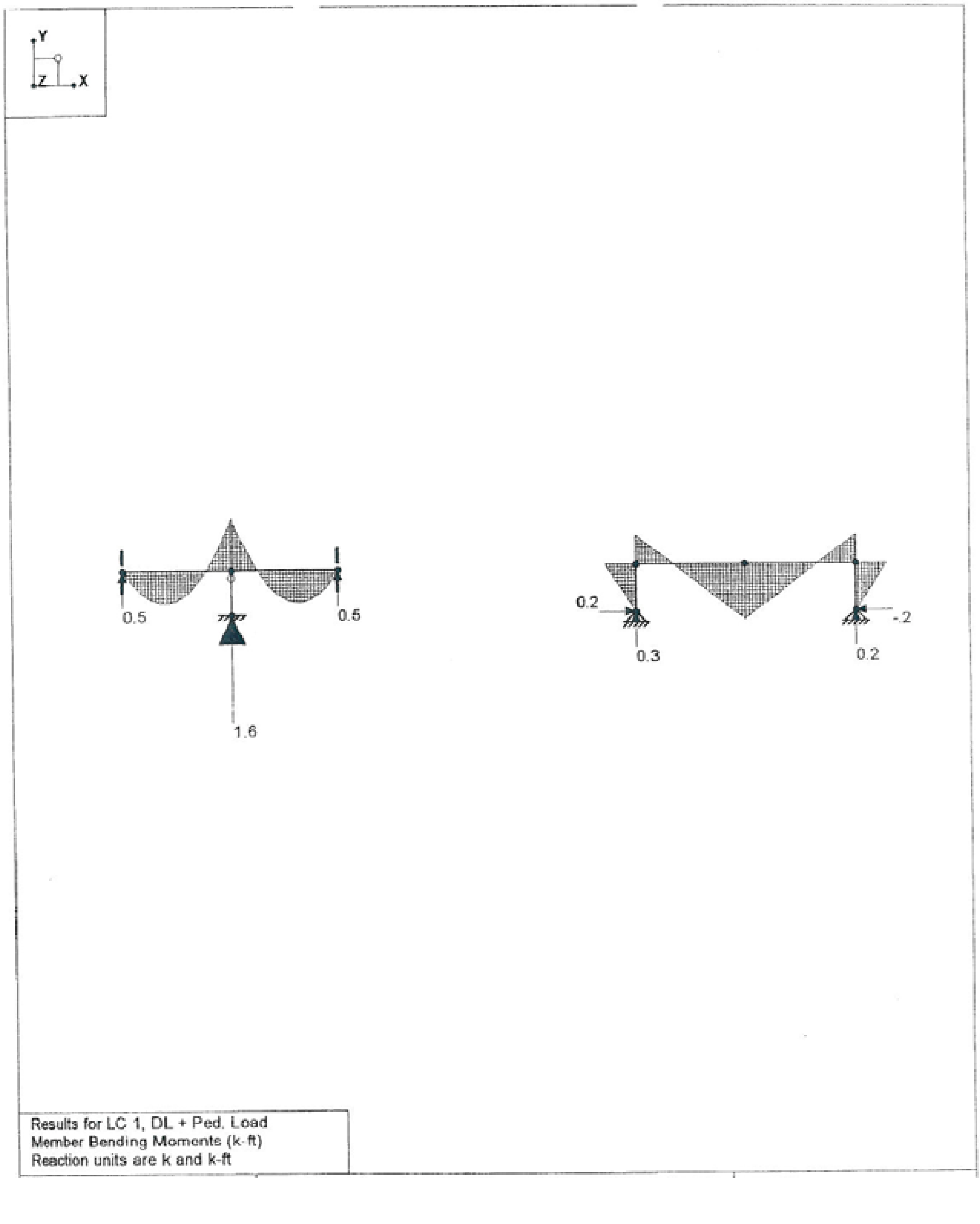
$\frac{2622\ lb}{4\ in^2} = 655\ psi$ NOT OK .

allowable load = 4000 psf at FOOT or 27.7 psi

TRy a 16" Block = 1.78 FT²

4000 psf (1.78 FT²) = 7111 lb. > 2622 lb OK!


-.375k/ft
-.375k/ft
N7A
-.5k
Loads: BLC 1, w1 - Dead Load
Results for LC 1, DL + Ped. Load


Y
Z
X
0.5
0.5
1.6
0.2
-.2
0.3
0.2
Results for LC 1, DL + Ped. Load
Member Bending Moments (k-ft)
Reaction units are k and k-ft

Member Data

Member Label	I Joint	J Joint	Rotate (degrees)	Shape / Section Set	Material Set	Phys Memb	TOM	End Releases I-End AVM	End Releases J-End AVM	End Offsets I-End (in)	End Offsets J-End (in)	Inactive Code	Length (ft)
M1	N6	N9		SEC2	AL	Y							3.5
M2	N7	N8		SEC3	AL	Y							1.599
M3	N5	N6		SEC3	AL	Y							1.599
M4	N5A	N6A		SEC4	AL	Y							3.5
M5	N6A	N7A		SEC4	AL	Y							3.5
M6	N8A	N6A		SEC3	AL	Y			PIN				1.5
M7	N9	N8		SEC2	AL	Y							3.5

Sections

Section Label	Database Shape	Material Label	Area (in)^2	SA (0,180)	SA (90,270)	I (90,270) (in^4)	I (0,180) (in^4)	T/C Only
SEC1	Welcome Ramp	AL	1.438	1.2	1.2	.421	2.02	
SEC2	Welcome Deck	AL	1.438	1.2	1.2	.421	1.378	
SEC3	TU2X2X2	AL	.897	1.2	1.2	.513	.513	
SEC4	WT4X10.5	AL	3.08	1.2	1.2	4.89	3.9	

Member Deflections, By Combination

LC	Member Label	Section	x-Translation (in)	y-Translation (in)	(n) L/y Ratio
1	M1	1	0	0	NC
		2	0	-.086	3035.648
		3	0	-.174	1377.517
		4	0	-.214	NC
1	M2	1	0	0	NC
		2	0	-.013	1458.898
		3	0	-.016	1167.118
		4	0	0	NC
1	M3	1	0	0	NC
		2	0	.013	1458.898
		3	0	.016	1167.118
		4	0	0	NC
1	M4	1	0	0	NC
		2	0	-.015	3103.087
		3	0	-.012	4257.729
		4	0	-.003	NC
1	M5	1	0	-.003	NC
		2	0	-.012	4257.729
		3	0	-.015	3103.087
		4	0	0	NC
1	M6	1	0	0	NC
		2	-.001	0	NC
		3	-.002	0	NC
		4	-.003	0	NC
1	M7	1	0	-.214	NC
		2	0	-.174	1377.517
		3	0	-.086	3035.648
		4	0	0	NC

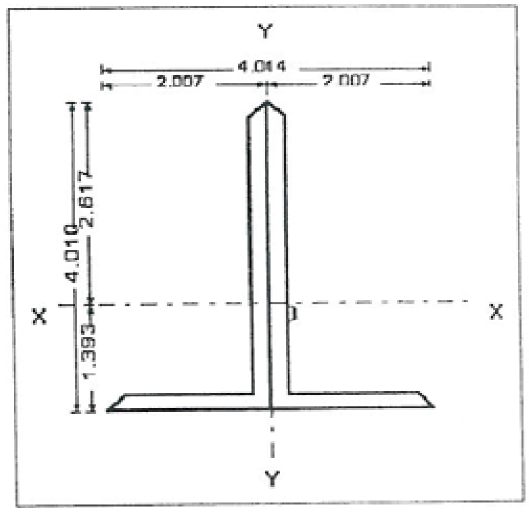
Member Stresses, By Combination

LC	Member Label	Section	Axial (ksi)	Shear (ksi)	Bending top (ksi)	Bending bot (ksi)
1	M1	1	.135	.21	-5.078	5.693
		2	.135	.21	-.271	.304
		3	.135	.21	4.536	-5.085
		4	.135	.21	9.343	-10.474
1	M2	1	.279	.464	0	0
		2	.279	.464	2.412	-2.412
		3	.279	.464	4.824	-4.824
		4	.279	.464	7.236	-7.236
1	M3	1	.279	-.464	0	0
		2	.279	-.464	-2.412	2.412
		3	.279	-.464	-4.824	4.824
		4	.279	-.464	-7.236	7.236
1	M4	1	0	.579	0	0
		2	0	.072	.838	-3.338
		3	0	-.435	.371	-1.479
		4	0	-.942	-1.401	5.577
1	M5	1	0	.942	-1.401	5.577
		2	0	.435	.371	-1.479
		3	0	-.072	.838	-3.338
		4	0	-.579	0	0
1	M6	1	1.812	0	0	0
		2	1.812	0	0	0
		3	1.812	0	0	0
		4	1.812	0	0	0
1	M7	1	.135	-.21	9.343	-10.474
		2	.135	-.21	4.536	-5.085
		3	.135	-.21	-.271	.304
		4	.135	-.21	-5.078	5.693

Section:RShape1

Section Properties:

Number of Shapes	= 2	
Total Width	= 4.014	in
Total Height	= 4.01	in
Center, Xo	= 14.995	in
Center, Yo	= -1.605	in
X-bar (Right)	=2.007in	
X-bar (Left)	=2.007in	
Y-bar (Top)	=2.617in	
Y-bar (Bot)	=1.393in	
Equivalent Properties:		
Area, Ax	= 2.24	in^2
Inertia, Ixx	= 3.607	in^4
Inertia, Iyy	= 0.9487	in^4
Inertia, Ixy	= 0.000	in^4
Torsional, J	= 0.0304	in^4
Modulus, Sx(Top)	= 1.378	in^3
Modulus, Sx(Bot)	= 2.589	in^3
Modulus, Sy(Left)	= 0.473	in^3
Modulus, Sy(Right)	= 0.473	in^3
Plastic Modulus, Zx	= 2.492	in^3
Plastic Modulus, Zy	= 16.794	in^3
Radius, rx	= 1.269	in
Radius, ry	= 0.651	in



Section Diagram

Basic Properties of Shapes in Section:

Sh. No.	Shape	Factor	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	Unequal L	1	2.00	4.00	14.60	-1.60	1.12	1.004	0.30
2	Unequal L	1	2.00	4.00	15.39	-1.61	1.12	1.804	0.30

Additional Properties of Shapes in Section:

Sh. No.	Shape	J in^4	Sx in^3	Sy in^3	Zx in^3	Zy in^3	rx in	ry in
1	Unequal L	0.0152	0.6905	0.1859	1.246	0.533	1.269	0.517
2	Unequal L	0.0152	0.6905	0.1859	1.246	0.533	1.269	0.517

Summary of Properties

Sh. No.	Section	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	RShape1	4.014	4.01	14.995	-1.605	2.24	3.607	0.949

Calculation Procedure

1) Closed Shapes:
The geometric properties for closed shapes are computed by using the Polygon method. All closed shapes are represented by closed polygons. Curvilinear and circular shapes or edges are represented by several straight line segments. The properties the overall shape are computed by geometric summation of the properties of a trapezoid defined by projection of two consecutive points of the cross-section on to the x and y axis.

2) Open Shapes:
The geometric properties for open (thin walled) shapes are computed by using the Polyline method. All open shapes are represented by polylines. Curvilinear and circular shapes or edges are represented by several straight line segments. The properties the overall shape are computed by geometric summation of the properties of a line defined by projection of two consecutive points of the cross-section on to the x and y axis
For details refer to the User's Manual

FOOTING SIZING CALCULATIONS

1) LOADING

Dead Load=	7	psf
Live Load =	100	psf
Total Load, RAMP_TL =	107	psf

2) FOOTING ON SOIL

Soil Allowable Bearing Pressure =	1500	psf
7' Platform Center Column, Area =	12.25	psf
Max Load =	1311	#
Min. Footing Area =	0.87	sf
Footing Pad w/ minimum Size =	11.22	inch

USE: 12-INCH, MIN. SQUARE PAD UNDER COLUMN ON SOIL

3) FOOTING ON PAVEMENT (Based on 8-inch Depth Pavement+Base)

Allowable Bearing Pressure =	8831	psf
7' Platform Center Column, Area =	12.25	psf
Max Load =	1311	#
Min. Footing Area =	0.15	sf
Footing Pad w/ minimum Size =	4.62	inch

USE: 5-INCH, MIN. SQUARE PAD UNDER COLUMN ON PAVEMENT

D. DEFLECTION CHECK FOR ALLUMINUM TUBES

ALLOWABLE $\delta = \ell/240 = .175''$

Load = 107(3.5') = 374.5 PLF

$$\delta = \frac{5 w \ell^4}{384 EI} = \frac{5(374.5/12)(3.5' \times 12)^4}{384(10{,}100 \times 1000)(2.074 \text{ in}^4)}$$

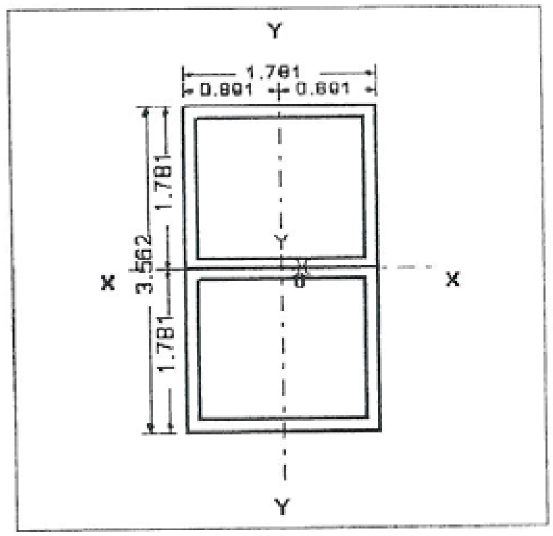
$$= .064'' < .175 \quad \text{OK}$$

USE 2 - 1.781" TUBES STACKED.

Section:Section1

Section Properties:

Number of Shapes	= 2	
Total Width	= 1.781	in
Total Height	= 3.562	in
Center, Xo	= 0.00	in
Center, Yo	= 0.00	in
X-bar (Right)	= 0.891	in
X-bar (Left)	= 0.891	in
Y-bar (Top)	= 1.781	in
Y-bar (Bot)	= 1.781	in
Equivalent Properties:		
Area, Ax	= 1.656	in^2
Inertia, Ixx	= 2.074	in^4
Inertia, Iyy	= 0.7612	in^4
Inertia, Ixy	= 0.000	in^4
Torsional, J	= 1.2688	in^4
Modulus, Sx(Top)	= 1.164	in^3
Modulus, Sx(Bot)	= 1.164	in^3
Modulus, Sy(Left)	= 0.855	in^3
Modulus, Sy(Right)	= 0.855	in^3
Plastic Modulus, Zx	= 1.568	in^3
Plastic Modulus, Zy	= 1.029	in^3
Radius, rx	= 1.119	in
Radius, ry	= 0.678	in



Section Diagram

Basic Properties of Shapes in Section: (Local Axis, for n=1)

Sh. No.	Shape	Modular Ratio(n)	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	Tube	1.00	1.781	1.781	0.00	-0.891	0.828	0.3806	0.3806
2	Tube	1.00	1.781	1.781	0.00	0.89	0.828	0.3806	0.3806

Additional Properties of Shapes in Section: (Local Axis, for n=1)

Sh. No.	Shape	J in^4	Sx-Top in^3	Sy-Right in^3	Zx in^3	Zy in^3	rx in	ry in
1	Tube	0.6344	0.4274	0.4274	0.5144	0.5144	0.678	0.678
2	Tube	0.6344	0.4274	0.4274	0.5144	0.5144	0.678	0.678

Summary of Section Properties

Sh. No.	Section	Width in	Height in	Xo in	Yo in	Ax in^2	Ixx in^4	Iyy in^4
1	Section1	1.781	3.562	0.00	0.00	1.656	2.074	0.7612

Calculation Procedure

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2) Open Shapes:
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For details refer to the User's Manual

STRUCTURAL ANALYSIS

Manufacturer Information - Planks

TRACTION TREAD LOAD TABLES

PLANKING

Plank Description
Plank: Traction Tread
Width: 12"
Guage: 13 GA

2" Channel Height
Se: 0.27 in^3
Mmax: 5335 lb-in

1 1/2" Channel Height
Se: 0.174 in^3
Mmax: 3438 lb-in

2" Channel Height

	2'-0	3'-0	4'-0	5'-0	6'-0	7'-0	8'-0	9'-0	10'-0
U	889	395	222	142	99	73	56	44	36
D	0.057	0.129	0.229	0.357	0.514	0.7	0.915	1.158	1.429
C	889	593	445	356	296	254	222	198	178
D	0.046	0.103	0.183	0.286	0.412	0.56	0.732	0.926	1.143

1 1/2" Channel Height

	2'-0	3'-0	4'-0	5'-0	6'-0	7'-0	8'-0	9'-0	10'-0
U	573	255	143	92	64	47	36	28	23
D	0.07	0.157	0.279	0.436	0.627	0.854	1.115	1.411	1.742
C	573	382	287	229	191	164	143	127	115
D	0.056	0.125	0.223	0.348	0.502	0.683	0.892	1.129	1.394

Notes:

@ 4'-8" u = 109 OK!

U = Uniform Load, psf
C = Concentrated Load, psf
D = Deflection, in.

1.) Allowable loads are based on the latest edition of AISI, 1986 Edition w/ 12/11/89 Addendum.
2.) This table is a theoretical calculation of the allowable loads and deflections for the specified spans. There are no test results to verify the actural load carrying capabilities. This table should be used as a reference only.
3.) Loads and deflections are based on side channel deflection only, and does not account for strut loading of the grating surface.

TRACTION TREAD LOAD TABLES

STAIRS

Plank Description
Plank: Traction Tread
Width: 12"
Guage: 11 GA

2" Channel Height			**1 1/2" Channel Height**		
Se:	0.541	in^3	Se:	0.331	in^3
Mmax:	10690	lb-in	Mmax:	6541	lb-in

2" Channel Height

	2'-0	3'-0	4'-0	5'-0	6'-0	7'-0	8'-0	9'-0	10'-0
U	1782	792	445	285	198	145	111	88	71
D	0.028	0.064	0.113	0.177	0.254	0.346	0.452	0.572	0.706
C	1782	1188	891	713	594	509	445	396	356
D	0.023	0.051	0.09	0.141	0.203	0.277	0.362	0.458	0.565

1 1/2" Channel Height

	2'-0	3'-0	4'-0	5'-0	6'-0	7'-0	8'-0	9'-0	10'-0
U	1090	484	273	174	121	89	68	54	44
D	0.035	0.079	0.14	0.219	0.315	0.429	0.561	0.71	0.876
C	1090	727	545	436	363	311	273	242	218
D	0.028	0.063	0.112	0.175	0.252	0.343	0.449	0.568	0.701

Notes:

U = Uniform Load, psf
C = Concentrated Load, psf
D = Deflection, in.

1.) Allowable loads are based on the latest edition of AISI, 1986 Edition w/ 12/11/89 Addendum.
2.) This table is a theoretical calculation of the allowable loads and deflections for the specified spans. There are no test results to verify the actural load carrying capabilities. This table should be used as a reference only.
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