Scan

kpff

July 14, 2017

Mr. Michael Stanner
LRS Architects
720 NW Davis Street, Suite 300
Portland, OR 97209

Re: Structural Calculations
Grand Avenue Apartments
1010 NE Grand Ave
Portland, OR

Dear Michael:

Attached please find calculation sheets 1 through 211, dated July 14, 2017, which verify the structural adequacy of the Grand Avenue Apartments, as shown on drawings S001 through S706 dated July 14, 2017. Design is based on the requirements of the 2014 Oregon Structural Specialty Code, based on the 2012 International Building Code.

If you have any questions or need further information, please call me.

Sincerely,

Jeffrey R. Diephuis, S.E.
Associate

JRD/jkd

2017_07_14_Grand_Avenue_Apartments_10021600385_Calculation_Letter

EXPIRES: 12-31-18

11-10-17 co

kpff

Grand Avenue

Structural Calculations

KPFF Project No. 21600385

July 12, 2017

Submitted to Client by PDF:

LRS Architects
720 NW Davis, Suite 300
Portland, OR 97209

Submitted By:

KPFF Consulting Engineers
111 SW Fifth Avenue, Suite 2500
Portland, OR 97204-3628

kpff	Project Grand Avenue	By CLH	Sheet No.
Location	Portland, Oregon	Date	Job No.
Client	LRS Architects	7.12.2017	21600385

Project: **Grand Avenue**

Project Manager: **Jeff Diephuis**

KPFF Project Engineer: **Cliff Horton**

KPFF Job No.: **21600385**

Structural Calculations Index

SCAN

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210 East 13th Street, Suite 300, Vancouver, Washington 98660-3231
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Job Memorandum

To: Michael Zeman **Date:** August 28, 2017

Firm: Pacific Foundation **Project:** Grand Avenue Apartments

Address: 7206 NE 47th Ave **Our Project No.:** A17.0220.00

Vancouver, WA 98661 **Your Project No.:**

Basis: ☐ Telephone ☐ Conference ☐ Observation ☒ Other

Subject: Application #17-204627.000.00.CO Site Development Review Response

The following are responses to the City of Portland BES Site Development review performed by Kevin Wells, on August 16, 2017. The responses pertain to the plan review items that are within our design scope:

10. The required notes have been added to drawing SH2.
11. The auger diameter value has been modified on the cantilever pile sections on drawing SH4 to match the calculations.

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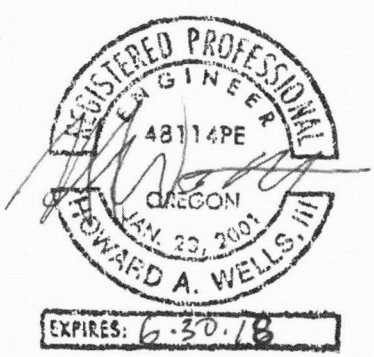
Prepared by: Dominic Webber

STRUCTURAL CALCULATIONS

GRAND AVENUE APARTMENTS
TEMPORARY SHORING
PORTLAND, OREGON

BergerABAM

Submitted to
Pacific Foundation
Vancouver, WA



A17.0220

Revision 1: 1 September 2017
13 July 2017

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Project Description:

The following calculations pertain to the temporary shoring design for the Grand Avenue Apartments project located at NE Hassalo Street Street and NE Grand Avenue in Portland, Oregon. The shoring wall is to be tieback soldier piles and cantilevered soldier piles with timber lagging. The shoring wall is designed for soil loads, construction live loads and traffic surcharges.

The tieback anchors are designed per the PTI Recommendations for Prestressed Rock and Soil Anchors. The grout-to-soil bond was determined from soil information given in the geotechnical data report - "Geotechnical Investigation and Site-specific Seismic Hazard Evaluation, NE Grand Avenue Affordable Housing" as prepared by GRI Inc., dated March 9, 2017. All anchors are to be proof tested and select anchors will undergo verification tests.

Material:

Soldier Pile - ASTM A992 GR 50
Tieback Pocket Plates - ASTM A36, Fy=36 ksi
Tieback Strand - 0.6 in. Diameter, 7 wier, ASTM A416, fpu = 270 ksi
Wedge Plates - Ductile Iron, ASTM A536
Centralizers and Spacers - Steel or Plastic
Timber Lagging - Rough Sawn Douglas Fir-Larch No. 2 or better.
Lean Concrete - 500 psi Minimum
Tieback Grout - f'c = 4000 psi

Soil Properties:
Unrestrained Active Pressure - Above water table = 35 pcf
Restrained Active Pressure - 25H psf Trapizoidal
Passive Pressure - 300 pcf over 2 pile diameters
Anchor Bond - 1.9 ksf (allowable) = 3 klf

Tieback Anchors

Tendon Size=	0.6	in. Dia.	Tendon Design=	34.83 kip/strand	Allowable Bond Strength= 3 klf
Ultimate Strength (f_{ult})=	270	ksi	Tendon Test Design=	46.44 kip/strand	
Area of Strand(As)=	0.215	sqr. In.			

Pile	Size	Top of Pile (ft)	Top of Excavation (ft)	Bottom of Excavation (ft)	Retained Height (ft)	Bottom of Pile (ft)	Pile Embedment (ft)	Total Pile Length (ft)	Tieback Elevation (ft)	Tieback Angle (degrees)	Horizontal Tieback Reaction (kip)	Tieback Design Load: DL (kip)	Proof Test Load: 133% DL (kip)	Verification Test Load: 150% DL (kip)	# of Strand	# of Test Strand	Unbond Length, L (ft)	Bond Length, L (ft)	Tail Length (ft)	Total Anchor Length (ft)
N1	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
N2	W18x97	128.87	128.37	113.33	15.0	93.83	19.50	35.04												
N3	W18x106	129.50	129.00	113.33	15.7	93.33	20.00	36.17												
N4	W18x106	129.50	129.00	113.33	15.7	93.33	20.00	36.17												
N5	W18x106	129.50	129.00	113.33	15.7	93.33	20.00	36.17												
N6	W18x97	128.87	128.37	113.33	15.0	93.83	19.50	35.04												
N7	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
N8	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
N9	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E1	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E2	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E3	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E4	W16x50	127.83	127.33	105.92	21.4	93.92	12.00	33.91	119.83	20	61	65	86	97	2	3	15	22	5	42
E5	W16x50	127.83	127.33	105.33	22.0	93.33	12.00	34.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E6	W16x50	127.83	127.33	105.33	22.0	93.33	12.00	34.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E7	W16x50	127.83	127.33	105.33	22.0	93.33	12.00	34.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E8	W16x50	127.83	127.33	105.33	22.0	93.33	12.00	34.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E9	W16x50	127.83	127.33	105.33	22.0	93.33	12.00	34.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E10	W16x50	127.83	127.33	107.33	20.0	95.33	12.00	32.50	119.83	15	61	63	84	95	2	3	15	22	5	42
E11	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E12	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E13	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
E14	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W1	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W2	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W3	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W4	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W5	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W6	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
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W9	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W10	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W11	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W12	W27x84	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W13	W27x84	127.83	127.33	112.33	15.0	92.83	19.50	35.00												
W14	W18x97	127.83	127.33	112.33	15.0	92.83	19.50	35.00												

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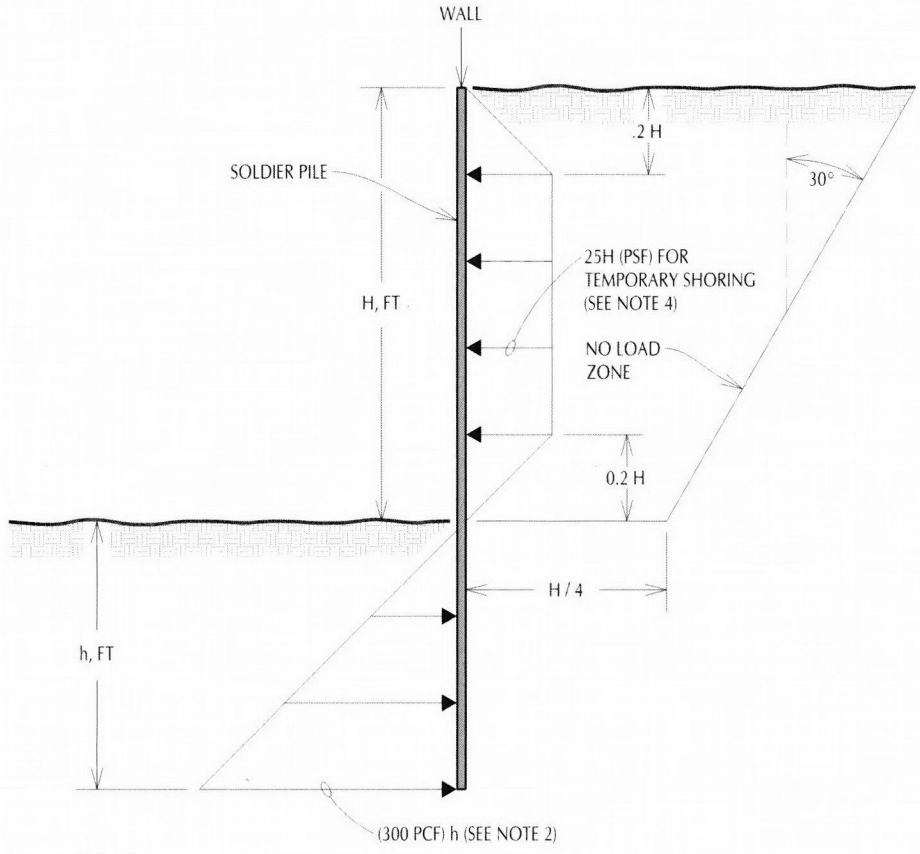

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3) DESIGN PRESSURES ASSUME FULLY DRAINED CONDITIONS.

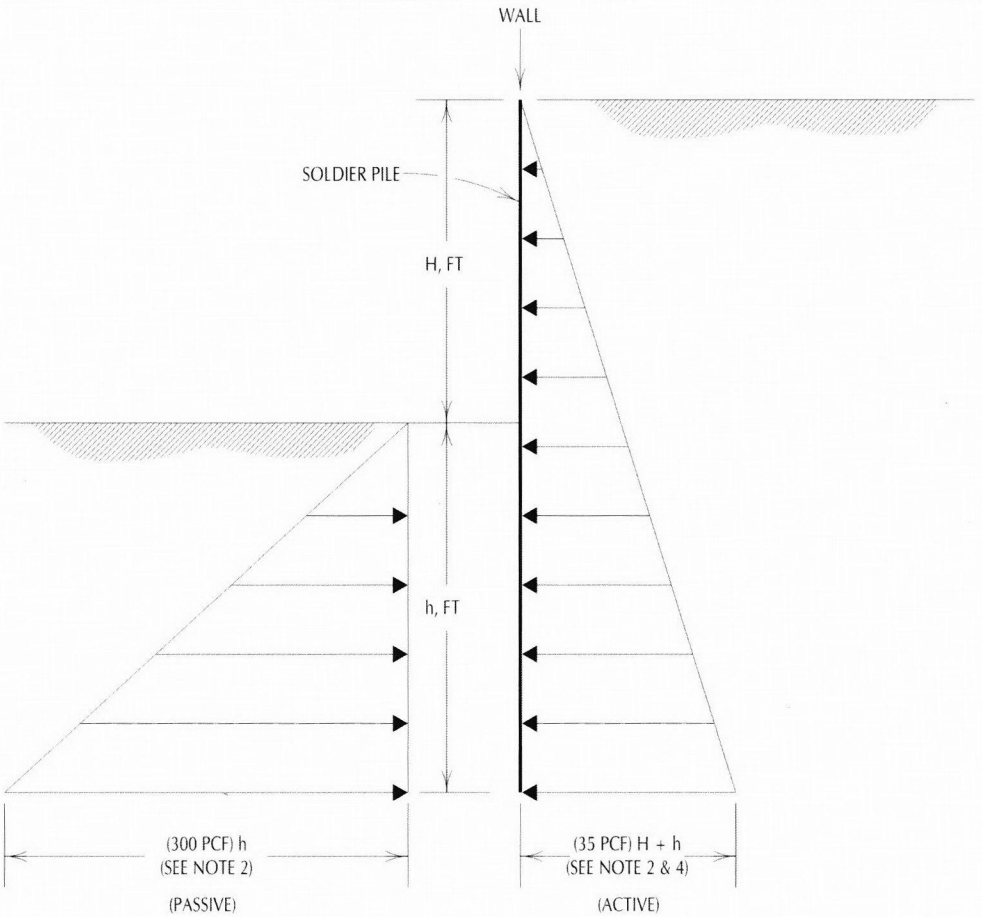
4) ACTIVE PRESSURE ACTS OVER THE ENTIRE EXPOSED SHORED AND / OR WALL AREA.

5) SOLDIER PILES SHOULD EXTEND AT LEAST 5 FT BELOW THE LOWEST ADJACENT EXCAVATION LEVEL.

GRI HOME FORWARD
NE GRAND AVENUE AFFORDABLE HOUSING

EARTH PRESSURES FOR BRACED SHORING

MAR. 2017 JOB NO. 5932 FIG. 6



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GRI HOME FORWARD
NE GRAND AVENUE AFFORDABLE HOUSING

EARTH PRESSURES FOR CANTILEVER SHORING

MAR. 2017 JOB NO. 5932 FIG. 5

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Tieback Anchor Capacity:

0.6 in diameter strand. $A_{strand} = 0.215\ in^2$ $f_{pu} = 270$ ksi

Allowable capacity = $0.6 \times f_{pu} \times A_s$ = 34.8 kip/strand

Load test capacity = $0.8 \times f_{pu} \times A_s$ = 46.4 kip/strand

Single Tieback Soldier Pile:

Maximum moment above tieback = 88 k-ft
Maximum moment below tieback = 63 k-ft
Maximum shear = 30 kip

Lagging resists pile out-of-plane deformations. Design as braced.

W16x50 pile

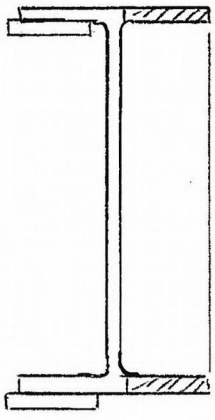
Mn/Omega = 50ksi x 92.0in3 / 1.67 = 2754 k-in = 229.5 k-ft OK
Vn/Omega = 0.6 x 50ksi x 16.3in x 0.38in / 1.67 = 111 kip OK

Tieback Pocket

Pile W16x50

M_{max} = 88 k-ft Mu = 1.6x88 k-ft = 141 k-ft = 1,690 k-in

Notch beam flange for tieback anchor



Add Cover Plates

W16x50 Z_x = 92.0 in^3 I_x = 659 in^4

3.25" of flange to be removed

Reduced Z_x = 92.0 in3 - 3.25in/4[$(16.3in)^2$ - $(15.04\ in)^2$] = 59.9 in_3

M_P=(36 ksi x $Z_{Req'd}$ + 50 ksi x 59.9in^3)x0.9 >/= M_U = 1,690 k-in

$Z_{Req'd}$ < 0 in^3 Add plates for good detailing practices

Try 5/8 x 4" plates, b = 4" d= 17.55" d1= 16.3"

Zplate = b/4(d^2 -d_1^2) = 42.3 in^3

Lagging

Per FHWA Geotechnical Engineering Circular No. 4 Table 12

Span = 8 ft (2.4 m) Recommended thickness = 3.9" (100 mm)

Use 4x12 rough sawn lagging.

Table 12. Recommended thickness of temporary timber lagging (after FHWA-RD-75-130, 1976)

	Soil Description	Unified Soil Classification	Depth (m)	Recommended thickness of lagging (roughcut) for clear spans of:					
				1.5 m	1.8 m	2.1 m	2.4 m	2.7 m	3.0 m
COMPETENT SOILS	Silt or fine sand and silt above water table	ML, SM-ML	0 - 8	50 mm	75 mm	75 mm	75 mm	100 mm	100 mm
	Sands and gravels (medium dense to dense)	GW, GP, GM, GS, SW, SP, SM							
	Clays (stiff to very stiff); non-fissured	CL, CH	8 - 18	75 mm	75 mm	75 mm	100 mm	100 mm	125 mm
	Clays, medium consistency and $\frac{\gamma H}{S_u} < 5$	CL, CH							
DIFFICULT SOILS	Sand and silty sand (loose)	SW, SP, SM	0 - 8	75 mm	75 mm	75 mm	100 mm	100 mm	125 mm
	Clayey sands (medium dense to dense) below water table	SC							
	Clay, heavily overconsolidated, fissured	CL, CH	8 - 18	75 mm	75 mm	100 mm	100 mm	125 mm	125 mm
	Cohesionless silt or fine sand and silt below water table	ML, SM-SL							
POTENTIALLY DANGEROUS SOILS	Soft clays $\frac{\gamma H}{S_u} > 5$	CL, CH	0 - 5	75 mm	75 mm	100 mm	125 mm	---------	--------
	Slightly plastic silts below water table	ML	5 - 8	75 mm	100 mm	125 mm	150 mm	---------	--------
	Clayey Sands (loose), below water table	SC	8-11	100 mm	125 mm	150 mm	---------	---------	---------

Notes:
1) In the category of "potentially dangerous soils", use of soldier beam and lagging wall systems is questionable.
2) The values shown are based on construction grade lumber.
3) Local experience may take precedence over recommended values in this table.

16 ft Cantilevered Soldier Pile Design

Pile # N3, N4, N5

Soil Parameters

Acitve Pressure (EFP)	35	pcf
Effective Pile Width, Active (xDia)	1	pile diameters
Passive Pressure (EFP)	300	pcf
Effective Width, Passive (xDia)	2	pile diameters
Surcharge Wall Pressure	100	psf
Acitve Pressure Below Wall (EFP)	35	pcf

Pile Parameters

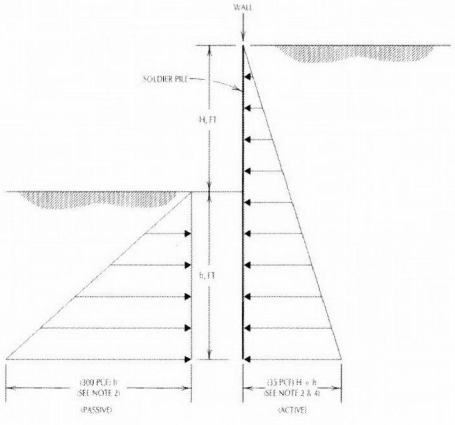
Depth of Excavation (H)	16	ft
Auger Diameter	2.5	ft
Pile Spacing	8	ft
Passive Soil to Neglect	0	ft
Pile Shape	W18X106	
Pile Diagonal	21.80	in

Pile Embedment

Active at Top of Wall	800	plf
Active at Botttom of wall	5280	plf
Active at Botttom of wall	1400	plf
Active at Passive = 0	1400	plf
Active below grade	87.5	plf/ft
Passive below grade	1500	plf/ft
Depth to Zero load (D)	0.99	ft
Horizontal Force P	49333.81	lb
Distance from P to zero load	6.94	ft
Determine depth of Passive (h')	8.36	ft
Embedment to Equilibrium	9.3	ft
Embedment to zero moment	16.8	ft
Pile Embedment	20	ft

Pile Strength

Max Moment	567.45	kip-ft	
Mn/Omega	573.85	Kip-Ft	OK
Diagonal	21.80	in	OK



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4) ACTIVE PRESSURE ACTS OVER THE ENTIRE EXPOSED SHORING AND / OR WALL AREA.

5) SOLDIER PILES SHOULD EXTEND AT LEAST 5 FT BELOW THE LOWEST ADJACENT EXCAVATION LEVEL.

15 ft Cantilevered Soldier Pile Design

Pile #

Soil Parameters

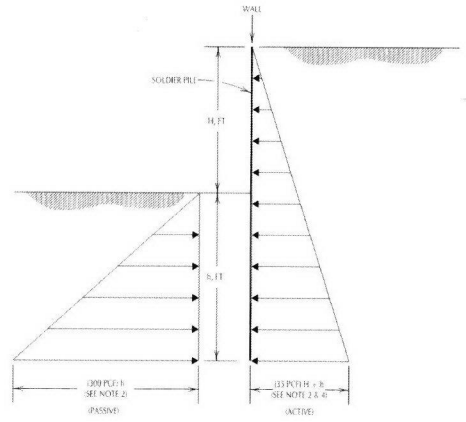
Acitve Pressure (EFP)	35	pcf
Effective Pile Width, Active (xDia)	1	pile diameters
Passive Pressure (EFP)	300	pcf
Effective Width, Passive (xDia)	2	pile diameters
Surcharge Wall Pressure	100	psf
Acitve Pressure Below Wall (EFP)	35	pcf

Pile Parameters

Depth of Excavation (H)	15	ft
Auger Diameter	2.5	ft
Pile Spacing	8	ft
Passive Soil to Neglect	0	ft
Pile Shape	W18X97	
Pile Diagonal	21.66	in

Pile Embedment

Active at Top of Wall	800	plf
Active at Botttom of wall	5000	plf
Active at Botttom of wall	1312.5	plf
Active at Passive = 0	1312.5	plf
Active below grade	87.5	plf/ft
Passive below grade	1500	plf/ft
Depth to Zero load (D)	0.93	ft
Horizontal Force P	44109.79	lb
Distance from P to zero load	6.54	ft
Determine depth of Passive (h')	7.90	ft
Embedment to Equilibrium	8.8	ft
Embedment to zero moment	15.9	ft
Pile Embedment	19	ft



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Pile Strength

Max Moment	479.66	kip-ft	
Mn/Omega	526.45	Kip-Ft	OK
Diagonal	21.66	in	OK

7 ft Cantilevered Soldier Pile Design

Pile #

Soil Parameters

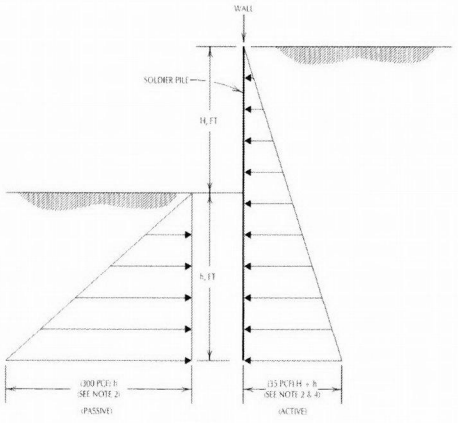
Acitve Pressure (EFP)	35	pcf
Effective Pile Width, Active (xDia)	1	pile diameters
Passive Pressure (EFP)	300	pcf
Effective Width, Passive (xDia)	2	pile diameters
Surcharge Wall Pressure	100	psf
Acitve Pressure Below Wall (EFP)	35	pcf

Pile Parameters

Depth of Excavation (H)	7	ft
Auger Diameter	2	ft
Pile Spacing	8	ft
Passive Soil to Neglect	2	ft
Pile Shape	W16X50	
Pile Diagonal	17.77	in

Pile Embedment

Active at Top of Wall	800	plf
Active at Botttom of wall	2760	plf
Active at Botttom of wall	490	plf
Active at Passive = 0	630	plf
Active below grade	70	plf/ft
Passive below grade	1200	plf/ft
Depth to Zero load (D)	2.56	ft
Horizontal Force P	13755.62	lb
Distance from P to zero load	5.03	ft
Determine depth of Passive (h')	4.93	ft
Embedment to Equilibrium	7.5	ft
Embedment to zero moment	12.2	ft
Pile Embedment	15	ft



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5) SOLDIER PILES SHOULD EXTEND AT LEAST 5 FT BELOW THE LOWEST ADJACENT EXCAVATION LEVEL.

Pile Strength

Max Moment	106.80	kip-ft	
Mn/Omega	229.54	Kip-Ft	OK
Diagonal	17.77	in	OK

10 ft Cantilevered Soldier Pile Design

Pile # Cantilever condition prior to tieback installation

Soil Parameters

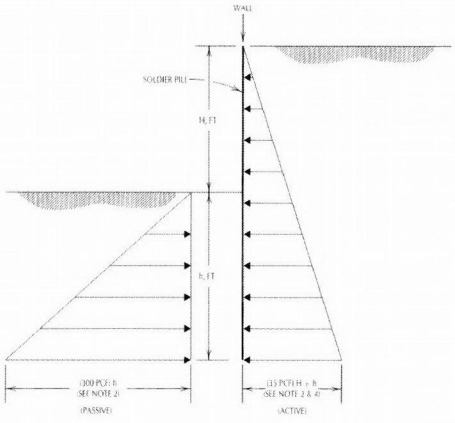
Acitve Pressure (EFP)	35	pcf
Effective Pile Width, Active (xDia)	1	pile diameters
Passive Pressure (EFP)	300	pcf
Effective Width, Passive (xDia)	2	pile diameters
Surcharge Wall Pressure	85	psf
Acitve Pressure Below Wall (EFP)	35	pcf

Pile Parameters

Depth of Excavation (H)	10	ft
Auger Diameter	2	ft
Pile Spacing	8	ft
Passive Soil to Neglect	2	ft
Pile Shape	W16X50	
Pile Diagonal	17.77	in

Pile Embedment

Active at Top of Wall	680	plf
Active at Botttom of wall	3480	plf
Active at Botttom of wall	700	plf
Active at Passive = 0	840	plf
Active below grade	70	plf/ft
Passive below grade	1200	plf/ft
Depth to Zero load (D)	2.74	ft
Horizontal Force P	22652.21	lb
Distance from P to zero load	6.20	ft
Determine depth of Passive (h')	6.33	ft
Embedment to Equilibrium	9.1	ft
Embedment to zero moment	15.1	ft
Pile Embedment	18	ft



NOTES:

1) SURCHARGE EFFECTS FROM TRAFFIC, CONSTRUCTION EQUIPMENT, ETC., SHOULD BE ADDED TO THE ABOVE DESIGN PRESSURES. LATERAL LOADS ON THE SHORING DUE TO SURCHARGE EFFECTS CAN BE COMPUTED USING THE CRITERIA PROVIDED IN FIGURE 7. THE ACTUAL AMOUNT OF THIS SURCHARGE WILL DEPEND ON THE CONTRACTOR'S APPROACH TO THE WORK. HOWEVER, WE RECOMMEND A MINIMUM ADDITIONAL VERTICAL PRESSURE OF 200 PSF BE ADDED BEHIND THE WALL.

2) FOR CANTILEVERED SOLDIER PILES WITH LAGGING, BELOW THE BOTTOM OF THE EXCAVATION, PASSIVE PRESSURE ACTS OVER TWO PILE DIAMETERS (ACTUAL AREA), AND ACTIVE PRESSURE ACTS OVER ONE PILE DIAMETER (ACTUAL AREA) ASSUMES A MINIMUM SOLDIER PILE SPACING OF THREE DIAMETERS.

3) DESIGN PRESSURES ASSUME FULLY DRAINED CONDITIONS.

4) ACTIVE PRESSURE ACTS OVER THE ENTIRE EXPOSED SHORING AND / OR WALL AREA.

5) SOLDIER PILES SHOULD EXTEND AT LEAST 5 FT BELOW THE LOWEST ADJACENT EXCAVATION LEVEL.

Pile Strength

Max Moment	218.92	kip-ft	
Mn/Omega	229.54	Kip-Ft	OK
Diagonal	17.77	in	OK

BergerABAM

Grand Ave Temporary Shoring
Tieback Shoring
Grand Ave. 22.5ft Wall

A17.0220.00
DAW
7/13/2017

Shoring Design **22.5 ft Soldier Pile:**

Geometry/Parameters

H	22.5	ft.	Excavation Height
Soil	25.0	x H psf	Active Earth Pressure
beta	0.20		Truncation of Soil Pressure Top & Bottom
Srch	100.0	psf	Surcharge Load
Pile spcng	8.0	ft.	Pile Spacing
dtb	7.5	ft.	Anchor Location from Top of Wall
α	15.0	degrees	Anchor Inclination Angle
qpsv	300.0	pcf	Passive Pressure Applied over No. of diam. Effective Pile Diameters
delta	0.0	ft.	Amount of passive resistance at top to ignore
Pile diam.	2.0	ft.	Soldier Pile Diameter
No. of diam.	2		Number of pile diameters to engage passive pressure

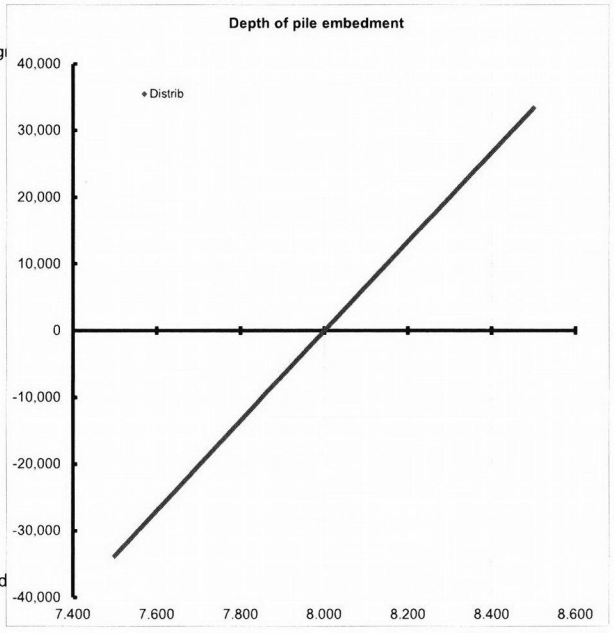
Horizontal Forces

P_{SOIL}	81,000.0	lbs	P_{SOIL} = Active Soil Pressure Force
P_{SRCH}	18,000.0	lbs	P_{SRCH} = Ground Surcharge Force
P_{TOTAL}	99,000.0	lbs	Sum of Soil Demand: Forces
M_{TOTAL}	1,113,750.0	ft-lbs	Sum of Soil Demand: Moments
qpsv*W	1,200.0	psf	Passive soil resistance

Embed Length

Iterate approx. and incremental depths until moment becomes zero (see g

Approx. depth =	**7.500**	ft.
Incremental depth =	**0.005**	ft.
Min. sum of moment =	50.0	ft-lbs
Min. Embed Length =	7.999	ft.
1.3* Embed Length =	10.399	ft.
Horiz. Tieback =	60,607.1	lbs
Tieback Force =	62,745.1	lbs
Embed Depth Used =	**12.0**	ft.
r1 =	0.0	* qs
r2 =	288.0	* qs
Needed Soil pressure (qs) =	184.2	pcf
Horiz. Tieback =	45,964.3	lbs
Tieback Force =	47,585.7	lbs



Shoring Pile Shear and Moment

Tieback below Truncated Load

Shear above tieback =	29,625.0	lbs
Moment above tieback =	88,312.5	ft-lbs
Shear below tieback =	-16,339.3	lbs
Point of zero Shear =	3.08	ft.
Max. Mnt. below tieback =	63,126.4	ft-lbs

Anchor Pullout

Unbonded Length of Anchor

No Load Zone offset =	5.63	ft.		
No Load Zone Soil slope =	**60.0**	degrees		
B =	14.29	ft.		
Additional Unbond Length =	**5.63**	ft.		
Minimum Bond Length =	**15.00**	ft.		
Unbond Length =	15.73	ft.	> 15 ft. ===> OK	

Required Bond Length

d =	**6**	inches		
Development Strength =	**2.88**	ksf		
Tieback Force =	62.7	kips	**1.00**	**= Increase Factor for Tieback Force**
Factor of Safety =	**1.50**			
Required Bond Length =	20.8	ft.		
Total Length of Tendon =	36.5	ft.		

Anchor Capacity

Tendon size =	0.6	inch diam. strand		
Ultimate Strength (F_{ULT}) =	270	ksi		
Area of Strand (A_S) =	0.215	sqr. Inches		
Number of Strands =	2			
Ultimate Tensile Design =	62.75	kips		
Proof Load =	83.45	kips		
Tendon Design =	69.66	kips	= 0.6 F_{ULT} A_S N	> (Tu)design ===> OK
Proof Load Design =	92.88	kips	= 0.8 F_{ULT} A_S N	> (Tu)proof ===> OK

BergerABAM

Project Grand Ave Apts Shoring
Sheet ____ of ____
Job Number A17.0220.00
Subject Temporary Shoring Design
Designer DAW
Pile Vertical Capacity
Date July 13, 2017

PILE VERTICAL CAPACITY

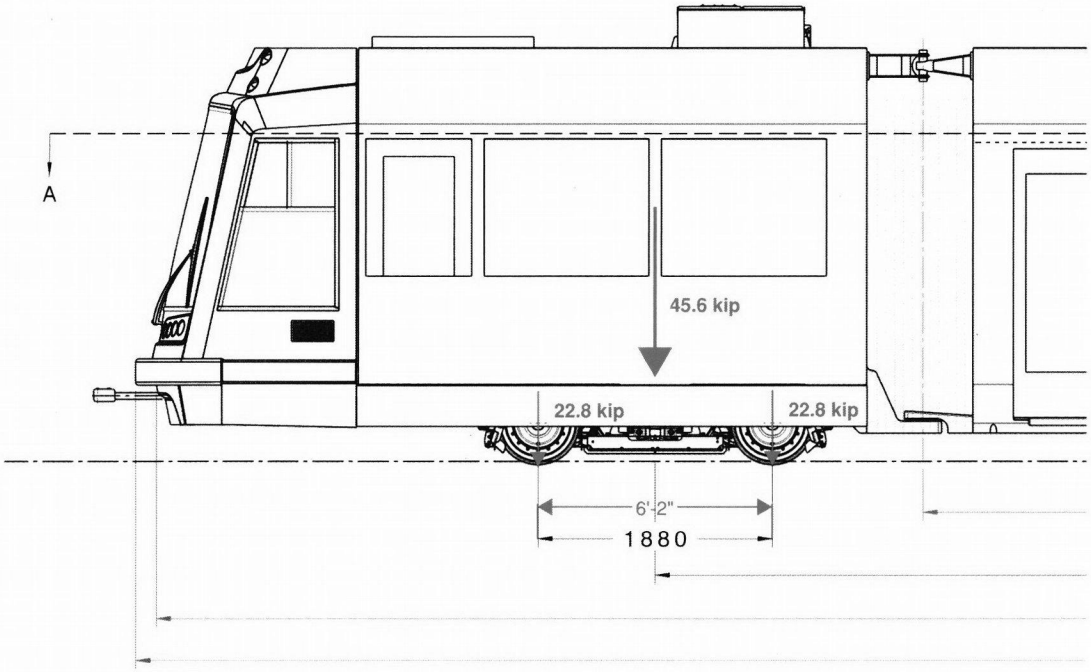
AUGER PILE-GRAVITY GROUT BOND = 1 KSF ALLOWABLE
24" DIA AUGER

ALLOWABLE SKIN FRICTION P= 2ft x pi x 1 KSF = 6.3 KLF

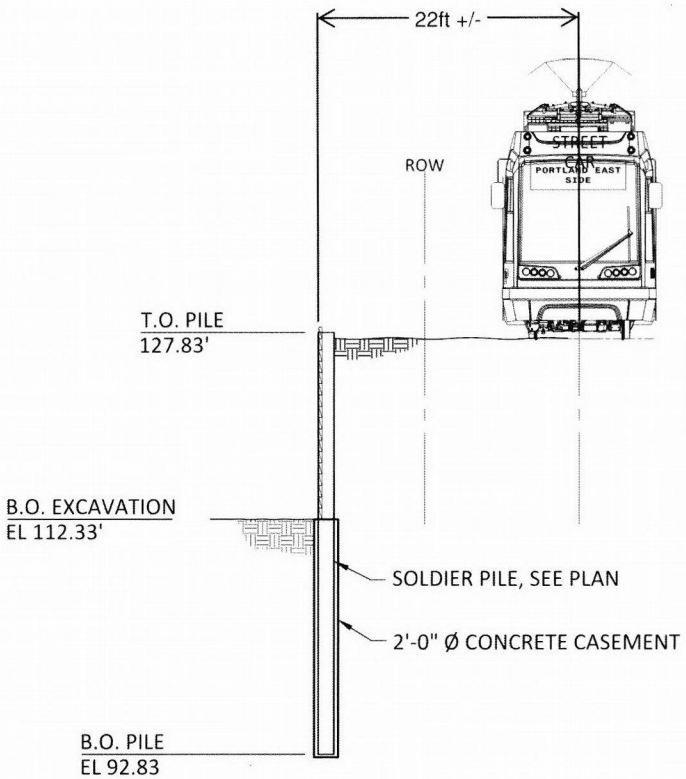
MAX VERTICAL LOAD

ANCHOR LOAD = 63 kip
VERTICAL LOAD = 63 kip x SIN 15° = 16.3 kip

REQUIRED EMBED = 16.3 kip / 6.3 klf = 2.6 FT < 10 ft OK


A
45.6 kip
22.8 kip
22.8 kip
6'-2"
1880

B - CAR

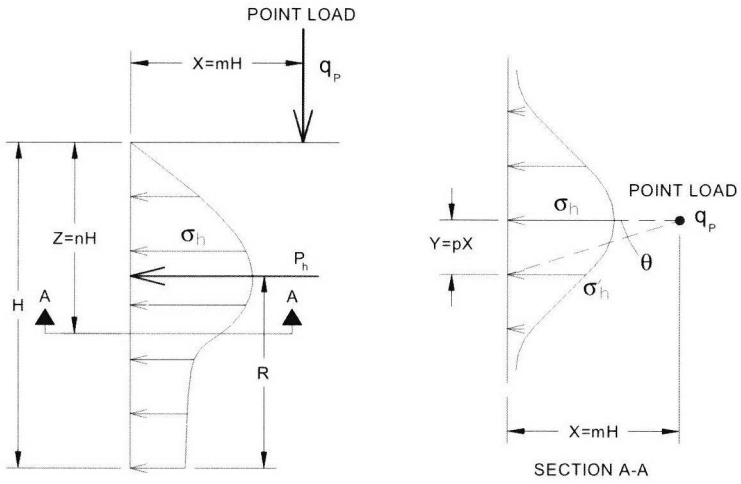

22ft +/-
ROW
STREET CAR
PORTLAND EAST SIDE
T.O. PILE
127.83'
B.O. EXCAVATION
EL 112.33'
SOLDIER PILE, SEE PLAN
2'-0" Ø CONCRETE CASEMENT
B.O. PILE
EL 92.83

Load on soldier pile from point load

Point Load	45.6 Kip
H=	15 ft
X=	22 ft
m=	1.4666667

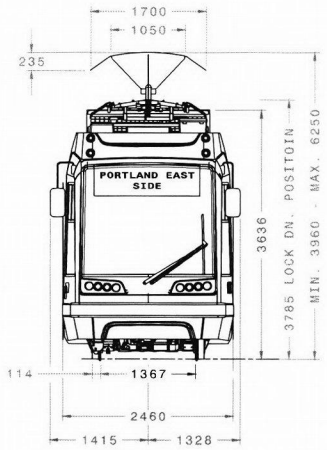
Z	Pressure (KSF) Y=0
0	
1	0.000
2	0.001
3	0.003
4	0.005
5	0.007
6	0.010
7	0.013
8	0.015
9	0.018
10	0.020
11	0.021
12	0.023
13	0.024
14	0.024
15	0.025

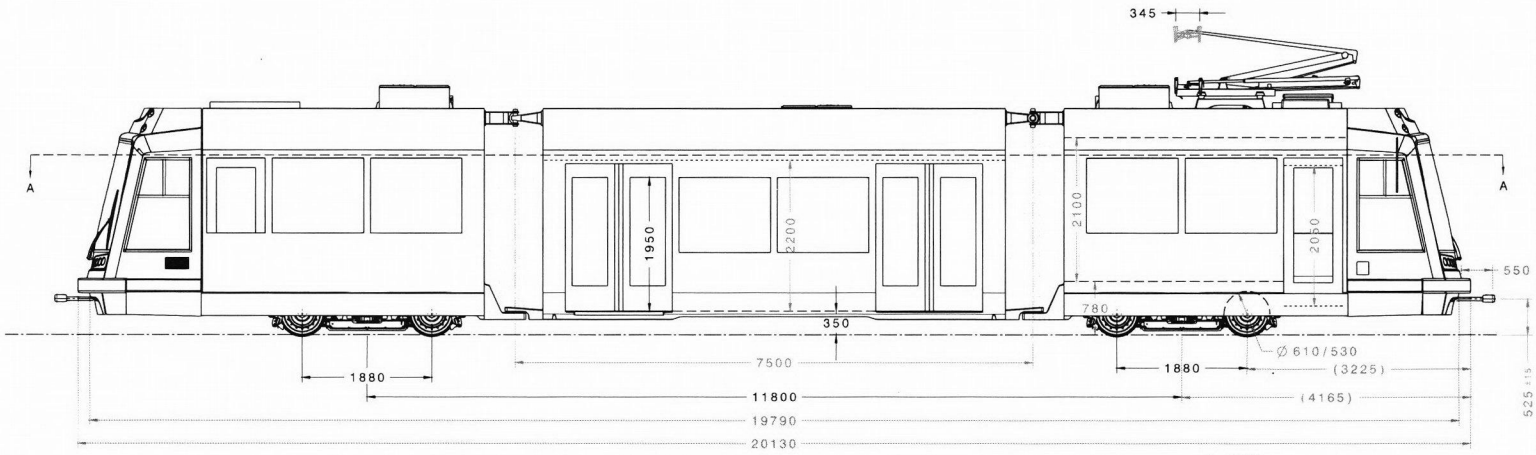
Max Pressure = 25 psf



$$\sigma_h = \frac{0.28\, n^2 q_p}{H^2 \left(0.16 + n^2\right)^3} \qquad m \le 0.4$$

$$\sigma_h = \frac{1.77\, m^2 n^2 q_p}{H^2 \left(m^2 + n^2\right)^3} \qquad m > 0.4$$





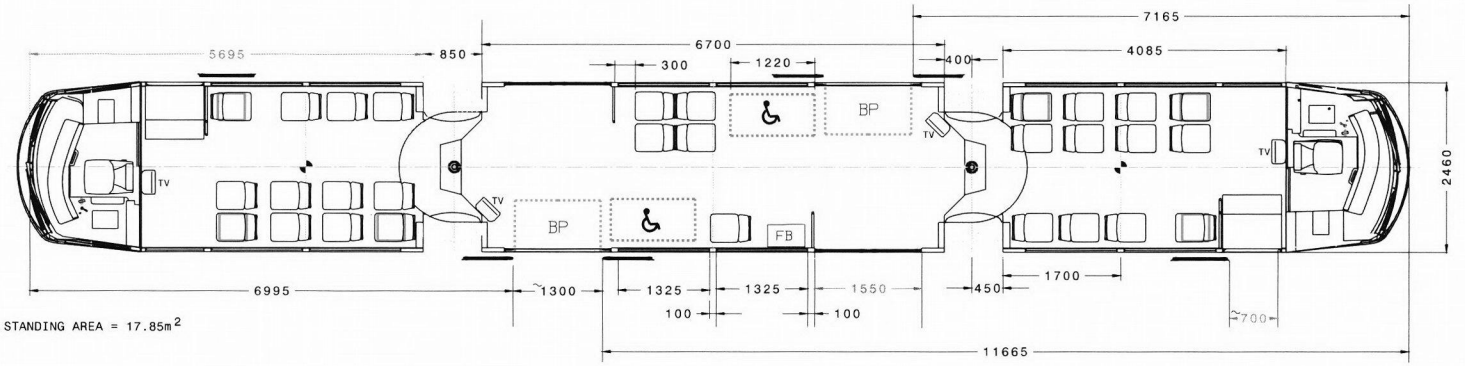
VEHICLE LOADING TABLE

LOADING	DESCRIPTION	TOTAL PASSENGERS AND OPERATOR	VEHICLE WEIGHT
AW0	EMPTY VEHICLE	-	31,800±3% kg
AW1	AW0 + SEATED + OPERATOR IN CAB A	29 + 1 = 30	33,900 kg
AW2	AW1 + 4 PASS./m2	29 + 1 + 71 = 101	38,870 kg
AW3	AW1 + 6 PASS./m2	29 + 1 + 107 = 137	41,390 kg

CENTER OF GRAVITY

LOADING	LONGITUDINAL CG (FROM CAR CENTER)*	LATERAL CG (FROM TRACK CL)**
AW0	-123 (mm)	-6 (mm)
AW1	-101(mm)	-2 (mm)
AW2	-85 (mm)	-4 (mm)
AW3	-78 (mm)	-5 (mm)

*A CAR = POSITIVE LONGITUDINAL DIRECTION
**LEFT OF A CAR = POSITIVE LATERAL DIRECTION



STANDING AREA = 17.85m^2

SECTION A-A

PANTOGRAPH OPERATING HEIGHT:
MINIMUM WIRE HEIGHT 3960mm
MAXIMUM WIRE HEIGHT 6250mm
MAXIMUM PANTOGRAPH HEIGHT IN LOCKDOWN.....3960mm

WHEELCHAIR ZONE ..... ♿
BRIDGEPLATE ..... BP
TICKET VALIDATOR ..... TV
FARE BOX ..... FB *

WAYSIDE POWER SUPPLY
NOMINAL ..... 750 V DC
MAXIMUM SUSTAINED ..... 925 V DC
MINIMUM SUSTAINED ..... 525 V DC

PERFORMANCE:
NOMINAL POWER OF TRACTION MOTORS ..... 4 x 90 kW
MAXIMUM OPERATING SPEED ..... 70 km/h

PASSENGER LOADING:
TOTAL SEATED PASSENGERS 29
TOTAL NUMBER OF PASSENGERS AT AW2 100
TOTAL AREA OF STANDEES 17.85 m2

* IF REQUIRED, AN ADDITIONAL SEAT CAN BE ADDED AND THE FB RELOCATED

CITY OF PORTLAND, OREGON
LOW-FLOOR, UNITED STREETCAR

NOTE: ALL DIMENSIONS ARE FOR REFERENCE ONLY

REV #	DATE	REVISED BY	DESCRIPTION
E	11/29/12	ZW	REVISED TO INCLUDE CENTER OF GRAVITY
D	11/19/12	BY	REVISED PER ECN-000758
C	11/07/12	BY	REVISED PER ECN-000745
B	04/12/11	KLS	REVISE SEATING ARRANGEMENT IN A AND B
A	09/21/11	KLS	INITIAL RELEASE

DRAWN BY:	KELLY STITES	PHASE:	PROTOTYPE
REVISED BY:	ZACK WILSON	STATE:	RELEASE
ENGINEER:	BRUK YIMESGEN	APPROVAL DATE:	11/29/2012
RELEASED BY:	ZACK WILSON	WEIGHT:	0kg

WHERE USED: N/A

DRAWING DESCRIPTION: DRAWING SCALE = NONE

STREETCAR 110 GENERAL DIM LAYOUT

DRAWING NUMBER: 0001300 REV: E

ZONE: SCHM SYSTEM: FIN

SHEET 1 OF 2

UNITED STREETCAR