B&T
DESIGN & ENGINEERING

STRUCTURAL CALCULATIONS
FOR
PERMANENT SOLDIER PILE SHORING WALL
FOR
THE MURRRAY RESIDENCE

FOREST WAY

MERCER ISLAND, WA 98040

March 29, 2021
BNT JOB NO. 18156

ARCHITECT:
RF ARCHITECTURE
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Design Criteria
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Materials

Weight of water (pcf) =	62.4		# of pile φ active pressure is effective over =	1
Weight of soil (pcf) =	125		# of pile φ passive pressure is effective over =	2
Steel Design Strength Fy (KSI) =	50		Factor of Safety for Pile Embedment (permanent)=	1.00
Allowable soil bearing @ bottom of pile (PSF) =	0		Factor of Safety for Pile Embedment (temporary)=	1.00
Allowable pile skin friction to reduce end brg. =	1,000			
Depth of soil to neglect for skin friction (ft) =	20	(below ex grade)		

Equivalent Fluid Pressures

	Permnt	Temp
Active Above Dredge Line - ka1 (pcf) =	45	40
Active Above Dredge Line - ka1 SLOPED (pcf) =	55	50
Active Below Dredge Line - ka2 (pcf) =	45	40
Active Below Dredge Line - ka2 SLOPED (pcf) =	55	50
Passive Below Dredge Line - kp1 (pcf) =	267	267
Depth of soil to neglect for passive at bottom of wall (ft) =	0.0	0.0
Neglected soil height used for passive surcharge (ft) =	0.0	0.0

Seismic Factor =	8	X H

Tieback Values

Tieback Capacity (klf) =	0.785
Angle of Installation (deg) =	20
Angle of "No Load" Zone (deg) =	60

Timber Lagging _Hem Fir, pressure treated_

Width (in) =	3.5 or 5.5
Depth (in) =	11.25
fb (psi) =	950
fv (psi) =	75
Allowable Load Reduction (%) =	50

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Pile Summary
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Pile Mark	Maximum Ht of Retainage (ft)	Temporary or Permanent Shoring?	Pile Spacing	Augered Pile Diameter (in) (available sizes = 14", 16", 18", 20", & 24")	Backfill Level or Sloped?	Pile Size	Chosen Pile Embedment (ft)	Additional Pile Length (ft)	Embedment Okay?	Total Wt of Pile (lb)	fb (Ksi)	WF okay for Stress?	WF Δ (in)	4x Lagging rqr'd Bending stress (KSI)	6x Lagging rqr'd Bending stress (KSI)	TW Roof (ft)	TW Floor (ft)	TW Residence Slab (ft)	TW Garage Slab (ft)	HT of Wall (ft)	Wall thickness (in)	Additional Load (lb)	Superimposed Gravity Load on Pile (K)	F.S. Bearing @ Bottom of Pile	Pile Okay for end bearing?	NOTES
SP1	16.75	P	6.00	30.00	LEVEL	W18X130	28.00	0.0	okay	5,818	36.89	okay	0.651	0.98	0.40	10.00	20.00	5.00	5.00	18.00	8.00	0.00	29.78	3.46	okay	3.84 in. clr. if WF is centered in pile
SP1-C	16.75	P	3.00	24.00	LEVEL	W12X87	24.00	0.0	okay	3,545	36.89	okay	1.083	0.25	0.10	10.00	20.00	5.00	5.00	18.00	8.00	0.00	14.89	4.38	okay	3.3 in. clr. if WF is centered in pile
SP2	15.50	P	6.00	30.00	LEVEL	W18X106	26.00	0.0	okay	4,399	36.68	okay	0.569	0.91	0.37	10.00	20.00	5.00	5.00	18.00	8.00	0.00	29.78	3.17	okay	4.1 in. clr. if WF is centered in pile
SP2-C	15.00	P	3.00	24.00	LEVEL	W12X65	22.00	0.0	okay	2,405	35.57	okay	0.866	0.22	0.09	10.00	20.00	5.00	5.00	18.00	8.00	0.00	14.89	3.86	okay	3.47 in. clr. if WF is centered in pile
SP2 (Sloped)	14.00	P	6.00	30.00	SLOPED	W18X106	26.00	0.0	okay	4,240	32.82	okay	0.364	0.98	0.40	0.00	0.00	0.00	5.00	14.00	8.00	0.00	11.88	4.45	okay	4.1 in. clr. if WF is centered in pile
SP2-C (Sloped)	14.00	P	3.00	24.00	SLOPED	W12X65	22.00	0.0	okay	2,340	35.14	okay	0.652	0.25	0.10	0.00	0.00	0.00	5.00	14.00	8.00	0.00	5.94	5.39	okay	3.47 in. clr. if WF is centered in pile
SP3	13.00	P	6.00	30.00	SLOPED	W18X76	24.00	0.0	okay	2,812	36.73	okay	0.361	0.91	0.37	10.00	20.00	5.00	0.00	12.00	8.00	0.00	22.70	3.09	okay	4.36 in. clr. if WF is centered in pile
SP2G	13.50	P	6.00	30.00	LEVEL	W18X106	23.00	0.0	okay	3,869	24.24	okay	0.285	0.79	0.32	0.00	0.00	0.00	0.00	12.00	8.00	0.00	7.20	4.63	okay	4.1 in. clr. if WF is centered in pile
SP2G-C	13.50	P	3.00	30.00	SLOPED	W18X106	24.00	0.0	okay	3,975	13.15	okay	0.152	0.24	0.10	10.00	20.00	5.00	0.00	11.00	8.00	0.00	11.05	4.20	okay	4.1 in. clr. if WF is centered in pile
SP3G-C	11.00	P	3.00	24.00	SLOPED	W12X35	20.00	0.0	okay	1,085	32.86	okay	0.365	0.20	0.08	0.00	0.00	0.00	0.00	11.00	8.00	0.00	3.30	5.00	okay	4.94 in. clr. if WF is centered in pile
SP4	12.50	P	6.00	24.00	LEVEL	W12X87	24.00	0.0	okay	3,176	34.77	okay	0.501	0.74	0.30	10.00	20.00	8.00	0.00	12.00	8.00	0.00	25.28	2.61	okay	3.3 in. clr. if WF is centered in pile
SP5	12.00	P	6.00	24.00	LEVEL	W12X72	22.00	0.0	okay	2,448	37.28	okay	0.507	0.71	0.29	10.00	20.00	8.00	0.00	12.00	8.00	0.00	25.28	2.31	okay	3.4 in. clr. if WF is centered in pile
SP6-T	14.50	T	6.00	24.00	LEVEL	W12X65	22.00	0.0	N.G.	2,373	72.86	N.G.	1.461	0.85	0.35	10.00	20.00	8.00	0.00	12.00	8.00	0.00	25.28	2.73	okay	3.47 in. clr. if WF is centered in pile
SP6	11.50	P	6.00	24.00	LEVEL	W12X65	22.00	0.0	okay	2,178	36.36	okay	0.459	0.68	0.28	10.00	20.00	8.00	0.00	12.00	8.00	0.00	25.28	2.24	okay	3.47 in. clr. if WF is centered in pile
SP7	10.50	P	6.00	24.00	LEVEL	W12X58	20.00	0.0	okay	1,769	31.18	okay	0.327	0.62	0.25	10.00	20.00	8.00	0.00	12.00	8.00	0.00	25.28	1.81	okay	4.11 in. clr. if WF is centered in pile
SP8	10.00	P	6.00	24.00	SLOPED	W12X53	20.00	0.0	okay	1,590	36.15	okay	0.304	0.70	0.29	0.00	0.00	0.00	20.00	13.00	8.00	0.00	21.72	1.92	okay	4.15 in. clr. if WF is centered in pile
SP9	10.00	P	4.00	24.00	SLOPED	W12X35	17.00	0.0	okay	945	34.49	okay	0.302	0.31	0.13	5.00	5.00	0.00	10.00	12.00	8.00	0.00	11.81	2.12	okay	4.94 in. clr. if WF is centered in pile
SP10	7.50	T	6.00	18.00	LEVEL	W8X24	14.00	0.0	okay	516	23.52	okay	0.137	0.34	0.14	0.00	0.00	0.00	5.00	12.00	8.00	0.00	10.68	0.47	N.G.	4.09 in. clr. if WF is centered in pile
SP11	5.50	T	8.00	18.00	LEVEL	W8X15	28.00	0.0	okay	503	23.46	okay	0.067	0.44	0.18	10.00	20.00	5.00	5.00	18.00	8.00	0.00	39.71	1.34	N.G.	4.53 in. clr. if WF is centered in pile
L-SP1	11.00	P	7.33	24.00	SLOPED	W12X87	24.00	0.0	okay	3,045	36.74	okay	0.344	1.14	0.47	0.00	6.00	0.00	36.00	13.00	8.00	0.00	43.14	1.64	okay	3.3 in. clr. if WF is centered in pile
L-SP1-C	13.00	P	3.00	24.00	SLOPED	W12X53	24.00	0.0	okay	1,961	35.02	okay	0.564	0.23	0.10	0.00	6.00	0.00	36.00	13.00	8.00	0.00	17.66	3.45	okay	4.15 in. clr. if WF is centered in pile
L-SP2	11.00	T	7.33	24.00	SLOPED	W12X72	23.00	0.0	okay	2,448	25.91	okay	0.196	0.91	0.37	0.00	6.00	0.00	36.00	13.00	8.00	0.00	43.14	1.56	okay	3.4 in. clr. if WF is centered in pile
L-SP2-C	8.00	P	8.00	24.00	LEVEL	W12X35	20.00	0.0	okay	980	33.49	okay	0.186	0.84	0.34	0.00	0.00	0.00	6.00	13.00	8.00	0.00	15.97	1.91	okay	4.94 in. clr. if WF is centered in pile
L-LANDSCAPE	4.00	T	10.00	18.00	LEVEL	W8X15	9.00	0.0	okay	195	11.94	okay	0.017	0.49	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	N.G.	4.53 in. clr. if WF is centered in pile

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Pile SP1
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SP1

INPUT		
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.50	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	16.75	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W18X130	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP1
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OUTPUT

Effective surcharge height "hs" =	**2.978**	ft. (upper grade)
Moment max. =	**786.9**	k-ft.
Sx (provided) =	**256**	in.^{3}
Ix (provided) =	**2460**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**11.20**	in.
d =	**19.30**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.89**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**22.32**	in. **3.84 in. clr. if WF is centered in pile**
WF Δ =	**0.651**	in. (at top of pile due to loading above lower grade)

W18X130 O.K. for stress

Lagging Design:

Lagging moment =	**2.00**	k-ft./ft.
Lagging required bending stress =	**0.98**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.40**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	130	plf			
Total length of pile:	44.75	ft.			
wt =	5.82	kips			
Concrete:	4.91	area	depth to consider for skin friction =	24.75	ft.
Total Length of concrete:	28.00	ft.	surface area of pile =	194.39	sq.ft.
wt =	20.62	kips	skin friction capacity =	194.39	kips
Superimposed Load on Pile =	29.78	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**56.22**	**kips**	**sum vertical capacity =**	**194.39**	

F.S. bearing = 3.46

Combined pile skin friction & end bearing is **O.K.**

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Pile SP1
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P = 0 kips at Guardrail

WF Δ = 0.65 in

hg = 0 ft.

hs = 2.98 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

52.54 k

Lagging ht.
H = 16.75 ft.

Passive surchg. ht. = 0 ft.

5.33 klf

6.58 ft.

Neglect 0 ft.

lower grade

2.22 klf
47.51 k

11.3 ft.

Required pile
embedment =
27.7 ft.

d1=21.4 ft.

1.335 over 5 ft.
1

0.113 over 2.5 ft.
1

25.79 k

28.57 klf

0 k

4.63 klf

V = 0 &   Mom. max. = 787 k-ft.

305.69 k

179.85 k spike

0.29 d1 = 6.3 ft.

pile dia.= 2.5 ft.

Pile SP1:   **W18X130**

SOLDIER PILE DESIGN ILLUSTRATION FOR 16.75 FT. WALL

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Pile SP1-C
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SP1-C	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.00	ft.
Pile spacing =	3.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	16.75	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X87	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP1-C
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OUTPUT

Effective surcharge height "hs" =	**2.978**	ft. (upper grade)
Moment max. =	**362.7**	k-ft.
Sx (provided) =	**118**	in.^{3}
Ix (provided) =	**740**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.10**	in.
d =	**12.50**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements, including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.89**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.40**	in. **3.3 in. clr. if WF is centered in pile**
WF Δ =	**1.083**	in. (at top of pile due to loading above lower grade)

W12X87 O.K. for stress

Lagging Design:

Lagging moment =	**0.50**	k-ft./ft.
Lagging required bending stress =	**0.25**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.10**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	87	plf			
Total length of pile:	40.75	ft.			
wt =	3.55	kips			
Concrete:	3.14	area	depth to consider for skin friction =	20.75	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	130.38	sq.ft.
wt =	11.31	kips	skin friction capacity =	130.38	kips
Superimposed Load on Pile =	14.89	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**29.75**	**kips**	**sum vertical capacity =**	**130.38**	

F.S. bearing = 4.38

Combined pile skin friction & end bearing is **O.K.**

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Pile SP1-C
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P = 0 kips at Guardrail

WF Δ = 1.08 in

hg = 0 ft.

hs = 2.98 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.135 over 3 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

26.27 k

Lagging ht.
H = 16.75 ft.

Passive surchg. ht. = 0 ft.

2.66 klf

6.58 ft.

Neglect 0 ft.

lower grade

1.78 klf

32.04 k

9.4 ft.

0.09 over 2 ft.
1

Required pile
embedment =
23.3 ft.

d1=18 ft.

1.068 over 4 ft.
1

14.58 k

19.22 klf

0 k

3.4 klf

V = 0 &   Mom. max. = 362.8 k-ft.

173.02 k

100.13 k spike

0.29 d1 = 5.3 ft.

pile dia.= 2 ft.

Pile SP1-C: **W12X87**

SOLDIER PILE DESIGN ILLUSTRATION FOR 16.75 FT. WALL

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Pile SP2
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SP2	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.50	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	15.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W18X106	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP2
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OUTPUT

Effective surcharge height "hs" =	**2.756**	ft. (upper grade)
Moment max. =	**623.5**	k-ft.
Sx (provided) =	**204**	in.^{3}
Ix (provided) =	**1910**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**11.20**	in.
d =	**18.70**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
        including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.68**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**21.80**	in. **4.1 in. clr. if WF is centered in pile**
WF Δ =	**0.569**	in. (at top of pile due to loading above lower grade)

W18X106 O.K. for stress

Lagging Design:

Lagging moment =	**1.85**	k-ft./ft.
Lagging required bending stress =	**0.91**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.37**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	106	plf			
Total length of pile:	41.50	ft.			
wt =	4.40	kips			
Concrete:	4.91	area	depth to consider for skin friction =	21.50	ft.
Total Length of concrete:	26.00	ft.	surface area of pile =	168.86	sq.ft.
wt =	19.14	kips	skin friction capacity =	168.86	kips
Superimposed Load on Pile =	29.78	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**53.32**	**kips**	**sum vertical capacity =**	**168.86**	

F.S. bearing = 3.17

Combined pile skin friction & end bearing is **O.K.**

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Pile SP2
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P = 0 kips at Guardrail

WF Δ = 0.57 in

hg = 0 ft.

hs = 2.76 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

44.99 k

Lagging ht.
H = 15.5 ft.

Passive surchg. ht. = 0 ft.

4.93 klf

6.09 ft.

Neglect 0 ft.

lower grade

2.05 klf
40.59 k

10.4 ft.

Required pile embedment = 25.7 ft.

d1=19.8 ft.

1.335 over 5 ft.
1

0.113 over 2.5 ft.
1

22.08 k

26.43 klf

0 k
261.69 k

4.28 klf

V = 0 & Mom. max. = 623.6 k-ft.

154.03 k spike

0.29 d1 = 5.9 ft.

pile dia.= 2.5 ft.

Pile SP2: **W18X106**

SOLDIER PILE DESIGN ILLUSTRATION FOR 15.5 FT. WALL

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(425) 557-0779

18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2-C
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SP2-C		INPUT		
Soil Wt. =		125	pcf *
Active EFP =		45	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.00	ft.
Pile spacing =		3.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		15.00	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W12X65	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2-C
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OUTPUT

Effective surcharge height "hs" =	**2.667**	ft. (upper grade)
Moment max. =	**260.6**	k-ft.
Sx (provided) =	**87.9**	in.^{3}
Ix (provided) =	**533**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.00**	in.
d =	**12.10**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
    including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**35.57**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.05**	in. **3.47 in. clr. if WF is centered in pile**
WF Δ =	**0.866**	in. (at top of pile due to loading above lower grade)

W12X65 O.K. for stress

Lagging Design:

Lagging moment =	**0.45**	k-ft./ft.
Lagging required bending stress =	**0.22**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.09**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	65	plf			
Total length of pile:	37.00	ft.			
wt =	2.41	kips			
Concrete:	3.14	area	depth to consider for skin friction =	17.00	ft.
Total Length of concrete:	22.00	ft.	surface area of pile =	106.81	sq.ft.
wt =	10.37	kips	skin friction capacity =	106.81	kips
Superimposed Load on Pile =	14.89	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**27.66**	**kips**	**sum vertical capacity =**	**106.81**	
			F.S. bearing =	**3.86**	

Combined pile skin friction & end bearing is **O.K.**

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2-C
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P = 0 kips at Guardrail

WF Δ = 0.87 in

hg = 0 ft.

hs = 2.67 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.135 over 3 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

21.07 k

Lagging ht.
H = 15 ft.

Passive surchg. ht. = 0 ft.

5.89 ft.

Neglect 0 ft.

2.39 klf

lower grade

1.59 klf
25.6 k

8.4 ft.

Required pile embedment = 20.8 ft.

d1=16.1 ft.

0.09 over 2 ft.
1

1.068 over 4 ft.
1

11.67 k

17.19 klf

0 k

3.04 klf

V = 0 &   Mom. max. = 260.6 k-ft.

138.42 k

80.08 k spike

0.29 d1 = 4.7 ft.

pile dia.= 2 ft.

Pile SP2-C: **W12X65**

SOLDIER PILE DESIGN ILLUSTRATION FOR 15 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2 Sloped
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SP2 (Sloped)		**INPUT**	
Soil Wt. =		125	pcf *
Active EFP =		55	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.50	ft.
Pile spacing =		6.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		14.00	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W18X106	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP2 Sloped
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OUTPUT

Effective surcharge height "hs" =	**2.036**	ft. (upper grade)
Moment max. =	**558.0**	k-ft.
Sx (provided) =	**204**	in.^{3}
Ix (provided) =	**1910**	in.^{4}
E_{WF} =	**29000**	ksi
bf =	**11.20**	in.
d =	**18.70**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
　　including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**32.82**	ksi　WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi　AISC 9th Edition pg. 5-155
WF diagonal =	**21.80**	in.　**4.1 in. clr. if WF is centered in pile**
WF Δ =	**0.364**	in. (at top of pile due to loading above lower grade)

W18X106 O.K. for stress

Lagging Design:
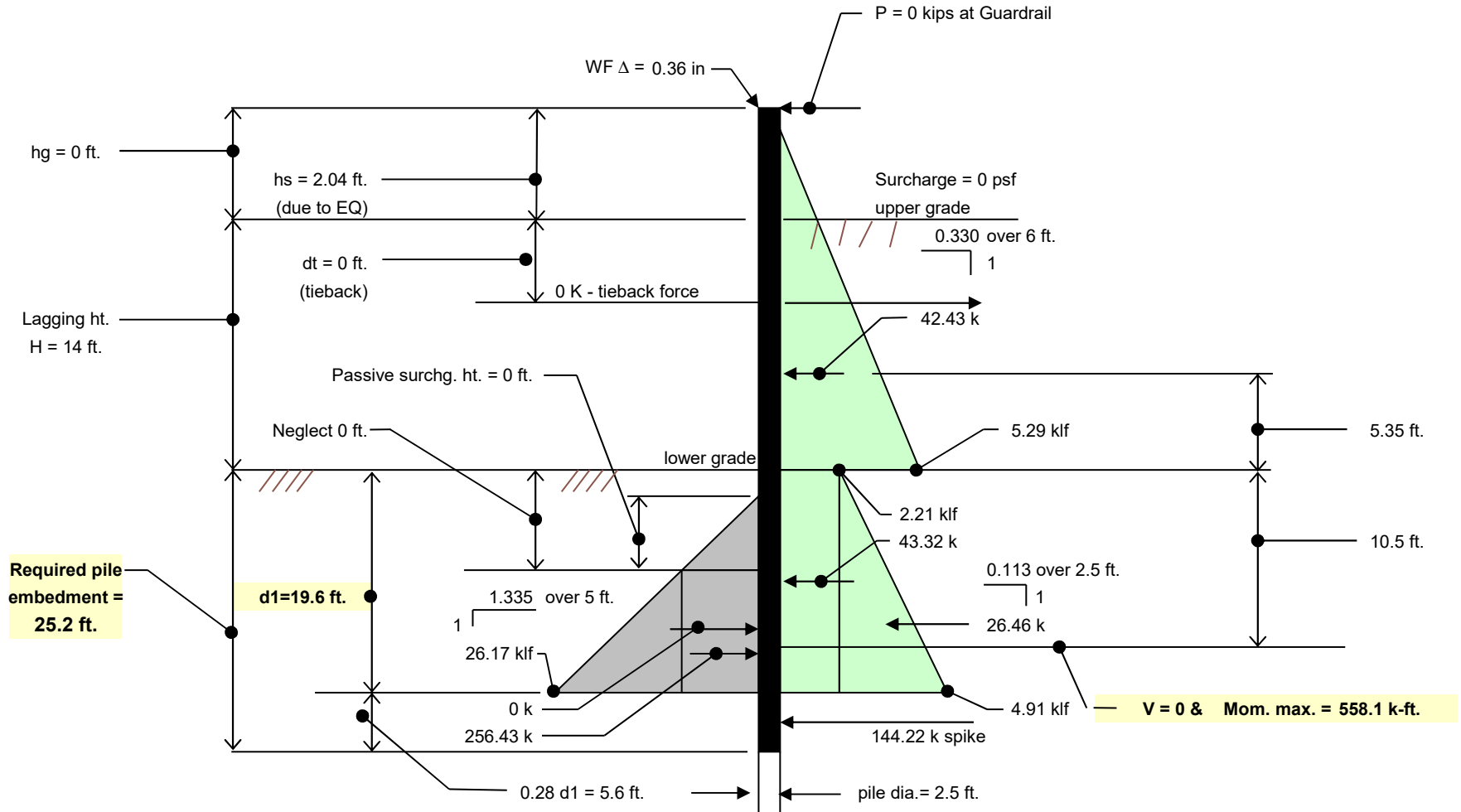
Lagging moment =	**1.98**	k-ft./ft.
Lagging required bending stress =	**0.98**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.40**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	106	plf			
Total length of pile:	40.00	ft.			
wt =	4.24	kips			
Concrete:	4.91	area	depth to consider for skin friction =	20.00	ft.
Total Length of concrete:	26.00	ft.	surface area of pile =	157.08	sq.ft.
wt =	19.14	kips	skin friction capacity =	157.08	kips
Superimposed Load on Pile =	11.88	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**35.26**	**kips**	**sum vertical capacity =**	**157.08**	

F.S. bearing = 4.45

Combined pile skin friction & end bearing is　**O.K.**

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2 Sloped
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P = 0 kips at Guardrail

WF Δ = 0.36 in

hg = 0 ft.

hs = 2.04 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.330 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

42.43 k

Lagging ht.
H = 14 ft.

Passive surchg. ht. = 0 ft.

5.35 ft.

Neglect 0 ft.

5.29 klf

lower grade

2.21 klf

43.32 k

10.5 ft.

Required pile embedment = 25.2 ft.

d1=19.6 ft.

0.113 over 2.5 ft.
1

26.46 k

1.335 over 5 ft.

1

26.17 klf

0 k

4.91 klf

V = 0 & Mom. max. = 558.1 k-ft.

256.43 k

144.22 k spike

0.28 d1 = 5.6 ft.

pile dia.= 2.5 ft.

Pile SP2 (Sloped): **W18X106**

SOLDIER PILE DESIGN ILLUSTRATION FOR 14 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2-C Sloped
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SP2-C (Sloped)		**INPUT**	
Soil Wt. =		125	pcf *
Active EFP =		55	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.00	ft.
Pile spacing =		3.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		14.00	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W12X65	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP2-C Sloped
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OUTPUT

Effective surcharge height "hs" =	**2.036**	ft. (upper grade)
Moment max. =	**257.4**	k-ft.
Sx (provided) =	**87.9**	in.^{3}
Ix (provided) =	**533**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.00**	in.
d =	**12.10**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
       including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**35.14**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.05**	in. **3.47 in. clr. if WF is centered in pile**
WF Δ =	**0.652**	in. (at top of pile due to loading above lower grade)

W12X65 O.K. for stress

Lagging Design:
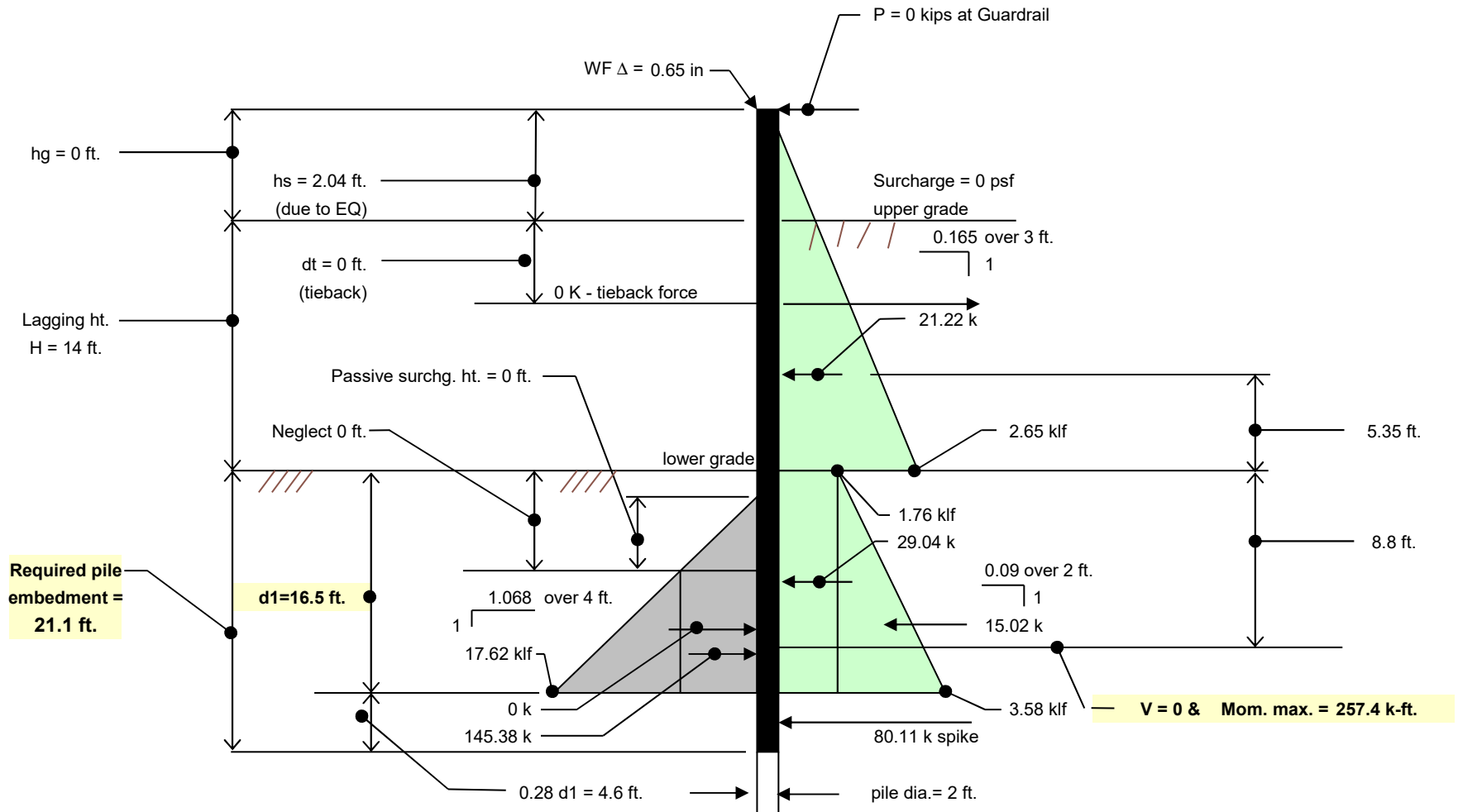
Lagging moment =	**0.50**	k-ft./ft.
Lagging required bending stress =	**0.25**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.10**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	65	plf			
Total length of pile:	36.00	ft.			
wt =	2.34	kips			
Concrete:	3.14	area	depth to consider for skin friction =	16.00	ft.
Total Length of concrete:	22.00	ft.	surface area of pile =	100.53	sq.ft.
wt =	10.37	kips	skin friction capacity =	100.53	kips
Superimposed Load on Pile =	5.94	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**18.65**	**kips**	**sum vertical capacity =**	**100.53**	

F.S. bearing = 5.39

Combined pile skin friction & end bearing is **O.K.**

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Pile SP2-C Sloped
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P = 0 kips at Guardrail

WF Δ = 0.65 in

hg = 0 ft.

hs = 2.04 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.165 over 3 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

21.22 k

Lagging ht.
H = 14 ft.

Passive surchg. ht. = 0 ft.

5.35 ft.

Neglect 0 ft.

2.65 klf

lower grade

1.76 klf

29.04 k

8.8 ft.

Required pile
embedment =
21.1 ft.

d1=16.5 ft.

1.068 over 4 ft.

0.09 over 2 ft.
1

1
17.62 klf

15.02 k

0 k

3.58 klf

V = 0 &   Mom. max. = 257.4 k-ft.

145.38 k

80.11 k spike

0.28 d1 = 4.6 ft.

pile dia.= 2 ft.

Pile SP2-C (Sloped):   **W12X65**

SOLDIER PILE DESIGN ILLUSTRATION FOR 14 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP3
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SP3

INPUT

Parameter	Value	Units
Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.50	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	13.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W18X76	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP3
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OUTPUT

Effective surcharge height "hs" =	**1.891**	ft. (upper grade)
Moment max. =	**446.9**	k-ft.
Sx (provided) =	**146**	in.^{3}
Ix (provided) =	**1330**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**11.00**	in.
d =	**18.20**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements, including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.73**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**21.27**	in. **4.36 in. clr. if WF is centered in pile**
WF Δ =	**0.361**	in. (at top of pile due to loading above lower grade)
	W18X76 O.K. for stress	

Lagging Design:
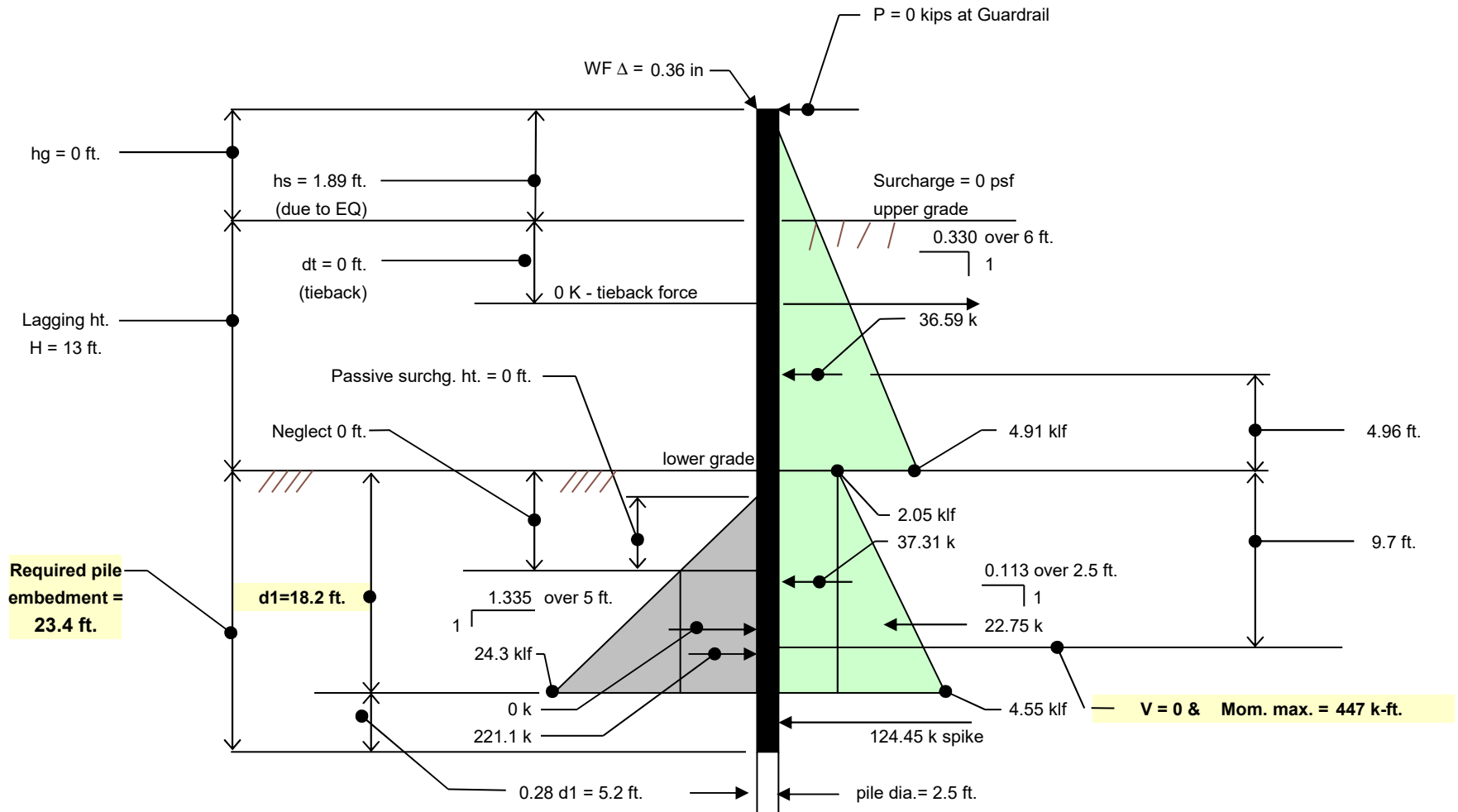
Lagging moment =	**1.84**	k-ft./ft.
Lagging required bending stress =	**0.91**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.37**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	76	plf			
Total length of pile:	37.00	ft.			
wt =	2.81	kips			
Concrete:	4.91	area	depth to consider for skin friction =	17.00	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	133.52	sq.ft.
wt =	17.67	kips	skin friction capacity =	133.52	kips
Superimposed Load on Pile =	22.70	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**43.19**	**kips**	**sum vertical capacity =**	**133.52**	
			F.S. bearing =	**3.09**	

Combined pile skin friction & end bearing is **O.K.**

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Pile SP3
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P = 0 kips at Guardrail

WF Δ = 0.36 in

hg = 0 ft.

hs = 1.89 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.330 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

36.59 k

Lagging ht.
H = 13 ft.

Passive surchg. ht. = 0 ft.

4.96 ft.

Neglect 0 ft.

4.91 klf

lower grade

2.05 klf

37.31 k

9.7 ft.

Required pile embedment = 23.4 ft.

d1=18.2 ft.

0.113 over 2.5 ft.
1

1.335 over 5 ft.
1

22.75 k

24.3 klf

0 k

4.55 klf

V = 0 &   Mom. max. = 447 k-ft.

221.1 k

124.45 k spike

0.28 d1 = 5.2 ft.

pile dia.= 2.5 ft.

Pile SP3:   **W18X76**

SOLDIER PILE DESIGN ILLUSTRATION FOR 13 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2G
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SP2G

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.50	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	13.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W18X106	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2G
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OUTPUT

Effective surcharge height "hs" =	**2.400**	ft. (upper grade)
Moment max. =	**412.0**	k-ft.
Sx (provided) =	**204**	in.^{3}
Ix (provided) =	**1910**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**11.20**	in.
d =	**18.70**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".
2.) * = Per soils engineer's requirements,
including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**24.24**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**21.80**	in. **4.1 in. clr. if WF is centered in pile**
WF Δ =	**0.285**	in. (at top of pile due to loading above lower grade)

W18X106 O.K. for stress
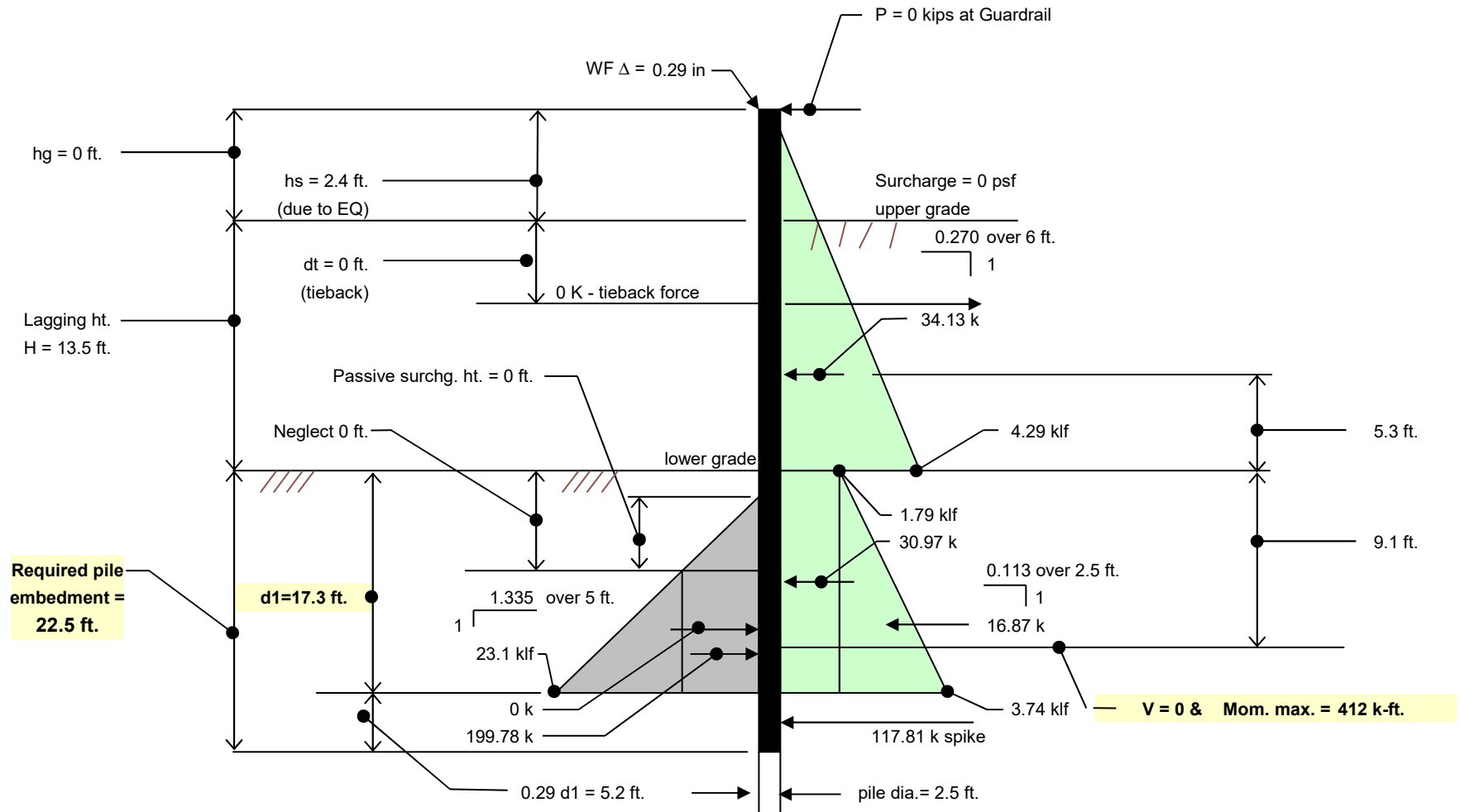
Lagging Design:

Lagging moment =	**1.61**	k-ft./ft.
Lagging required bending stress =	**0.79**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.32**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	106	plf			
Total length of pile:	36.50	ft.			
wt =	3.87	kips			
Concrete:	4.91	area	depth to consider for skin friction =	16.50	ft.
Total Length of concrete:	23.00	ft.	surface area of pile =	129.59	sq.ft.
wt =	16.94	kips	skin friction capacity =	129.59	kips
Superimposed Load on Pile =	7.20	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**28.00**	**kips**	**sum vertical capacity =**	**129.59**	
			F.S. bearing = 4.63		
			Combined pile skin friction & end bearing is **O.K.**		

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP2G
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P = 0 kips at Guardrail

WF Δ = 0.29 in

hg = 0 ft.

hs = 2.4 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

34.13 k

Lagging ht.
H = 13.5 ft.

Passive surchg. ht. = 0 ft.

4.29 klf

5.3 ft.

Neglect 0 ft.

lower grade

1.79 klf
30.97 k

9.1 ft.

Required pile embedment = 22.5 ft.

d1=17.3 ft.

0.113 over 2.5 ft.
1

16.87 k

1.335 over 5 ft.
1

23.1 klf

0 k

199.78 k

3.74 klf

117.81 k spike

V = 0 &   Mom. max. = 412 k-ft.

0.29 d1 = 5.2 ft.

pile dia.= 2.5 ft.

Pile SP2G: **W18X106**

SOLDIER PILE DESIGN ILLUSTRATION FOR 13.5 FT. WALL

SP2G-C

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.50	ft.
Pile spacing =	3.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	13.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W18X106	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP2G-C
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OUTPUT

Effective surcharge height "hs" =	**1.964**	ft. (upper grade)
Moment max. =	**223.6**	k-ft.
Sx (provided) =	**204**	in.^{3}
Ix (provided) =	**1910**	in.^{4}
E_{WF} =	**29000**	ksi
bf =	**11.20**	in.
d =	**18.70**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
      including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**13.15**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**21.80**	in. **4.1 in. clr. if WF is centered in pile**
WF Δ =	**0.152**	in. (at top of pile due to loading above lower grade)

W18X106 O.K. for stress

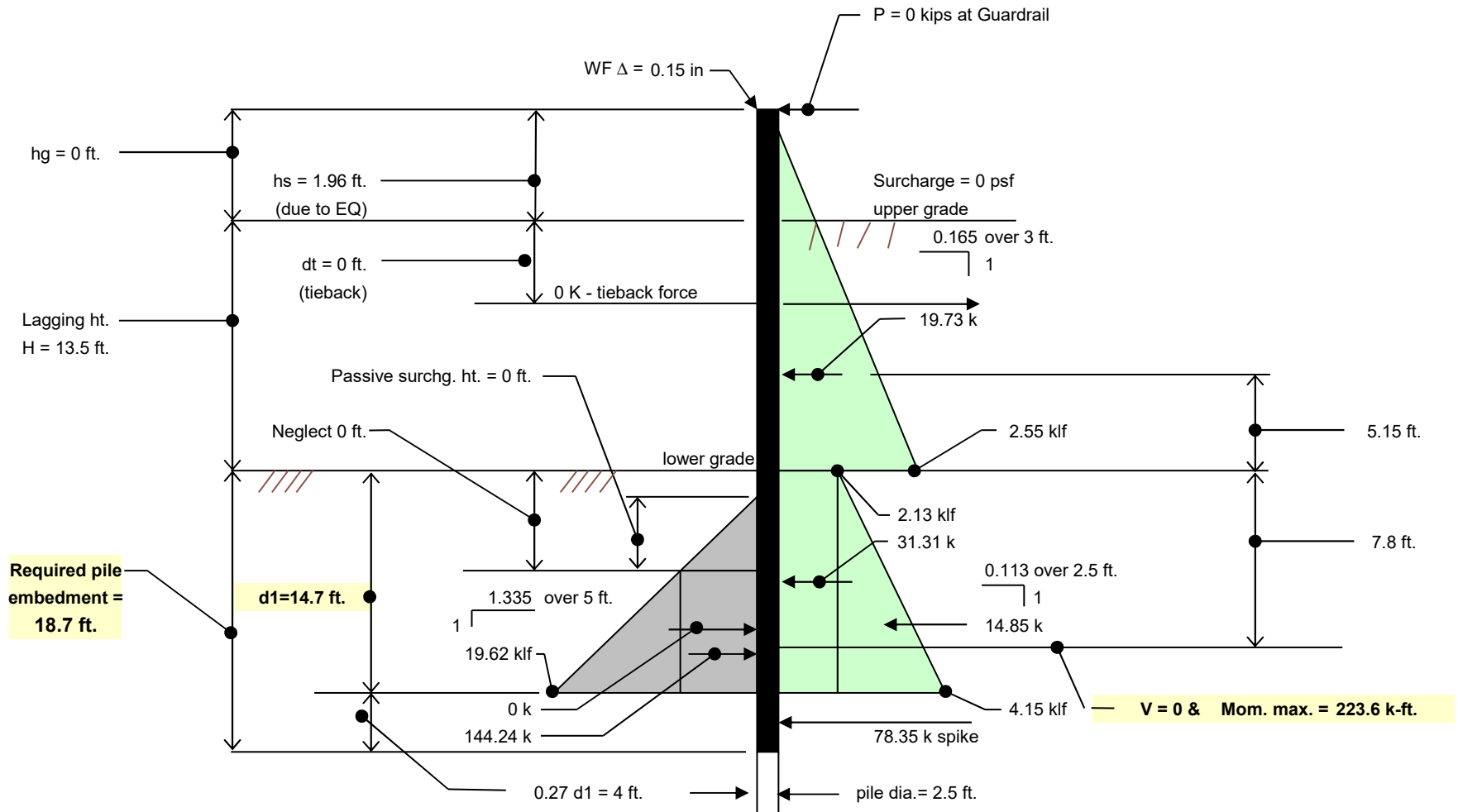### Lagging Design:

Lagging moment =	**0.48**	k-ft./ft.
Lagging required bending stress =	**0.24**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.10**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	106	plf			
Total length of pile:	37.50	ft.			
wt =	3.98	kips			
Concrete:	4.91	area	depth to consider for skin friction =	17.50	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	137.44	sq.ft.
wt =	17.67	kips	skin friction capacity =	137.44	kips
Superimposed Load on Pile =	11.05	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**32.70**	**kips**	**sum vertical capacity =**	**137.44**	

F.S. bearing = 4.20

Combined pile skin friction & end bearing is **O.K.**

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Pile SP2G-C
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P = 0 kips at Guardrail

WF Δ = 0.15 in

hg = 0 ft.

hs = 1.96 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.165 over 3 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

19.73 k

Lagging ht.
H = 13.5 ft.

Passive surchg. ht. = 0 ft.

5.15 ft.

Neglect 0 ft.

2.55 klf

lower grade

2.13 klf

7.8 ft.

31.31 k

0.113 over 2.5 ft.
1

Required pile embedment = 18.7 ft.

d1=14.7 ft.

1.335 over 5 ft.
1

14.85 k

19.62 klf

0 k

4.15 klf

V = 0 & Mom. max. = 223.6 k-ft.

144.24 k

78.35 k spike

0.27 d1 = 4 ft.

pile dia.= 2.5 ft.

Pile SP2G-C: **W18X106**

SOLDIER PILE DESIGN ILLUSTRATION FOR 13.5 FT. WALL

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Pile SP3G-C
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SP3G-C

INPUT

Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.00	ft.
Pile spacing =	3.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	11.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X35	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP3G-C
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OUTPUT

Effective surcharge height "hs" =	**1.600**	ft. (upper grade)
Moment max. =	**124.9**	k-ft.
Sx (provided) =	**45.6**	in.^{3}
Ix (provided) =	**285**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**6.56**	in.
d =	**12.50**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
   including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

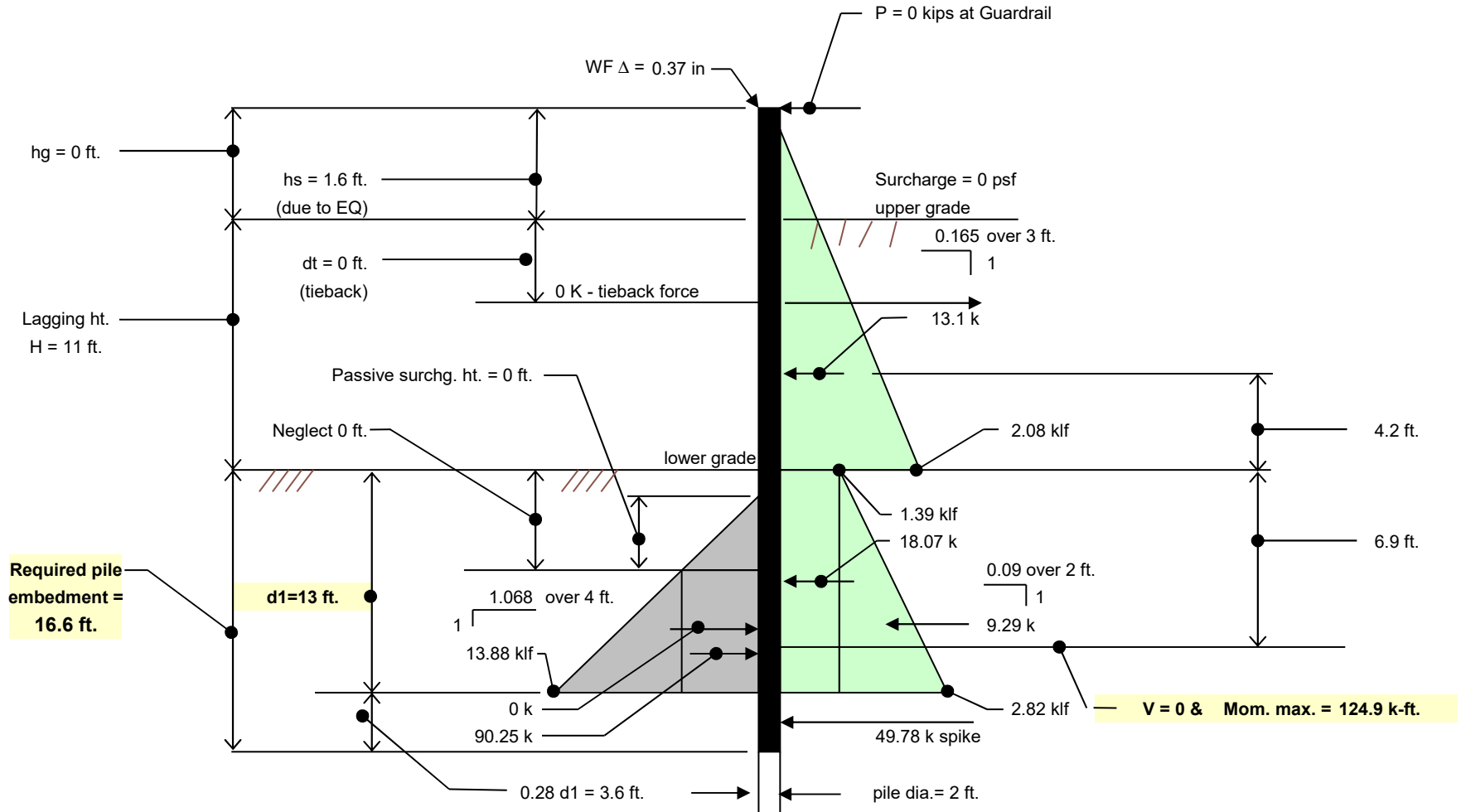|		
fb (actual) =	**32.86**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**14.12**	in. **4.94 in. clr. if WF is centered in pile**
WF Δ =	**0.365**	in. (at top of pile due to loading above lower grade)
	W12X35 O.K. for stress	

Lagging Design:

Lagging moment =	**0.39**	k-ft./ft.
Lagging required bending stress =	**0.20**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.08**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	35	plf			
Total length of pile:	31.00	ft.			
wt =	1.09	kips			
Concrete:	3.14	area	depth to consider for skin friction =	11.00	ft.
Total Length of concrete:	20.00	ft.	surface area of pile =	69.12	sq.ft.
wt =	9.42	kips	skin friction capacity =	69.12	kips
Superimposed Load on Pile =	3.30	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**13.81**	**kips**	sum vertical capacity =	**69.12**	
			F.S. bearing =	**5.00**	

Combined pile skin friction & end bearing is **O.K.**

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Pile SP3G-C
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P = 0 kips at Guardrail

WF Δ = 0.37 in

hg = 0 ft.

hs = 1.6 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.165 over 3 ft.

1

dt = 0 ft.
(tieback)

0 K - tieback force

13.1 k

Lagging ht.
H = 11 ft.

Passive surchg. ht. = 0 ft.

Neglect 0 ft.

2.08 klf

4.2 ft.

lower grade

1.39 klf

18.07 k

6.9 ft.

Required pile
embedment =
16.6 ft.

d1=13 ft.

0.09 over 2 ft.

1

1.068 over 4 ft.

9.29 k

1

13.88 klf

0 k

2.82 klf

V = 0 &   Mom. max. = 124.9 k-ft.

90.25 k

49.78 k spike

0.28 d1 = 3.6 ft.

pile dia.= 2 ft.

Pile SP3G-C: **W12X35**

SOLDIER PILE DESIGN ILLUSTRATION FOR 11 FT. WALL

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Pile SP4
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SP4		INPUT	
Soil Wt. =		125	pcf *
Active EFP =		45	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.00	ft.
Pile spacing =		6.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		12.50	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W12X87	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP4
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OUTPUT

Effective surcharge height "hs" =	**2.222**	ft. (upper grade)
Moment max. =	**341.9**	k-ft.
Sx (provided) =	**118**	in.^{3}
Ix (provided) =	**740**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.10**	in.
d =	**12.50**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".
2.) * = Per soils engineer's requirements,
       including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**34.77**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.40**	in. **3.3 in. clr. if WF is centered in pile**
WF Δ =	**0.501**	in. (at top of pile due to loading above lower grade)
	W12X87 O.K. for stress	

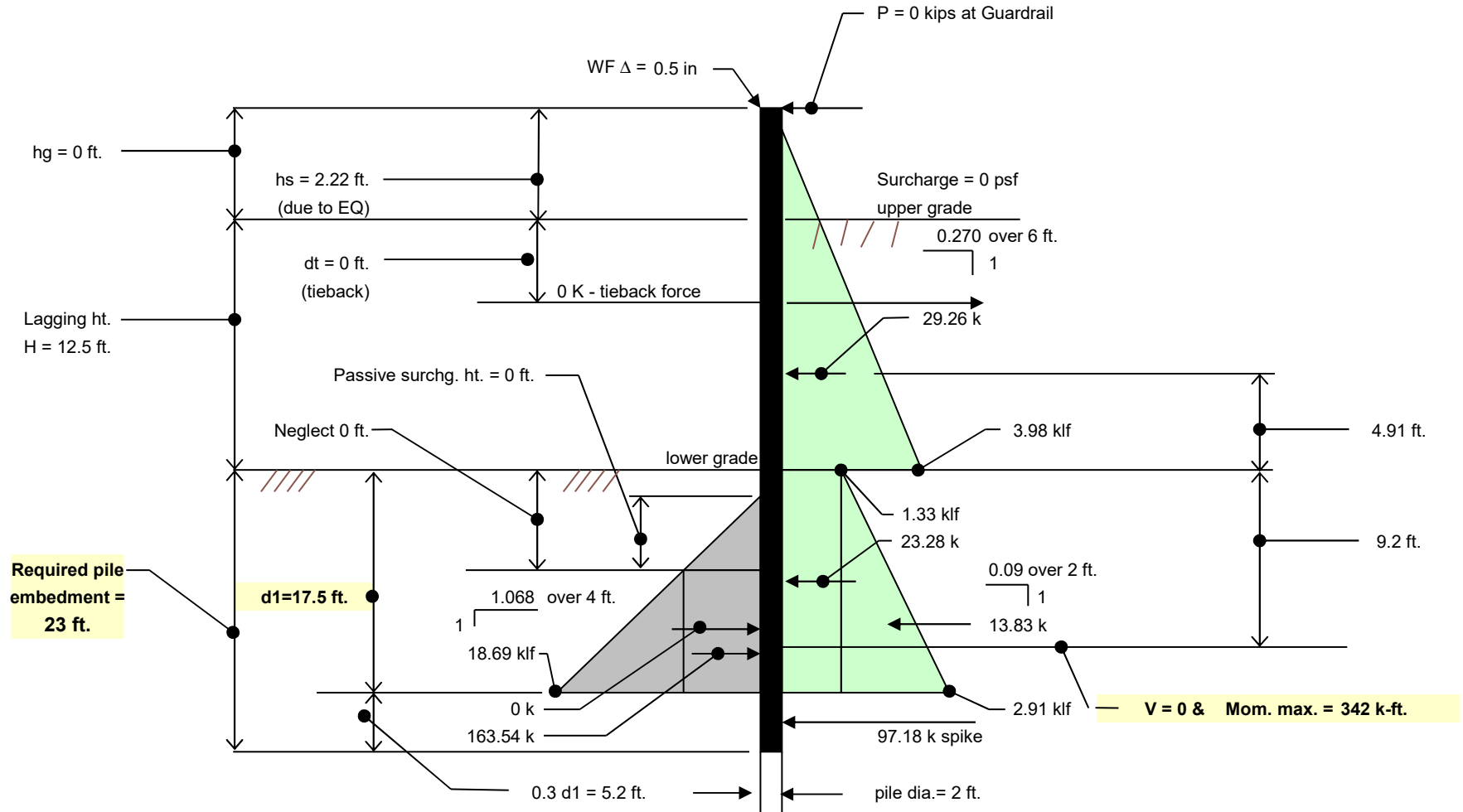### Lagging Design:

Lagging moment =	**1.49**	k-ft./ft.
Lagging required bending stress =	**0.74**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.30**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	87	plf			
Total length of pile:	36.50	ft.			
wt =	3.18	kips			
Concrete:	3.14	area	depth to consider for skin friction =	16.50	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	103.67	sq.ft.
wt =	11.31	kips	skin friction capacity =	103.67	kips
Superimposed Load on Pile =	25.28	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**39.76**	**kips**	**sum vertical capacity =**	**103.67**	

F.S. bearing = 2.61

Combined pile skin friction & end bearing is **O.K.**

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Pile SP4
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P = 0 kips at Guardrail

WF Δ = 0.5 in

hg = 0 ft.

hs = 2.22 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

29.26 k

Lagging ht.
H = 12.5 ft.

Passive surchg. ht. = 0 ft.

3.98 klf

4.91 ft.

Neglect 0 ft.

lower grade

1.33 klf

23.28 k

9.2 ft.

Required pile embedment = 23 ft.

d1=17.5 ft.

0.09 over 2 ft.
1

1.068 over 4 ft.

1

13.83 k

18.69 klf

0 k

2.91 klf

V = 0 &   Mom. max. = 342 k-ft.

163.54 k

97.18 k spike

0.3 d1 = 5.2 ft.

pile dia.= 2 ft.

Pile SP4:   **W12X87**

SOLDIER PILE DESIGN ILLUSTRATION FOR 12.5 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP5
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SP5	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.00	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	12.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X72	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP5
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OUTPUT

Effective surcharge height "hs" =	**2.133**	ft. (upper grade)
Moment max. =	**302.6**	k-ft.
Sx (provided) =	**97.4**	in.^{3}
Ix (provided) =	**597**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.00**	in.
d =	**12.30**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
    including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**37.28**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.19**	in. **3.4 in. clr. if WF is centered in pile**
WF Δ =	**0.507**	in. (at top of pile due to loading above lower grade)
	W12X72 O.K. for stress	

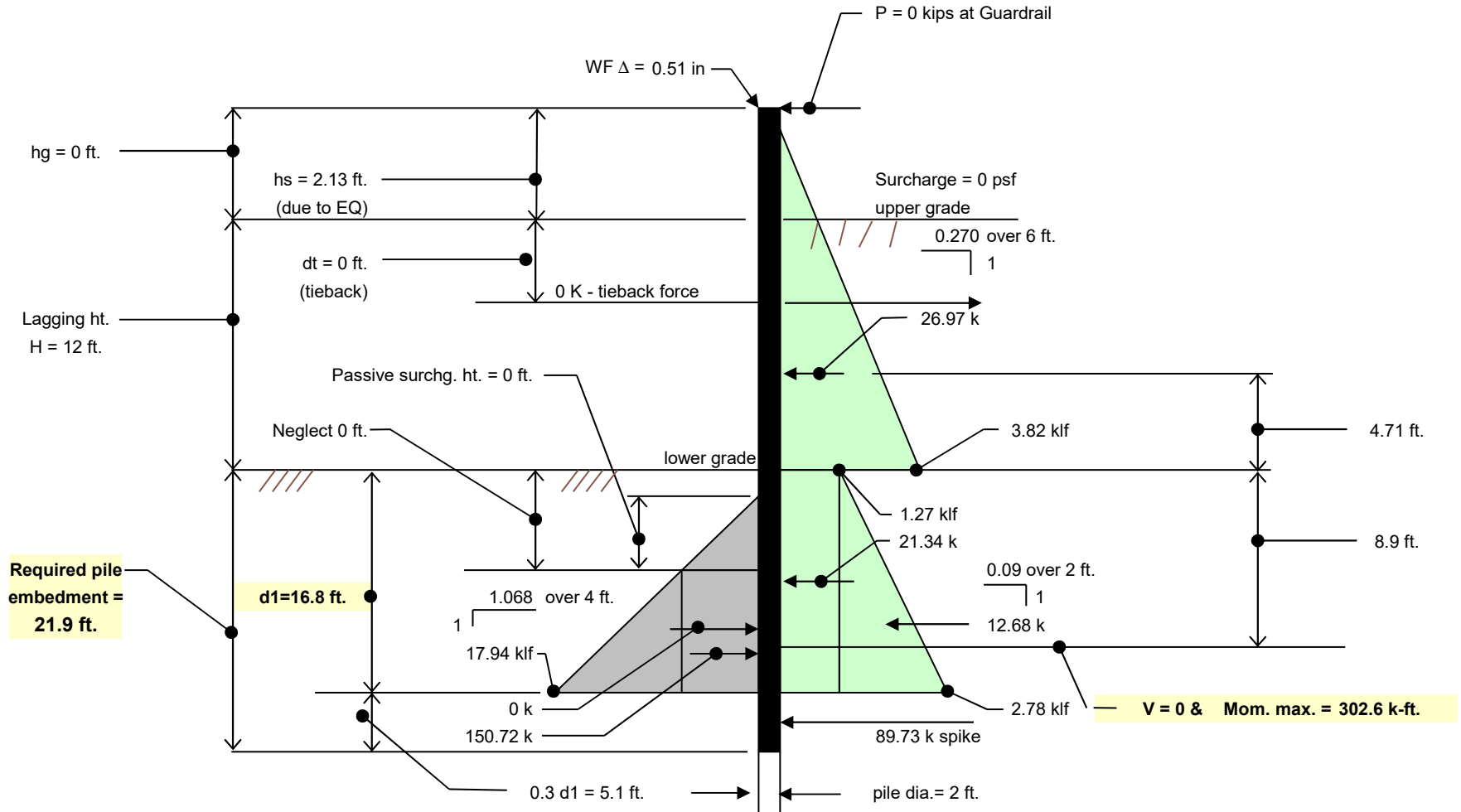**Lagging Design:**

Lagging moment =	**1.43**	k-ft./ft.
Lagging required bending stress =	**0.71**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.29**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	72	plf			
Total length of pile:	34.00	ft.			
wt =	2.45	kips			
Concrete:	3.14	area	depth to consider for skin friction =	14.00	ft.
Total Length of concrete:	22.00	ft.	surface area of pile =	87.96	sq.ft.
wt =	10.37	kips	skin friction capacity =	87.96	kips
Superimposed Load on Pile =	25.28	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**38.09**	**kips**	**sum vertical capacity =**	**87.96**	

F.S. bearing = 2.31

Combined pile skin friction & end bearing is **O.K.**

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Pile SP5
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P = 0 kips at Guardrail

WF Δ = 0.51 in

hg = 0 ft.

hs = 2.13 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

26.97 k

Lagging ht.
H = 12 ft.

Passive surchg. ht. = 0 ft.

3.82 klf

4.71 ft.

Neglect 0 ft.

lower grade

1.27 klf

8.9 ft.

21.34 k

0.09 over 2 ft.
1

Required pile embedment = 21.9 ft.

d1=16.8 ft.

1.068 over 4 ft.

12.68 k

1

17.94 klf

0 k

2.78 klf

V = 0 & Mom. max. = 302.6 k-ft.

150.72 k

89.73 k spike

0.3 d1 = 5.1 ft.

pile dia.= 2 ft.

Pile SP5: **W12X72**

SOLDIER PILE DESIGN ILLUSTRATION FOR 12 FT. WALL

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Pile SP6 - T
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SP6-T

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.00	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	14.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X65	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP6 - T
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OUTPUT

Effective surcharge height "hs" =	**2.578**	ft. (upper grade)
Moment max. =	**533.7**	k-ft.
Sx (provided) =	**87.9**	in.^{3}
Ix (provided) =	**533**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.00**	in.
d =	**12.10**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
    including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**72.86**	ksi WF is OVERSTRESSED - provide a stronger beam section
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.05**	in. **3.47 in. clr. if WF is centered in pile**
WF Δ =	**1.461**	in. (at top of pile due to loading above lower grade)

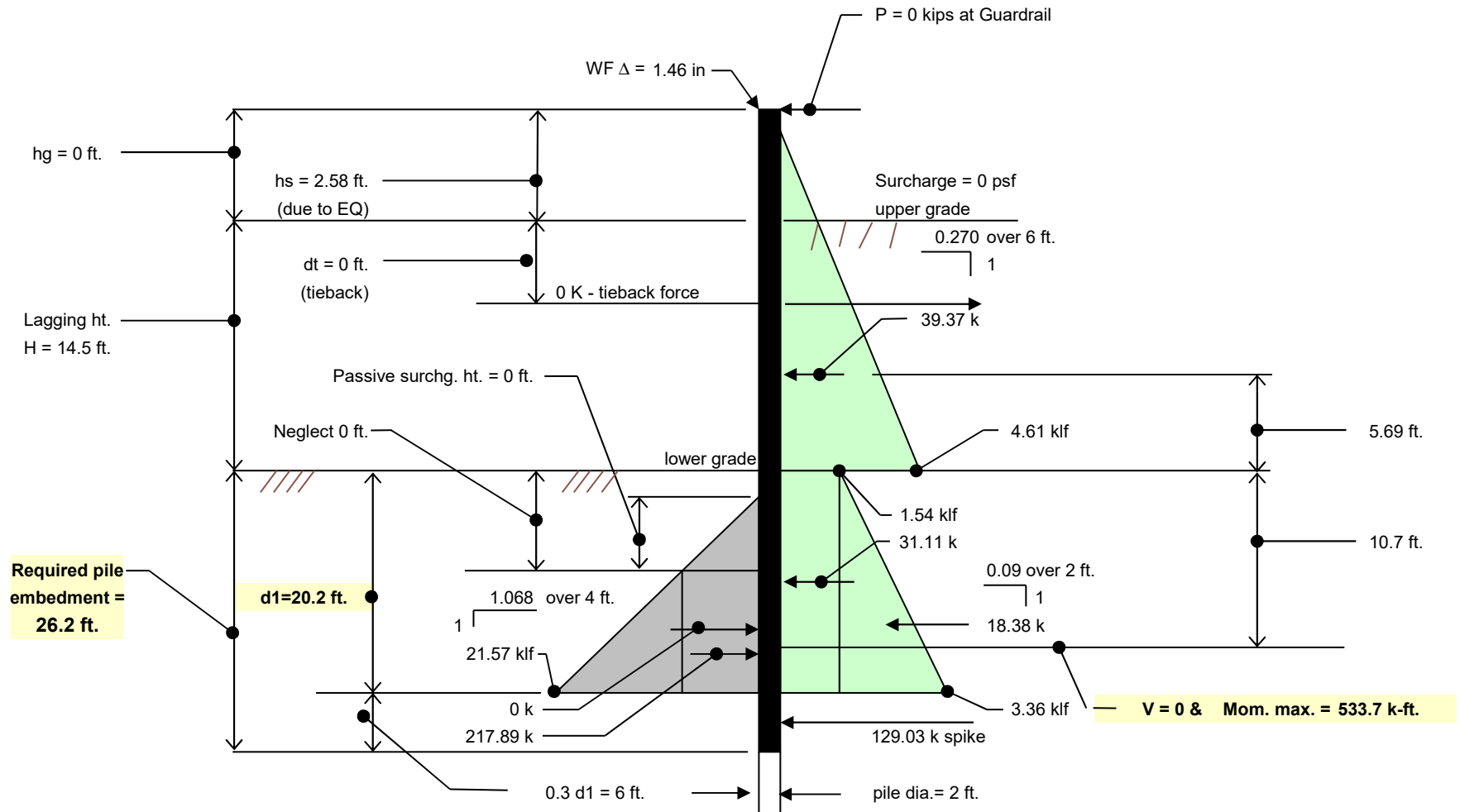**W12X65 is overstressed - provide a stronger beam section**

Lagging Design:

Lagging moment =	**1.73**	k-ft./ft.
Lagging required bending stress =	**0.85**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.35**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	65	plf			
Total length of pile:	36.50	ft.			
wt =	2.37	kips			
Concrete:	3.14	area	depth to consider for skin friction =	16.50	ft.
Total Length of concrete:	22.00	ft.	surface area of pile =	103.67	sq.ft.
wt =	10.37	kips	skin friction capacity =	103.67	kips
Superimposed Load on Pile =	25.28	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**38.02**	**kips**	**sum vertical capacity =**	**103.67**	

F.S. bearing = 2.73

Combined pile skin friction & end bearing is **O.K.**

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Pile SP6 - T
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P = 0 kips at Guardrail

WF Δ = 1.46 in

hg = 0 ft.

hs = 2.58 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

39.37 k

Lagging ht.
H = 14.5 ft.

Passive surchg. ht. = 0 ft.

5.69 ft.

Neglect 0 ft.

4.61 klf

lower grade

1.54 klf

31.11 k

10.7 ft.

Required pile embedment = 26.2 ft.

d1=20.2 ft.

0.09 over 2 ft.
1

18.38 k

1.068 over 4 ft.
1

21.57 klf

0 k

3.36 klf

V = 0 &   Mom. max. = 533.7 k-ft.

217.89 k

129.03 k spike

0.3 d1 = 6 ft.

pile dia.= 2 ft.

Pile SP6-T: **W12X65**

SOLDIER PILE DESIGN ILLUSTRATION FOR 14.5 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP6
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SP6		INPUT	
Soil Wt. =		125	pcf *
Active EFP =		45	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.00	ft.
Pile spacing =		6.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		11.50	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W12X65	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP6
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OUTPUT

Effective surcharge height "hs" =	**2.044**	ft. (upper grade)
Moment max. =	**266.3**	k-ft.
Sx (provided) =	**87.9**	in.^{3}
Ix (provided) =	**533**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**12.00**	in.
d =	**12.10**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
      including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.36**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.05**	in. **3.47 in. clr. if WF is centered in pile**
WF Δ =	**0.459**	in. (at top of pile due to loading above lower grade)
	W12X65 O.K. for stress	

Lagging Design:
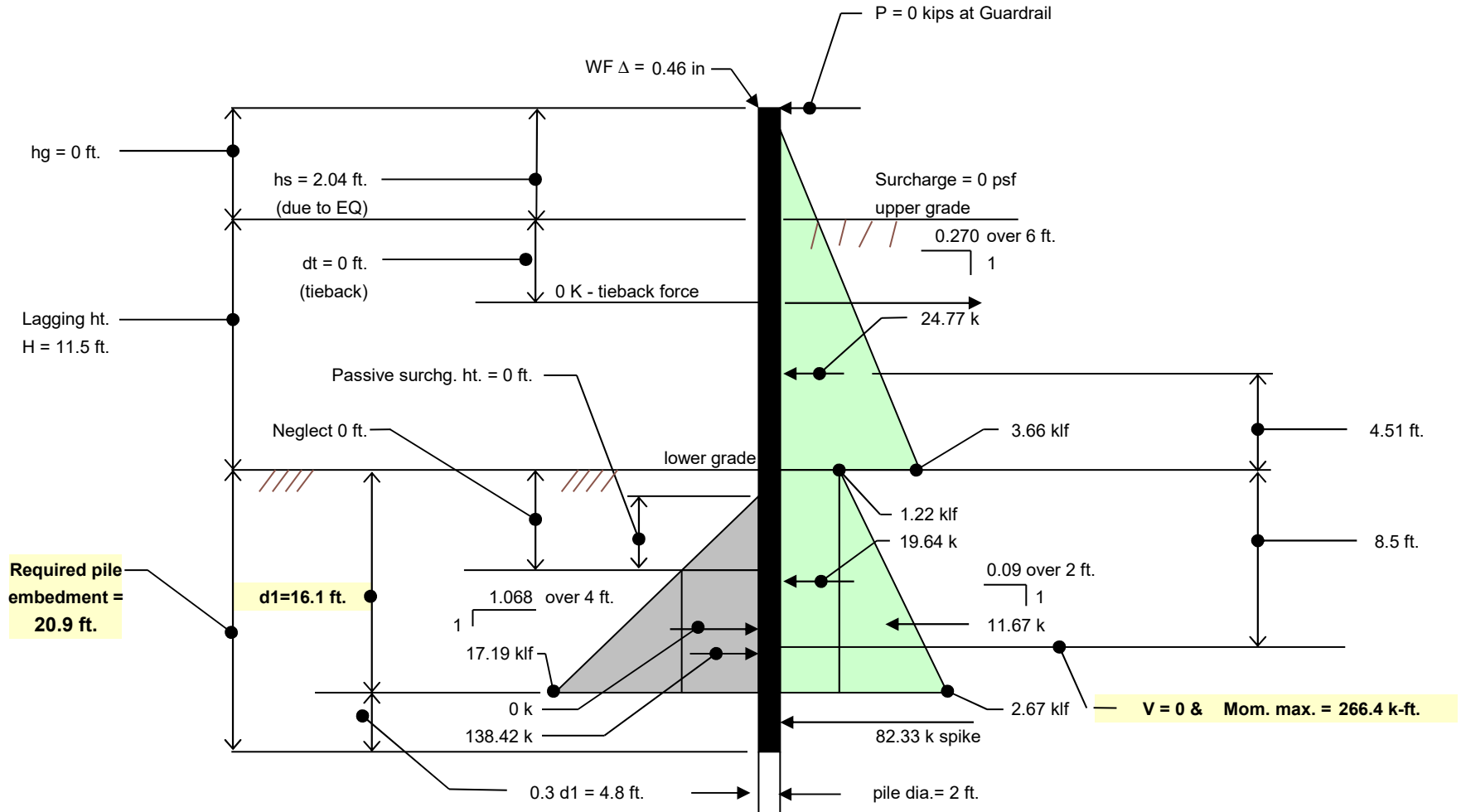
Lagging moment =	**1.37**	k-ft./ft.
Lagging required bending stress =	**0.68**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.28**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	65	plf			
Total length of pile:	33.50	ft.			
wt =	2.18	kips			
Concrete:	3.14	area	depth to consider for skin friction =	13.50	ft.
Total Length of concrete:	22.00	ft.	surface area of pile =	84.82	sq.ft.
wt =	10.37	kips	skin friction capacity =	84.82	kips
Superimposed Load on Pile =	25.28	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**37.82**	**kips**	**sum vertical capacity =**	**84.82**	

F.S. bearing = 2.24

Combined pile skin friction & end bearing is **O.K.**

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Pile SP6
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P = 0 kips at Guardrail

WF Δ = 0.46 in

hg = 0 ft.

hs = 2.04 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

24.77 k

Lagging ht.
H = 11.5 ft.

Passive surchg. ht. = 0 ft.

3.66 klf

4.51 ft.

Neglect 0 ft.

lower grade

1.22 klf
19.64 k

8.5 ft.

**Required pile
embedment =
20.9 ft.**

d1=16.1 ft.

1.068 over 4 ft.

0.09 over 2 ft.
1

1

11.67 k

17.19 klf

0 k
138.42 k

2.67 klf

82.33 k spike

V = 0 &   Mom. max. = 266.4 k-ft.

0.3 d1 = 4.8 ft.

pile dia.= 2 ft.

Pile SP6:   **W12X65**

SOLDIER PILE DESIGN ILLUSTRATION FOR 11.5 FT. WALL

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Pile SP7
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SP7

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.00	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	10.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X58	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP7
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OUTPUT

Effective surcharge height "hs" =	**1.867**	ft. (upper grade)	
Moment max. =	**202.7**	k-ft.	NOTE : -
Sx (provided) =	**78**	in.^{3}	1.) d1 range is from "H" to "6H only".
Ix (provided) =	**475**	in.^{4}	2.) * = Per soils engineer's requirements,
E $_{WF}$ =	**29000**	ksi	including appropriate Factors of safety.
bf =	**10.00**	in.	
d =	**12.20**	in.	

Maximum Bending Stress on WF Pile:

fb (actual) =	**31.18**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**15.78**	in. **4.11 in. clr. if WF is centered in pile**
WF Δ =	**0.327**	in. (at top of pile due to loading above lower grade)
	W12X58 O.K. for stress	

Lagging Design:
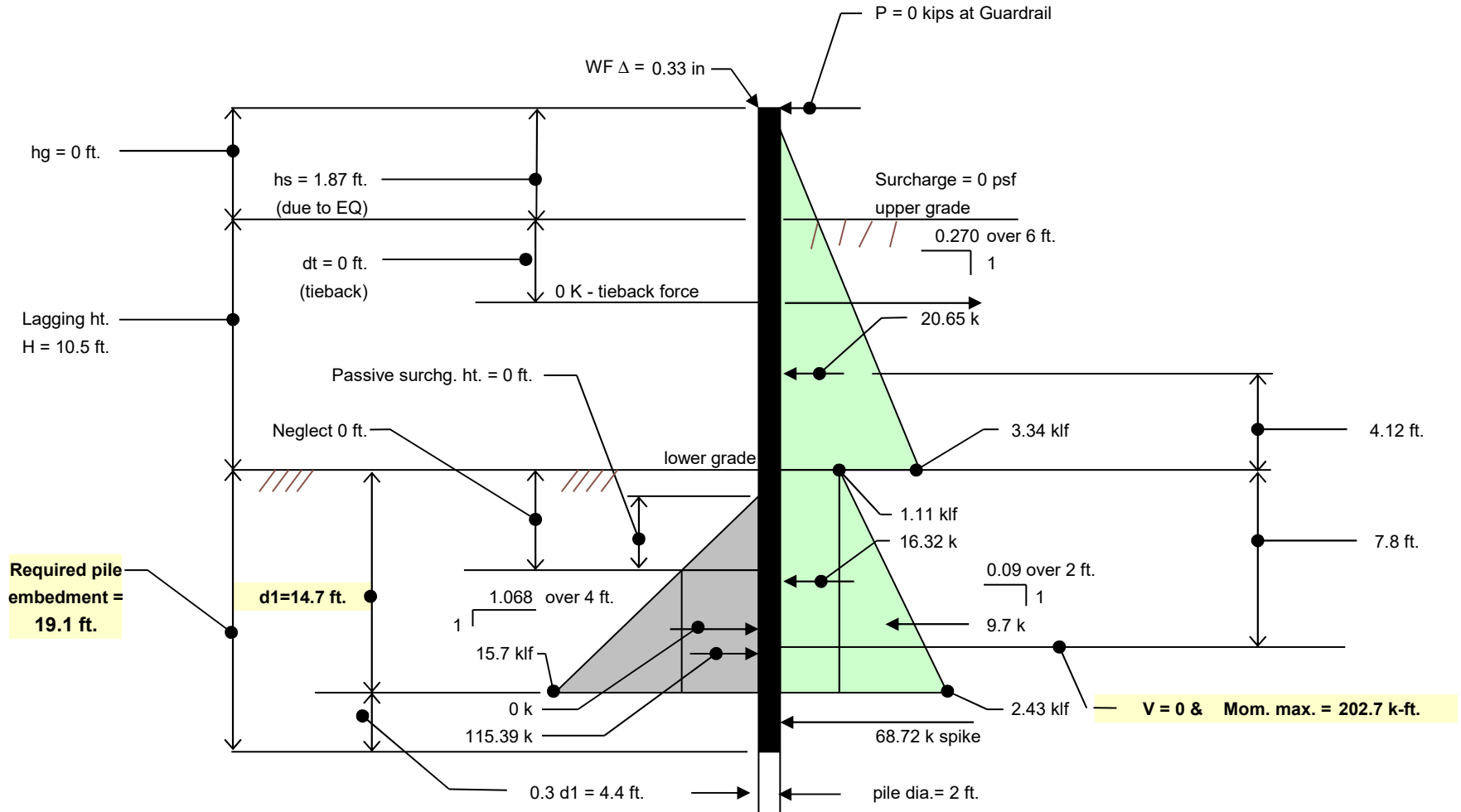
Lagging moment =	**1.25**	k-ft./ft.
Lagging required bending stress =	**0.62**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.25**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	58	plf			
Total length of pile:	30.50	ft.			
wt =	1.77	kips			
Concrete:	3.14	area	depth to consider for skin friction =	10.50	ft.
Total Length of concrete:	20.00	ft.	surface area of pile =	65.97	sq.ft.
wt =	9.42	kips	skin friction capacity =	65.97	kips
Superimposed Load on Pile =	25.28	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**36.47**	**kips**	**sum vertical capacity =**	**65.97**	
			F.S. bearing = 1.81		
			Combined pile skin friction & end bearing is **O.K.**		

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Pile SP7
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P = 0 kips at Guardrail

WF Δ = 0.33 in

hg = 0 ft.

hs = 1.87 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.270 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

20.65 k

Lagging ht.
H = 10.5 ft.

Passive surchg. ht. = 0 ft.

Neglect 0 ft.

3.34 klf

4.12 ft.

lower grade

1.11 klf

16.32 k

7.8 ft.

Required pile embedment = 19.1 ft.

d1=14.7 ft.

1.068 over 4 ft.

0.09 over 2 ft.
1

9.7 k

1

15.7 klf

0 k

V = 0 &   Mom. max. = 202.7 k-ft.

2.43 klf

115.39 k

68.72 k spike

0.3 d1 = 4.4 ft.

pile dia.= 2 ft.

Pile SP7:   **W12X58**

SOLDIER PILE DESIGN ILLUSTRATION FOR 10.5 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP8
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SP8		INPUT		
Soil Wt. =		125	pcf *
Active EFP =		55	pcf *
Passive EFP =		267	pcf *
Additional Uniform Load [rectangular] =		0	psf *
Seismic factor =		8	x "H"
# of pile φ active pressure is effective over =		1	below lagging *
# of pile φ passive pressure is effective over =		2	below lagging *
Effective Concrete Pile φ =		2.00	ft.
Pile spacing =		6.00	ft.
Surcharge =		0	psf
Retained (lagging) height "H" =		10.00	ft.
Height of Tieback from Bottom of Excavation =		0.00	ft.
Height of influence from additional Uniform Load =		0	ft.
Trial WF size =		W12X53	
WF Fy =		50	ksi
Required WF clearance within pile =		2	in. (all around)
For Passive resistance neglect top		0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge		0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =		50	% * @ lower grade
Allowable soil bearing @ bottom of pile =		0	psf *
Allowable pile skin friction to reduce end brg. =		1,000	psf *
Guardrail impact load per pile =		0	kips
Guardrail height above upper grade hg =		0	ft.
Duration increase for passive pres. w/ impact =		1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile SP8
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OUTPUT

Effective surcharge height "hs" =	**1.455**	ft. (upper grade)
Moment max. =	**212.7**	k-ft. NOTE : -
Sx (provided) =	**70.6**	in.^{3} 1.) d1 range is from "H" to "6H only".
Ix (provided) =	**425**	in.^{4} 2.) * = Per soils engineer's requirements,
E $_{WF}$ =	**29000**	ksi including appropriate Factors of safety.
bf =	**10.00**	in.
d =	**12.10**	in.

Maximum Bending Stress on WF Pile:

fb (actual) =	**36.15**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**15.70**	in. **4.15 in. clr. if WF is centered in pile**
WF Δ =	**0.304**	in. (at top of pile due to loading above lower grade)
	W12X53 O.K. for stress	

Lagging Design:
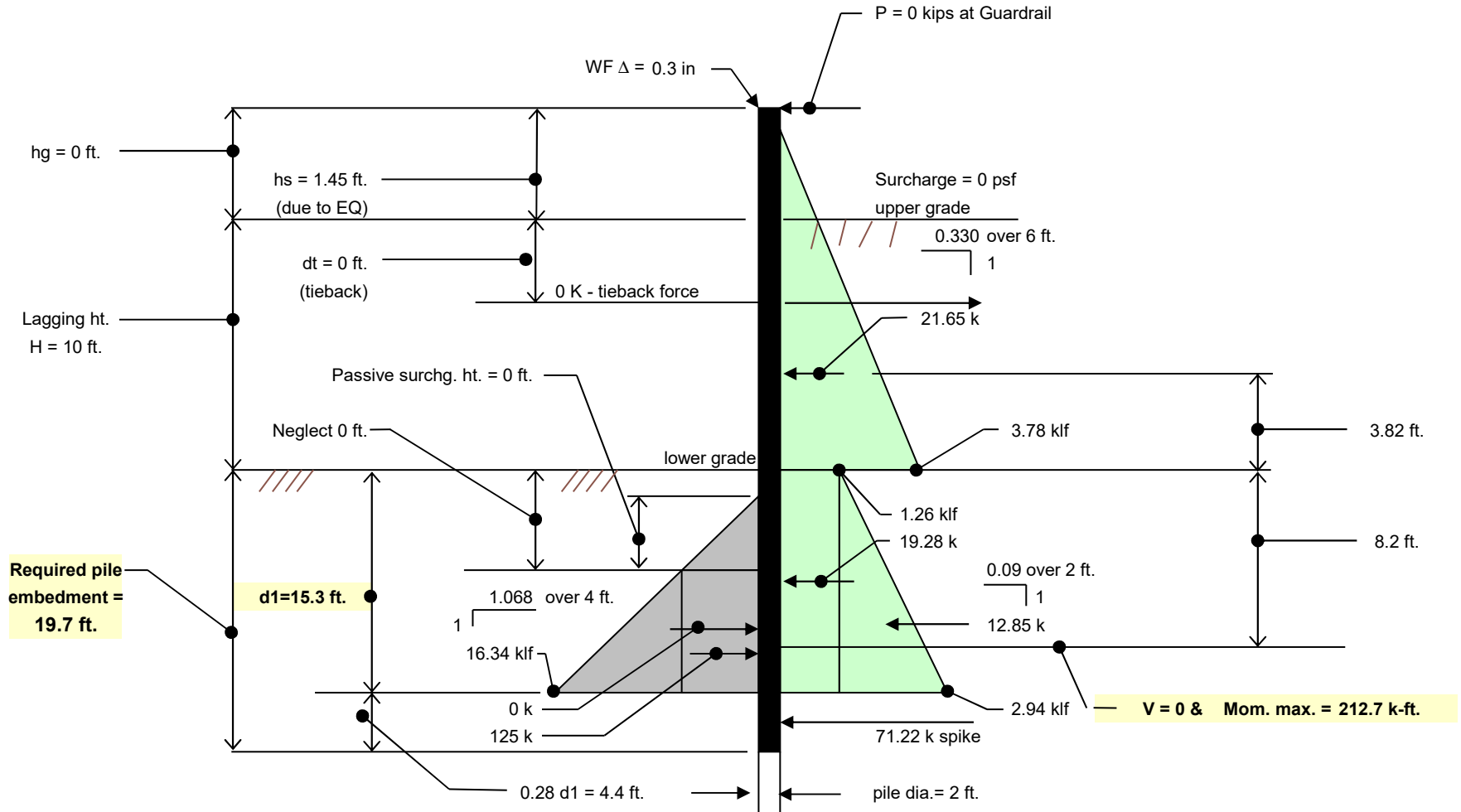
Lagging moment =	**1.42**	k-ft./ft.
Lagging required bending stress =	**0.70**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.29**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	53	plf			
Total length of pile:	30.00	ft.			
wt =	1.59	kips			
Concrete:	3.14	area	depth to consider for skin friction =	10.00	ft.
Total Length of concrete:	20.00	ft.	surface area of pile =	62.83	sq.ft.
wt =	9.42	kips	skin friction capacity =	62.83	kips
Superimposed Load on Pile =	21.72	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**32.73**	**kips**	**sum vertical capacity =**	**62.83**	
			F.S. bearing = 1.92		
			Combined pile skin friction & end bearing is **O.K.**		

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Pile SP8
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P = 0 kips at Guardrail

WF Δ = 0.3 in

hg = 0 ft.

hs = 1.45 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.330 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

21.65 k

Lagging ht.
H = 10 ft.

Passive surchg. ht. = 0 ft.

Neglect 0 ft.

lower grade

3.78 klf

3.82 ft.

1.26 klf
19.28 k

**Required pile
embedment =
19.7 ft.**

d1=15.3 ft.

0.09 over 2 ft.
1

8.2 ft.

1.068 over 4 ft.
1

12.85 k

16.34 klf

0 k

2.94 klf

V = 0 & Mom. max. = 212.7 k-ft.

125 k

71.22 k spike

0.28 d1 = 4.4 ft.

pile dia.= 2 ft.

Pile SP8:   **W12X53**

SOLDIER PILE DESIGN ILLUSTRATION FOR 10 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP9
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SP9	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.00	ft.
Pile spacing =	4.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	10.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X35	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP9
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OUTPUT

Effective surcharge height "hs" =	**1.455**	ft. (upper grade)
Moment max. =	**131.1**	k-ft.
Sx (provided) =	**45.6**	in.^{3}
Ix (provided) =	**285**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**6.56**	in.
d =	**12.50**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
　　　including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**34.49**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**14.12**	in. **4.94 in. clr. if WF is centered in pile**
WF Δ =	**0.302**	in. (at top of pile due to loading above lower grade)

W12X35 O.K. for stress

Lagging Design:
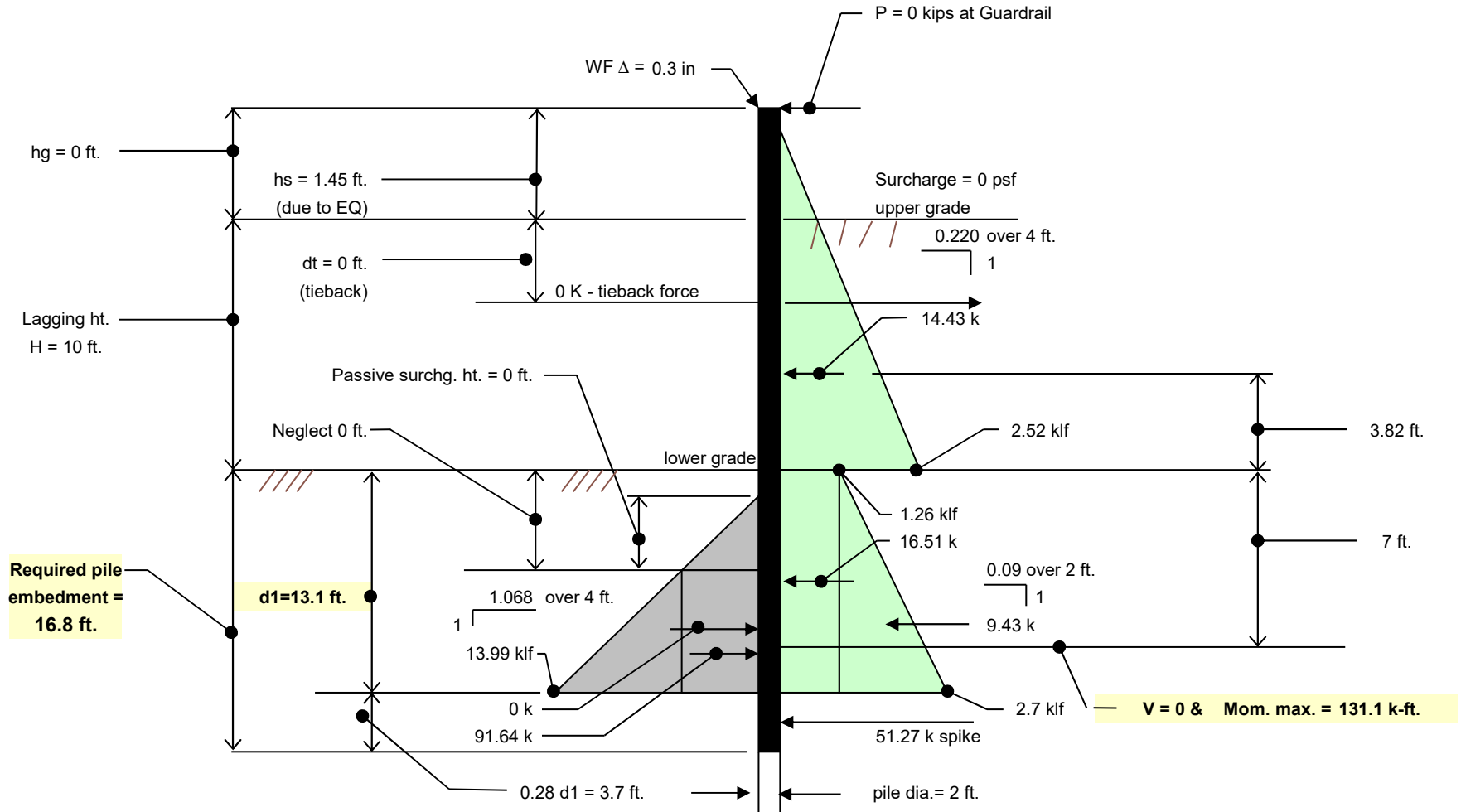
Lagging moment =	**0.63**	k-ft./ft.
Lagging required bending stress =	**0.31**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.13**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	35	plf			
Total length of pile:	27.00	ft.			
wt =	0.95	kips			
Concrete:	3.14	area	depth to consider for skin friction =	7.00	ft.
Total Length of concrete:	17.00	ft.	surface area of pile =	43.98	sq.ft.
wt =	8.01	kips	skin friction capacity =	43.98	kips
Superimposed Load on Pile =	11.81	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**20.77**	**kips**	**sum vertical capacity =**	**43.98**	

F.S. bearing = 2.12

Combined pile skin friction & end bearing is **O.K.**

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Pile SP9
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P = 0 kips at Guardrail

WF Δ = 0.3 in

hg = 0 ft.

hs = 1.45 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.220 over 4 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

14.43 k

Lagging ht.
H = 10 ft.

Passive surchg. ht. = 0 ft.

Neglect 0 ft.

2.52 klf

3.82 ft.

lower grade

1.26 klf

16.51 k

7 ft.

0.09 over 2 ft.
1

Required pile
embedment =
16.8 ft.

d1=13.1 ft.

1.068 over 4 ft.
1

9.43 k

13.99 klf

0 k

2.7 klf

V = 0 &   Mom. max. = 131.1 k-ft.

91.64 k

51.27 k spike

0.28 d1 = 3.7 ft.

pile dia.= 2 ft.

Pile SP9: **W12X35**

SOLDIER PILE DESIGN ILLUSTRATION FOR 10 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP10
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SP10

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	40	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	0	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	1.50	ft.
Pile spacing =	6.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	7.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W8X24	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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18156 - The Murray Residence Shoring Wall.xlsx

Pile SP10
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OUTPUT

Effective surcharge height "hs" =	**0.000**	ft. (upper grade)
Moment max. =	**41.0**	k-ft.
S_x (provided) =	**20.9**	in.^{3}
I_x (provided) =	**82.7**	in.^{4}
E_{WF} =	**29000**	ksi
bf =	**6.50**	in.
d =	**7.93**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements, including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**23.52**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**9.82**	in. **4.09 in. clr. if WF is centered in pile**
WF Δ =	**0.137**	in. (at top of pile due to loading above lower grade)

W8X24 O.K. for stress

Lagging Design:
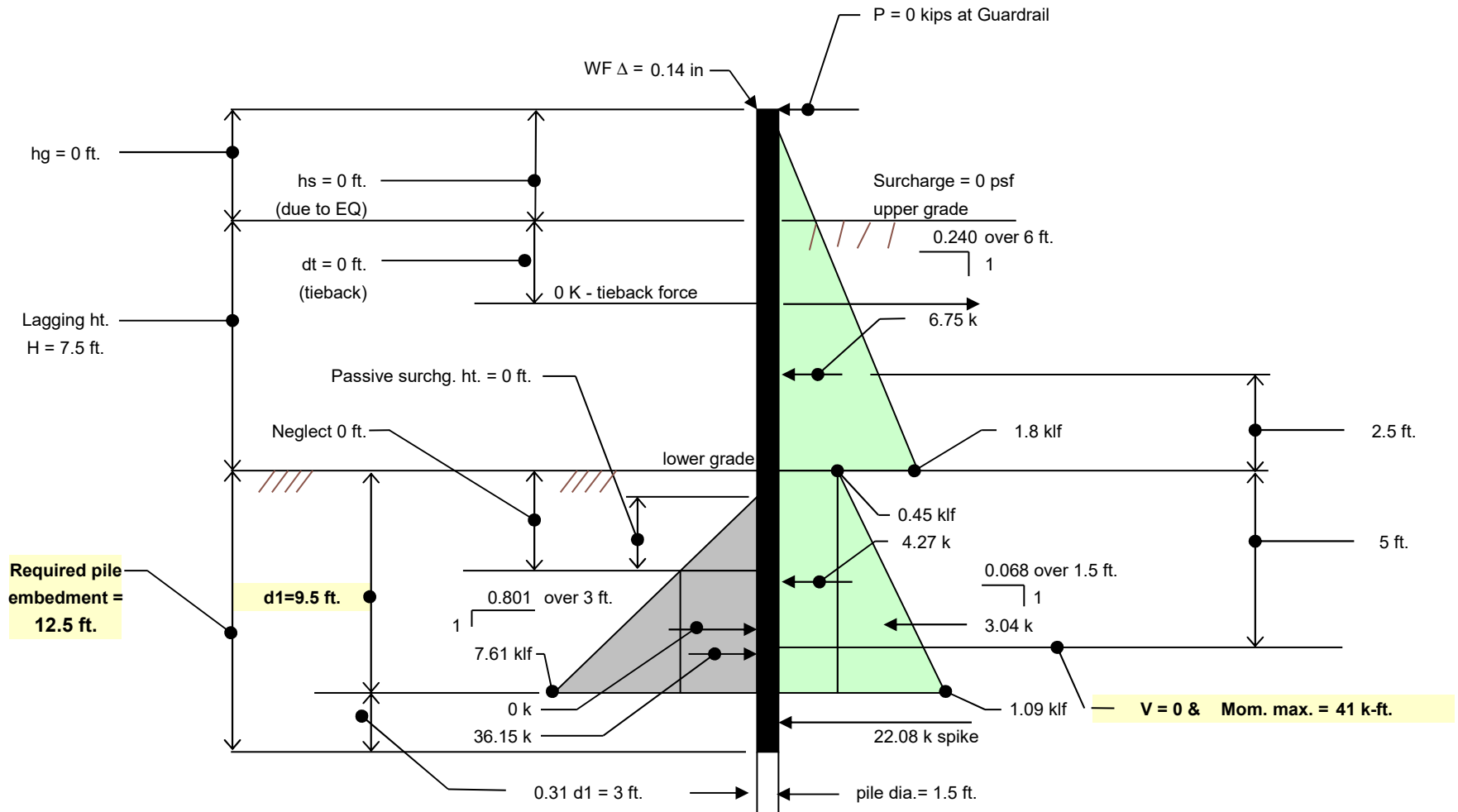
Lagging moment =	**0.68**	k-ft./ft.
Lagging required bending stress =	**0.34**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.14**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	24	plf			
Total length of pile:	21.50	ft.			
wt =	0.52	kips			
Concrete:	1.77	area	depth to consider for skin friction =	1.50	ft.
Total Length of concrete:	14.00	ft.	surface area of pile =	7.07	sq.ft.
wt =	3.71	kips	skin friction capacity =	7.07	kips
Superimposed Load on Pile =	10.68	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**14.91**	**kips**	**sum vertical capacity =**	**7.07**	

F.S. bearing = 0.47

Combined pile skin friction & end bearing is **No Good**

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Pile SP10
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P = 0 kips at Guardrail

WF Δ = 0.14 in

hg = 0 ft.

hs = 0 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.240 over 6 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

6.75 k

Lagging ht.
H = 7.5 ft.

Passive surchg. ht. = 0 ft.

1.8 klf

2.5 ft.

Neglect 0 ft.

lower grade

0.45 klf
4.27 k

5 ft.

Required pile
embedment =
12.5 ft.

d1=9.5 ft.

0.801 over 3 ft.
1

0.068 over 1.5 ft.
1

3.04 k

7.61 klf

0 k

36.15 k

1.09 klf

22.08 k spike

V = 0 &   Mom. max. = 41 k-ft.

0.31 d1 = 3 ft.

pile dia.= 1.5 ft.

Pile SP10:   **W8X24**

SOLDIER PILE DESIGN ILLUSTRATION FOR 7.5 FT. WALL

B&T Design & Engineering, Inc.
(425) 557-0779

18156 - The Murray Residence Shoring Wall.xlsx

Pile SP11
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SP11

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	40	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	0	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	1.50	ft.
Pile spacing =	8.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	5.50	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W8X15	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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OUTPUT

Effective surcharge height "hs" =	**0.000**	ft. (upper grade)	
Moment max. =	**23.1**	k-ft.	NOTE : -
Sx (provided) =	**11.8**	in.^{3}	1.) d1 range is from "H" to "6H only".
Ix (provided) =	**48**	in.^{4}	2.) * = Per soils engineer's requirements,
E $_{WF}$ =	**29000**	ksi	including appropriate Factors of safety.
bf =	**4.01**	in.	
d =	**8.11**	in.	

Maximum Bending Stress on WF Pile:

fb (actual) =	**23.46**	ksi	WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi	AISC 9th Edition pg. 5-155
WF diagonal =	**8.94**	in.	**4.53 in. clr. if WF is centered in pile**
WF Δ =	**0.067**	in. (at top of pile due to loading above lower grade)	

W8X15 O.K. for stress
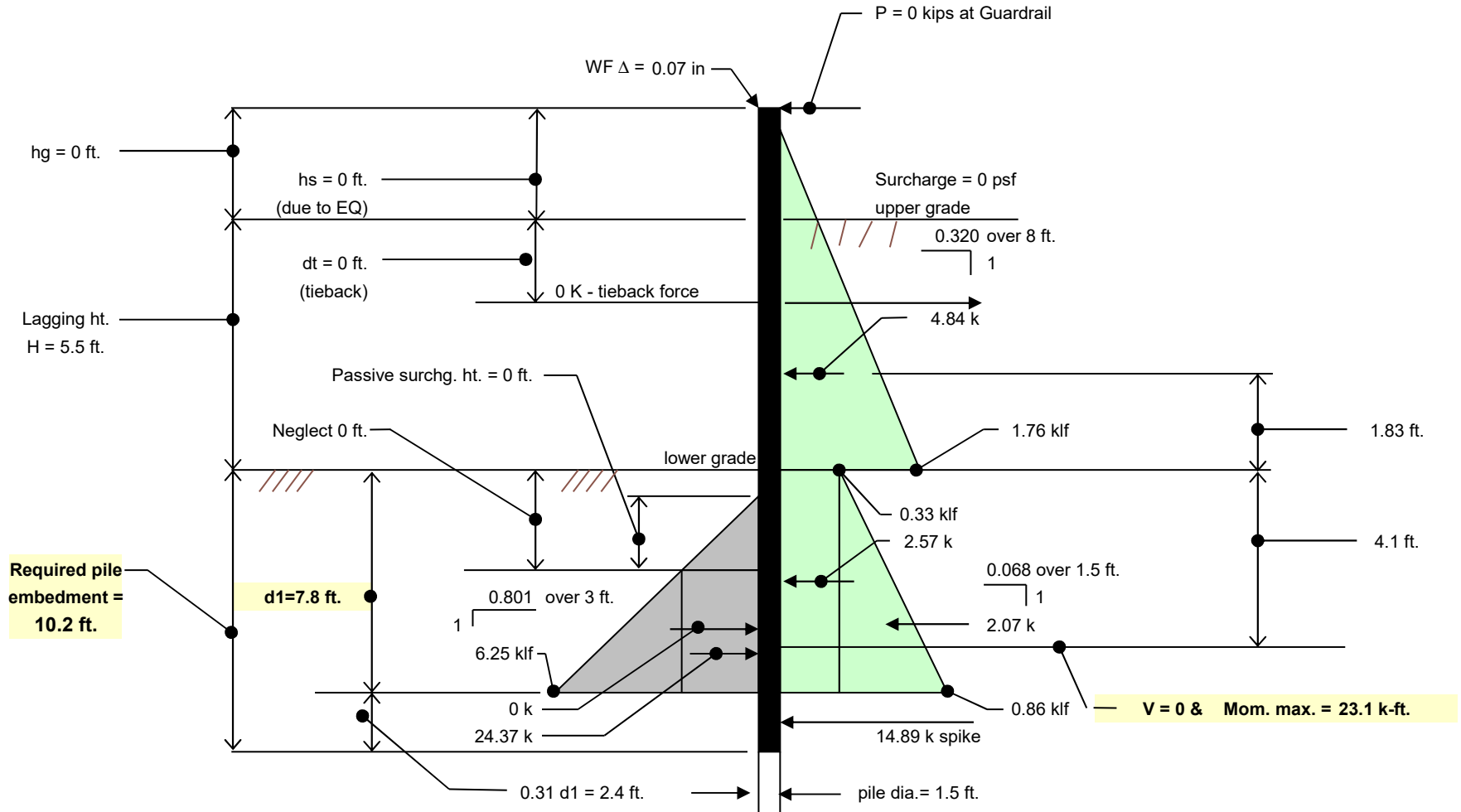
Lagging Design:

Lagging moment =	**0.88**	k-ft./ft.
Lagging required bending stress =	**0.44**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.18**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	15	plf			
Total length of pile:	33.50	ft.			
wt =	0.50	kips			
Concrete:	1.77	area	depth to consider for skin friction =	13.50	ft.
Total Length of concrete:	28.00	ft.	surface area of pile =	63.62	sq.ft.
wt =	7.42	kips	skin friction capacity =	63.62	kips
Superimposed Load on Pile =	39.71	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**47.63**	**kips**	**sum vertical capacity =**	**63.62**	
			F.S. bearing =	**1.34**	

Combined pile skin friction & end bearing is **O.K.**

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P = 0 kips at Guardrail

WF Δ = 0.07 in

hg = 0 ft.

hs = 0 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.320 over 8 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

4.84 k

Lagging ht.
H = 5.5 ft.

Passive surchg. ht. = 0 ft.

Neglect 0 ft.

1.76 klf

1.83 ft.

lower grade

0.33 klf
2.57 k

0.068 over 1.5 ft.
1

4.1 ft.

Required pile embedment = 10.2 ft.

d1=7.8 ft.

0.801 over 3 ft.
1

2.07 k

6.25 klf

0 k

24.37 k

0.86 klf

14.89 k spike

V = 0 &   Mom. max. = 23.1 k-ft.

0.31 d1 = 2.4 ft.

pile dia.= 1.5 ft.

Pile SP11:   **W8X15**

SOLDIER PILE DESIGN ILLUSTRATION FOR 5.5 FT. WALL

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Pile L-SP1
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L-SP1

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.00	ft.
Pile spacing =	7.33	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	11.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X87	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile L-SP1
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OUTPUT

Effective surcharge height "hs" =	**1.600**	ft. (upper grade)
Moment max. =	**361.2**	k-ft. NOTE : -
Sx (provided) =	**118**	in.^{3} 1.) d1 range is from "H" to "6H only".
Ix (provided) =	**740**	in.^{4} 2.) * = Per soils engineer's requirements,
E $_{WF}$ =	**29000**	ksi including appropriate Factors of safety.
bf =	**12.10**	in.
d =	**12.50**	in.

Maximum Bending Stress on WF Pile:

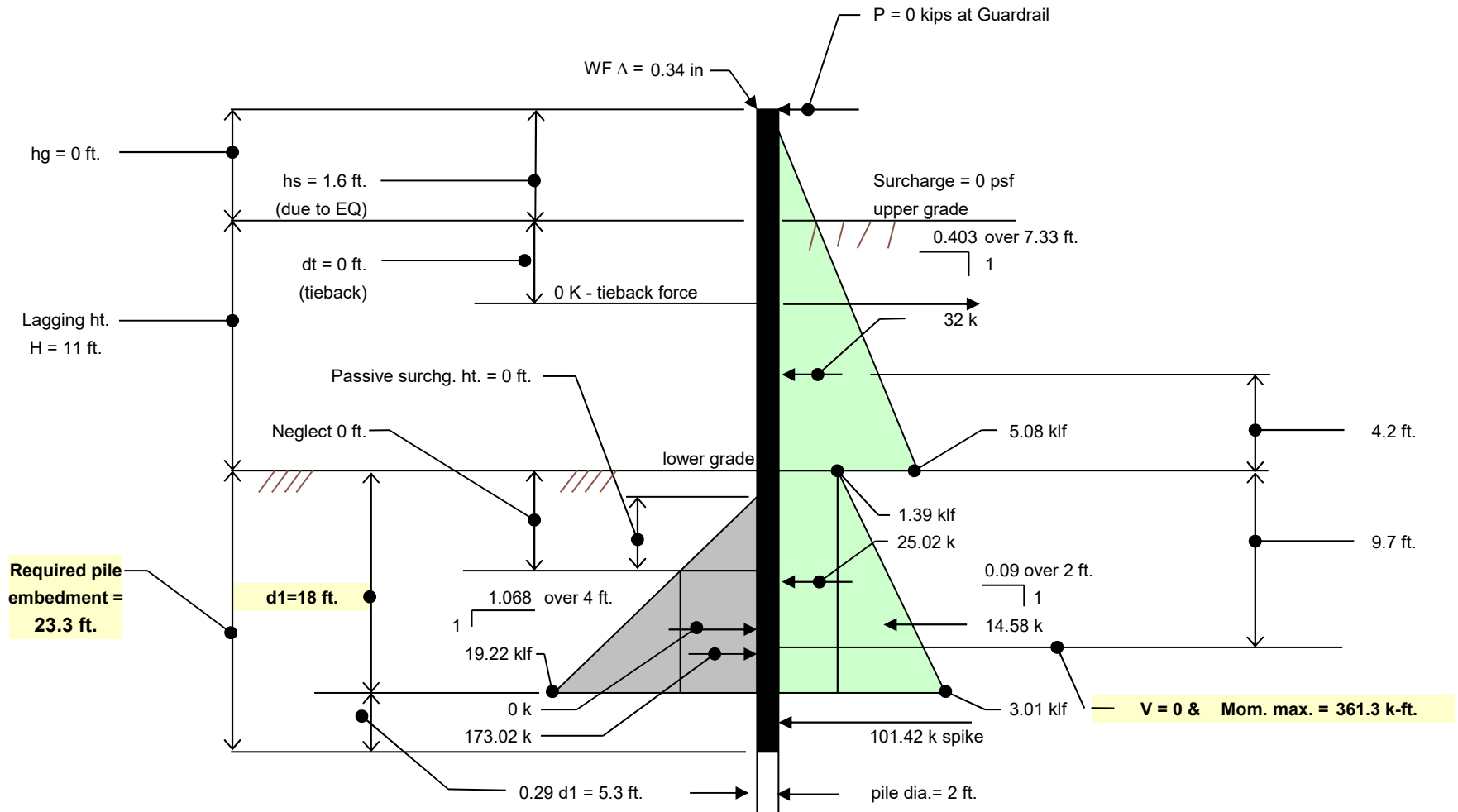|		
fb (actual) =	**36.74**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.40**	in. **3.3 in. clr. if WF is centered in pile**
WF Δ =	**0.344**	in. (at top of pile due to loading above lower grade)
	W12X87 O.K. for stress	

Lagging Design:

Lagging moment =	**2.33**	k-ft./ft.
Lagging required bending stress =	**1.14**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.47**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	87	plf			
Total length of pile:	35.00	ft.			
wt =	3.05	kips			
Concrete:	3.14	area	depth to consider for skin friction =	15.00	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	94.25	sq.ft.
wt =	11.31	kips	skin friction capacity =	94.25	kips
Superimposed Load on Pile =	43.14	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**57.50**	**kips**	**sum vertical capacity =**	**94.25**	
			F.S. bearing = 1.64		
			Combined pile skin friction & end bearing is **O.K.**		

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Pile L-SP1
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P = 0 kips at Guardrail

WF Δ = 0.34 in

hg = 0 ft.

hs = 1.6 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.403 over 7.33 ft.

1

dt = 0 ft.
(tieback)

0 K - tieback force

32 k

Lagging ht.
H = 11 ft.

Passive surchg. ht. = 0 ft.

5.08 klf

4.2 ft.

Neglect 0 ft.

lower grade

1.39 klf

25.02 k

9.7 ft.

Required pile embedment = 23.3 ft.

d1=18 ft.

1.068 over 4 ft.

0.09 over 2 ft.

1

1

14.58 k

19.22 klf

0 k

V = 0 &   Mom. max. = 361.3 k-ft.

3.01 klf

173.02 k

101.42 k spike

0.29 d1 = 5.3 ft.

pile dia.= 2 ft.

Pile L-SP1:   **W12X87**

SOLDIER PILE DESIGN ILLUSTRATION FOR 11 FT. WALL

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Pile L-SP1-C
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L-SP1-C

	INPUT	
Soil Wt. =	125	pcf *
Active EFP =	55	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.00	ft.
Pile spacing =	3.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	13.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X53	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile L-SP1-C
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OUTPUT

Effective surcharge height "hs" =	**1.891**	ft. (upper grade)
Moment max. =	**206.0**	k-ft.
Sx (provided) =	**70.6**	in.^{3}
Ix (provided) =	**425**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**10.00**	in.
d =	**12.10**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
   including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**35.02**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**15.70**	in. **4.15 in. clr. if WF is centered in pile**
WF Δ =	**0.564**	in. (at top of pile due to loading above lower grade)

W12X53 O.K. for stress

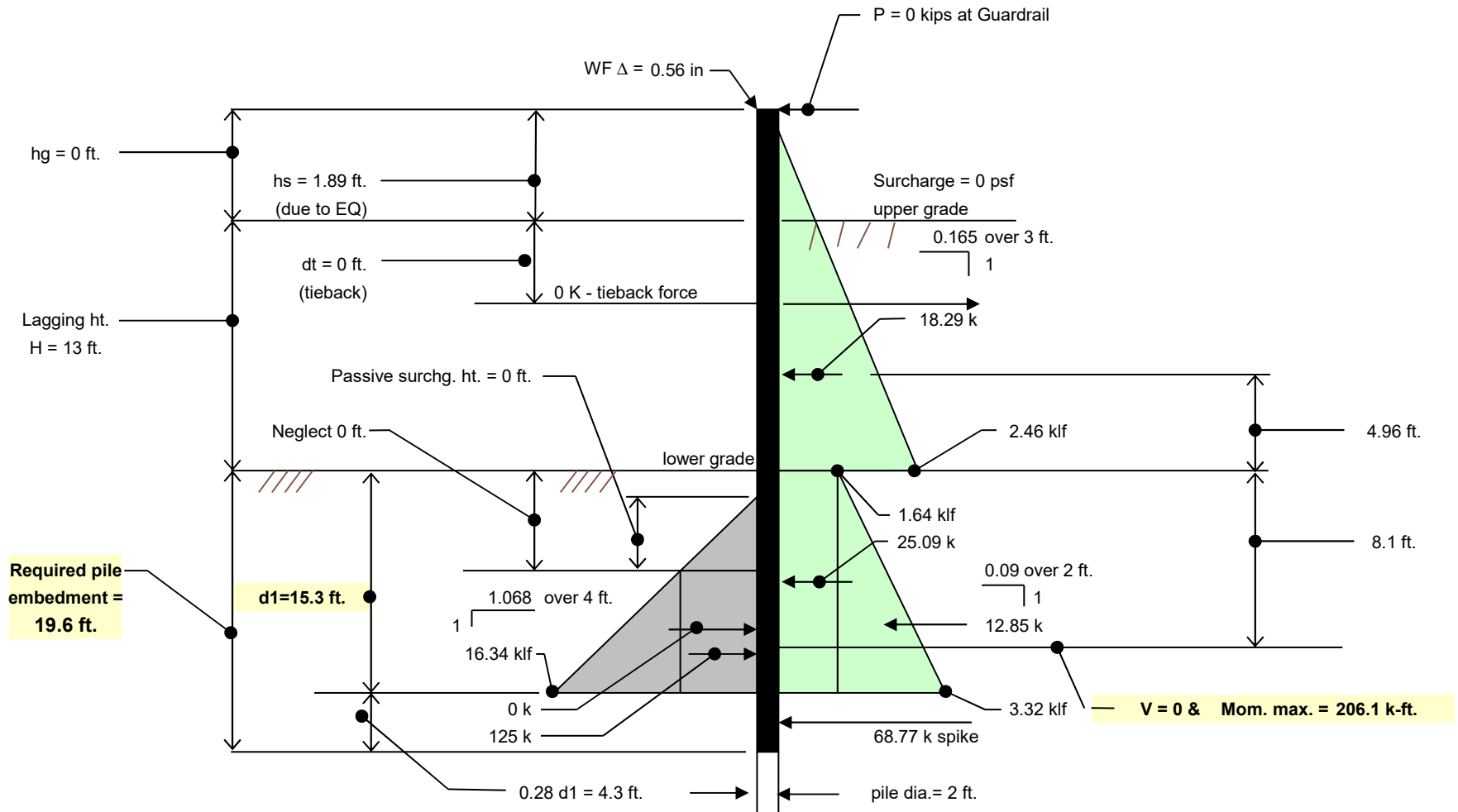**Lagging Design:**

Lagging moment =	**0.46**	k-ft./ft.
Lagging required bending stress =	**0.23**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.10**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	53	plf			
Total length of pile:	37.00	ft.			
wt =	1.96	kips			
Concrete:	3.14	area	depth to consider for skin friction =	17.00	ft.
Total Length of concrete:	24.00	ft.	surface area of pile =	106.81	sq.ft.
wt =	11.31	kips	skin friction capacity =	106.81	kips
Superimposed Load on Pile =	17.66	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**30.93**	**kips**	**sum vertical capacity =**	**106.81**	
			F.S. bearing =	**3.45**	

Combined pile skin friction & end bearing is **O.K.**

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Pile L-SP1-C
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P = 0 kips at Guardrail

WF Δ = 0.56 in

hg = 0 ft.

hs = 1.89 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.165 over 3 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

18.29 k

Lagging ht.
H = 13 ft.

Passive surchg. ht. = 0 ft.

4.96 ft.

Neglect 0 ft.

2.46 klf

lower grade

1.64 klf
25.09 k

8.1 ft.

Required pile
embedment =
19.6 ft.

d1=15.3 ft.

1.068 over 4 ft.
1

0.09 over 2 ft.
1

12.85 k

16.34 klf

0 k

3.32 klf

V = 0 &   Mom. max. = 206.1 k-ft.

125 k

68.77 k spike

0.28 d1 = 4.3 ft.

pile dia.= 2 ft.

Pile L-SP1-C: **W12X53**

SOLDIER PILE DESIGN ILLUSTRATION FOR 13 FT. WALL

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Pile L-SP2
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L-SP2

INPUT

Soil Wt. =	125	pcf *
Active EFP =	50	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	0	x "H"
# of pile φ active pressure is effective over =	1	below lagging *
# of pile φ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile φ =	2.00	ft.
Pile spacing =	7.33	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	11.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X72	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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OUTPUT

Effective surcharge height "hs" =	**0.000**	ft. (upper grade)
Moment max. =	**210.3**	k-ft. NOTE : -
Sx (provided) =	**97.4**	in.^{3} 1.) d1 range is from "H" to "6H only".
Ix (provided) =	**597**	in.^{4} 2.) * = Per soils engineer's requirements,
E $_{WF}$ =	**29000**	ksi including appropriate Factors of safety.
bf =	**12.00**	in.
d =	**12.30**	in.

Maximum Bending Stress on WF Pile:

fb (actual) =	**25.91**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**17.19**	in. **3.4 in. clr. if WF is centered in pile**
WF Δ =	**0.196**	in. (at top of pile due to loading above lower grade)
	W12X72 O.K. for stress	

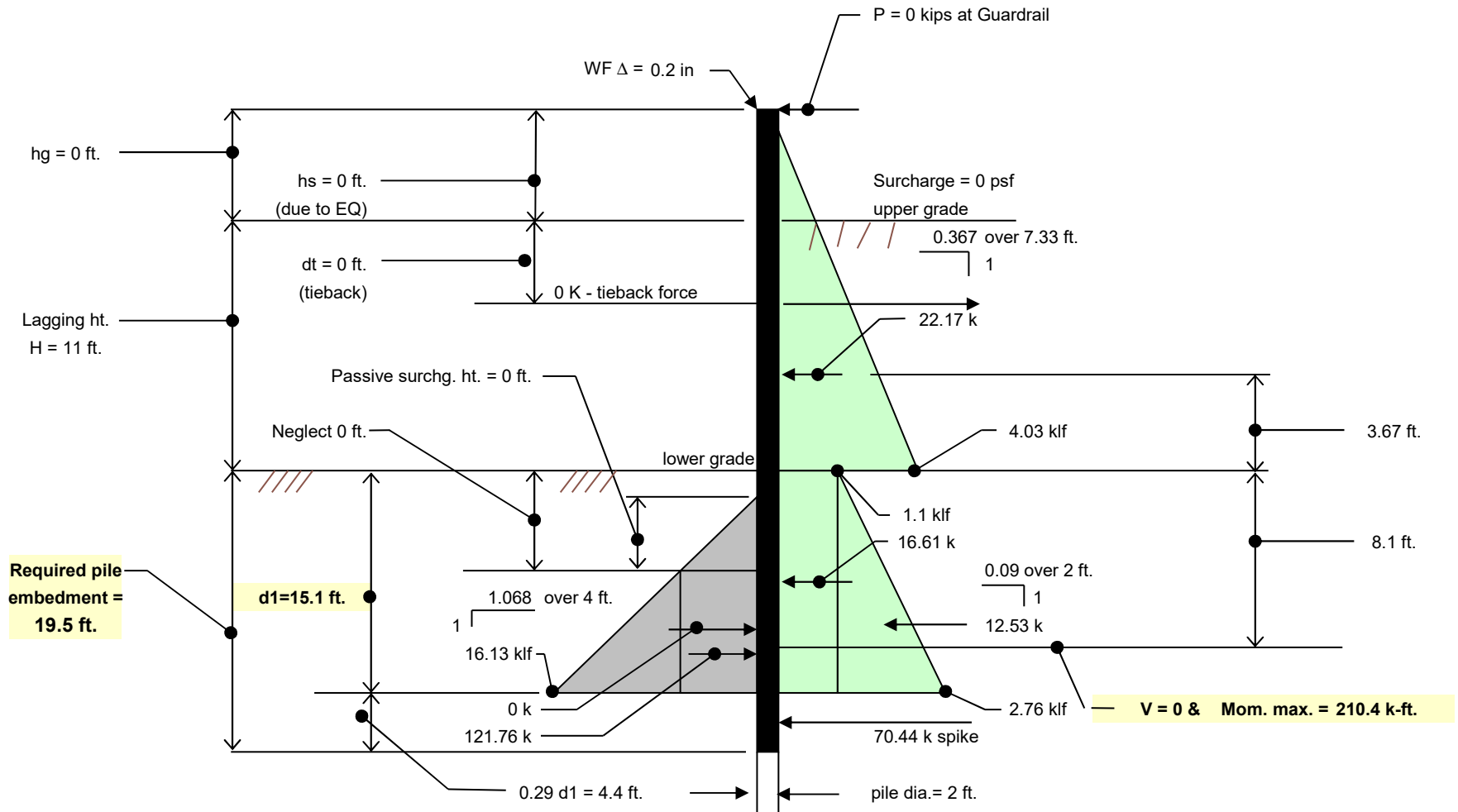**Lagging Design:**

Lagging moment =	**1.85**	k-ft./ft.
Lagging required bending stress =	**0.91**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.37**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	72	plf			
Total length of pile:	34.00	ft.			
wt =	2.45	kips			
Concrete:	3.14	area	depth to consider for skin friction =	14.00	ft.
Total Length of concrete:	23.00	ft.	surface area of pile =	87.96	sq.ft.
wt =	10.84	kips	skin friction capacity =	87.96	kips
Superimposed Load on Pile =	43.14	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**56.43**	**kips**	**sum vertical capacity =**	**87.96**	
			F.S. bearing =	**1.56**	
			Combined pile skin friction & end bearing is	**O.K.**	

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Pile L-SP2
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P = 0 kips at Guardrail

WF Δ = 0.2 in

hg = 0 ft.

hs = 0 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.367 over 7.33 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

22.17 k

Lagging ht.
H = 11 ft.

Passive surchg. ht. = 0 ft.

3.67 ft.

Neglect 0 ft.

4.03 klf

lower grade

1.1 klf

16.61 k

8.1 ft.

Required pile
embedment =
19.5 ft.

d1=15.1 ft.

0.09 over 2 ft.
1

1.068 over 4 ft.
1

12.53 k

16.13 klf

0 k

2.76 klf

V = 0 &   Mom. max. = 210.4 k-ft.

121.76 k

70.44 k spike

0.29 d1 = 4.4 ft.

pile dia.= 2 ft.

Pile L-SP2:   **W12X72**

SOLDIER PILE DESIGN ILLUSTRATION FOR 11 FT. WALL

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Pile L-SP2-C
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L-SP2-C

INPUT

Soil Wt. =	125	pcf *
Active EFP =	45	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	8	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	2.00	ft.
Pile spacing =	8.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	8.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W12X35	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	0	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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Pile L-SP2-C
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OUTPUT

Effective surcharge height "hs" =	**1.422**	ft. (upper grade)
Moment max. =	**127.3**	k-ft.
Sx (provided) =	**45.6**	in.^{3}
Ix (provided) =	**285**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**6.56**	in.
d =	**12.50**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
        including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**33.49**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**14.12**	in. **4.94 in. clr. if WF is centered in pile**
WF Δ =	**0.186**	in. (at top of pile due to loading above lower grade)
	W12X35 O.K. for stress	

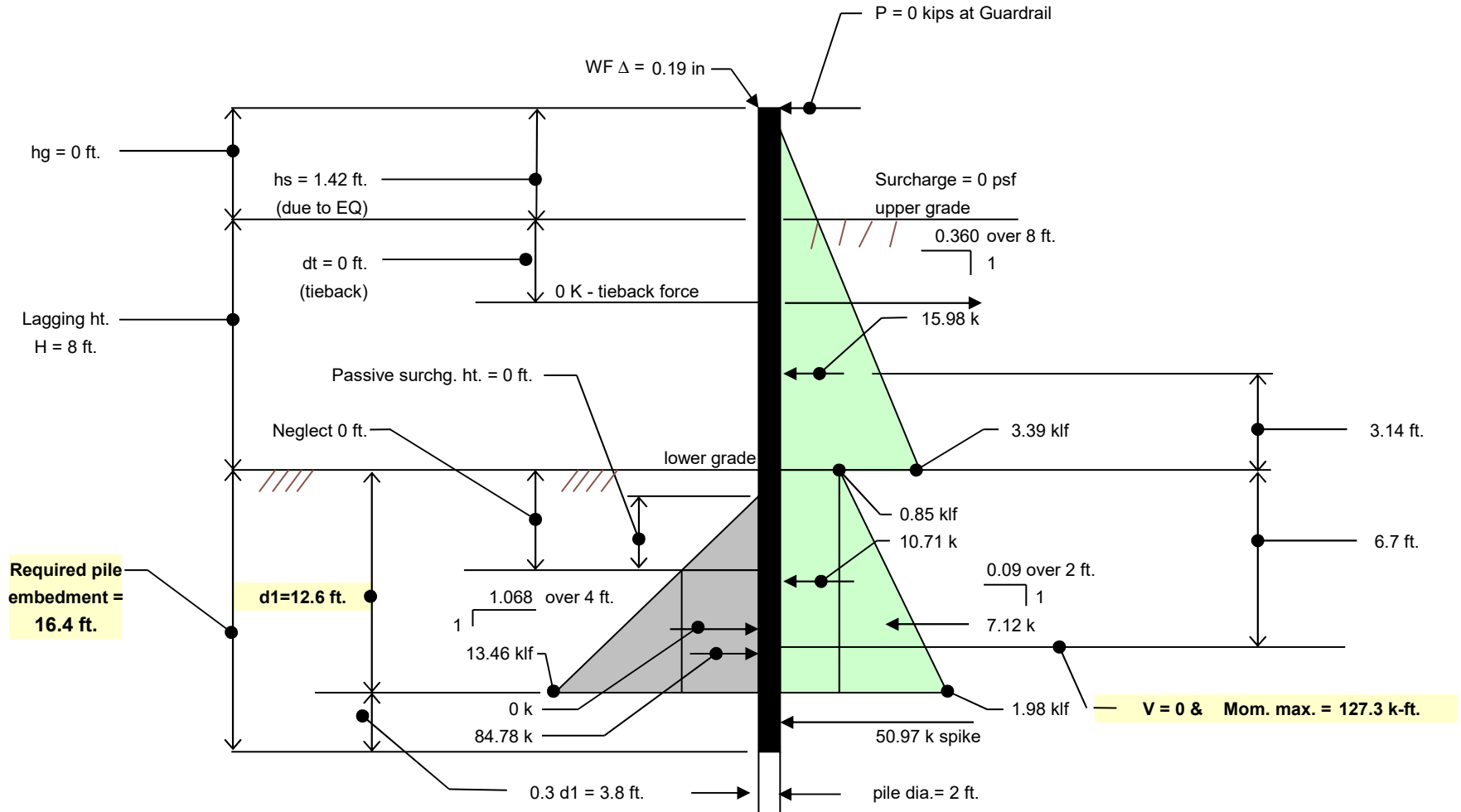**Lagging Design:**

Lagging moment =	**1.70**	k-ft./ft.
Lagging required bending stress =	**0.84**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.34**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	35	plf			
Total length of pile:	28.00	ft.			
wt =	0.98	kips			
Concrete:	3.14	area	depth to consider for skin friction =	8.00	ft.
Total Length of concrete:	20.00	ft.	surface area of pile =	50.27	sq.ft.
wt =	9.42	kips	skin friction capacity =	50.27	kips
Superimposed Load on Pile =	15.97	kips	bearing capacity =	0.00	kips
Sum Pile DL =	**26.37**	**kips**	**sum vertical capacity =**	**50.27**	
			F.S. bearing = 1.91		
			Combined pile skin friction & end bearing is **O.K.**		

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Pile L-SP2-C
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P = 0 kips at Guardrail

WF Δ = 0.19 in

hg = 0 ft.

hs = 1.42 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.360 over 8 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

15.98 k

Lagging ht.
H = 8 ft.

Passive surchg. ht. = 0 ft.

3.39 klf

3.14 ft.

Neglect 0 ft.

lower grade

0.85 klf

10.71 k

6.7 ft.

**Required pile
embedment =
16.4 ft.**

d1=12.6 ft.

1.068 over 4 ft.

1

0.09 over 2 ft.
1

7.12 k

13.46 klf

0 k

84.78 k

1.98 klf

50.97 k spike

V = 0 &   Mom. max. = 127.3 k-ft.

0.3 d1 = 3.8 ft.

pile dia.= 2 ft.

Pile L-SP2-C: **W12X35**

SOLDIER PILE DESIGN ILLUSTRATION FOR 8 FT. WALL

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18156 - The Murray Residence Shoring Wall.xlsx

Pile L-Landscape
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L-LANDSCAPE	**INPUT**	
Soil Wt. =	125	pcf *
Active EFP =	40	pcf *
Passive EFP =	267	pcf *
Additional Uniform Load [rectangular] =	0	psf *
Seismic factor =	0	x "H"
# of pile ϕ active pressure is effective over =	1	below lagging *
# of pile ϕ passive pressure is effective over =	2	below lagging *
Effective Concrete Pile ϕ =	1.50	ft.
Pile spacing =	10.00	ft.
Surcharge =	0	psf
Retained (lagging) height "H" =	4.00	ft.
Height of Tieback from Bottom of Excavation =	0.00	ft.
Height of influence from additional Uniform Load =	0	ft.
Trial WF size =	W8X15	
WF Fy =	50	ksi
Required WF clearance within pile =	2	in. (all around)
For Passive resistance neglect top	0	ft.* of soil (lower grade)
Neglected soil ht. used for passive surcharge	0	ft.* of soil (lower grade)
Max.active pressure used for lagging design =	50	% * @ lower grade
Allowable soil bearing @ bottom of pile =	1,000	psf *
Allowable pile skin friction to reduce end brg. =	1,000	psf *
Guardrail impact load per pile =	0	kips
Guardrail height above upper grade hg =	0	ft.
Duration increase for passive pres. w/ impact =	1.00	Guardrail impact (Range 1.00 to 1.33)

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OUTPUT

Effective surcharge height "hs" =	**0.000**	ft. (upper grade)
Moment max. =	**11.7**	k-ft.
Sx (provided) =	**11.8**	in.^{3}
Ix (provided) =	**48**	in.^{4}
E $_{WF}$ =	**29000**	ksi
bf =	**4.01**	in.
d =	**8.11**	in.

NOTE : -

1.) d1 range is from "H" to "6H only".

2.) * = Per soils engineer's requirements,
      including appropriate Factors of safety.

Maximum Bending Stress on WF Pile:

fb (actual) =	**11.94**	ksi WF O.K. for stress
Fb = .76 Fy =	**38.00**	ksi AISC 9th Edition pg. 5-155
WF diagonal =	**8.94**	in. **4.53 in. clr. if WF is centered in pile**
WF Δ =	**0.017**	in. (at top of pile due to loading above lower grade)

W8X15 O.K. for stress

Lagging Design:
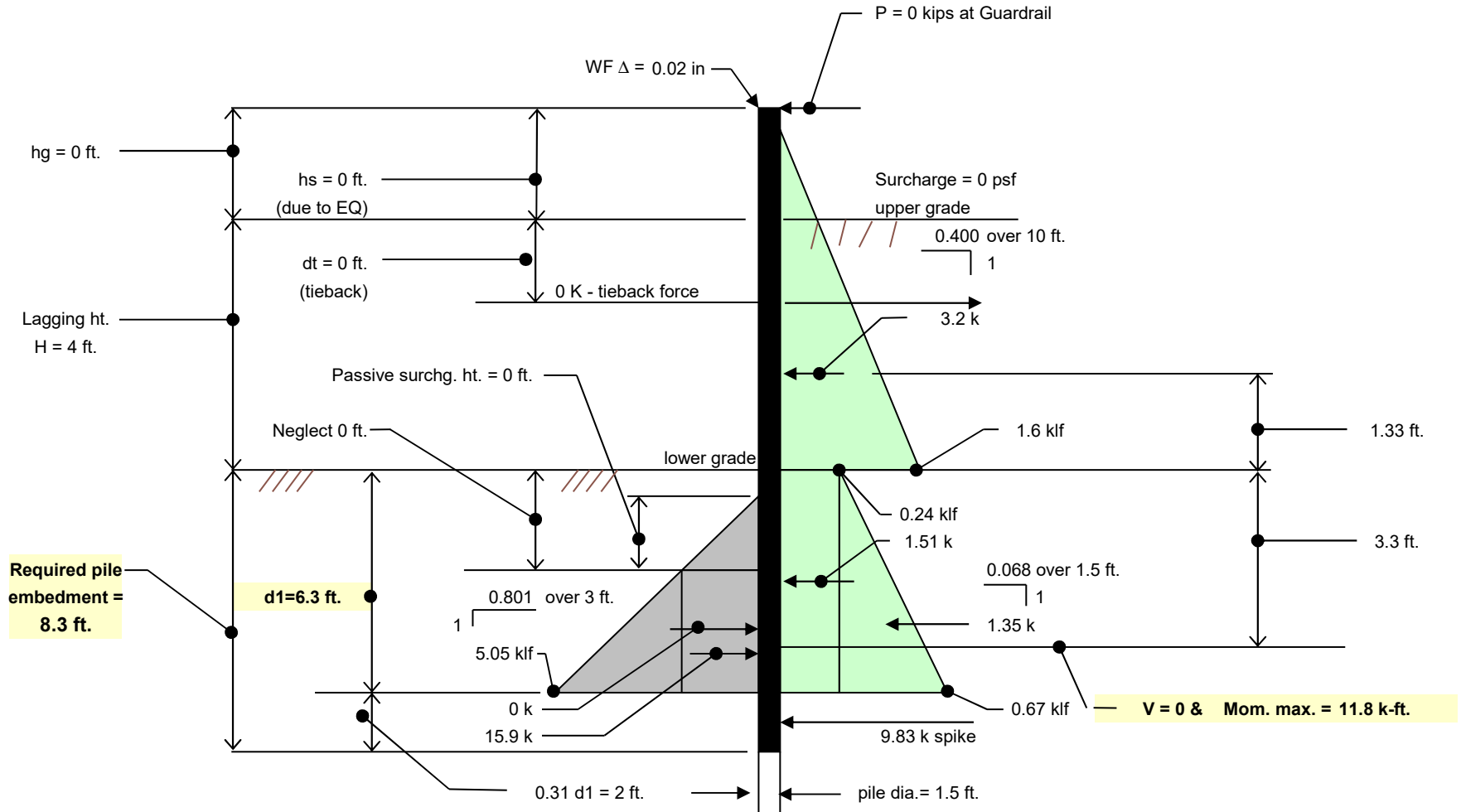
Lagging moment =	**1.00**	k-ft./ft.
Lagging required bending stress =	**0.49**	ksi (for 3-1/2 in. thick pressure treated lagging at 50% full active EFP)
Lagging required bending stress =	**0.20**	ksi (for 5-1/2 in. thick pressure treated lagging at 50% full active EFP)

Combined Pile Skin Friction & End Bearing:

Weight per lineal foot of WF:	15	plf			
Total length of pile:	13.00	ft.			
wt =	0.20	kips			
Concrete:	1.77	area	depth to consider for skin friction =	0.00	ft.
Total Length of concrete:	9.00	ft.	surface area of pile =	0.00	sq.ft.
wt =	2.39	kips	skin friction capacity =	0.00	kips
Superimposed Load on Pile =	0.00	kips	bearing capacity =	1.77	kips
Sum Pile DL =	**2.58**	**kips**	**sum vertical capacity =**	**1.77**	

F.S. bearing = 0.68

Combined pile skin friction & end bearing is **No Good**

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P = 0 kips at Guardrail

WF Δ = 0.02 in

hg = 0 ft.

hs = 0 ft.
(due to EQ)

Surcharge = 0 psf
upper grade

0.400 over 10 ft.
1

dt = 0 ft.
(tieback)

0 K - tieback force

3.2 k

Lagging ht.
H = 4 ft.

Passive surchg. ht. = 0 ft.

1.6 klf

Neglect 0 ft.

lower grade

1.33 ft.

0.24 klf

1.51 k

3.3 ft.

Required pile embedment = 8.3 ft.

d1=6.3 ft.

0.068 over 1.5 ft.
1

0.801 over 3 ft.
1

1.35 k

5.05 klf

0 k

0.67 klf

V = 0 &   Mom. max. = 11.8 k-ft.

15.9 k

9.83 k spike

0.31 d1 = 2 ft.

pile dia.= 1.5 ft.

Pile L-LANDSCAPE: **W8X15**

SOLDIER PILE DESIGN ILLUSTRATION FOR 4 FT. WALL