

DESIGN CRITERIA:

AASHTO simplified method GRS wall and based on FHWA-PUB HRT-11-026.
 $\phi=34^\circ$ Class I Backfill friction angle
 $\gamma_{soil}=125(LB/CF)$ PCF unit weight with 95% AASHTO T180
 $\psi=1.5$ Horizontal Earth Pressure Factor
 $\gamma_v=1.35$ Vertical Earth Pressure Factor
 $LS=1.75$ Live Load Surcharge Factor
 $LLSurg=2'$ Live Load Surcharge
 $d_{max}=2''$ CDOT Class I Backfill Max Size
 $HMA_{thk}=12''$ HMA Thickness
 $HMA=140(LB/CF)$ HMA unit weight
 $\gamma_{HMA}=\max:1.5 \min:0.65$ HMA design factor
 $\beta=\tan(0.5)$ Backfill angle
 $B1=\text{if } \beta \leq \tan(6 \times \tan(\beta)/2 \times z), \beta$ AASHTO Fig 3.11.5.8.1-3 Broken Backfill 6' Typ. set back
 otherwise $B1=\tan(6 \times \tan(\beta)/2 \times z)$ and 3' Max. fill height

Rail Impact=0 Neglect rail impact load due to 3' Max. fill height
 $Kaf = \frac{\cos(B1) \times \cos(B1) - \sqrt{\cos^2(B1) - \cos^2(\phi)}}{\cos(B1) + \sqrt{\cos^2(B1) - \cos^2(\phi)}}$ Rankine Active Earth Pressure Kaf
 $Rv(z) = \gamma_{soil} \times [\gamma_v \times (z+3.0) + LS \times LLSurg]$ Resultant of Soil & Surcharge

$\sigma_{AH1} = \frac{1}{2} Kaf \times g_{h1} \times g_{soil} \times (z+3.0)^2$ Overburden Earth Pressure at back face of active zone
 $\sigma_{AH2} = Kaf \times LS \times LLSurg \times g_{soil} \times (z+3.0)$ Surcharge pressure at back face of active zone
 $Mo(z) = \frac{1}{2} (z+3) \times \cos(B1) \times \sigma_{AH1} + \frac{1}{2} (z+3) \times \cos(B1) \times \sigma_{AH2}$ Overturning Moment

$Mr(z) = [g_v \times g_{soil} \times (z+3)] \times \frac{RL^2}{2} + RL \times \sin(B1) \times \sigma_{AH1} + RL \times \sin(B1) \times \sigma_{AH2}$ Righting Moment
 $Ecc(z) = \frac{RL(z) - Mo(z)}{2 - Rv(z) \times RL(z) + \sin(B1) \times (\sigma_{AH1} + \sigma_{AH2})}$ Eccentricity of Resultant
 $\sigma_{v1}(z) = \gamma_v \times \gamma_{soil} \times (z+3) + LS \times \gamma_{soil} \times LLSurg$ Overburden with LS

$\sigma_{v2}(z) = \gamma_{soil} \times (z+3) + LLSurg \times \gamma_{soil}$ Unfactored Overburden without LS
 $\sigma_H(z) = Kaf \times \sigma_{v1}(z) \times GRSfactor$ Lateral Earth Pressure AASHTO LRFD Eq 11.10.6.2.1-1
 $\sigma_h(z) = \sigma_H(z)$ (lb./ft.)
 $Sum\sigma_h(z) = \sigma_H(z) \times spacing(z)$ Summation of Eq 11.10.6.2.1-1

$T_{max}(z) = \frac{\sigma_h(z) \times spacing(z)}{12}$ AASHTO LRFD Eq 11.10.6.2.1-2
 $\alpha=0.6$ Scale Correction Factor
 $Rc=1.0$ Coverage Ratio
 $\phi_p=0.9$ Resistance Factor Reinforcing Pullout
 $Cp=2.0$ Both Top and Bottom
 $Fp=0.67 \times \tan(\phi)$ Pullout Friction Factor

$Le(z) = \frac{T_{max}(z)}{(\phi_p \times Fp \times \alpha \times \gamma_{soil} \times (z+3) \times Cp \times Rc)}$ AASHTO LRFD Eq 11.10.6.3.2-1
 $Bear(z) = \frac{1}{2} \times 1000 \times \frac{RL(z) \times Rv(z) + \sin(B1) \times [\sigma_{AH1} + \sigma_{AH2}]}{(RL(z) - 2 \times ecc(z))}$ AASHTO LRFD Eq 11.6.3.2.-1 (Bearing Pressure in TSF)
 $GRSspacing=8''$ Soil reinforcement spacing including short tail reinforcements

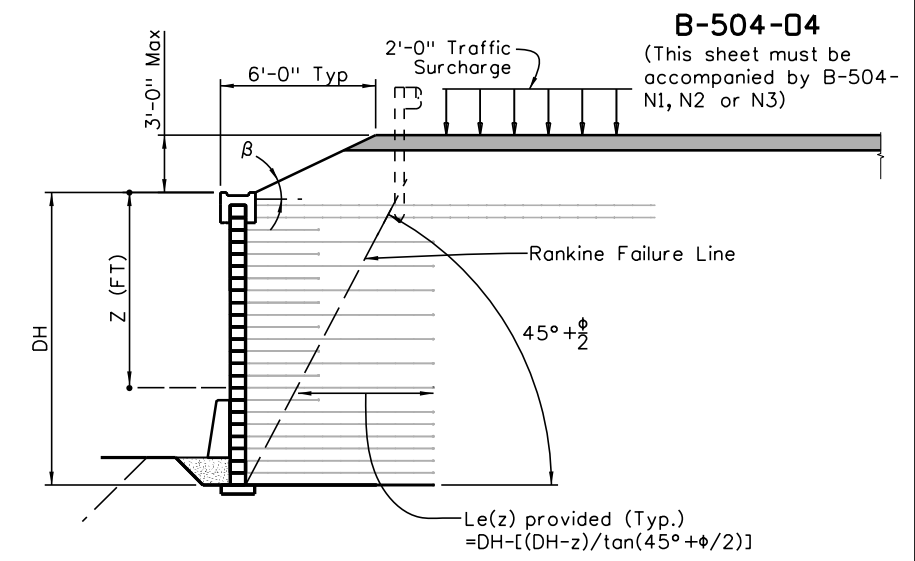
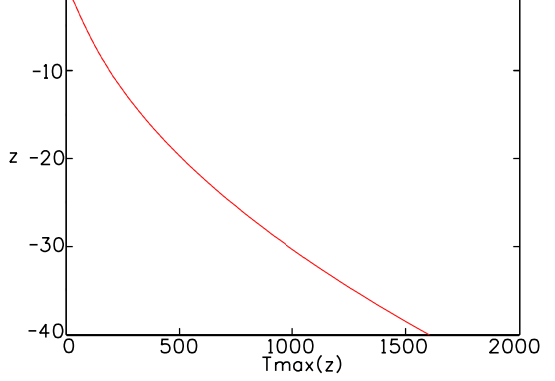
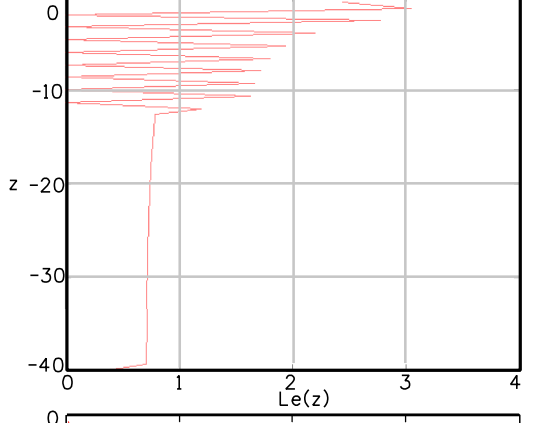
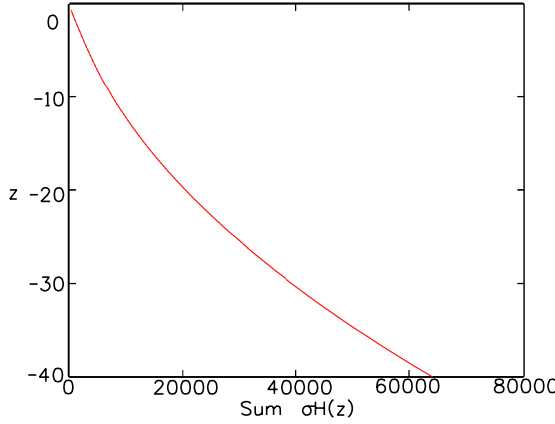
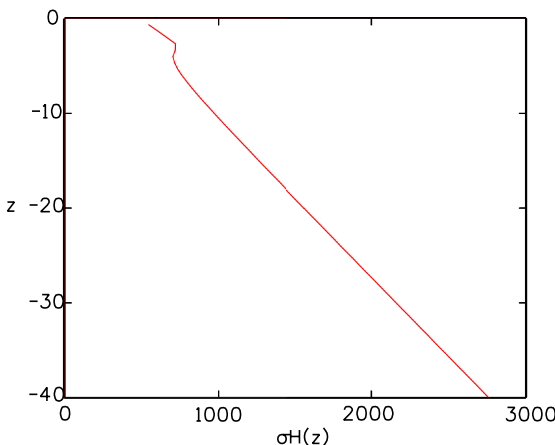
$GRSfactor = \left[\frac{1}{0.7 [GRSspacing / (6 \times d_{max})]} \right] = 1.268$ GRS wall factor (FHWA-HRT-11-026 Eq 31)

With the accompanied earthquake (EQ) resistance wall details, MSE wall design without EQ load combination meets LRFD Seismic Performance Zones (SPZ) 1 through 3. For avoiding seismic induced backfill leaks due to roadway tension cracks, block topping or panel splitting; these details including coping, extended top two layers of soil reinforcing, panel joint, rail anchor slab/beam, leveling pad and end of wall treatment shall be used.

Table values are per linear feet of wall.

DH or Z (Ft)	# DF BLOCKS	σ_H (Lb/Ft)	$\Sigma \sigma_H \times spacing$ (Lb/Ft)	RL TYPE	SPACING	Le (Ft)
0.667	Coping	544.284	362.856	TOP	12"	2.433
1.333	2	602.255	764.360	TOP	16"	3.037
2.000	3	660.226	1.21E+03	TAIL	N/A	NA
2.667	4	718.198	1.68E+03	FULL	16"	2.77
3.333	5	717.611	2.16E+03	TAIL	N/A	NA
4.000	6	702.437	2.63E+03	FULL	16"	2.193
4.667	7	712.544	3.11E+03	TAIL	N/A	NA
5.333	8	734.000	3.59E+03	FULL	16"	1.925
6.000	9	761.519	4.10E+03	TAIL	N/A	NA
6.667	10	792.642	4.63E+03	FULL	16"	1.792
7.333	11	826.070	5.18E+03	TAIL	N/A	NA
8.000	12	861.055	5.76E+03	FULL	16"	1.711
8.667	13	897.139	6.35E+03	TAIL	N/A	NA
9.333	14	934.023	6.98E+03	FULL	16"	1.655
10.000	15	971.508	7.62E+03	TAIL	N/A	NA
10.667	16	1.01E+03	8.30E+03	FULL	16"	1.614
12.000	18	1.09E+03	9.72E+03	FULL	12"	1.187
12.667	19	1.13E+03	1.05E+04	FULL	8"	0.785
13.333	20	1.16E+03	1.13E+04	FULL	8"	0.779
14.000	21	1.20E+03	1.21E+04	FULL	8"	0.773
14.667	22	1.24E+03	1.29E+04	FULL	8"	0.769
15.333	23	1.28E+03	1.37E+04	FULL	8"	0.764
16.000	24	1.32E+03	1.46E+04	FULL	8"	0.76
16.667	25	1.36E+03	1.55E+04	FULL	8"	0.756
17.333	26	1.40E+03	1.65E+04	FULL	8"	0.753
18.000	27	1.44E+03	1.74E+04	FULL	8"	0.75
18.667	28	1.48E+03	1.84E+04	FULL	8"	0.747
19.333	29	1.52E+03	1.94E+04	FULL	8"	0.744
20.000	30	1.56E+03	2.05E+04	FULL	8"	0.741
20.667	31	1.60E+03	2.15E+04	FULL	8"	0.739
21.333	32	1.64E+03	2.26E+04	FULL	8"	0.736
22.000	33	1.68E+03	2.37E+04	FULL	8"	0.734
22.667	34	1.72E+03	2.49E+04	FULL	8"	0.732
23.333	35	1.76E+03	2.61E+04	FULL	8"	0.73
24.000	36	1.80E+03	2.73E+04	FULL	8"	0.728
24.667	37	1.84E+03	2.85E+04	FULL	8"	0.727
25.333	38	1.88E+03	2.97E+04	FULL	8"	0.725
26.000	39	1.92E+03	3.10E+04	FULL	8"	0.723
26.667	40	1.96E+03	3.23E+04	FULL	8"	0.722
27.333	41	2.00E+03	3.37E+04	FULL	8"	0.721
28.000	42	2.04E+03	3.50E+04	FULL	8"	0.719
28.667	43	2.08E+03	3.64E+04	FULL	8"	0.718
29.333	44	2.12E+03	3.78E+04	FULL	8"	0.717
30.000	45	2.16E+03	3.93E+04	FULL	8"	0.716
30.667	46	2.20E+03	4.07E+04	FULL	8"	0.714
31.333	47	2.24E+03	4.22E+04	FULL	8"	0.713
32.000	48	2.28E+03	4.37E+04	FULL	8"	0.712
32.667	49	2.32E+03	4.53E+04	FULL	8"	0.711
33.333	50	2.36E+03	4.69E+04	FULL	8"	0.71
34.000	51	2.40E+03	4.85E+04	FULL	8"	0.709
34.667	52	2.44E+03	5.01E+04	FULL	8"	0.708
35.333	53	2.48E+03	5.17E+04	FULL	8"	0.708
36.000	54	2.52E+03	5.34E+04	FULL	8"	0.707
36.667	55	2.56E+03	5.51E+04	FULL	8"	0.706
37.333	56	2.60E+03	5.69E+04	FULL	8"	0.705
38.000	57	2.64E+03	5.86E+04	FULL	8"	0.704
38.667	58	2.68E+03	6.04E+04	FULL	8"	0.704
39.333	59	2.72E+03	6.22E+04	FULL	8"	0.703
40.000	60	2.76E+03	6.41E+04	FULL	4"	0.351

* Summation of σ_H above Z
 ** Tributary spacing



APPLICATION DIAGRAM (DH=16' AS SHOWN)

EXAMPLES:

Biaxial woven polyester (PET) geotextile with ultimate strengths of 4,800 and 7,200 LB./FT. is used for soil reinforcing layers. See CDOT B504 Standard Special for K Values

- $T_{al} = T_{ult} \times K$
 $K = 30\%(\text{PET})$
- Given:
 - Check T_{max} for $DH=16'$, $Z=10.667'$, spacing=16", $R_c=1$ (For 100% coverage) and $\phi=0.9$ $T_{max} \leq \phi T_{al} R_c$ AASHTO 11.10.6.4.1-1
 $T_{max} = \sigma_H \times Spacing = 1010 \times 16 / 12 = 1346.7$ Lb/Ft
 - The 16' high wall has 8 layers of tails and 16 full layers, neglecting tail contribution check sum of all layers. $\Sigma \sigma_H = 16 \times 1440 = 2.30 \times 10^4$ Lb/Ft > 1.46×10^4 Lb/Ft
- $DH=40'$; Check $z=39.333$
 - $T_{max} = \sigma_H \times Spacing = 2.72 \times 10 \times 8 / 12 = 1813$ VS 2160 Lb/Ft
 - $\Sigma \sigma_H \times spacing$; (Full Layers) $37 \times 1440 + 15 \times 2160 = 8.56 \times 10^4$ Lb/Ft > 6.41×10^4 Lb/Ft
- Check the second layer down $z=1.333$, Le (Required from Table) = 2.1333'
 $Le(\text{Provided}) = 6' - (6 - 1.333) / \tan(45^\circ + \phi/2) = 6 - 2.48 = 3.52' > 2.1333'$
- Factored bearing pressure (BP) for $DH=40'$
 From B-504-N1 BP=5.673 TSF
 From B-504-N2 BP=10.778 TSF
 From B-504-N3 BP=10.122 TSF
 Must check against ultimate bearing capacity in geotechnical report.

Revision Dates
09-16
10-24

INITIALS	DESIGN	DATE	DETAIL	DATE	QUANTITY	DATE
By						
Checked By						

All seals for this set of drawings are applied to the cover page(s)	Print Date: \$DATE\$	Sheet Revisions			Colorado Department of Transportation 2829 West Howard Place, 3rd Floor Denver, CO 80204 Phone: 303-512-4079 FAX: 303-757-9197 Staff Bridge Branch	As Constructed No Revisions: Revised: Void:	LRFD GRS WALL WITH 2H(MIN.):1V BROKEN BACK SLOPE DESIGN CHARTS/TABLE			Project No./Code Sheet Number
	File Name: Sheet_B-504-04.dgn	Date:	Comments	Init.			Designer: XXXXXXXX	Structure Numbers: XXXXXXXXXXXXX		
	Horiz. Scale: Vert. Scale: As Noted						Detailer: XXXXXXXX	Subset Sheets: WXX of XXX		
	Unit Information Unit Leader Initials						Sheet Subset: WALL			