

DESIGN CRITERIA:

Note to Designer: Update design for current MASH loads.

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
 $\gamma_h=1.5$ Horizontal Earth Pressure Factor
 $\gamma_v=1.35$ Vertical Earth Pressure Factor
 $LS=1.75$ Live Load Surcharge Factor
 $LLSurg=2'$ Live Load Surcharge
 $dmax=2''$ CDDT Class I Backfill Max Size
 $HMAthk=3''$ hma=140(LB/CF) HMA Thickness / HMA unit weight
 $\gamma_{HMA} = \max(1.5 \text{ min}; 0.65)$ HMA design factor
 $Cthk=8''$ $\gamma_C=145(LB/CF)$ Concrete Thickness/ Concrete design unit weight
 $Cmax=1.5$ $Cmin=0.9$ Concrete design factor
 $Ka = \frac{1-\sin(\phi)}{1+\sin(\phi)}$ Active Earth Pressure Coefficient Ka

$Rv(z) = \gamma_v \gamma_{soil} (z - \frac{Cthk}{12}) + Cmax \gamma_C \frac{Cthk}{12}$ Resultant of Soil & Surcharge
 $+ \gamma_{HMA} \max(xhmax, \frac{HMAthk}{12}) + LS \gamma_{ys} xLLSurg$

$Mo(z) = \frac{1}{2} K_a x L S \gamma_{soil} x z^2 + \frac{1}{2} K_a x \gamma_{HMA} \max(xhmax, \frac{HMAthk}{12}) z^2$ Overturning Moment (HMA layer treated as soil)

$Mr(z) = Rv(z) \times RL(z) \times RL(z) / 2$ Righting Moment

$ecc(z) = RL(z) / 2 - [(Mr(z) - Mo(z)) / (Rv(z) \times RL(z))]$ Eccentricity of Resultant

$\sigma v1(z) = Rv(z)$ Overburden with LS

$\sigma v2(z) = \gamma_{soil} (z - Cthk/12) + \gamma_C x Cthk/12 + hmax \gamma_{HMA} / 12$ Unfactored Overburden without LS

$\sigma h(z) = Ka \times \sigma v1(z) \times GRSfactor$ AASHTO LRFD Eq 11.10.6.2.1-1 (Lb/Ft)

Rail Impact(z) = if $z \leq 15.1'$, $660(1-z/15.1)$, otherwise=0
 $\sigma h(z) =$ if $z \leq 15.1'$, $\sigma h(z) +$ Rail Impact 54 kips for TL-4
 otherwise $\sigma h(z) = \sigma H(z)$

$\sum \sigma h(z) = \sigma h(z) \times spacing(z)$ Summation of Eq 11.10.6.2.1-1

$Tmax(z) = \frac{\sigma h(z) \times spacing(z)}{12}$ 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

$Le(z) = \frac{Tmax(z)}{(\phi_p \times Fp \times \alpha \times \sigma v2(z) \times Cp \times Rc)}$ AASHTO LRFD Eq 11.10.6.3.2-1

$Bear(z) = \frac{1}{2} \times \frac{1}{1000} \times \frac{RL(z) \times Rv(z)}{(RL(z) - 2 \times ecc(z))}$ AASHTO LRFD Eq 11.6.3.2.-1 (Bearing Pressure in TSF)

$GRSspacing=8''$ Soil reinforcement spacing including short tail reinforcements

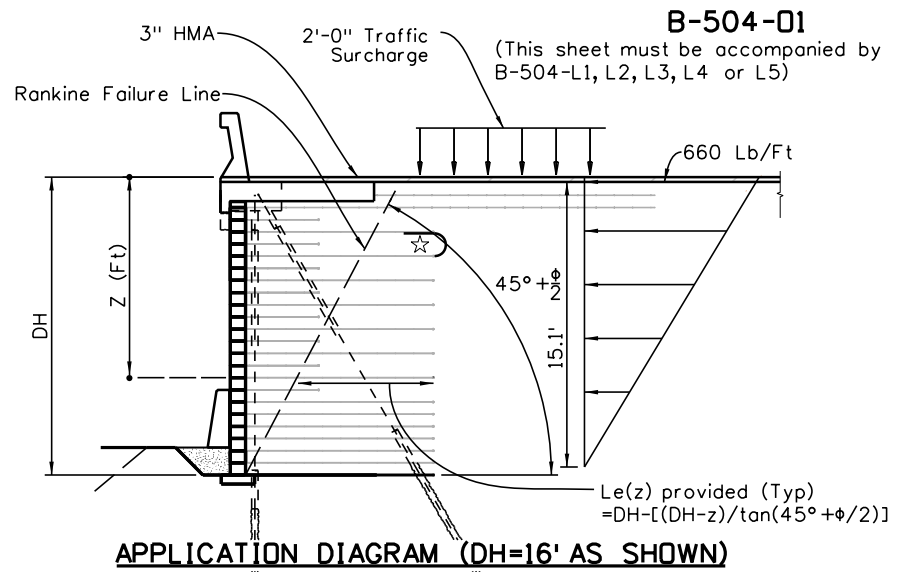
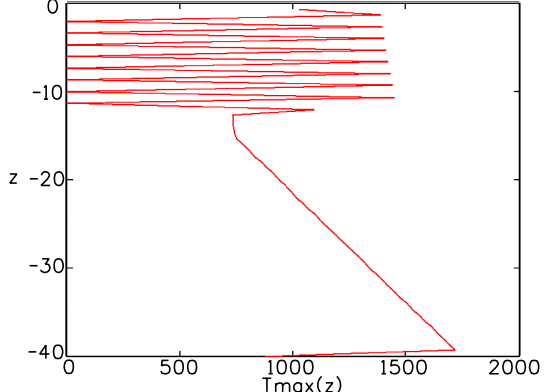
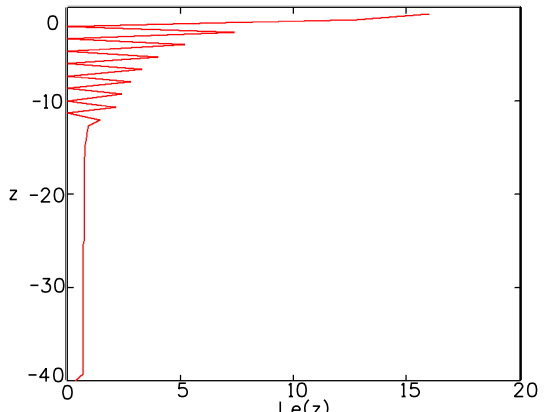
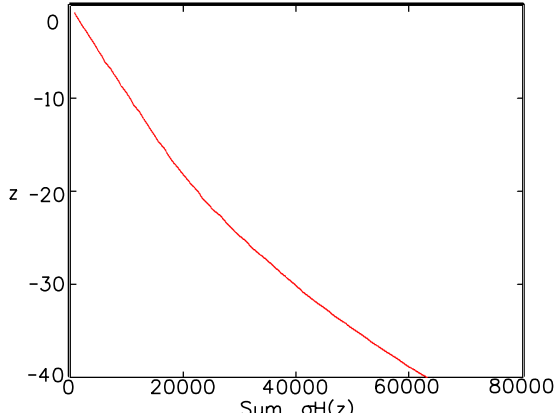
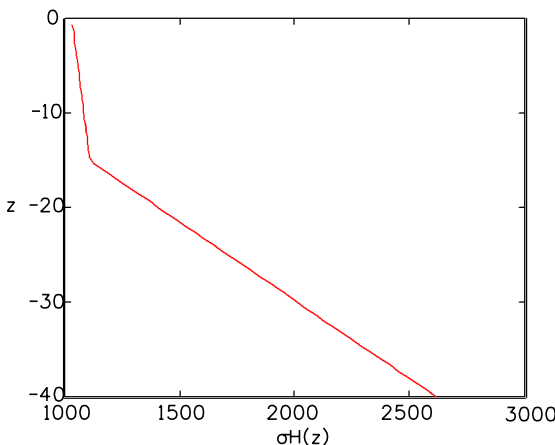
$GRSfactor = \left[\frac{1}{0.7 [GRSspacing / (6 \times dmax)]} \right] = 1.268$ GRS wall factor (FHWA-HRT-11-026 Eq 31)

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)	# OF BLOCKS	σH (Lb/Ft)	$\sum \sigma h \times spacing$ (Lb/Ft)	RL TYPE	SPACING	Le (Ft)
0.667	Coping	1.03E+03	685.28	TOP	12"	15.995
1.333	2	1.04E+03	1.38E+03	TOP	16"	12.782
2.000	3	1.04E+03	2.07E+03	TAIL	N/A	NA
2.667	4	1.04E+03	2.77E+03	FULL	16"	7.344
3.333	5	1.05E+03	3.46E+03	TAIL	N/A	NA
4.000	6	1.05E+03	4.17E+03	FULL	16"	5.172
4.667	7	1.05E+03	4.87E+03	TAIL	N/A	NA
5.333	8	1.06E+03	5.57E+03	FULL	16"	4.003
6.000	9	1.06E+03	6.28E+03	TAIL	N/A	NA
6.667	10	1.06E+03	6.99E+03	FULL	16"	3.273
7.333	11	1.07E+03	7.70E+03	TAIL	N/A	NA
8.000	12	1.07E+03	8.42E+03	FULL	16"	2.773
8.667	13	1.07E+03	9.13E+03	TAIL	N/A	NA
9.333	14	1.08E+03	9.85E+03	FULL	16"	2.41
10.000	15	1.08E+03	1.06E+04	TAIL	N/A	NA
10.667	16	1.08E+03	1.13E+04	FULL	16"	2.134
11.333	17	1.09E+03	1.20E+04	TAIL	N/A	NA
12.000	18	1.09E+03	1.28E+04	FULL	12"	1.438
12.667	19	1.10E+03	1.35E+04	FULL	8"	0.913
13.333	20	1.10E+03	1.42E+04	FULL	8"	0.871
14.000	21	1.10E+03	1.49E+04	FULL	8"	0.833
14.667	22	1.11E+03	1.57E+04	FULL	8"	0.799
15.333	23	1.12E+03	1.64E+04	FULL	8"	0.777
16.000	24	1.16E+03	1.72E+04	FULL	8"	0.772
16.667	25	1.20E+03	1.80E+04	FULL	8"	0.768
17.333	26	1.24E+03	1.88E+04	FULL	8"	0.764
18.000	27	1.28E+03	1.97E+04	FULL	8"	0.76
18.667	28	1.32E+03	2.06E+04	FULL	8"	0.757
19.333	29	1.36E+03	2.15E+04	FULL	8"	0.753
20.000	30	1.40E+03	2.24E+04	FULL	8"	0.75
20.667	31	1.44E+03	2.34E+04	FULL	8"	0.747
21.333	32	1.48E+03	2.44E+04	FULL	8"	0.745
22.000	33	1.53E+03	2.54E+04	FULL	8"	0.742
22.667	34	1.57E+03	2.64E+04	FULL	8"	0.74
23.333	35	1.61E+03	2.75E+04	FULL	8"	0.738
24.000	36	1.65E+03	2.86E+04	FULL	8"	0.736
24.667	37	1.69E+03	2.97E+04	FULL	8"	0.734
25.333	38	1.73E+03	3.09E+04	FULL	8"	0.732
26.000	39	1.77E+03	3.20E+04	FULL	8"	0.73
26.667	40	1.81E+03	3.33E+04	FULL	8"	0.728
27.333	41	1.85E+03	3.45E+04	FULL	8"	0.727
28.000	42	1.89E+03	3.57E+04	FULL	8"	0.725
28.667	43	1.93E+03	3.70E+04	FULL	8"	0.724
29.333	44	1.97E+03	3.83E+04	FULL	8"	0.722
30.000	45	2.01E+03	3.97E+04	FULL	8"	0.721
30.667	46	2.05E+03	4.10E+04	FULL	8"	0.72
31.333	47	2.09E+03	4.24E+04	FULL	8"	0.719
32.000	48	2.13E+03	4.39E+04	FULL	8"	0.717
32.667	49	2.17E+03	4.53E+04	FULL	8"	0.716
33.333	50	2.21E+03	4.68E+04	FULL	8"	0.715
34.000	51	2.25E+03	4.83E+04	FULL	8"	0.714
34.667	52	2.29E+03	4.98E+04	FULL	8"	0.713
35.333	53	2.33E+03	5.14E+04	FULL	8"	0.712
36.000	54	2.37E+03	5.29E+04	FULL	8"	0.711
36.667	55	2.41E+03	5.45E+04	FULL	8"	0.71
37.333	56	2.45E+03	5.62E+04	FULL	8"	0.709
38.000	57	2.49E+03	5.78E+04	FULL	8"	0.709
38.667	58	2.53E+03	5.95E+04	FULL	8"	0.708
39.333	59	2.57E+03	6.12E+04	FULL	8"	0.707
40.000	60	2.61E+03	6.30E+04	FULL	4"	0.353

Note: Le of top two layers are not developed, layers used for avoiding roadway tension cracks.
 * Summation of σH above Z including rail impact.
 ** Tributary spacing.
 ☆ Example looped geotextile layer for meeting pullout.



EXAMPLES:

Biaxial woven polyester (PET) geotextile with an ultimate strength of 4,800 or 7,200 Lb/Ft is used for soil reinforcing layers. See CDDT B504 Standard Special for K Values

- $T_{al} = T_{ult} \times K$
 $K = 30\%$ (PET)
- Given:
 - Check T_{max} for $DH=16'$, $Z=10.667'$ (T_{max}), spacing=16", $R_c=1$ (For 100% coverage) $T_{max} \leq T_{al} R_c$ AASHTO 11.10.6.4.1-1
 $T_{max} = \sigma H \times Spacing = 1080 \times 16 / 12 = 1436$ Lb/Ft
 1436 Lb/Ft < 1440 Lb/Ft
 - The 16' high wall has 8 layers of tails and 16 full layers, neglecting tail contribution check sum of all layers. $\sum \sigma H = 16 \times 1440 = 2.30 \times 10^4$ Lb/Ft > 1.72×10^4 Lb/Ft
- $DH=40'$, Check $z=39.333$
 - $T_{max} = \sigma H \times Spacing = 2.57 \times 10^3 \times 8 / 12 = 1700$ VS 2160 Lb/Ft
 - $\sum \sigma H \times spacing$; 39 (Full Layers) $\times 1440 + 12 \times 2160 = 8.20 \times 10^4$ Lb/Ft > 6.30×10^4 Lb/Ft
- Neglect the top layer pullout requirement for $DH=6'$ Truncated Base wall on B-504-G3. Check the third layer down $z=2.667'$, Le (Required from Table) = $7.34'$, $Le(Provided) = 6' - (6 - 2.667) / \tan(45^\circ + \phi/2) = 6 - 1.772 = 4.228' < 7.34'$. For any layer not meeting pullout requirement, failing layer may be looped with an adjacent layer to increase resistance.
- Factored bearing pressure (BP) for $DH=40'$
 From B-504-L1 BP=4.722 TSF
 From B-504-L2 or L3 BP=9.709 TSF
 From B-504-L4 or L5 BP=8.963 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	As Constructed No Revisions: Revised: Void:	LRFD GRS WALL WITH RAIL ANCHOR SLAB/B EAM DESIGN CHARTS/TABLE			Project No./Code
	File Name: Sheet_B-504-01.dgn	Date:	Comments	Init.			Designer: XXXXXXXX	Structure Numbers: XXXXXXXXXXXXX		
	Horiz. Scale: Vert. Scale: As Noted	Unit Information	Unit Leader Initials				Detailer: XXXXXXXX	Sheet Subset: WALL	Subset Sheets: WXX of XXX	