

Revision Dates	
09-16	10-24

INITIALS	DESIGN	DATE	DETAIL	DATE	QUANTITY	DATE
By						
Checked By						

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
 $\gamma_{\text{soil}}=125(\text{LB/CF})$ 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
 $LL_{\text{Surg}}=2'$ Live Load Surcharge
 $d_{\text{max}}=2''$ CDDT Class I Backfill Max Size
 $HMA_{\text{thk}}=3''$ $h_{\text{ma}}=140(\text{LB/CF})$ HMA Thickness / HMA unit weight
 $\gamma_{\text{HMA}}=\text{max:}1.5 \text{ min:}0.65$ HMA design factor
 $C_{\text{thk}}=8''$ $\gamma_C=145(\text{LB/CF})$ Concrete Thickness/ Concrete unit weight
 $C_{\text{max}}=1.5$ $C_{\text{min}}=0.9$ Concrete design factor
 $K_a=\frac{1-\sin(\phi)}{1+\sin(\phi)}$ Active Earth Pressure Coefficient K_a

$R_v(z)=\gamma_v \gamma_{\text{soil}} x(z-\frac{C_{\text{thk}}}{12})+C_{\text{max}} \gamma_C x \frac{C_{\text{thk}}}{12}$ Resultant of Soil & Surcharge
 $+ \gamma_{\text{HMA}} \text{max} x h_{\text{ma}} \frac{HMA_{\text{thk}}}{12} + LS \gamma_{\text{soil}} LL_{\text{Surg}}$

$M_o(z)=\frac{1}{6} K_a \gamma_{\text{soil}} x^3 z^3 + \frac{1}{2} K_a \gamma_{\text{HMA}} \text{max} x^2 z^2 + \frac{1}{2} K_a \gamma_{\text{HMA}} \text{max} x z^2$ Overturning Moment
(HMA layer treated as soil)

$M_r(z)=R_v(z) \times RL(z) \times RL(z)/2$ Righting Moment

$e_{\text{cc}}(z)=RL(z)/2-[M_r(z)-M_o(z)]/(R_v(z) \times RL(z))$ Eccentricity of Resultant

$\sigma_v1(z)=R_v(z)$ Overburden with LS

$\sigma_v2(z)=\gamma_{\text{soil}}(z-C_{\text{thk}}/12)+\gamma_C C_{\text{thk}}/12$ Unfactored Overburden without LS
 $+ h_{\text{ma}} \gamma_{\text{HMA}}/12$

$\sigma_h(z)=K_a \sigma_v1(z) \times GRS_{\text{factor}}$ 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 Rail Impact
 $\sigma_h(z)=$ if $z \leq 15.1$, $\sigma_h(z) + \text{Rail Impact}$ 54 kips
otherwise $\sigma_h(z)=\sigma_H(z)$ for TL-4

$\text{Sum}\sigma_h(z)=\sigma_h(z) \times \text{spacing}(z)$ Summation of Eq 11.10.6.2.1-1

$T_{\text{max}}(z)=\frac{\sigma_h(z) \times \text{spacing}(z)}{12}$ AASHTO LRFD Eq 11.10.6.2.1-2

$\alpha=0.6$ Scale Correction Factor
 $R_c=1.0$ Coverage Ratio
 $\phi_p=0.9$ Resistance Factor
 $C_p=2.0$ Both Top and Bottom
 $F_p=0.67 \times \tan(\phi)$ Pullout Friction Factor

$Le(z)=\frac{T_{\text{max}}(z)}{(\phi_p F_p \alpha \times \sigma_v2(z) \times C_p \times R_c)}$ AASHTO LRFD Eq 11.10.6.3.2-1

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

$GRS_{\text{spacing}}=8''$ Soil reinforcement spacing including short tail reinforcements

$GRS_{\text{factor}}=\left[\frac{1}{0.7 [GRS_{\text{spacing}}/(6 \times d_{\text{max}})]}\right]=1.268$ 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.

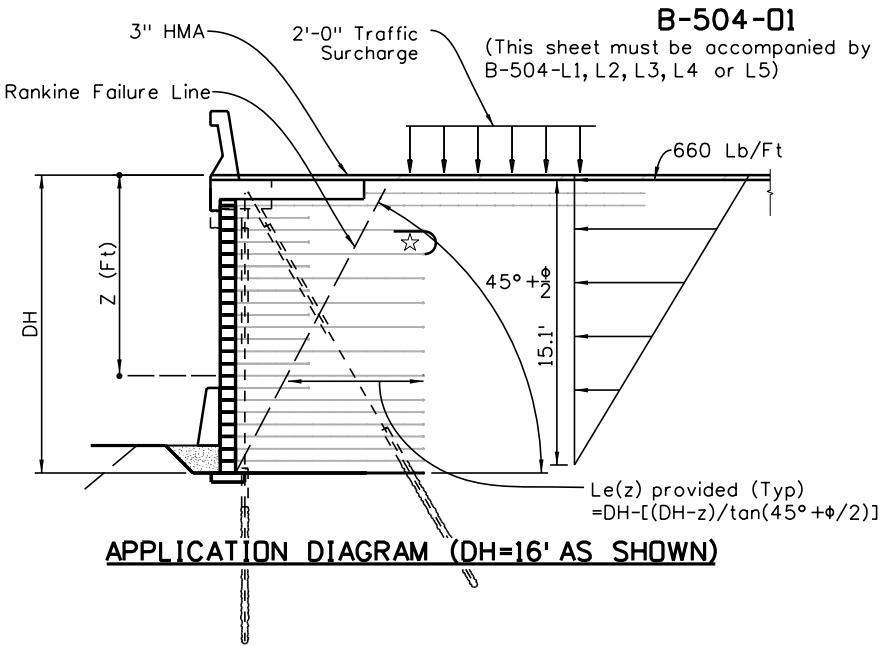
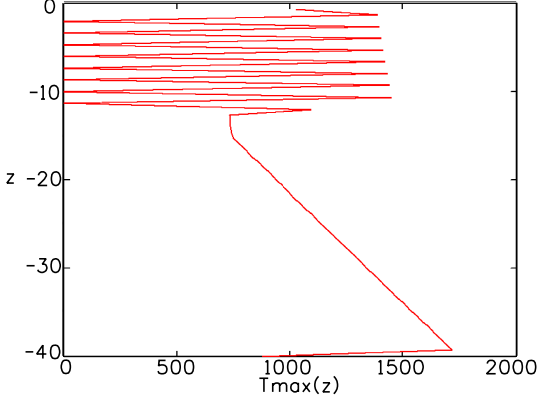
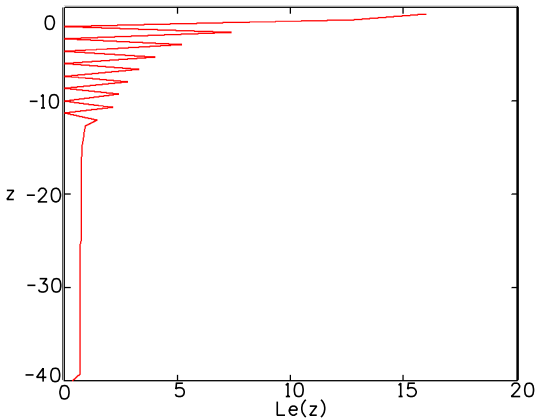
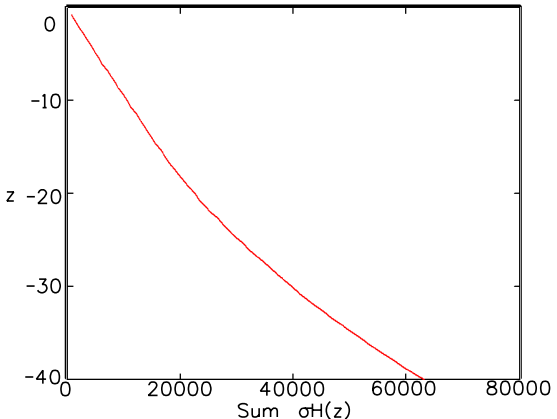
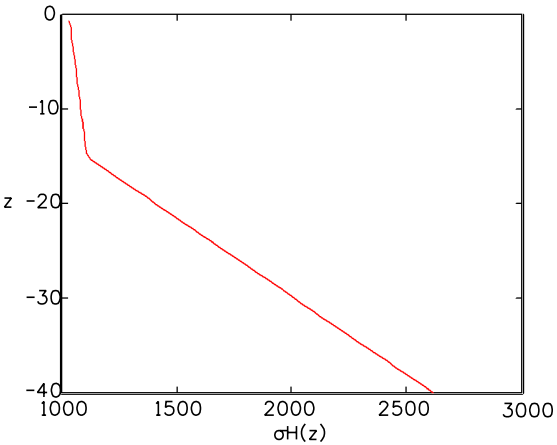
DH or Z (Ft)	# OF BLOCKS	σ_H (Lb/Ft)	$\sum \sigma_H \times \text{spacing}$ (Lb/Ft)	RL TYPE	SPACING	Le (Ft)
0.667	Coping	1.03E+03	685.28	TOP	12"	15.995
1.333	2	1.04E+03	1.38E+03	TOP	16"	12.782
2.000	3	1.04E+03	2.07E+03	TAIL	N/A	NA
2.667	4	1.04E+03	2.77E+03	FULL	16"	7.344
3.333	5	1.05E+03	3.46E+03	TAIL	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 σ_H 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:
a. Check T_{max} for $DH=16'$, $Z=10.667'$ (T_{max}), spacing=16", $R_c=1$ (For 100% coverage) $T_{\text{max}} \leq T_{al} R_c$ AASHTO 11.10.6.4.1-1
 $T_{\text{max}} = \sigma_H \times \text{Spacing} = 1080 \times 16/12 = 1436 \text{ Lb/Ft}$
 $1436 \text{ Lb/Ft} < 1440 \text{ Lb/Ft}$
b. The 16' high wall has 8 layers of tails and 16 full layers, neglecting tail contribution check sum of all layers. $\sum \sigma_H = 16 \times 1440 = 2.30 \times 10^4 \text{ Lb/Ft}$
 $\text{Lb/Ft} > 1.72 \times 10^4 \text{ Lb/Ft}$
- $DH=40'$, Check $z=39.333$
a. $T_{\text{max}} = \sigma_H \times \text{Spacing} = 2.57 \times 10^3 \times 8/12 = 1700 \text{ VS } 2160 \text{ Lb/Ft}$
b. $\sum \sigma_H \times \text{spacing}$; 39 (Full Layers) $\times 1440 + 12 \times 2160 = 8.20 \times 10^4 \text{ Lb/Ft} > 6.30 \times 10^4 \text{ Lb/Ft}$
- 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', $Le(\text{Provided}) = 6' - (6-2.667)/\tan(45^\circ + \phi/2) = 6-1.772 = 4.228' < 7.34'$. 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.

Print Date: \$DATE\$
File Name: Sheet_B-504-01.dgn
Horiz. Scale: Vert. Scale: As Noted
Unit Information Unit Leader Initials

Sheet Revisions

Date:	Comments	Init.

Colorado Department of Transportation



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Staff Bridge Branch

Initials

As Constructed

No Revisions:

Revised:

Void:

LRFD GRS WALL
WITH RAIL ANCHOR SLAB/BEAM
DESIGN CHARTS/TABLE

Designer:	XXXXXXXX	Structure	XXXXXXXXXXXXXX
Detailer:	XXXXXXXX	Numbers	XXXXXXXXXXXXXX
Sheet Subset:	WALL	Subset Sheets:	WXX of XXX

Project No./Code

Sheet Number

All seals for this set of drawings are applied to the cover page(s)