DESIGN CRITERIA:

Note to Designer: Update design for current MASH loads.

AASHTO simplified method GRS wall and based on FHWA-PUB HRT-11-26

ϕ=34° — Class I Backfill friction angle
γsoil=125(LB/CF) — PCF unit weight with 95% AASHTO T180
γh=1.5 — Horizontal Earth Pressure Factor
γv=1.35 — Vertical Earth Pressure Factor
LS=1.75 — Live Load Surcharge Factor
LLSurg=2' — Live Load Surcharge
dmax=2" — CDOT Class I Backfill Max Size
HMAthk=12" — HMA Thickness
hma=140(LB/CF) — HMA unit weight
γHMA= max:1.5 min:0.65 — HMA design factor

$Ka=\frac{1-\sin(\phi)}{1+\sin(\phi)}$ — Active Earth Pressure Coefficient Ka

$Rv(z)=\gamma soil\times(\gamma v\times z+LS\times LLSurg)\times RL(z)$ — Resultant of Soil & Surcharge

$Mo(z)=\frac{1}{6}\times Ka\times\gamma h\times\gamma soil\times z^3+\frac{1}{2}\times Ka\times LS\times\gamma soil\times LLSurg\times z^2$
$Mr(z)=Rv(z)\times RL(z)^2/2$ — Overturning Moment (Use γsoil for HMA); Righting Moment (Use γsoil for HMA)

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

$\sigma v1(z)=\gamma v\times\gamma soil\times(z-\frac{HMAthk}{12})+\gamma HMAmax\times hma\times\frac{HMAthk}{12}+LS\times\gamma soil\times LLSurg$ — Overburden with LS

$\sigma v2(z)=\gamma soil\times(z-\frac{HMAthk}{12})+hma\times\frac{HMAthk}{12}$ — 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=900 lb./Ft. — Per layer Rail Impact with factor of 3

$\sigma h(z)$= if $z\le2$, $\sigma H(z)$ + Rail Impact 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

α=0.6 — Scale Correction Factor
Rc=1.0 — Coverage Ratio
ϕp=0.9 — Resistance Factor Reinforcing Pullout
Cp=2.0 — Both Top and Bottom
Fp=0.67×Tan(ϕ) — 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

$Bear(z)=\frac{1}{2}\times\frac{1}{1000}\times\frac{Rv(z)\times RL(z)}{(RL(z)-2\times ecc(z))}$ — 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 sesmic 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.

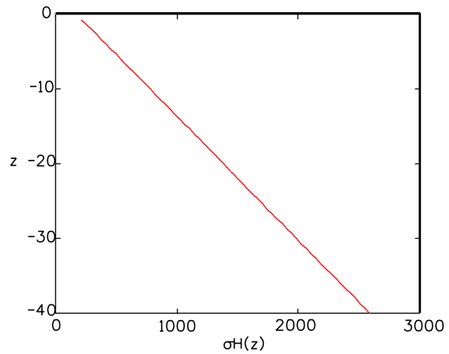
Table values are per linear feet of wall.

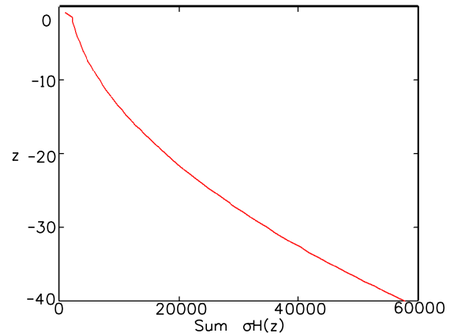
DH or Z (Ft)	# OF BLOCKS	σH (Lb/Ft)	ΣσH×spacing (Lb/Ft) *	RL TYPE	SPACING **	Le (Ft)
0.667	Coping	207.095	1.04E+03	TOP	12"	24.303
1.333	2	252.368	2.11E+03	TOP	16"	13.945
2.000	3	292.712	2.30E+03	TAIL	N/A	NA
2.667	4	333.055	2.52E+03	FULL	16"	2.612
3.333	5	373.398	2.77E+03	TAIL	N/A	NA
4.000	6	413.741	3.05E+03	FULL	16"	2.195
4.667	7	454.084	3.35E+03	TAIL	N/A	NA
5.333	8	494.427	3.68E+03	FULL	16"	1.981
6.000	9	534.77	4.04E+03	TAIL	N/A	NA
6.667	10	575.113	4.42E+03	FULL	16"	1.852
7.333	11	615.456	4.83E+03	TAIL	N/A	NA
8.000	12	655.799	5.27E+03	FULL	16"	1.765
8.667	13	696.143	5.73E+03	TAIL	N/A	NA
9.333	14	736.486	6.22E+03	FULL	16"	1.703
10.000	15	776.829	6.74E+03	TAIL	N/A	NA
10.667	16	817.172	7.29E+03	FULL	16"	1.656
11.333	17	857.515	7.86E+03	TAIL	N/A	NA
12.000	18	897.858	8.46E+03	FULL	12"	1.214
12.667	19	938.201	9.08E+03	FULL	8"	0.802
13.333	20	978.544	9.73E+03	FULL	8"	0.795
14.000	21	1.02E+03	1.04E+04	FULL	8"	0.789
14.667	22	1.06E+03	1.11E+04	FULL	8"	0.783
15.333	23	1.10E+03	1.19E+04	FULL	8"	0.778
16.000	24	1.14E+03	1.26E+04	FULL	8"	0.773
16.667	25	1.18E+03	1.34E+04	FULL	8"	0.768
17.333	26	1.22E+03	1.42E+04	FULL	8"	0.764
18.000	27	1.26E+03	1.51E+04	FULL	8"	0.760
18.667	28	1.30E+03	1.59E+04	FULL	8"	0.757
19.333	29	1.34E+03	1.68E+04	FULL	8"	0.754
20.000	30	1.38E+03	1.77E+04	FULL	8"	0.751
20.667	31	1.42E+03	1.87E+04	FULL	8"	0.748
21.333	32	1.46E+03	1.97E+04	FULL	8"	0.745
22.000	33	1.50E+03	2.07E+04	FULL	8"	0.742
22.667	34	1.54E+03	2.17E+04	FULL	8"	0.740
23.333	35	1.58E+03	2.28E+04	FULL	8"	0.738
24.000	36	1.62E+03	2.38E+04	FULL	8"	0.736
24.667	37	1.66E+03	2.49E+04	FULL	8"	0.734
25.333	38	1.71E+03	2.61E+04	FULL	8"	0.732
26.000	39	1.75E+03	2.72E+04	FULL	8"	0.730
26.667	40	1.79E+03	2.84E+04	FULL	8"	0.728
27.333	41	1.83E+03	2.97E+04	FULL	8"	0.727
28.000	42	1.87E+03	3.09E+04	FULL	8"	0.725
28.667	43	1.91E+03	3.22E+04	FULL	8"	0.724
29.333	44	1.95E+03	3.35E+04	FULL	8"	0.722
30.000	45	1.99E+03	3.48E+04	FULL	8"	0.721
30.667	46	2.03E+03	3.61E+04	FULL	8"	0.720
31.333	47	2.07E+03	3.75E+04	FULL	8"	0.718
32.000	48	2.11E+03	3.89E+04	FULL	8"	0.717
32.667	49	2.15E+03	4.04E+04	FULL	8"	0.716
33.333	50	2.19E+03	4.18E+04	FULL	8"	0.715
34.000	51	2.23E+03	4.33E+04	FULL	8"	0.714
34.667	52	2.27E+03	4.48E+04	FULL	8"	0.713
35.333	53	2.31E+03	4.64E+04	FULL	8"	0.712
36.000	54	2.35E+03	4.79E+04	FULL	8"	0.711
36.667	55	2.39E+03	4.95E+04	FULL	8"	0.710
37.333	56	2.43E+03	5.11E+04	FULL	8"	0.709
38.000	57	2.47E+03	5.28E+04	FULL	8"	0.708
38.667	58	2.51E+03	5.45E+04	FULL	8"	0.708
39.333	59	2.55E+03	5.62E+04	FULL	8"	0.707
40.000	60	2.59E+03	5.79E+04	FULL	4"	0.353

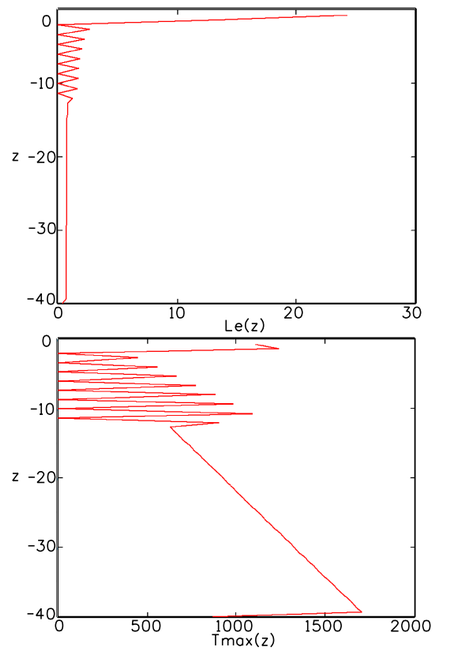
Note: Le of top two layers are not developed, layers used for avoiding roadway tension cracks.

* Summation of σH above Z includes rail impact.

** Tributary spacing

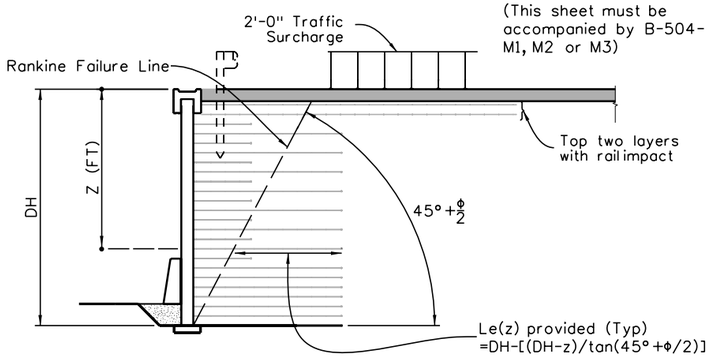






B-504-02

(This sheet must be accompanied by B-504-M1, M2 or M3)



APPLICATION DIAGRAM (DH=16' AS SHOWN)

EXAMPLES:

Biaxial woven polyester (PET) geotextiles with ultimate strengths of 4,800 & 7,200 Lb./Ft. are used for soil reinforcing layers. See CDOT B504 Standard Special for K Values

1. $T_{al}=T_{ult}\times K$
   K=30%(PET)

2. Given:
   a. Check Tmax for DH=16', Z=10.667', spacing=16", R_C=1 (For 100% coverage) $Tmax\le\phi Tal\,Rc$ AASHTO 11.10.6.4.1-1
      $Tmax=\sigma H\times Spacing=817.172\times\frac{16}{12}=1089.56$ Lb/Ft.
      1089.56 Lb/Ft < 1440 Lb/Ft.
   b. The 16' high wall has 8 layers of tails and 16 full layers, neglecting tail contribution check sum of all layers. $\Sigma\sigma H=16\times1440=2.30\times10^4$ Lb/Ft $>1.26\times10^4$ Lb/Ft.
3. DH=40', Check z=39.333
   a. $Tmax=\sigma H\times Spacing=2.55\times10^4\times\frac{8}{12}=1700$ VS 2160 Lb/Ft
   b. $\Sigma\sigma H\times spacing$; 31 (Full Layers) x 1440 + 12 x 2160 = 8.20×10^4 LB/Ft $>5.79\times10^4$ Lb/Ft
4. Neglect the top layer pull out requirement for DH=6' Truncated Base wall on B-504-G3. Check the third layer down z=2.667, Le (Required from Table) = 2.612', Le(Provided) = 6' - (6-2.667)/tan(45°+$\frac{\phi}{2}$) =6-1.772=4.228'>2.612'
5. Factored bearing pressure (BP) for DH=40'
   From B-504-M1 BP=4.721 TSF
   From B-504-M2 BP=9.596 TSF
   From B-504-M3 BP=8.850 TSF
   Must check against ultimate bearing capacity in geotechnical report.

INITIALS	DESIGN	DATE	DETAIL	DATE	QUANTITY	DATE
By						
Checked By						

Revision Dates: 09-16, 10-24

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

Print Date: $DATE$
File Name: Sheet_B-504-02.dgn
Horiz. Scale: Vert. Scale: As Noted
Unit Information Unit Leader Initials

Sheet Revisions		
Date:	Comments	Init.

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Staff Bridge Branch Initials

As Constructed
No Revisions:
Revised:
Void:

LRFD GRS WALL WITH ROADWAY RAIL DESIGN CHARTS/TABLE

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

Project No./Code

Sheet Number

$PLOT_INFO$