

DESIGN CRITERIA:

[Note to Designer: Update design for current MASH loads.]

AASHTO simplified method mse wall for extensible reinforcement and coherent gravity method for inextensible reinforcement.

$\phi=34^\circ$ Class I Backfill friction angle
 $\gamma_{soil}=125(LB/CF)$ PCF unit weight with 95% AASHTO T180
 $\psi=1.5$ Horizontal Earth Pressure Factor
 $\gamma=1.35$ Vertical Earth Pressure Factor
 $LS=1.75$ Live Load Surcharge Factor
 $LLSurg=2'$ Live Load Surcharge
 $dmax=2''$ CDDT Class I Backfill Max Size
 $HMA_{thk}=3''$ hma=140(LB/CF) HMA Thickness / HMA unit weight
 $\gamma_{HMA} = \max:1.5 \min:0.65$ HMA design factor
 $C_{thk}=8''$ $\gamma_C=145(LB/CF)$ Concrete Thickness/ Concrete unit weight
 $C_{max}=1.5$ $C_{min}=0.9$ Concrete design factor
 $K_a = \frac{1-\sin(\phi)}{1+\sin(\phi)}$ Active Earth Pressure Coefficient
 $K_o=1-\sin(\phi)$ At Rest Earth Pressure Coefficient

$K_r(z) =$ if $z \leq 20'$, $K_o - \frac{z}{20}(K_o - K_a)$, otherwise K_a AASHTO Fig 11.10.6.2.1d-1
 For inextensible reinforcement equations listed below K_a shall be replaced with $K_r(z)$, and $\sigma_{v1}(z)$ shall be replaced with $Bear(z)$ for $\sigma_H(z)$ computation.

$R_v(z) = \gamma \times soil \times (z - \frac{C_{thk}}{12}) + C_{max} \times \gamma_C \times \frac{C_{thk}}{12}$ Resultant of Soil & Surcharge
 $+ \gamma_{HMA} \times h_{max} \times \frac{HMA_{thk}}{12} + LS \times \gamma_{ys} \times LLSurg$

$Mo(z) = \frac{1}{6} \times K_a \times \gamma \times h \times \gamma_{soil} \times z^3 + \frac{1}{2} \times K_a \times L \times \gamma_{soil} \times LLSurg \times z^2 + \frac{1}{2} \times K_a \times \gamma_{HMA} \times h_{max} \times \frac{HMA_{thk}^2}{12}$ Overturning Moment (HMA layer treated as soil)

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

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

$\sigma_{v1}(z) = R_v(z)$ Overburden with LS

$\sigma_{v2}(z) = \gamma_{soil} \times (z - \frac{C_{thk}}{12}) + \gamma_C \times \frac{C_{thk}}{12} + h_{max} \times \gamma_{HMA} / 12$ Unfactored Overburden without LS

$\sigma_H(z) = K_a \times \sigma_{v1}(z) \times GRS_{factor}$ 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 54 kips for TL-4

$\sigma_H(z) =$ if $z \leq 15.1'$, $\sigma_H(z) +$ Rail Impact otherwise $\sigma_H(z) = \sigma_H(z)$

$\Sigma \sigma_H(z) = \sigma_H(z) \times spacing(z)$ 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
 $R_c=1.0$ Coverage Ratio
 $\phi_p=0.9$ Resistance Factor Reinforcing Pullout
 $C_p=2.0$ Both Top and Bottom
 $F_p=0.67 \times \tan(\phi)$ Pullout Friction Factor

$Le(z) = \frac{T_{max}(z)}{\phi_p \times F_p \times \alpha \times \sigma_{v2}(z) \times C_p \times R_c}$ AASHTO LRFD Eq 11.10.6.3.2-1

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

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)	Spacing (In.)	σ_H (Lb/Ft)	$\Sigma \sigma_H \times spacing$ (Lb/Ft)	Le (Ft)
0.667	12	810.385	540.257	12.61
1.333	12	817.645	1090	7.558
2.000	NA	820.312	1630	NA
2.667	16	822.978	2180	5.789
3.333	NA	825.644	2730	NA
4.000	24	828.311	3280	6.116
4.667	NA	830.977	3840	NA
5.333	NA	833.644	4390	NA
6.000	NA	836.31	4950	NA
6.667	32	838.976	5510	5.160
7.333	NA	841.643	6070	NA
8.000	NA	844.309	6630	NA
8.667	NA	846.975	7200	NA
9.333	32	849.642	7770	3.800
10.000	NA	852.308	8330	NA
10.667	NA	854.974	8900	NA
11.333	NA	857.641	9480	NA
12.000	28	860.307	10100	2.645
12.667	NA	862.973	10600	NA
13.333	NA	865.64	11200	NA
14.000	24	8.68E+02	11800	1.971
14.667	NA	8.71E+02	12400	NA
15.333	NA	8.84E+02	13000	NA
16.000	24	9.16E+02	13600	1.826
16.667	NA	9.47E+02	14200	NA
17.333	NA	9.79E+02	14800	NA
18.000	24	1.01E+03	15500	1.797
18.667	NA	1.04E+03	16200	NA
19.333	NA	1.08E+03	16900	NA
20.000	24	1.11E+03	17700	1.775
20.667	NA	1.14E+03	18400	NA
21.333	NA	1.17E+03	19200	NA
22.000	24	1.20E+03	20000	1.756
22.667	NA	1.23E+03	20800	NA
23.333	NA	1.27E+03	21700	NA
24.000	24	1.30E+03	22500	1.740
24.667	NA	1.33E+03	23400	NA
25.333	NA	1.36E+03	24300	NA
26.000	24	1.39E+03	25300	1.727
26.667	NA	1.43E+03	26200	NA
27.333	NA	1.46E+03	27200	NA
28.000	20	1.49E+03	28200	1.429
28.667	NA	1.52E+03	29200	NA
29.333	16	1.55E+03	30200	1.139
30.000	NA	1.58E+03	31300	NA
30.667	16	1.62E+03	32400	1.135
31.333	NA	1.65E+03	33500	NA
32.000	16	1.68E+03	34600	1.131
32.667	NA	1.71E+03	35700	NA
33.333	16	1.74E+03	36900	1.128
34.000	NA	1.77E+03	38100	NA
34.667	16	1.81E+03	39300	1.124
35.333	NA	1.84E+03	40500	NA
36.000	12	1.87E+03	41700	0.841
36.667	8	1.90E+03	40300	0.560
37.333	8	1.93E+03	44300	0.559
38.000	8	1.97E+03	45600	0.559
38.667	8	2.00E+03	46900	0.558
39.333	8	2.03E+03	48300	0.557
40.000	4	2.06E+03	49700	0.278

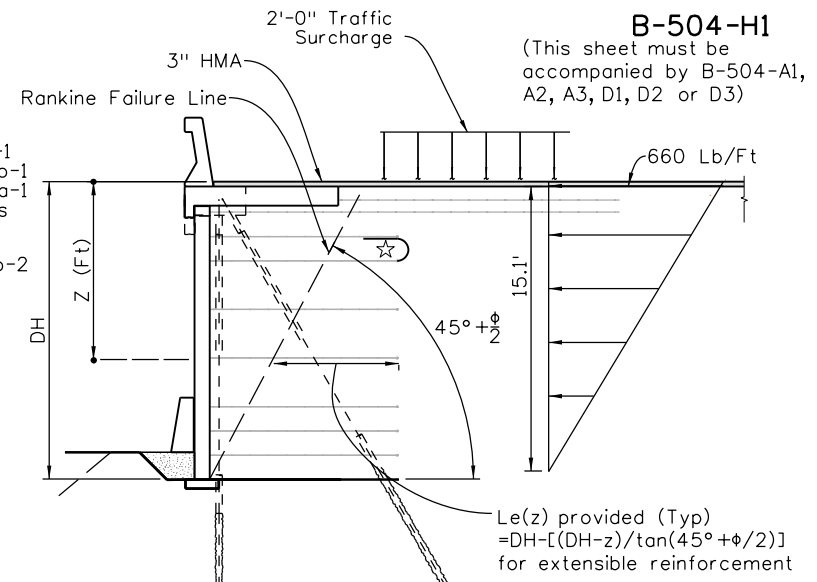
Note: Table is for both extensible and inextensible soil reinforcement, but values are only good for 40' wall. See figure to right for lower inextensible walls.
 * Example spacing
 ** Summation of σ_H above Z includes rail impact.
 *** Le based on extensible, $0.8 \times Le$ for inextensible. Le of top two layers are not developed, layers used for avoiding roadway tension cracks.

☆ Example looped geotextile layer for meeting pullout.

EXAMPLES:

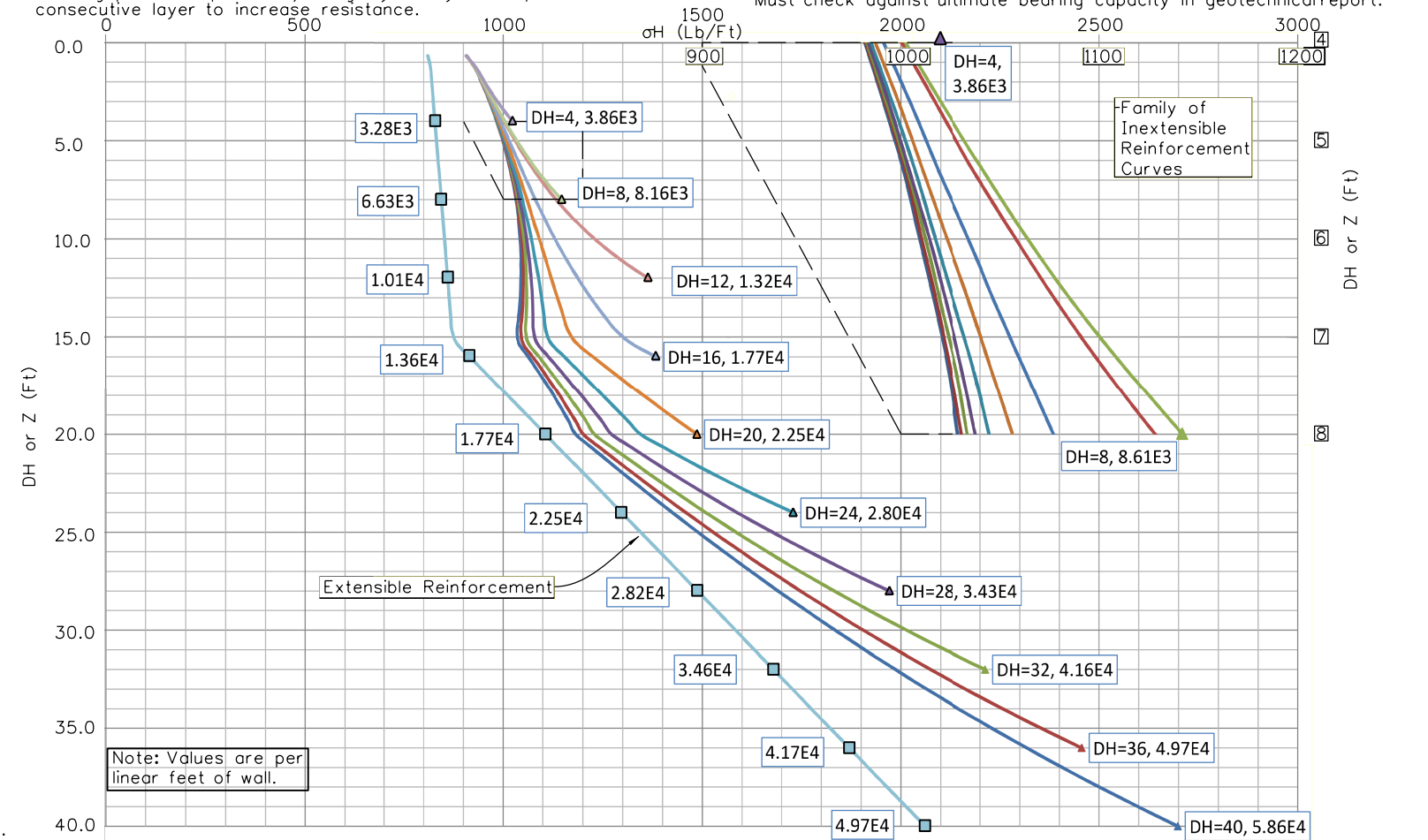
Biaxial woven polypropylene (PP) geotextile with an ultimate strength of 4,800 Lb/Ft is used for the top two reinforcing layers, other layers are 7,800 Lb/Ft HDPE grids, 12,000 Lb/Ft HDPE, 14,400 Lb/Ft HDPE, or grade 65 steel strips hot dipped zinc coated ribbed (50mmx4mm or 1.969"x0.157"). See Standard Special for K Values.

- $T_{max} \leq T_{a1} \times R_c$
 Geotextile: $T_{a1} = T_{ult} \times K$
 Steel: $T_{a1} = A_c \times F_y / b$
 where $b=1.969''$ $A_c=2.00''$
 $\phi_{steel}=0.75$ (Strips) vs $\phi_{geotextile}=0.90$ AASHTO 11.10.6.4.3b-2
- For $DH=12'$ Check T_{max} at $Z=9.333'$, spacing=32", $R_c=1$ (For 100% coverage) $T_{max} \leq T_{a1} \times R_c$ (AASHTO 11.10.6.4.1-1)
 a. $T_{max} = \sigma_H \times Spacing = 1194 \times 32 = 3840$ Lb/Ft. $\leq 12000 \times 0.27 = 3240$ Lb/Ft
 b. The 12' high wall has 4 HDPE layers 3 PP layers, check sum of all layers. $\Sigma \sigma_H = 2 \times 2106 + 2 \times 3240 + 3 \times 864 = 13284$ Lb/Ft > 10100 Lb/Ft
- $DH=40'$, Check T_{max} @ $z=26'$ for grid and strip and $\Sigma \sigma_H$:
 a. $T_{max} = \sigma_H \times Spacing = 1390 \times 24 = 33360$ Lb/Ft. $\leq 2780 \times 12000 \times 0.27 = 3240$ Lb/Ft
 b. For steel strips: $T_{a1} = 2 \times 65000 / 1.969 = 6602$ Lb/STRIP per Ft. Assuming a 10' wide panel: #ofStrips = $10' \times 2780$ (Lb/Ft) / (0.75x6602) (Lb/STRIP FOOT) requires 6 strips.
 c. For 40' wall check all extensibles. $\Sigma \sigma_H \times spacing$: 1×14400 (HDPE) + 16×12000 (HDPE) + 3×7800 (HDPE) + 7×4800 (PP layers) = T_{ult} 68094 Lb/Ft > 49700 Lb/Ft.
- Neglect top layer pullout requirement for $DH=6'$ Truncated Base wall on B-504-B3/E3. Check 3rd layer down $z=2.667'$ Le (Required from Table) = $2.059' Le$ (Provided with 2.0 RL Max) = $8 - (8 - 2.667) / \tan(45^\circ + \phi/2) = 8 - 2.84 = 5.16' < 5.789'$. For any layer not meeting pullout requirement, failing layer may be looped with consecutive layer to increase resistance.



APPLICATION DIAGRAM (DH=16' AS SHOWN)

Factored bearing pressure (BP) for $DH=40'$
 From B-504-A1 or D1 BP=4.772 TSF
 From B-504-A2 or D2 BP=9.709 TSF
 From B-504-A4 or D4 BP=8.963 TSF
 Must check against ultimate bearing capacity in geotechnical report.



Revision Dates
10-24
09-16

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		As Constructed		LRFD MSE WALL FOR BLOCK AND PANEL FACING WITH ROADWAY RAIL DESIGN CHARTS/TABLE		Project No./Code
	File Name: Sheet_B-504-HI.dgn	Date:	Comments	Init.	2829 West Howard Place, 3rd Floor Denver, CO 80204 Phone: 303-512-4079 FAX: 303-757-9197		No Revisions:			
	Horiz. Scale: Vert. Scale: As Noted				Staff Bridge Branch		Revised:	Designer: XXXXXXXX	Structure Numbers: XXXXXXXXXXXXX	
	Unit Information Unit Leader Initials				Initials		Void:	Detailer: XXXXXXXX	Subset Sheets: WXX of XXX	Sheet Number