The sole purpose of this design spreadsheet is to assist engineers in the analysis of the GRS-IBS. It is the responsibility of the user (i.e. experienced engineer) to determine the appropriateness and accuracy of input data and to review and verify the correctness of the computed results. FHWA does not assume any liabilities for any damages that may result from the use or misuse of this spreadsheet. Foundation settlement is not considered in this analysis and should be assessed separately. FHWA does not warrant that the spreadsheet is free from all bugs, errors, or omissions. This spreadsheet is provided "as is" without warranty or condition of any kind, either express or implied.

ASD

Inputs

PERFORMANCE CRITERIA

Tolerable Vertical Strain	$\varepsilon_{v,tol}$	0.5	%
Tolerable Lateral Strain	$\varepsilon_{h,tol}$	1	%

LAYOUT

Span Length	L_{span}	78	ft
Wall Height	H	15.25	ft
Width of Wall Facing Element	b_{block}	0.64	ft
Length of Individual Wall Facing Element	L_{block}	1.30	ft
Height of Individual Wall Facing Element	H_{block}	0.64	ft
Weight of Individual Facing Element	W_{block}	44	lb
Number of Facing Elements in a Single Column	N_{block}	24	
Base Width of Wall (including wall facing)	B_{total}	6	ft
Base Width of Wall (not including wall facing)	B	5.36	ft
Check Base to Height Ratio ≥ 0.3	**B/H**	**0.35**	**OK**
Set Back (Section 4.3.4, FHWA-HRT-11-026)	a_b	12	in
Clear Space (Section 4.3.4, FHWA-HRT-11-026)	d_e	4	in
Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	B_{RSF}	7.50	ft
Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	D_{RSF}	1.5	ft
Minimum Distance of RSF in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)	x_{RSF}	1.50	ft
Reinforcement Spacing	S_v	7.625	in
Number of Reinforcement Layers	N_{Sv}	24	
Secondary Reinforcement Spacing	$S_{v,s}$	3.8125	in

SOIL AND REINFORCEMENT CONDITIONS

Retained Soil Unit Weight	γ_b	125	lb/ft^3
Retained Soil Undrained Shear Strength	c_b	500	lb/ft^2
Retained Soil Effective Cohesion	c'_b	0	lb/ft^2
Retained Soil Friction Angle	ϕ_b	28	deg
Active Earth Pressure Coefficient - Backfill	K_{ab}	0.36	
Reinforced Fill Unit Weight	γ_r	110	lb/ft^3
Maximum Diameter of Reinforced Fill	d_{max}	0.5	in
Reinforced Fill Cohesion	c_r	0	lb/ft^2
Reinforced Fill Friction Angle	ϕ_r	48	deg
Active Earth Pressure Coefficient - Reinforced Fill	K_{ar}	0.15	
Passive Earth Pressure Coefficient - Reinforced Fill	K_{pr}	6.79	
Foundation Soil Unit Weight	γ_f	125	lb/ft^3
Foundation Soil Effective Unit Weight	γ'_f	62.6	lb/ft^3
Foundation Soil Undrained Shear Strength	c_f	4000	lb/ft^2
Foundation Soil Effective Cohesion	c'_f	4000	lb/ft^2
Foundation Soil Friction Angle	ϕ_f	0	deg
Active Earth Pressure Coefficient - Foundation	K_{af}	1.00	
Road Base Unit Weight	γ_{rb}	140	lb/ft^3
Road Base Cohesion	c_{rb}	0	lb/ft^2
Road Base Friction Angle	ϕ_{rb}	40	deg
Active Earth Pressure Coefficient - Road Base	K_{arb}	0.22	
Reinforced Soil Foundation Unit Weight	γ_{rsf}	140	lb/ft^3
Reinforced Soil Foundation Effective Unit Weight	γ'_{rsf}	77.6	lb/ft^3
Reinforced Soil Foundation Friction Angle	ϕ_{rsf}	40	deg
Ultimate Reinforcement Strength	T_f	4800	lb/ft
Reinforcement Strength at 2%	$T_{@\varepsilon=2\%}$	1370	lb/ft

SAFETY FACTORS

Capacity	$FS_{capacity}$	3.5
Reinforcement Strength	FS_{reinf}	3.5
Direct Slide	FS_{slide}	1.5

ASD

			Inputs
Bearing Capacity	$FS_{bearing}$	2.5	
Global Stability	FS_{global}	1.5	

LOADING CONDITIONS

Geometry

Equivalent Height for Traffic (Table 3.11.6.4-1 in AASHTO LRFD Bridge Design Specs, 2010)	$H_{t,eq}$	2.48	ft
Height of Bridge Beam	H_{bridge}	3.00	ft
Bridge Seat Width	b	4	ft
Width of Bridge	B_b	34	ft
Width of Traffic and Road Base Surcharge Over Wall	$b_{rb,t}$	0.36	ft

Dead Loads

Total Dead Load	Q_{bridge}	707200	lb
Dead Load per Abutment	$Q_{abutment}$	353600	lb
Bridge Surcharge	q_b	2600	lb/ft^2
Road Base Surcharge	q_{rb}	420.00	lb/ft^2
Weight of GRS Abutment including facing (Eq. 16 - modified, FHWA-HRT-11-026)	W	8991	lb/ft
Weight of RSF	W_{RSF}	873	lb/ft
Weight of Wall Face	W_{face}	811	lb/ft

Live Loads

Approach Roadway Live Load	q_t	310	lb/ft^2
Bridge Live Load (HL-93)	q_{LL}	1400	lb/ft^2

Bearing Stress

Applied Vertical Stress (Eq. 24, FHWA-HRT-11-026)	$V_{applied}$	4000	lb/ft^2

EXTERNAL STABILITY

Direct Slide at Base of Abutment

Driving Forces

Lateral Load from Retained Soil (Eq. 10, FHWA-HRT-11-026)	F_b	5248	lb/ft
Lateral Load from Road Base (Eq. 11, FHWA-HRT-11-026)	F_{rb}	2312	lb/ft
Lateral Load from Traffic Surcharge (Eq. 12, FHWA-HRT-11-026)	F_t	1707	lb/ft
Total Driving Force (Eq. 13, FHWA-HRT-11-026)	F_n	9267	lb/ft

Resisting Forces

Resisting Weight (Eq. 15, FHWA-HRT-11-026)	W_t	20354	lb/ft
Critical Friction Angle (Section 4.3.6.1, FHWA-HRT-11-026)	ϕ_{crit}	38	deg
Sliding Friction (Section 4.3.6.1, FHWA-HRT-11-026)	μ	0.79	
Total Resisting Force (Eq. 14, FHWA-HRT-11-026)	R_n	16132	lb/ft
Factor of Safety for Direct Slide (Eq. 17, FHWA-HRT-11-026)	$FS_{slide,calc}$	1.74	
Direct Slide Check		**OK**	

Direct Slide at Base of RSF

Driving Forces

Lateral Load from Retained Soil above RSF (Eq. 10, FHWA-HRT-11-026)	F_b	5248	lb/ft
Lateral Load from Road Base (Eq. 11, FHWA-HRT-11-026)	F_{rb}	1530	lb/ft
Lateral Load from Traffic Surcharge (Eq. 12, FHWA-HRT-11-026)	F_t	1875	lb/ft
Lateral Load from Retained Fill and Foundation Soil behind RSF	F_f	2930	lb/ft
Total Driving Force (Eq. 13, FHWA-HRT-11-026)	F_n	11582	lb/ft

Resisting Forces (note: passive resistance in front of RSF is ignored)

Resisting Weight (Eq. 15, FHWA-HRT-11-026)	W_t	21227	lb/ft
Critical Friction Angle (Section 4.3.6.1, FHWA-HRT-11-026)	ϕ_{crit}	38	deg
Sliding Friction (Section 4.3.6.1, FHWA-HRT-11-026)	μ	0.78	
Passive Resistance in front of RSF	R_p	6035.21	lb/ft
Assumed Adhesion Resistance of Foundation Soil	R_{af}	20000	lb/ft
Total Resisting Force (Eq. 14, FHWA-HRT-11-026)	R_n	42619	lb/ft
Factor of Safety for Direct Slide (Eq. 17, FHWA-HRT-11-026)	$FS_{slide,calc}$	3.68	
Direct Slide Check		**OK**	

Bearing Capacity

Bearing Pressure

Driving Moments

Traffic		14294.33	

ASD

				Inputs
Road Base		19366.51		
Retained Soil		29299.54		
Face		1565.25		
Driving Moments (Equation may vary depending on geometry - check for your conditions)	ΣM_D	64526	ft-lb/ft	
Resisting Moments				
Weight		9621		
DL		14456		
LL		7784		
Road Base		540		
Traffic		398		
Resisting Moments (Equation may vary depending on geometry - check for your conditions)	ΣM_R	32799	ft-lb/ft	
Total Vertical Load (Eq. 19, FHWA-HRT-11-026)	ΣV	26938	lb/ft	
Eccentricity (Eq. 20, FHWA-HRT-11-026)	$e_{B,n}$	1.18	ft	
Vertical Pressure at the Base (Eq. 18, FHWA-HRT-11-026)	$\sigma_{v,base,n}$	5236.32	lb/ft^2	
Bearing Capacity				
Bearing Capacity Factors (Table 10.6.3.1.2a-1, AASHTO LRFD Bridge Design Specs, 2010)	N_c	30.10		
	N_γ	22.40		
	N_q	18.40		
Bearing Capacity (Eq. 21, FHWA-HRT-11-026)	q_n	125734.66	lb/ft^2	
Factor of Safety for Bearing Capacity (Eq. 22, FHWA-HRT-11-026)	$FS_{bearing,calc}$	24.01		
Bearing Capacity Check		**OK**		
Global Stability				
Stability Program Selected		ReSSA		
Global Stability FS	FS_{GS}	1.58		
Global Stability Check		**OK**		

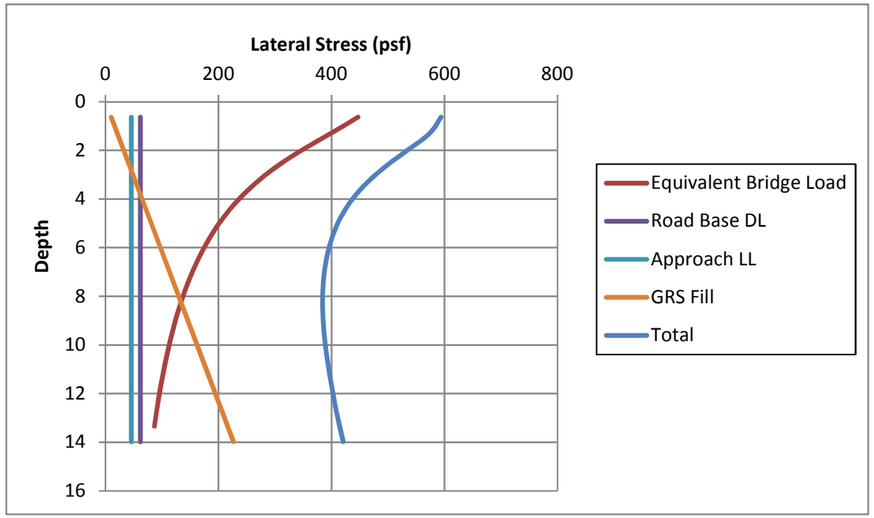
INTERNAL STABILITY

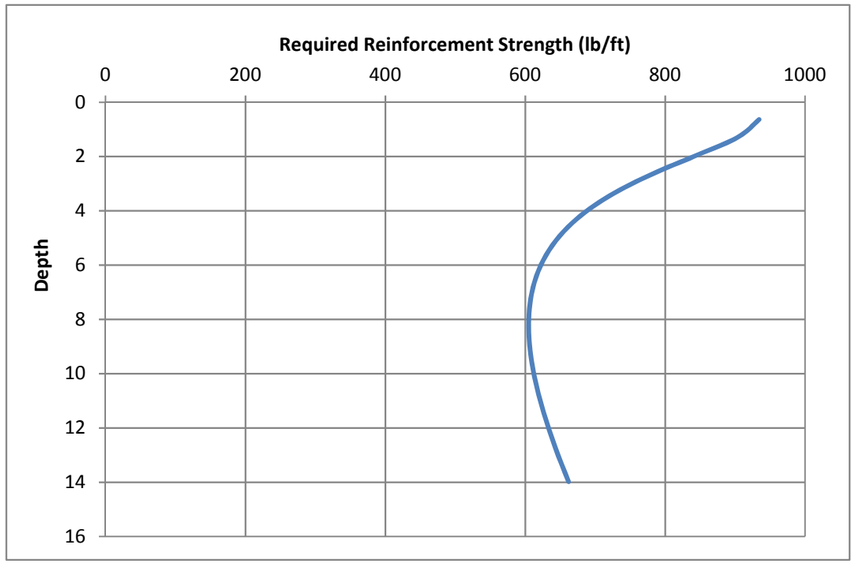
Deformations

Vertical Strain (From applicable performance test)	ε_v	0.4	%	
Vertical Deformation	D_V	0.73	in	
Vertical Strain Check		**OK**		
Lateral Strain (Eq. 30, FHWA-HRT-11-026)	ε_L	0.8	%	
Lateral Deformation (Eq. 29, FHWA-HRT-11-026)	D_L	0.48	in	
Lateral Deformation Check		**OK**		
Ultimate Capacity - Empirical				
Capacity (From applicable performance test)	$q_{ult,emp}$	25000	lb/ft^2	
Allowable Load (Eq. 23, FHWA-HRT-11-026)	$V_{allow,emp}$	7143	lb/ft^2	
Capacity Check		**OK**		
Ultimate Capacity - Analytical				
Ultimate Capacity (Eq. 25, FHWA-HRT-11-026)	$q_{ult,an}$	20707	lb/ft^2	
Allowable Load (Eq. 27, FHWA-HRT-11-026)	$V_{allow,an}$	5916	lb/ft^2	
Capacity Check		**OK**		
Reinforcement Strength				
Allowable Reinforcement Strength (Eq. 38, FHWA-HRT-11-026)	T_{allow}	1371	lb/ft	
Reinforcement Strength at 2%	$T_{@\varepsilon=2\%}$	1370	lb/ft	
Equivalent Bridge Load	q_{bridge}	3270	lb/ft^2	
Maximum Required Reinforcement Strength	T_{req}	934	lb/ft	
Reinforcement Strength Check		**OK**		
Serviceability Check		**OK**		
Minimum Required Depth of Bearing Bed Reinforcement	z_s	2.86	ft	
Minimum Number of Bearing Reinforcement Layers	$N_{Sv,s}$	5		

		Dist. from top of wall	Equivalent Bridge Load			Road Base DL and Approach LL		GRS Fill	Total	Req. Strength	Ultimate Check	2% Check
No.	Layer	z (ft)	α	β	$\sigma_{h,bridge}$ (psf)	$\sigma_{h,rb}$ (psf)	$\sigma_{h,t}$ (psf)	$\sigma_{h,W}$ (psf)	$\sigma_{h,total}$ (psf)	T_{req} (lb/ft)	$T_{req} > T_{allow}$	$T_{req} > T@2\%$
1	1	0.6	2.53	-1.26	476	62	46	10	594	934	NO	NO
2	2	1.3	2.01	-1.00	447	62	46	21	575	905	NO	NO
3	3	1.9	1.62	-0.81	401	62	46	31	540	849	NO	NO
4	4	2.5	1.33	-0.67	354	62	46	41	502	790	NO	NO
5	5	3.2	1.12	-0.56	311	62	46	51	470	739	NO	NO
6	6	3.8	0.97	-0.48	274	62	46	62	444	698	NO	NO
7	7	4.4	0.85	-0.42	244	62	46	72	424	667	NO	NO
8	8	5.1	0.75	-0.37	219	62	46	82	409	644	NO	NO
9	9	5.7	0.67	-0.34	199	62	46	93	399	628	NO	NO
10	10	6.4	0.61	-0.30	181	62	46	103	392	617	NO	NO
11	11	7.0	0.56	-0.28	167	62	46	113	387	610	NO	NO
12	12	7.6	0.51	-0.26	154	62	46	124	385	606	NO	NO
13	13	8.3	0.48	-0.24	143	62	46	134	384	605	NO	NO
14	14	8.9	0.44	-0.22	133	62	46	144	385	606	NO	NO
15	15	9.5	0.41	-0.21	125	62	46	154	387	609	NO	NO
16	16	10.2	0.39	-0.19	118	62	46	165	390	614	NO	NO
17	17	10.8	0.37	-0.18	111	62	46	175	394	619	NO	NO
18	18	11.4	0.35	-0.17	105	62	46	185	398	626	NO	NO
19	19	12.1	0.33	-0.16	100	62	46	196	403	634	NO	NO
20	20	12.7	0.31	-0.16	95	62	46	206	409	643	NO	NO
21	21	13.3	0.30	-0.15	91	62	46	216	414	652	NO	NO
22	22	14.0	0.28	-0.14	87	62	46	227	421	662	NO	NO
23	23	14.6	0.27	-0.14	83	62	46	237	427	672	NO	NO
24	24	15.3	0.26	-0.13	80	62	46	247	434	683	NO	NO
25	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
26	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
27	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
28	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
29	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
30	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
31	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
32	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
33	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
34	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
35	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
36	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
37	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
38	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
39	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
40	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
41	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
42	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
43	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
44	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
45	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
46	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
47	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
48	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
49	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
50	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
51	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-

		Dist. from top of wall	Equivalent Bridge Load			Road Base DL and Approach LL		GRS Fill	Total	Req. Strength	Ultimate Check	2% Check
No.	Layer	z (ft)	α	β	$\sigma_{h,bridge}$ (psf)	$\sigma_{h,rb}$ (psf)	$\sigma_{h,t}$ (psf)	$\sigma_{h,W}$ (psf)	$\sigma_{h,total}$ (psf)	T_{req} (lb/ft)	$T_{req} > T_{allow}$	$T_{req} > T@2\%$
52	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
53	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
54	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
54.5	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
55	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
56	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
57	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
58	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
59	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
60	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
61	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
62	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
63	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
64	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
65	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
66	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
67	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
68	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
69	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
70	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
71	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
72	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
73	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
74	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
75	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
76	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
77	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
78	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
79	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
80	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
81	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
82	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
83	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
84	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
85	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
86	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
87	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
88	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
89	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
90	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
91	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
92	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
93	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
94	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
95	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
96	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
97	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
98	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
99	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-
100	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-


Lateral Stress (psf)
0
200
400
600
800
Depth
0
2
4
6
8
10
12
14
16
Equivalent Bridge Load
Road Base DL
Approach LL
GRS Fill
Total


Required Reinforcement Strength (lb/ft)
0
200
400
600
800
1000
Depth
0
2
4
6
8
10
12
14
16

LRFD

PERFORMANCE CRITERIA

Tolerable Vertical Strain

Tolerable Lateral Strain

LAYOUT

Span Length

Wall Height

Width of wall facing

Length of Individual Wall Facing Element

Height of Individual Wall Facing Element

Weight of Individual Facing Element

Number of Facing Elements in a Single Column

Base Width of Wall (including wall facing)

Base Width of Wall (not including wall facing)

Check Base to Height Ratio ≥ 0.3

Set Back (Section 4.3.4, FHWA-HRT-11-026)

Clear Space (Section 4.3.4, FHWA-HRT-11-026)

Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)

Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)

Minimum Distance of RSF in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)

Reinforcement Spacing

Number of Reinforcement Layers

Secondary Reinforcement Spacing

SOIL AND REINFORCEMENT CONDITIONS

Retained Soil Unit Weight

Retained Soil Undrained Shear Strength

Retained Soil Effective Cohesion

Retained Soil Friction Angle

Active Earth Pressure Coefficient - Backfill

Reinforced Fill Unit Weight

Maximum Diameter of Reinforced Fill

Reinforced Fill Cohesion

Reinforced Fill Friction Angle
Active Earth Pressure Coefficient - Reinforced Fill
Passive Earth Pressure Coefficient - Reinforced Fill

Foundation Soil Unit Weight
Foundation Soil Effective Unit Weight
Foundation Soil Undrained Shear Strength
Foundation Soil Effective Cohesion
Foundation Soil Friction Angle
Active Earth Pressure Coefficient - Foundation

Road Base Unit Weight
Road Base Cohesion
Road Base Friction Angle
Active Earth Pressure Coefficient - Road Base

Reinforced Soil Foundation Unit Weight
Reinforced Soil Foundation Effective Unit Weight
Reinforced Soil Foundation Friction Angle

Ultimate Reinforcement Strength
Reinforcement Strength at 2%

LOAD AND RESISTANCE FACTORS

Load Combination (Section 3.4, AASHTO LRFD Bridge Design Specs, 2010)
Dead Load Max (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Dead Load Min (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Horizontal Active Earth Pressure Max (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Horizontal Active Earth Pressure Min (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Vertical Earth Pressure Max (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Vertical Earth Pressure Min (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Earth Surcharge Max (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Earth Surcharge Min (Table 3.4.1-2, AASHTO LRFD Bridge Design Specs, 2010)
Live Load Surcharge (Table 3.4.1-1, AASHTO LRFD Bridge Design Specs, 2010)

Capacity Resistance (Section C.2.2.1, FHWA-HRT-11-026)
Reinforcement Resistance (Section C.2.2.3, FHWA-HRT-026)
Soil-Sliding Resistance (Table 11.5.6-1, AASHTO LRFD Bridge Design Specs, 2010)
Bearing Capacity Resistance (Table 11.5.6-1, AASHTO LRFD Bridge Design Specs, 2010)

LOADING CONDITIONS

Geometry

Equivalent Height for Traffic (Table 3.11.6.4-1 in AASHTO LRFD Bridge Design Specs, 2010)

Height of Bridge Beam

Bridge Seat Width

Width of Bridge Beam

Width of Traffic and Roadbase Load Behind Wall

Dead Loads

Total Dead Load

Dead Load per Abutment

Bridge Surcharge

Road Base Surcharge

Weight of GRS Abutment (Eq. 16, FHWA-HRT-11-026)

Weight of RSF

Weight of Wall Face

Live Loads

Approach Roadway Live Load

Bridge Live Load (HL-93)

Bearing Stress

Applied Vertical Stress (Eq. 24, FHWA-HRT-11-026)

Factored Applied Vertical Stress (Eq. 82, FHWA-HRT-11-026)

EXTERNAL STABILITY

Direct Slide at Base of Abutment

Driving Forces

Lateral Load from Retained Soil (Eq. 10, FHWA-HRT-11-026)

Lateral Load from Road Base (Eq. 11, FHWA-HRT-11-026)

Lateral Load from Traffic Surcharge (Eq. 12, FHWA-HRT-11-026)

Total Driving Force (Eq. 13, FHWA-HRT-11-026)

Factored Driving Force (Eq. 106, FHWA-HRT-11-026)

Resisting Forces

Resisting Weight (Eq. 72, FHWA-HRT-11-026)

Critical Friction Angle (Section 4.3.6.1, FHWA-HRT-11-026)

Sliding Friction (Section 4.3.6.1, FHWA-HRT-11-026)

Factored Resisting Force (Eq. 71, FHWA-HRT-11-026)

Direct Slide Check

Direct Slide at Base of RSF

Driving Forces

Lateral Load from Retained Soil above RSF (Eq. 10, FHWA-HRT-11-026)

Lateral Load from Road Base (Eq. 11, FHWA-HRT-11-026)

Lateral Load from Traffic Surcharge (Eq. 12, FHWA-HRT-11-026)

Lateral Load from Retained Fill and Foundation Soil behind RSF

Total Driving Force (Eq. 13, FHWA-HRT-11-026)

Factored Driving Force (Eq. 106, FHWA-HRT-11-026)

Resisting Forces

Resisting Weight (Eq. 15, FHWA-HRT-11-026)

Critical Friction Angle (Section 4.3.6.1, FHWA-HRT-11-026)

Sliding Friction (Section 4.3.6.1, FHWA-HRT-11-026)

Factored Passive Resistance in front of RSF

Assumed Adhesion Resistance of Foundation Soil

Total Factored Resisting Force (Eq. 14, FHWA-HRT-11-026)

Direct Slide Check

Bearing Capacity

Bearing Pressure

Driving Moments

- Traffic
- Road Base
- Retained Soil
- Face

Driving Moments (Equation may vary depending on geometry - check for your conditions)

Resisting Moments

- Weight
- DL
- LL
- Road Base
- Traffic

Resisting Moments (Equation may vary depending on geometry - check for your conditions)

Total Factored Vertical Load (Eq. 75, FHWA-HRT-11-026)

Eccentricity (Eq. 76, FHWA-HRT-11-026)

Vertical Pressure at the Base (Eq. 74, FHWA-HRT-11-026)

Bearing Capacity

Bearing Capacity Factors (Table 10.6.3.1.2a-1, AASHTO LRFD Bridge Design Specs, 2010)

Factored Bearing Capacity (Eq. 77, FHWA-HRT-11-026)

Bearing Capacity Check

Global Stability

Stability Program Selected

Global Stability FS

Global Stability Check

INTERNAL STABILITY

Deformations

Vertical Strain using unfactored loads (From applicable performance test)

Vertical Deformation

Vertical Strain Check

Lateral Strain (Eq. 30, FHWA-HRT-11-026)

Lateral Deformation (Eq. 29, FHWA-HRT-11-026)

Lateral Deformation Check

Ultimate Capacity - Empirical

Nominal Capacity (From applicable performance test)

Factored Capacity

Capacity Check

Nominal Capacity (Eq. 81, FHWA-HRT-11-026)

Factored Resistance Capacity

Capacity Check

Reinforcement Strength

Factored Reinforcement Capacity (Eq. 93, FHWA-HRT-11-026)

Reinforcement Strength at 2%

Equivalent Bridge Load (Unfactored)

Equivalent Bridge Load (Factored)

Maximum Factored Required Reinforcement Strength

Reinforcement Strength Check

Serviceability Check

Minimum Required Depth of Bearing Bed Reinforcement

Minimum Number of Bearing Reinforcement Layers

Inputs

$\varepsilon_{v,tol}$	0.5	%	
$\varepsilon_{h,tol}$	1	%	
L_{span}	78	ft	
H	15.25	ft	
b_{block}	0.64	ft	
L_{block}	1.30	ft	
H_{block}	0.64	ft	
W_{block}	44	lb	
N_{block}	24		
B_{wf}	6	ft	
B	5.36	ft	
B/H	**0.35**	**OK**	
a_b	12	in	
d_e	4	in	
B_{RSF}	7.50	ft	
D_{RSF}	1.5	ft	
x_{RSF}	1.50	ft	
S_v	8	in	
N_{Sv}	23		
$S_{v,s}$	8	in	**ERROR!! MAXIMUM SPACING IS 6 IN.**
γ_b	125	lb/ft^3	
c_b	500	lb/ft^2	
c'_b	500	lb/ft^2	
ϕ_b	28	deg	
K_{ab}	0.36		
γ_r	110	lb/ft^3	
d_{max}	0.5	in	
c_r	0	lb/ft^2	

ϕ_r	48	deg
K_{ar}	0.15	
K_{pr}	6.79	
γ_f	125	lb/ft^3
γ'_f	62.6	lb/ft^3
c_f	4000	lb/ft^2
c'_f	4000	lb/ft^2
ϕ_f	0	deg
K_{af}	1.00	
γ_{rb}	140	lb/ft^3
c_{rb}	0	lb/ft^2
ϕ_{rb}	40	deg
K_{arb}	0.22	
γ_{rsf}	140	lb/ft^3
γ'_{rsf}	77.6	lb/ft^3
ϕ_{rsf}	40	deg
T_f	4800	lb/ft
$T_{@\varepsilon=2\%}$	1370	lb/ft

LC	STRENGTH 1
$\gamma_{DC\ MAX}$	1.25
$\gamma_{DC\ MIN}$	0.9
$\gamma_{EH\ MAX}$	1.5
$\gamma_{EH\ MIN}$	0.9
$\gamma_{EV\ MAX}$	1.35
$\gamma_{EV\ MIN}$	1
$\gamma_{ES\ MAX}$	1.5
$\gamma_{ES\ MIN}$	0.75
γ_{LS}	1.75
ϕ_{cap}	0.45
ϕ_{reinf}	0.4
ϕ_τ	1
ϕ_{bc}	0.65

$H_{t,eq}$	2.48	ft
H_{bridge}	3.00	ft
b	4	ft
B_b	34	ft
$b_{rb,t}$	0.36	ft
Q_{bridge}	707200	lb
$Q_{abutment}$	353600	lb
q_b	2600	lb/ft^2
q_{rb}	420.00	lb/ft^2
W	8999	lb/ft
W_{RSF}	873	lb/ft
W_{face}	811	lb/ft
q_t	310	lb/ft^2
q_{LL}	1400	lb/ft^2
$V_{applied}$	4000	lb/ft^2
$V_{applied,f}$	5700	lb/ft^2
F_b	5248	lb/ft
F_{rb}	2312	lb/ft
F_t	1707	lb/ft
F_n	9267	lb/ft
F_R	14327	lb/ft
$W_{t,R}$	18474	lb/ft
ϕ_{crit}	38	deg
μ	0.78	

R_R	14433.42	lb/ft
	OK	

F_b	5248	lb/ft
F_{rb}	1530	lb/ft
F_t	1875	lb/ft
F_f	2930	lb/ft
F_n	11582	lb/ft
F_R	17841	lb/ft

$W_{t,R}$	19204	lb/ft
ϕ_{crit}	38	deg
μ	0.78	
$R_{p,R}$	5431.69	lb/ft
$R_{af,R}$	15000	lb/ft
R_R	35435	lb/ft
	OK	

	25015.08	
	29049.77	
	43949.30	
	1958.88	
ΣM_D	99973	ft-lb/ft
	12971	
	18010	
	13577	
	819	
	706	
ΣM_R	46084	ft-lb/ft
$\Sigma V_{R,R}$	37569	lb/ft
$e_{B,R}$	1.43	ft
$\sigma_{v,base,R}$	8112	lb/ft^2

N_c	30.10	
N_γ	22.4	
N_q	18.4	
q_R	84717	lb/ft^2
	OK	

	ReSSA	
FS_{GS}	1.58	
	OK	

ε_v	0.4	%
D_V	0.73	in
	OK	

D_L	0.8	%
D_L	0.48	in
	OK	

$q_{ult,emp}$	26000	lb/ft^2
$q_{ult,emp,f}$	11700	lb/ft^2
	OK	

$q_{n,an}$	18876	lb/ft^2
$q_{n,an,f}$	8494	lb/ft^2
	OK	

$T_{f,f}$	1920	lb/ft
$T_{@\varepsilon=2\%}$	1370	lb/ft

q_{bridge}	3270	lb/ft^2
$q_{bridge,f}$	4528	lb/ft^2

$T_{req,f}$	1459	lb/ft
	OK	

FAILED. BEARING BED REINFORCEMENT NEEDED.

z_s	2.67	ft
$N_{Sv,s}$	2	

		Dist. from top of wall	Equivalent Bridge Load				Road Base DL and Approach LL				GRS Fill		Factored	Unfactored	Factored	Ultimate Check	Unfactored	2% Check
No.	Layer	z (ft)	α	β	$\sigma_{h,bridge}$ (psf)	$\sigma_{h,bridge,f}$ (psf)	$\sigma_{h,rb}$ (psf)	$\sigma_{h,rb,f}$ (psf)	$\sigma_{h,t}$ (psf)	$\sigma_{h,t,f}$ (psf)	$\sigma_{h,W}$ (psf)	$\sigma_{h,W,f}$ (psf)	$\sigma_{h,total,f}$ (psf)	$\sigma_{h,total}$ (psf)	$T_{req,f}$ (lb/ft)	$T_{req,f} > T_{f,f}$	T_{req} (lb/ft)	T_{req} >T@2%
1.0	1.0	0.7	2.5	-1.2	475	658	62	93	46	80	11	15	845	594	1459	NO	1024	NO
2.0	2.0	1.3	2.0	-1.0	443	613	62	93	46	80	22	29	815	572	1407	NO	988	NO
3.0	3.0	2.0	1.6	-0.8	394	546	62	93	46	80	32	44	762	534	1316	NO	922	NO
4.0	4.0	2.7	1.3	-0.6	345	477	62	93	46	80	43	58	708	495	1222	NO	855	NO
5.0	5.0	3.3	1.1	-0.5	301	417	62	93	46	80	54	73	663	463	1143	NO	799	NO
6.0	6.0	4.0	0.9	-0.5	265	367	62	93	46	80	65	88	627	437	1082	NO	755	NO
7.0	7.0	4.7	0.8	-0.4	235	326	62	93	46	80	76	102	601	418	1037	NO	722	NO
8.0	8.0	5.3	0.7	-0.4	211	292	62	93	46	80	86	117	581	405	1003	NO	699	NO
9.0	9.0	6.0	0.6	-0.3	191	264	62	93	46	80	97	131	568	396	980	NO	683	NO
10.0	10.0	6.7	0.6	-0.3	174	241	62	93	46	80	108	146	559	389	965	NO	672	NO
11.0	11.0	7.3	0.5	-0.3	160	221	62	93	46	80	119	160	554	386	956	NO	666	NO
12.0	12.0	8.0	0.5	-0.2	147	204	62	93	46	80	130	175	552	385	952	NO	664	NO
13.0	13.0	8.7	0.5	-0.2	137	189	62	93	46	80	140	190	552	385	952	NO	664	NO
14.0	14.0	9.3	0.4	-0.2	128	177	62	93	46	80	151	204	554	386	955	NO	667	NO
15.0	15.0	10.0	0.4	-0.2	120	166	62	93	46	80	162	219	557	389	961	NO	672	NO
16.0	16.0	10.7	0.4	-0.2	112	156	62	93	46	80	173	233	562	393	970	NO	678	NO
17.0	17.0	11.3	0.3	-0.2	106	147	62	93	46	80	184	248	568	397	980	NO	686	NO
18.0	18.0	12.0	0.3	-0.2	100	139	62	93	46	80	195	263	574	402	991	NO	695	NO
19.0	19.0	12.7	0.3	-0.2	95	132	62	93	46	80	205	277	582	408	1004	NO	704	NO
20.0	20.0	13.3	0.3	-0.1	91	126	62	93	46	80	216	292	590	414	1018	NO	715	NO
21.0	21.0	14.0	0.3	-0.1	86	120	62	93	46	80	227	306	599	421	1033	NO	726	NO
22.0	22.0	14.7	0.3	-0.1	83	114	62	93	46	80	238	321	608	428	1049	NO	739	NO
23.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
64.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Dist. from top of wall	Equivalent Bridge Load				Road Base DL and Approach LL					GRS Fill		Factored	Unfactored	Factored	Ultimate Check	Unfactored	2% Check
No.	Layer	z (ft)	α	β	$\sigma_{h,bridge}$ (psf)	$\sigma_{h,bridge,f}$ (psf)	$\sigma_{h,rb}$ (psf)	$\sigma_{h,rb,f}$ (psf)	$\sigma_{h,t}$ (psf)	$\sigma_{h,t,f}$ (psf)	$\sigma_{h,W}$ (psf)	$\sigma_{h,W,f}$ (psf)	$\sigma_{h,total,f}$ (psf)	$\sigma_{h,total}$ (psf)	$T_{req,f}$ (lb/ft)	$T_{req,f} > T_{f,f}$	T_{req} (lb/ft)	T_{req} >T@2%
76.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
78.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
82.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
84.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
87.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
88.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
90.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
91.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
92.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
93.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
94.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
95.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
96.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
97.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
98.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
99.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100.0	End of reinforcement layers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-