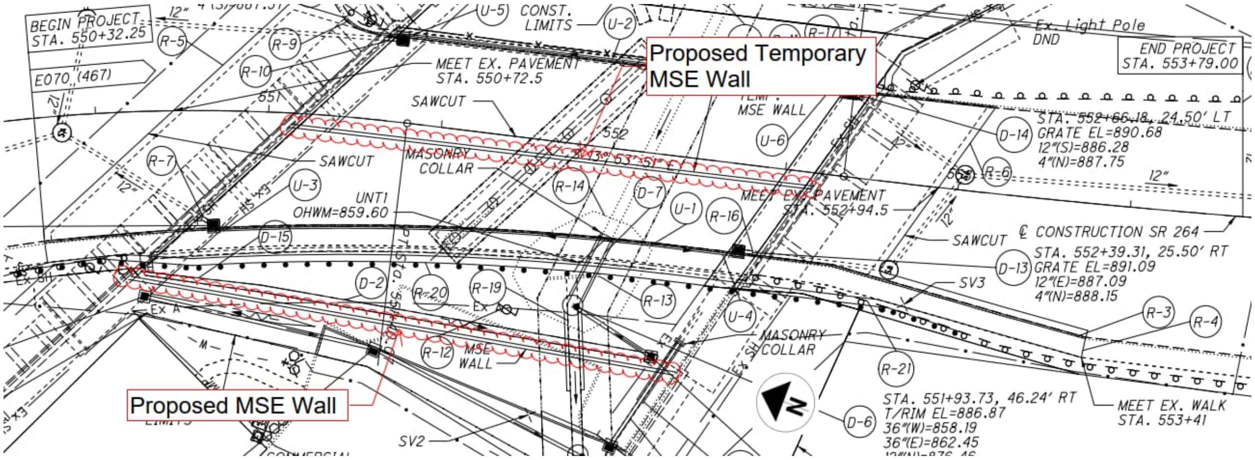
MSE RETAINING WALL MEMO

Project: HAM-264-10.42	**Structure:** MSE Retaining Wall
PID: 99962	**SFN:**
Report By: Munal Pandey, E.I.T. Brent Langlois, P.E.	**Terracon Project #:** N1205396
Submittal Date: May 13, 2025	**Reviewed By:** Jeffrey Dunlap, P.E.

INTRODUCTION

As part of the HAM-264-10.42 project, it is proposed to remove the existing SR-264 bridge over an abandoned railroad track. The existing bridge will be replaced with an MSE wall to support the SR-264 roadway. This wall will be approximately 160 feet long and have a maximum anticipated exposed wall height of about 24 feet at the start of the wall (about Station 560+00). A temporary MSE retaining wall, approximately 150 feet in length and 20 feet in maximum exposed height, will also be constructed to support the existing roadway during construction.



The scope of this memo is to summarize the findings of the test borings performed in this area and provide recommendations for the proposed MSE walls. For our analyses, we have included Stations 550+75 and 551+50 for the permanent MSE wall and Station 552+00 for the temporary MSE wall, as well as Station 551+50 for the settlement calculation. This work has been performed in general accordance with the ODOT Geotechnical Design Manual (GDM), ODOT Specifications for Geotechnical Exploration (SGE), AASHTO LRFD, ODOT SS840, and ODOT SS867.

SITE RECONNAISSANCE & EXPLORATION

Field reconnaissance was performed by Terracon personnel on December 10, 2020. The surrounding land usage primarily consists of commercial. The current ground cover consists of asphalt-paved roadway, concrete sidewalks, brush underneath the existing bridge, and grass in the flat/sloped areas adjacent to the existing roadway.

Bedrock in the area is mapped as the Ordovician Age Waynesville and Arnheim Formations with interbedded shale (~60%-70%) and limestone (~30%-40%). During our field exploration, bedrock at the retaining wall borings was encountered at depths ranging from 12 to 32 feet below existing site grades.

Four (4) test borings were performed by Terracon on 1/13/2021. All borings were drilled on either side of Glenway Avenue in grass-covered areas. The test borings were drilled using a CME-55 track-mounted drill rig. The test borings were drilled to depths of 16.1 to 34.3 feet below the existing ground surface. The drill rig utilized hollow-stem augers to permit split-spoon sampling in the overburden soils. Rock coring was not performed at any of the test borings. Drilling and sampling procedures were performed in general accordance with the ODOT Specifications for Geotechnical Exploration (SGE). The average drill rod energy ratio (ER) for the CME-55 drill rig was determined to be 89.5 percent (calibrated on 3/8/2020). Groundwater levels were observed during and at the completion of the drilling activities at each test boring location. No long-term (24-hour) water level readings were obtained at the test boring locations. Upon completion of the drilling activities and following water level observations, the boreholes were backfilled with a mixture of bentonite chips and soil cuttings.

FINDINGS

Subsurface conditions at the wall alignment consist of existing fill to depths of 8 to 27 feet below existing site grades overlying natural overburden or residual soils. The existing fill generally consists of a varying mix of clay (A-7-6) and silty clay (A-6b) with some gravel (A-1-b, A-2-6) layers. The natural overburden soils immediately below the existing fill consist primarily of soft to stiff clay (A-7-6) or silty clay (A-6b), and the residual soils consist of hard silt and clay (A-6a).

Based on the test borings, laboratory results, GDM Section 400, and SS840 Table 840.04-1, the soil parameters provided on the following pages were utilized for the MSE wall analyses.

Definition of terms used in the table below:

Cec = Compresssion Ratio/(1+e_o)
Cer = Recompression Ratio/(1+e_o)
OCR = Overconsolidation Ratio
Ca = Secondary Compression Ratio/(1+e_o)
Car = Secondary Recompression Ratio/(1+e_o)
Cv = Coefficient of Vertical Consolidation
K = Hydraulic Conductivity

Boring B-001-0-20: Used for analyses of the permanent MSE wall at Station 550+75

Soil Description	**Elevation Range (ft.)**	**Depth Range in Settlement Analysis (ft.)**	**Design Soil Unit Weight (pcf)**	**Long-Term**		**Short-Term**	**Cec**	**Cer**	**OCR**	**Ca**	**Car**	**Cv (ft2/day)**	**k (ft/day)**
				Friction Angle (deg)	**Cohesion (psf)**	**Undrained Shear Strength (psf)**							
MSE Reinforced Soil (Select Granular Backfill) [1]	-	-	120	34	0	-	-	-	-	-	-	-	-
Item Embankment Fill[2]	-	-	125	26	200	2,000	-	-	-	-	-	-	-
MSE Foundation Preparation (Type C Granular) [1]	863-862	0-1	130	34	0	-	0.005	0.001	2.0	-	-	-	-
Existing Fill (A-2-6, med. dense)	862-860	1-3	125	33	-	-	0.0125	0.0025	2.0	-	-	-	-
Existing Fill (A-6b, med. stiff)	860-857	3-6	118	26	50	1,000	0.08	0.016	2.0	0.001	0.0001	0.75	1.0
Silty Clay (A-6b, med. stiff)	857-855	6-8	120	26	50	500	0.08	0.016	1.5	0.001	0.0001	0.4	0.5
Clay (A-7-6, soft)	855-852	8-11	115	24	50	250	0.08	0.016	1.5	0.001	0.0001	0.2	0.25
Silt and Clay (A-6a, hard)	852-850	11-13	135	28	100	4,500	0.01	0.003	4.0	0.001	0.0001	0.2	0.4
Interbedded Shale and Limestone Bedrock													

1. Design parameters per BDM Table 307-1
2. Embankment fill properties per BDM Table 500-2 (A-7-6 assumed for the analyses)
3. Groundwater was encountered at an Elevation of about 858 feet, which is approximately 7 feet below the bottom elevation of the exposed portion of the proposed wall, and this depth was used in the analyses.

B-003-0-20: Used for the settlement analyses as well as analyses of the permanent MSE wall at Station 551+50

Soil Description	**Elevation Range (ft.)**	**Depth Range in Settlement Analysis (ft.)**	**Design Soil Unit Weight (pcf)**	**Long-Term**		**Short-Term**	**Cec**	**Cer**	**OCR**	**Ca**	**Car**	**Cv (ft2/day)**	**k (ft/day)**
				Friction Angle (deg)	**Cohesion (psf)**	**Undrained Shear Strength (psf)**							
MSE Reinforced Soil (Select Granular Backfill) [1]	-	-	120	34	0	-	-	-	-	-	-	-	-
Item Embankment Fill[2]	-	-	125	26	200	2,000	-	-	-	-	-	-	-
MSE Foundation Preparation (Type C Granular) [1]	864-863	0-1	130	34	-	-	0.005	0.001	2.0	-	-	-	-
Existing Fill (A-7-6, med. stiff)	863-861	1-3	120	26	50	750	0.08	0.016	2.0	0.001	0.0001	0.5	1.0
Existing Fill (A-2-6, med. dense)	861-857	3-6	125	33	-	-	0.0125	0.0025	2.0	-	-	-	-
Silt and Clay (A-6a, hard)	857-854	6-9	135	28	100	4,500	0.01	0.003	4.0	0.001	0.0001	0.2	0.4
Interbedded Shale and Limestone Bedrock													

1. Design parameters per BDM Table 307-1
2. Embankment fill properties per BDM Table 500-2 (A-7-6 assumed for the analyses)
3. Groundwater was encountered at an Elevation of about 862 feet, which is approximately 9 feet below the bottom elevation of the exposed portion of the proposed wall, and this depth was used in the analyses.

B-004-0-20: Used for analyses of the temporary MSE wall at Station 552+00

Soil Description	**Elevation Range (ft.)**	**Depth Range in Settlement Analysis (ft.)**	**Design Soil Unit Weight (pcf)**	**Long-Term**		**Short-Term**	**Cec**	**Cer**	**OCR**	**Ca**	**Car**	**Cv (ft2/day)**	**k (ft/day)**
				Friction Angle (deg)	**Cohesion (psf)**	**Undrained Shear Strength (psf)**							
MSE Reinforced Soil (Select Granular Backfill) [1]	-	-	120	34	0	-	-	-	-	-	-	-	-
Item Embankment Fill[2]	-	-	125	26	200	2,000	-	-	-	-	-	-	-
MSE Foundation Preparation (Type C Granular) [1]	871-870	0-1	130	34	0	-	0.005	0.001	2.0	-	-	-	-
Existing Fill (A-7-6, med. stiff)	870-861	1-10	120	26	50	750	0.08	0.016	2.0	0.001	0.0001	0.5	1.0
Silt and Clay (A-6a, hard)	861-859	10-12	135	28	100	4,500	0.01	0.003	4.0	0.001	0.0001	0.2	0.4
Interbedded Shale and Limestone Bedrock													

4. Design parameters per BDM Table 307-1
5. Embankment fill properties per BDM Table 500-2 (A-7-6 assumed for the analyses)
6. Groundwater was encountered at an Elevation of about 862 feet, which is approximately 9 feet below the bottom elevation of the exposed portion of the proposed wall, and this depth was used in the analyses.

MSE WALL SETTLEMENT

A settlement analysis has been performed considering the existing soil conditions and the planned construction. The soil parameters used are provided in the tables above. A settlement analysis was performed at about Station 551+50, considering that this section will receive the most amount of new fill. The table below summarizes the results of the retaining wall foundation soil total soil settlement and time rate of settlement analyses to achieve 90% consolidation per BDM requirements.

Analysis Location	**Approx. Wall Height (ft)**	**Estimated Total Settlement- Final Conditions (in)**	**Estimated Time to 90% Consolidation- Final Conditions (days)**[1]
Station 551+50 C/L	22 (Temporary Wall) 19 (Permanent Wall)	1 to 2 (Temporary Wall) 2 to 3 (Permanent Wall)	20 to 30

1. This does not include the time required for the consolidation of the new embankment fill.

Based on our analyses, the time to achieve 90 percent consolidation of the MSE retaining wall foundation soils is highly dependent on the drainage behavior of the cohesive soils (both native and existing fill). If the behavior of these layers allows dissipation of the pore pressures to more granular seams and lenses within the clay soils, the anticipated time to achieve overall 90 percent consolidation of the retaining wall foundation soils is reduced from the estimated times provided in the table. Settlement monitoring is recommended to determine the rate of consolidation during construction if the project schedule needs to be accelerated in these areas.

Vibrating wire settlement plates are recommended in lieu of conventional settlement plates. Advantages to vibrating wire settlement plates include continuous and remote data acquisition, as well as they can be covered by the MSE and embankment fill, and do not require pipe extensions, which are frequently hit by earthmoving equipment. In addition, the use of vibrating wire settlement plates will also allow the project team to closely monitor and evaluate settlement and instability risks.

Per BDM 307.1.6, differential settlement along the MSE wall should be limited to 1/100, regardless of the size of the panels. Based on the results of our analysis, the differential settlement along the proposed permanent MSE Wall is anticipated to be less than 1/100. In addition to this, the total settlement along this wall is estimated to be as much as 2 to 2.5 inches. If this settlement is not acceptable, foundation improvement using techniques like aggregate piers or stone columns to reduce this settlement to acceptable levels can be considered. Installation of aggregate piers or stone columns would also reduce the consolidation time of the foundation soils since the elements would act as additional drainage paths within the foundation soils.

MSE WALL ANALYSIS

The MSE walls will have a maximum total height of approximately 24 feet. The foundation leveling pad for the MSE wall shall consist of excavation of at least 12 inches below the proposed bottom-of-leveling pad elevation and the placement of Granular Material Type C according to requirements in C&MS 204.07. Following excavation to the base of the undercut, the exposed surface should be inspected and densified per ODOT specifications. This foundation preparation area should extend across the entire wall leveling pad and reinforced zone, and at least 12 inches horizontally in front of the leveling pad.

Per typical ODOT practice, the MSE wall construction will involve the use of granular backfill soil (reinforced zone) and thin metallic strips to form a gravity mass capable of supporting or restraining large, imposed loads. The backfill material should consist of Select Granular Backfill (SGB) per SS840.03.E behind the MSE panel facing. Additionally, a minimum vertical distance of 3 feet from the top of the leveling pad to any point on the ground surface within 4 feet of the face of the wall should be maintained. The MSE wall should be designed to satisfy internal and external stability. For external stability, a vertically reinforced soil structure must satisfy the same external design criteria as a conventional retaining wall. Terracon has performed geotechnical analyses for external stability, which include sliding as a rigid body at or below the base, overturning (eccentricity), bearing capacity failure, and global stability. The design of the MSE wall structure for internal and compound stability is typically performed by the contractor/manufacturer. Terracon did not perform internal and compound stability analyses for this wall.

BDM and LRFD criteria indicate that reinforcement lengths in mechanically stabilized earth walls should have a minimum length of 70 percent of the total wall height or a minimum value of 8 feet, whichever is greater. The vertical MSE retaining structures must be designed to resist lateral earth pressures and surcharge pressures transferred from the traffic surcharge (a minimum of 250 psf traffic loading should be applied).

The design of this type of system requires that the interface friction should resist the soil pressure from the backfill layer between reinforcements, that the reinforcement length is adequate to support the interface friction and provide a stable mass, and that the reinforcement is strong enough to resist the tensile forces that develop. The length of reinforcements must be extended beyond the zone of Rankine failure.

The external stability of the MSE wall was evaluated with the MSEW+ software (2023.21) for the final MSE wall configuration and the intermediate surcharge configuration. The capacity demand ratios (CDR) were calculated for the bearing capacity and the sliding resistance of the MSE wall using LRFD methods outlined by AASHTO. The CDR value is defined as the factored resistance divided by the factored loads; thus, a CDR value greater than 1.0 indicates the factored resistance is greater than the factored loads. A summary of the calculated values is listed below. The results of the MSEW analyses are attached.

We have performed global stability analyses for the MSE walls using GeoStudio 2022.1 (version 11.4.2.250), the subsurface conditions encountered at the borings, and the cross-sections included in the plan set '20250416-025349-PlanSet-Addendum-R1_AsRevised' provided by ODOT District 8. The factor of safety (F.S.) for overall stability has been calculated using the AASHTO LRFD procedure and presented in the table below. The results of the Global Stability analyses are attached.

Case	Strap Length/ Wall Height (%)	Sliding	Bearing Failure	Eccentricity	Global Stability[1]	
					Long-Term	Short-Term
Minimum Value	70%	CDR≥1.0	CDR≥1.0	e/L≤0.25	FS≥1.3	F.S. ≥1.3
Permanent MSE Wall (Station 550+75[1])	70%	1.35	1.27	0.13	1.35	1.38
Permanent MSE Wall (Station 551+50)	70%	1.03	1.09	0.24	1.37	1.48
Temporary MSE Wall (Station 552+00)	70%	1.33	1.27	0.14	1.59	2.05

1. Surcharge Load L = 250 psf for traffic was considered.

Based on the MSE wall analyses, the recommended minimum MSE wall reinforcement strap length at all MSE Wall sections corresponds to the minimum BDM Section 307.4 reinforcement length of 70% of the total MSE wall height (including the embedment and the abutment wall).

ATTACHMENTS

Boring Location Plan
Test Boring Logs
Calculations
    Embankment Settlement
    MSE Wall Analysis
    Global Stability Analysis

EXPLORATION PLAN

HAM-264-10.42 PID 25349 ■ Cincinnati, Hamilton County, Ohio
Terracon Project No. N1205396

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

PROJECT: HAM-264-10.42
TYPE: RETAINING WALL
PID: 99962 SFN:
START: 1/13/21 END: 1/13/21

DRILLING FIRM / OPERATOR: TERRACON / KH
SAMPLING FIRM / LOGGER: TERRACON / AK
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 55/300 TRACK
HAMMER: AUTOMATIC HAMMER
CALIBRATION DATE: 3/8/20
ENERGY RATIO (%): 89.5

STATION / OFFSET: 551+12, 59' RT.
ALIGNMENT: SR264
ELEVATION: 865.6 (MSL) EOB: 18.8 ft.
COORD: 418124.8676 N, 1371058.2740 E

EXPLORATION ID
B-001-0-21

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MATERIAL DESCRIPTION AND NOTES	ELEV. 865.6	DEPTHS		SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
									GR	CS	FS	SI	CL	LL	PL	PI			
TOPSOIL 3 INCHES	865.4																		
GRAY TO BROWN, **SILTY CLAY**, SOME GRAVEL, SOME SAND, DAMP (FILL)	862.6		2.5	3 3 2	7	67	SS-1	2.00	27	18	13	20	22	35	17	18	14	A-6b (4)	
DARK BROWN TO BLACK, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST (FILL)	859.6		5.0	20 8 4	18	100	SS-2	1.75	43	16	13	15	13	36	24	12	12	A-2-6 (0)	
GRAY, **SILTY CLAY**, SOME GRAVEL AND GLASS FRAGMENTS, SOME SAND, MOIST (FILL)	857.6	W 857.6	7.5	2 2 3	7	89	SS-3	1.00	23	15	12	28	22	37	20	17	30	A-6b (5)	
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, MOIST	855.1		10.0	1 3 4	10	100	SS-4	0.50	-	-	-	-	-	-	-	-	28	A-6b (V)	
SOFT TO MEDIUM STIFF, GRAY, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	852.6		12.5	1 2 2	6	100	SS-5	0.25	1	5	15	39	40	42	18	24	25	A-7-6 (14)	
HARD, BROWN TRACE GRAY, **SILT AND CLAY**, SOME GRAVEL, LITTLE SAND, TRACE TO LITTLE LIMESTONE LAYERS, MOIST (RESIDUUM)	850.6	TR	15.0	9 23 50/4"	-	75	SS-6	4.50	22	7	9	30	32	30	16	14	17	A-6a (7)	
INTERBEDDED SHALE AND LIMESTONE ; SHALE: GRAY, SLIGHTLY WEATHERED TO UNWEATHERED, VERY WEAK TO WEAK LIMESTONE: LIGHT GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG.				50/2"	-	100	SS-7	-	-	-	-	-	-	-	-	-	-	Rock (V)	
	846.8	EOB	17.5	50/3"	-	100	SS-8	-	-	-	-	-	-	-	-	-	-	Rock (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH AUGER CUTTINGS; 5 BAGS BENTONITE CHIPS

PROJECT: HAM-264-10.42
TYPE: RETAINING WALL
PID: 99962 SFN:
START: 1/13/21 END: 1/13/21

DRILLING FIRM / OPERATOR: TERRACON / KH
SAMPLING FIRM / LOGGER: TERRACON / AK
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 55/300 TRACK
HAMMER: AUTOMATIC HAMMER
CALIBRATION DATE: 3/8/20
ENERGY RATIO (%): 89.5

STATION / OFFSET: 551+74, 58' LT.
ALIGNMENT: SR264
ELEVATION: 886.1 (MSL) EOB: 33.8 ft.
COORD: 418096.3161 N, 1371186.9300 E

EXPLORATION ID
B-002-0-21

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MATERIAL DESCRIPTION AND NOTES	ELEV. 886.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI			
TOPSOIL 3 INCHES	885.8																	
BROWN WITH BLACK, **CLAY**, LITTLE TO SOME SILT, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP TO MOIST (FILL)		2.5	2 2 3	7	67	SS-1	1.25	17	13	9	19	42	52	19	33	18	A-7-6 (15)	
		5.0	3 3 2	7	11	SS-2	0.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
- GRADES TO BROWN WITH TRACE GRAY BELOW 6 FEET		7.5	2 4 6	15	78	SS-3	1.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		10.0	2 2 3	7	72	SS-4	1.25	7	6	10	32	45	48	18	30	24	A-7-6 (18)	
		12.5	2 3 4	10	75	SS-5	0.75	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
		15.0	3 3 5	12	72	SS-6	1.50	3	5	8	35	49	46	18	28	24	A-7-6 (16)	
		17.5	2 2 5	10	89	SS-7	1.75	11	5	5	41	38	44	17	27	22	A-7-6 (16)	
		20.0	4 4 5	13	28	SS-8	-	-	-	-	-	-	-	-	-	28	A-7-6 (V)	
	862.6	22.5																
GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET (FILL)		25.0	3 18 10	42	50	SS-9	-	44	23	10	11	12	29	16	13	55	A-2-6 (0)	
	859.1																	
HARD, BROWN TRACE GRAY, **SILT AND CLAY**, SOME GRAVEL, LITTLE SAND, TRACE TO LITTLE LIMESTONE LAYERS, DAMP (RESIDUUM)		27.5	40 50/2"	-	100	SS-10	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		30.0																
	854.1	TR																
INTERBEDDED SHALE AND LIMESTONE ; SHALE: GRAY, SLIGHTLY WEATHERED TO UNWEATHERED, VERY WEAK TO WEAK LIMESTONE: LIGHT GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG.		32.5																
	852.3	EOB	50/4"	-	100	SS-11	-	-	-	-	-	-	-	-	-	-	Rock (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH AUGER CUTTINGS; 8 BAGS BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/8/21 11:01 - C:\USERS\BMLANGLOIS\ONEDRIVE - TERRACON CONSULTANTS INC\DESKTOP\TEMP OFFLINE WORK\CIN\PROJEC

PROJECT: HAM-264-10.42
TYPE: RETAINING WALL
PID: 99962 SFN:
START: 1/13/21 END: 1/13/21

DRILLING FIRM / OPERATOR: TERRACON / KH
SAMPLING FIRM / LOGGER: TERRACON / AK
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 55/300 TRACK
HAMMER: AUTOMATIC HAMMER
CALIBRATION DATE: 3/8/20
ENERGY RATIO (%): 89.5

STATION / OFFSET: 552+07, 69' RT.
ALIGNMENT: SR264
ELEVATION: 864.9 (MSL) EOB: 16.1 ft.
COORD: 418033.7008 N, 1371071.3030 E

EXPLORATION ID
B-003-0-21

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MATERIAL DESCRIPTION AND NOTES	ELEV. 864.9	DEPTHS
TOPSOIL 2 INCHES	864.7	
BROWN TRACE BLACK, **CLAY**, SOME GRAVEL, SOME SAND, LITTLE SILT, MOIST (FILL)	861.9	2.5
DARK BROWN TO BLACK, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, WET (FILL)	858.9	5.0
GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, WET (FILL)	856.9	7.5
HARD, BROWN, **SILT AND CLAY**, SOME SAND, SOME GRAVEL, TRACE TO LITTLE LIMESTONE LAYERS, DAMP (RESIDUUM)	853.9	10.0 TR
INTERBEDDED SHALE AND LIMESTONE ; SHALE: BROWN, MODERATELY WEATHERED, VERY WEAK LIMESTONE: LIGHT GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG.	851.9	12.5
INTERBEDDED SHALE AND LIMESTONE ; SHALE: GRAY, SLIGHTLY WEATHERED TO UNWEATHERED, VERY WEAK TO WEAK LIMESTONE: LIGHT GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG.	848.8	15.0 EOB

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
					GR	CS	FS	SI	CL	LL	PL	PI			
4 5 4	13	56	SS-1	1.00	33	20	12	18	17	-	-	-	19	A-7-6 (V)	
6 6 7	19	100	SS-2	0.50	27	25	14	15	19	34	23	11	18	A-2-6 (0)	
4 7 4	16	72	SS-3	-	45	21	13	11	10	30	25	5	17	A-1-b (0)	
20 50/4"	-	100	SS-4	4.50	24	12	14	20	30	30	15	15	6	A-6a (5)	
50	-	100	SS-5	-	-	-	-	-	-	-	-	-	-	Rock (V)	
50/2"	-	100	SS-6	-	-	-	-	-	-	-	-	-	-	Rock (V)	
50/1"	-	100	SS-7	-	-	-	-	-	-	-	-	-	-	Rock (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH AUGER CUTTINGS; 5 BAGS BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/8/21 11:01 - C:\USERS\BMLANGLOIS\ONEDRIVE - TERRACON CONSULTANTS INC\DESKTOP\TEMP OFFLINE WORK\CIN\PROJEC

PROJECT: HAM-264-10.42
TYPE: RETAINING WALL
PID: 99962 SFN:
START: 1/13/21 END: 1/13/21

DRILLING FIRM / OPERATOR: TERRACON / KH
SAMPLING FIRM / LOGGER: TERRACON / AK
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 55/300 TRACK
HAMMER: AUTOMATIC HAMMER
CALIBRATION DATE: 3/8/20
ENERGY RATIO (%): 89.5

STATION / OFFSET: 552+70, 59' LT.
ALIGNMENT: SR264
ELEVATION: 888.1 (MSL) EOB: 34.3 ft.
COORD: 418002.9984 N, 1371211.2020 E

EXPLORATION ID
B-004-0-21

PAGE
1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 888.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI			
TOPSOIL 2 INCHES	887.9																	
BROWN TRACE GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST (FILL)		2.5	2 3 5	12	67	SS-1	1.75	7	9	8	24	52	53	23	30	21	A-7-6 (19)	
		5.0	5 5 7	18	89	SS-2	2.00	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		7.5	5 5 6	16	78	SS-3	1.50	6	7	8	32	47	44	18	26	19	A-7-6 (15)	
	877.6	10.0	2 2 3	7	89	SS-4	0.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
BLUISH GRAY, **SILTY CLAY**, LITTLE GRAVEL, LITTLE SAND, MOIST (FILL)	875.1	12.5	3 3 5	12	89	SS-5	1.75	16	7	9	32	36	40	18	22	29	A-6b (11)	
BLUISH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST (FILL)		15.0	2 2 3	7	56	SS-6	0.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		17.5	3 4 7	16	56	SS-7	0.75	7	10	8	31	44	44	20	24	30	A-7-6 (14)	
		20.0	3 3 4	10	0	SS-8	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	
	864.6	22.5																
BLACK, **SILTY CLAY**, SOME GRAVEL, SOME SAND, DAMP (FILL)	863.6	25.0	5 8 8	24	83	SS-9	2.5/ 0.5	26	16	14	21	23	35	18	17	8	A-6b (4)	
GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP (FILL)	861.1	W 861.6																
HARD, BROWN, **SILT AND CLAY**, SOME GRAVEL, LITTLE SAND, TRACE TO LITTLE LIMESTONE LAYERS, DAMP (RESIDUUM)	859.6	27.5 TR																
INTERBEDDED SHALE AND LIMESTONE ; SHALE: BROWN TO GRAY, MODERATELY WEATHERED, VERY WEAK TO WEAK LIMESTONE: LIGHT GRAY, UNWEATHERED, MODERATELY STRONG TO STRONG.		30.0	40 23 50/5"	-	65	SS-10	4.50	-	-	-	-	-	-	-	-	-	Rock (V)	
		32.5																
	853.8	EOB	41 50/3"	-	50	SS-11	-	-	-	-	-	-	-	-	-	-	Rock (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH AUGER CUTTINGS; 8 BAGS BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/8/21 11:01 - C:\USERS\BMLANGLOIS\ONEDRIVE - TERRACON CONSULTANTS INC\DESKTOP\TEMP OFFLINE WORK\CIN\PROJEC

Squish - Cover Sheet and Input Summary

PROJECT INFORMATION

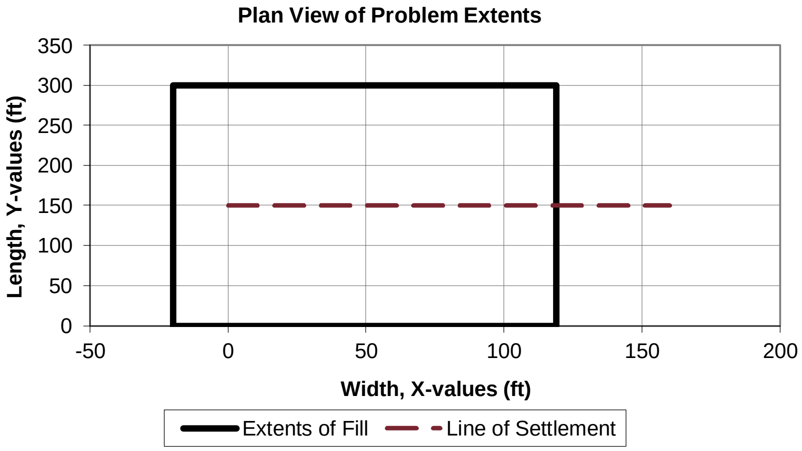
Project Name:	**HAM-264-10.42**
Project Number:	**N1205396**
Location or Station:	**Sta 551+50**
Notes/Description:	**Permanent MSE Wall**
Date of Analysis:	**May 9, 2025**

SUMMARY OF FILL/EMBANKMENT INPUT

Embankments Block Types:	Existing =	3	Proposed =	5	Surcharge =	0

Line of Settlement Calcs:	Beginning X =	0	Ending X =	160
(17 points along this line.)	Beginning Y =	150	Ending Y =	150

The graph to the right shows the plan view of the problem extent as well as the line along which stresses and settlement are calculated. See the "Fill" sheet for additional information and graphs of the modeled blocks.



SUMMARY OF SOIL INPUT

Total Number of Soil Layers	4

Time Dependent Soil Layers	2

Timeframe for Secondary	20 years
Primary Assumed Complete at	90%
Stress to Induce Secondary	200 psf
Rebound after surcharge	Excluded
Secondary Reduction Method	None

Secondary Reduction Method - Explanation

No reduction in secondary consolidation has been made. Any surcharges will not decrease the amount of secondary settlement.

Total Number of Time Steps	4000
Maximum Beta	0.2
Maximum Calculated Time (days)	400
Preconsolidation Pressure Method	OCR
Stress Distribution Method	Boussinesq

See the input and output sheets from Squish for additional information. The results of this program should be independently verified.

Squish - Embankment Fill Input

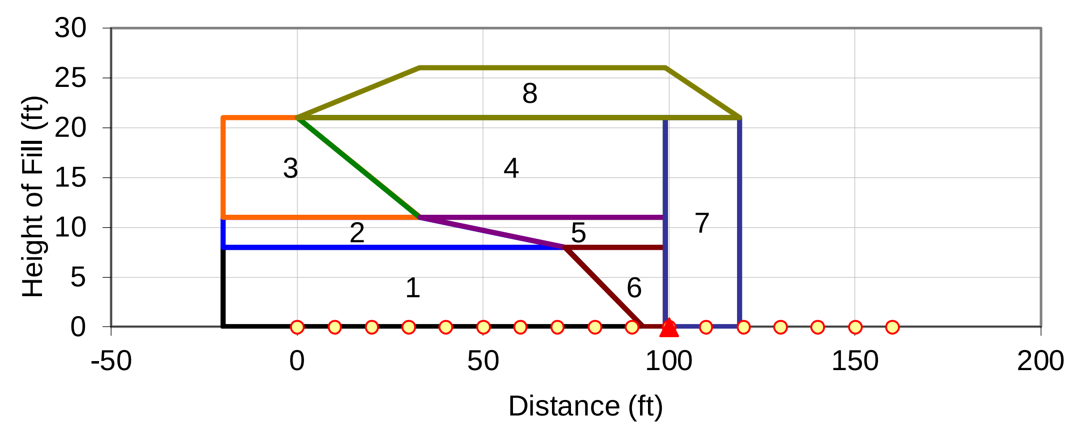
Block Number		1	2	3	4	5	6	7	8
Fill Type		Existing	Existing	Existing	Proposed	Proposed	Proposed	Proposed	Proposed
γ (pcf)		120.0	120	120.0	120.0	120.0	120.0	120.0	120.0
Bottom of Block (ft)	Left X	-20	-20	-20	33	72	93	99	0
	Left Z	0	8.0	11.0	11	8	0	0	21
	Right X	93	72	33	99	99	99	119	119
	Right Z	0	8	11	11	8	0	0	21
Top of Block (ft)	Left X	-20	-20	-20	0	33	72	99	33
	Left Z	8	11.0	21.0	21	11	8	21	26
	Right X	72	33	0	99	99	99	119	99
	Right Z	8	11	21	21	11	8	21	26
Calculated Slopes	Left Side Slope	Vertical	Vertical	Vertical	-3.3H:1V	-13H:1V	-2.63H:1V	Vertical	6.6H:1V
	Right Side Slope	-2.63H:1V	-13H:1V	-3.3H:1V	Vertical	Vertical	Vertical	Vertical	-4H:1V

Line of Settlement Calculations (ft)	Left X	0
	Left Y	150
	Right X	160
	Right Y	150
	Number of Points	*17*

Length of Embankment (ft)	300
Horizontal Slice Thickness (ft)	0.1

☑ Display the Block Numbers on the Graph?

Calculate Settlement and Time for Settlement to Occur



Squish - Subsurface Profile Input Values

Depth to Groundwater (ft) 9
σ_p' Option OCR ▼

Calculate Settlement and Time for Settlement

Time for Secondary Consol (years) 20
Assume Primary Complete at Ui = 90%
Min. $\Delta\sigma$' to Induce Secondary (psf) = 200
Rebound after surcharge Exclude ▼
Secondary Consol Reduction Method None ▼

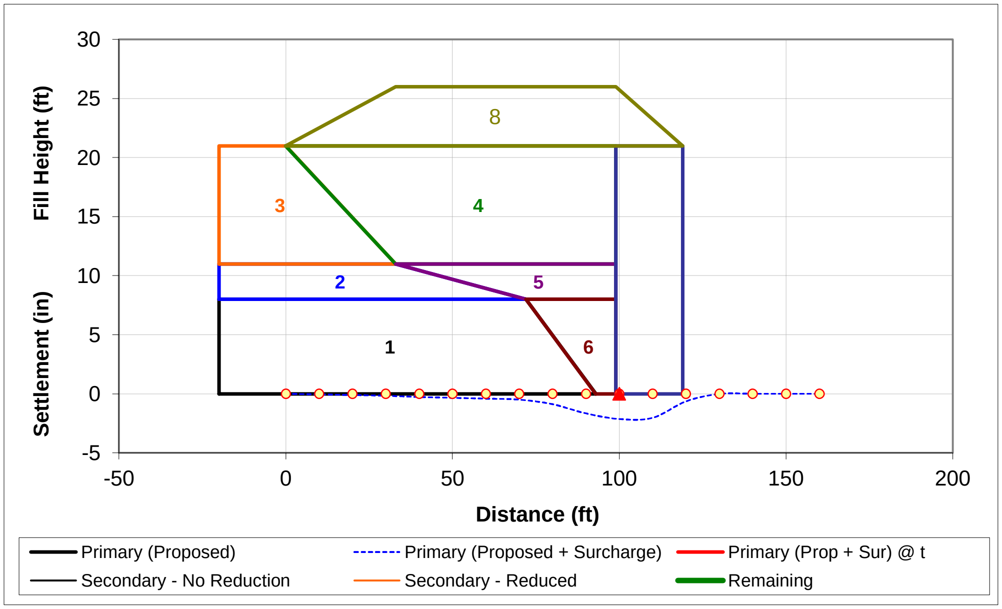
Number of Time Steps 4000
Maximum Beta (finite difference) 0.2
Max Time Calculated (days) *400*

Stress distribution method
● Boussinesq
○ Westergaard

Layer Thickness		Settlement Parameters						Time Rate of Settlement Values					Wicks	Strength Values	
Top (ft)	Bottom (ft)	γ (pcf)	Cεc	Cεr	OCR	Cα	Cαr	Time Dependent	Cv (ft^2/day)	k (ft/day)	Top Drained	Bottom Drained	C_h (ft^2/day)	s	m
0	1	130	0.005	0.001	2.0			No							
1	3	120	0.080	0.016	2.0	0.001	0.0001	**Yes**	0.5	1	Yes	Yes			
3	6	125	0.013	0.003	2.0			No							
6	9	135	0.010	0.003	4.0	0.001	0.0001	**Yes**	0.2	0.4	Yes	No			

Squish - Settlement Results

Evaluate Effective Stresses at t = 24.0 **days**



Block	Fill Type
1	Existing
2	Existing
3	Existing
4	Proposed
5	Proposed
6	Proposed
7	Proposed
8	Proposed

Items to Graph

Primary Consolidation

☐ Proposed Only

☑ Final P + S

☐ P+S at t = 24 days

Secondary Consolidation

☐ No Reduction

☐ With Reduction

☐ **Total Remaining**

Calculations are based on effective stress present at t = 24 days

Location of Point		Proposed Embankment (t = ∞)		Settlement between t = 24 days and 20 years.		
X (ft)	Y (ft)	Primary (in)	Secondary (in)	Primary (in)	Secondary (in)	Total (in)
Maximum Values		***2.1***	***0.1***	***0.0***	***0.1***	***0.2***
0.0	150	0.0	0.0	0.0	0.0	0.0
10.0	150	0.1	0.0	0.0	0.0	0.0
20.0	150	0.1	0.0	0.0	0.0	0.0
30.0	150	0.2	0.1	0.0	0.1	0.1
40.0	150	0.3	0.1	0.0	0.1	0.1
50.0	150	0.3	0.1	0.0	0.1	0.1
60.0	150	0.4	0.1	0.0	0.1	0.1
70.0	150	0.5	0.1	0.0	0.1	0.1
80.0	150	0.9	0.1	0.0	0.1	0.1
90.0	150	1.7	0.1	0.0	0.1	0.1
100.0	150	2.1	0.1	0.0	0.1	0.2
110.0	150	2.0	0.1	0.0	0.1	0.1
120.0	150	0.6	0.1	0.0	0.1	0.1
130.0	150	0.0	0.0	0.0	0.0	0.0
140.0	150	0.0	0.0	0.0	0.0	0.0
150.0	150	0.0	0.0	0.0	0.0	0.0
160.0	150	0.0	0.0	0.0	0.0	0.0

Squish - Detailed Settlement Results

View results at: X=100, Y=150 **Evaluate Settlement at t =** 24.0 **days**

	Settlement from Proposed at t = 20 years. Assumes all pore pressures have dissipated.				**Settlement from Proposed + Surcharge at t= 24 days**		**Settlement between t = 24 days and 20 years.**		
Primary =	2.1	Secondary =	0.1	2.3	Min = 67%	2.1	0.0	0.1	0.2
Depth Interval (ft)	**Primary (in)**	Time for Primary, Tp (days)	Secondary (in)	Total (in)	Degree Consol	**Primary (in)**	**Primary (in)**	Secondary (in)	Total (in)
0 - 1	0.1	0	0.0	0.1	100%	0.1	0.0	0.0	0.0
1 - 2	1.0	2	0.0	1.0	100%	1.0	0.0	0.0	0.0
2 - 3	0.8	2	0.0	0.8	100%	0.8	0.0	0.0	0.0
3 - 4	0.1	0	0.0	0.1	100%	0.1	0.0	0.0	0.0
4 - 5	0.1	0	0.0	0.1	100%	0.1	0.0	0.0	0.0
5 - 6	0.1	0	0.0	0.1	100%	0.1	0.0	0.0	0.0
6 - 7	0.0	22	0.0	0.1	91%	0.0	0.0	0.0	0.0
7 - 8	0.0	40	0.0	0.0	76%	0.0	0.0	0.0	0.0
8 - 9	0.0	46	0.0	0.0	67%	0.0	0.0	0.0	0.0

Squish - Cover Sheet and Input Summary

PROJECT INFORMATION

Project Name:	**HAM-264-10.42**
Project Number:	**N1205396**
Location or Station:	**Sta 551+50**
Notes/Description:	**Temporary MSE Wall**
Date of Analysis:	**May 9, 2025**

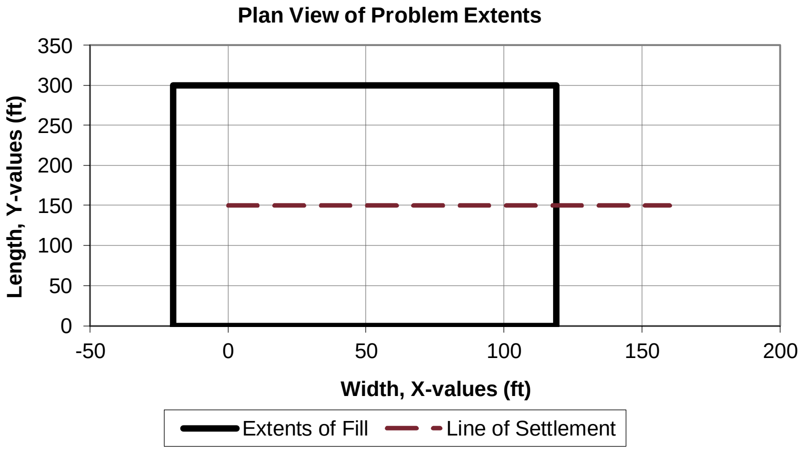
SUMMARY OF FILL/EMBANKMENT INPUT

Embankments Block Types: Existing = 3 Proposed = 5 Surcharge = 0

Line of Settlement Calcs:
(17 points along this line.)

Beginning X = 0
Beginning Y = 150
Ending X = 160
Ending Y = 150

The graph to the right shows the plan view of the problem extent as well as the line along which stresses and settlement are calculated. See the "Fill" sheet for additional information and graphs of the modeled blocks.



SUMMARY OF SOIL INPUT

Total Number of Soil Layers	4
Time Dependent Soil Layers	2

Timeframe for Secondary	20 years
Primary Assumed Complete at	90%
Stress to Induce Secondary	200 psf
Rebound after surcharge	Excluded
Secondary Reduction Method	None

Secondary Reduction Method - Explanation

No reduction in secondary consolidation has been made. Any surcharges will not decrease the amount of secondary settlement.

Total Number of Time Steps	4000
Maximum Beta	0.2
Maximum Calculated Time (days)	400
Preconsolidation Pressure Method	OCR
Stress Distribution Method	Boussinesq

See the input and output sheets from Squish for additional information. The results of this program should be independently verified.

Squish - Embankment Fill Input

		1	2	3	4	5	6	7	8
	Block Number	1	2	3	4	5	6	7	8
	Fill Type	Existing	Existing	Existing	Proposed	Proposed	Proposed	Proposed	Proposed
	γ (pcf)	120.0	120	120.0	120.0	120.0	120.0	120.0	120.0
Bottom of Block (ft)	Left X	-20	-20	-20	33	72	93	99	0
	Left Z	0	8.0	11.0	11	8	0	0	21
	Right X	93	72	33	99	99	99	119	119
	Right Z	0	8	11	11	8	0	0	21
Top of Block (ft)	Left X	-20	-20	-20	0	33	72	99	33
	Left Z	8	11.0	21.0	21	11	8	21	26
	Right X	72	33	0	99	99	99	119	99
	Right Z	8	11	21	21	11	8	21	26

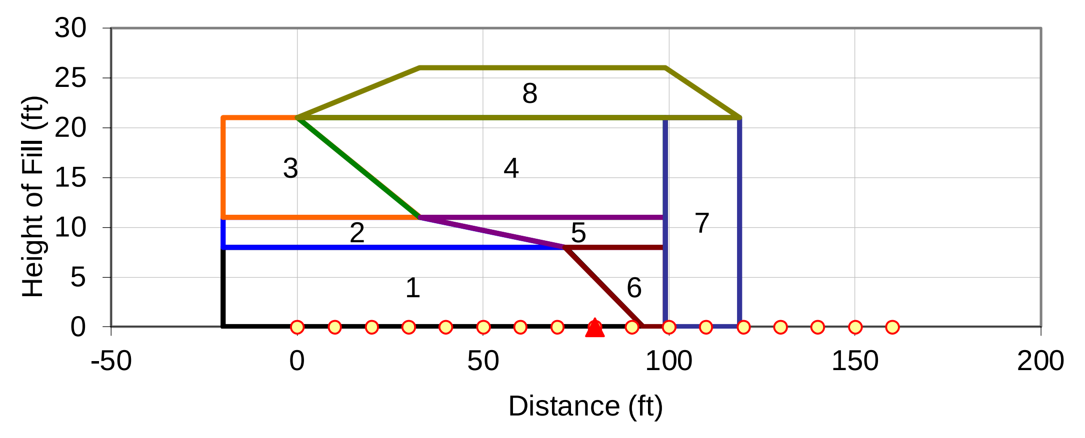
Calculated Slopes	Left Side Slope	Vertical	Vertical	Vertical	-3.3H:1V	-13H:1V	-2.63H:1V	Vertical	6.6H:1V
	Right Side Slope	-2.63H:1V	-13H:1V	-3.3H:1V	Vertical	Vertical	Vertical	Vertical	-4H:1V

Line of Settlement Calculations (ft)	Left X	0
	Left Y	150
	Right X	160
	Right Y	150
	Number of Points	*17*

Length of Embankment (ft)	300
Horizontal Slice Thickness (ft)	0.1

☑ Display the Block Numbers on the Graph?

Calculate Settlement and Time for Settlement to Occur



Squish - Subsurface Profile Input Values

Depth to Groundwater (ft) 9

σ_p' Option OCR

Calculate Settlement and Time for Settlement

Time for Secondary Consol (years) 20

Assume Primary Complete at Ui = 90%

Min. Δσ' to Induce Secondary (psf) = 200

Rebound after surcharge Exclude

Secondary Consol Reduction Method None

Number of Time Steps 4000

Maximum Beta (finite difference) 0.2

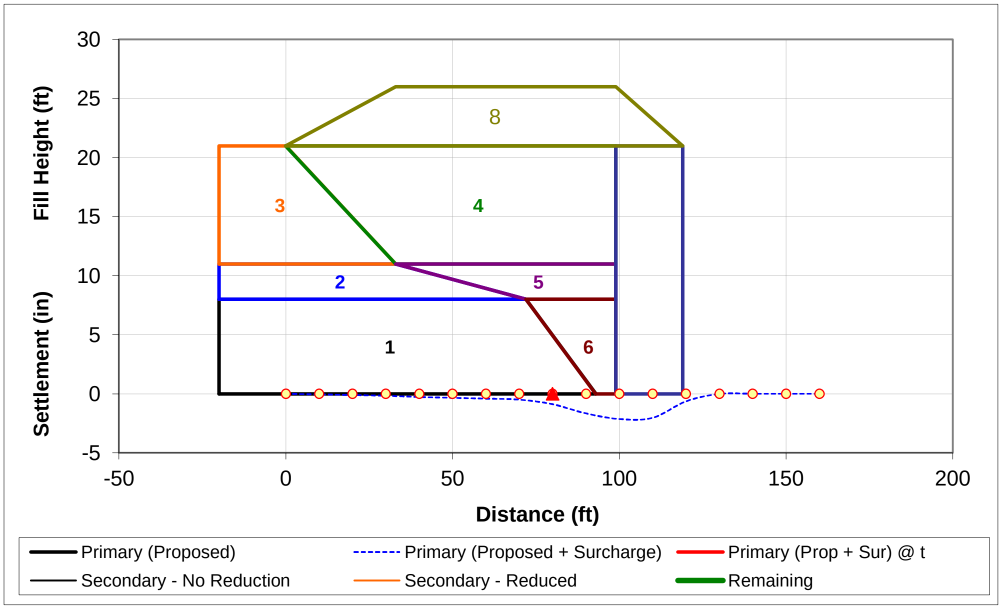
Max Time Calculated (days) *400*

Stress distribution method ● Boussinesq ○ Westergaard

Layer Thickness		***Settlement Parameters***						***Time Rate of Settlement Values***					***Wicks***	***Strength Values***	
Top (ft)	Bottom (ft)	γ (pcf)	Cεc	Cεr	OCR	Cα	Cαr	Time Dependent	Cv (ft^2/day)	k (ft/day)	Top Drained	Bottom Drained	C_h (ft^2/day)	s	m
0	1	130	0.005	0.001	2.0			No							
1	3	120	0.080	0.016	2.0	0.001	0.0001	**Yes**	0.5	1	Yes	Yes			
3	6	125	0.013	0.003	2.0			No							
6	9	135	0.010	0.003	4.0	0.001	0.0001	**Yes**	0.2	0.4	Yes	No			

Squish - Settlement Results

Evaluate Effective Stresses at t = 24.0 **days**



Block	Fill Type
1	Existing
2	Existing
3	Existing
4	Proposed
5	Proposed
6	Proposed
7	Proposed
8	Proposed

Items to Graph

Primary Consolidation

☐ Proposed Only

☑ Final P + S

☐ P+S at t = 24 days

Secondary Consolidation

☐ No Reduction

☐ With Reduction

☐ **Total Remaining**

Calculations are based on effective stress present at t = 24 days

Location of Point		Proposed Embankment (t = ∞)		Settlement between t = 24 days and 20 years.		
X (ft)	Y (ft)	Primary (in)	Secondary (in)	Primary (in)	Secondary (in)	Total (in)
Maximum Values		***2.1***	***0.1***	***0.0***	***0.1***	***0.2***
0.0	150	0.0	0.0	0.0	0.0	0.0
10.0	150	0.1	0.0	0.0	0.0	0.0
20.0	150	0.1	0.0	0.0	0.0	0.0
30.0	150	0.2	0.1	0.0	0.1	0.1
40.0	150	0.3	0.1	0.0	0.1	0.1
50.0	150	0.3	0.1	0.0	0.1	0.1
60.0	150	0.4	0.1	0.0	0.1	0.1
70.0	150	0.5	0.1	0.0	0.1	0.1
80.0	150	0.9	0.1	0.0	0.1	0.1
90.0	150	1.7	0.1	0.0	0.1	0.1
100.0	150	2.1	0.1	0.0	0.1	0.2
110.0	150	2.0	0.1	0.0	0.1	0.1
120.0	150	0.6	0.1	0.0	0.1	0.1
130.0	150	0.0	0.0	0.0	0.0	0.0
140.0	150	0.0	0.0	0.0	0.0	0.0
150.0	150	0.0	0.0	0.0	0.0	0.0
160.0	150	0.0	0.0	0.0	0.0	0.0

Squish - Detailed Settlement Results

View results at: X=80, Y=150 ▼ **Evaluate Settlement at t =** 24.0 ▼ **days**

	Settlement from Proposed at t = 20 years. Assumes all pore pressures have dissipated.				**Settlement from Proposed + Surcharge at t= 24 days**		**Settlement between t = 24 days and 20 years.**		
Primary =	0.9	Secondary =	0.1	1.0	Min = 67%	0.9	0.0	0.1	0.1
Depth Interval (ft)	**Primary (in)**	Time for Primary, Tp (days)	Secondary (in)	Total (in)	Degree Consol	**Primary (in)**	**Primary (in)**	Secondary (in)	Total (in)
0 - 1	0.0	0	0.0	0.0	100%	0.0	0.0	0.0	0.0
1 - 2	0.4	2	0.0	0.4	100%	0.4	0.0	0.0	0.0
2 - 3	0.3	2	0.0	0.4	100%	0.3	0.0	0.0	0.0
3 - 4	0.0	0	0.0	0.0	100%	0.0	0.0	0.0	0.0
4 - 5	0.0	0	0.0	0.0	100%	0.0	0.0	0.0	0.0
5 - 6	0.0	0	0.0	0.0	100%	0.0	0.0	0.0	0.0
6 - 7	0.0	22	0.0	0.0	91%	0.0	0.0	0.0	0.0
7 - 8	0.0	40	0.0	0.0	76%	0.0	0.0	0.0	0.0
8 - 9	0.0	46	0.0	0.0	67%	0.0	0.0	0.0	0.0

AASHTO 2017-2020
HAM-264-10.42 Permanent Wall

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title:	HAM-264-10.42 Permanent Wall
Project Number:	N1205396
Client:	ODOT- District 8
Designer:	MP
Station Number:	550+75

Description:

Company's information:

Name: Terracon Consultants, Inc.
Street: 611 Lunken Park Dr

Cincinnati, Ohio 45226
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\mpandey\OneDrive - Terracon\OneDrive - Terraco.....
.....l1A- Sta 102+00.BENp

Original date and time of creating this file: 5/9/2025 3:50 P.M.

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	26.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	118.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	26.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	50.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3472 (eq. 17 is utilized to calculate Ka for all batters)
(For external stability user specified $\delta = 17.30°$)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 22.25 $N\gamma = 12.54$

SEISMICITY

Not Applicable

FOR EXTERNAL STABILITY

Ka = 0.3472 In Coulomb equation for Ka, Omega was taken as ZERO
and backslope inclined at angle I.

INPUT DATA: Metal strips
(Analysis)

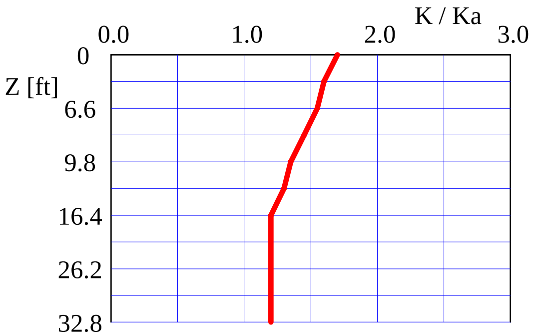
DATA	Metal strip type #1	Metal strip type #2	Metal strip type #3	Metal strip type #4	Metal strip type #5
Yield strength of steel, Fy [kips/in ^{2}]	65.3	N/A	N/A	N/A	N/A
Gross width of strip, b [in]	2.0	N/A	N/A	N/A	N/A
Vertical spacing, Sv [ft]	Varies	N/A	N/A	N/A	N/A
Design cross section area, Ac [in ^{2}]	0.232	N/A	N/A	N/A	N/A

Ribbed steel strips.
Uniformity Coefficient of reinforced soil, Cu = D60/D10 = 4.0

Friction angle along reinforcement-soil interface,	ρ				
@ the top	60.97	N/A	N/A	N/A	N/A
@ 19.7 ft or below	32.00	N/A	N/A	N/A	N/A
Pullout resistance factor, F*					
@ the top	1.80	N/A	N/A	N/A	N/A
@ 19.7 ft or below	0.62	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.00	N/A	N/A	N/A	N/A

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.70
3.3 ft	1.60
6.6 ft	1.55
9.8 ft	1.45
13.1 ft	1.35
16.4 ft	1.30
19.7 ft	1.20



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 27.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 24.00 ft }

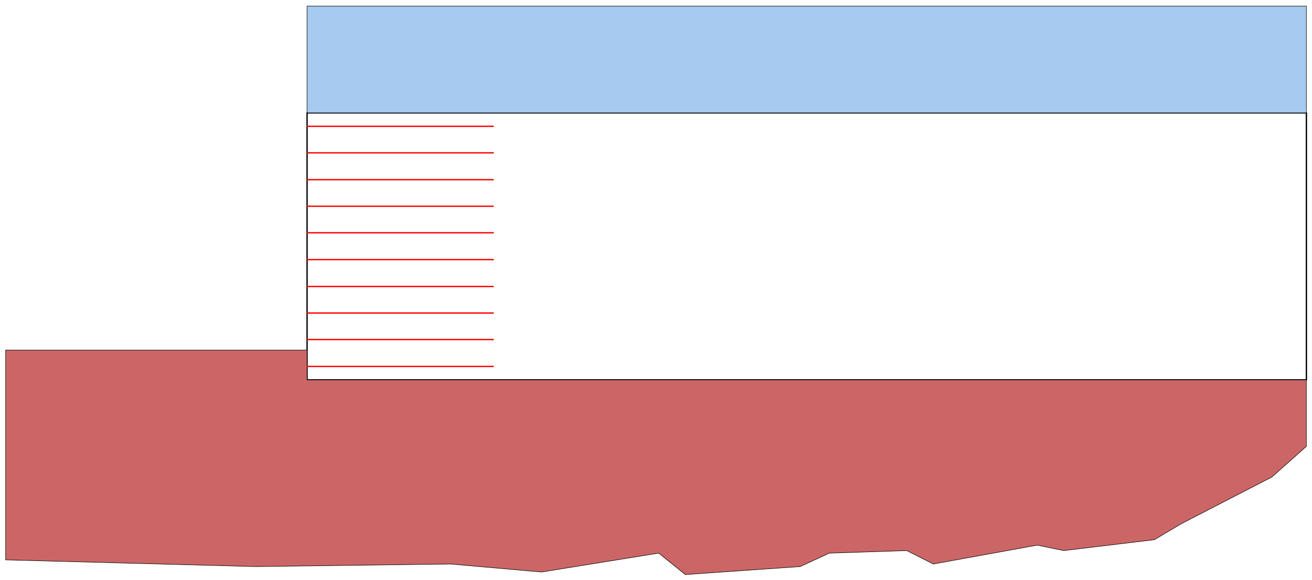
Soil in front of wall is Horizontal.

Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE

🟦 Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10[ft]

AASHTO 2017-2020 – Load and Resisting Factors

INTERNAL STABILITY

Load factor for vertical earth pressure, EV:	γ_{p-EV}	1.35	
Load factor for earthquake loads, EQ:	γ_{p-EQ}	1.00	
Load factor for live load surcharge, LS:	γ_{p-LS}	1.75	
(Same as in External Stability).			
Load factor for dead load surcharge, ES:	γ_{p-ES}	1.50	
(Same as in External Stability).			
Resistance factor for reinforcement tension	ϕ	Static	Combined static/seismic
Metal Strips:		0.75	1.00
Resistance factor for reinforcement tension in connectors	ϕ	Static	Combined static/seismic
Metal Strips:		0.75	1.00
Resistance factor for Metal Strips pullout	ϕ	1.00	1.00

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV		Static	Combined Static/Seismic	
Sliding and Eccentricity	γ_{p-EV}	1.00	γ_{p-EQ}	1.00
Bearing Capacity	γ_{p-EV}	1.35	γ_{p-EQ}	1.35

Load factor of active lateral earth pressure, EH	γ_{p-EH}	1.50
Load factor for earthquake loads, EQ (multiplies P_{AE} and P_{IR}):	γ_{p-EQ}	1.00
Load factor for live load surcharge under seismic conditions:	$(\gamma_{p-LS})_{EQ}$	1.00
Load factor for dead load surcharge under seismic conditions:	$(\gamma_{p-ES})_{EQ}$	1.00

Resistance factor for shear resistance along common interfaces		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00
Resistance factor for bearing capacity of shallow foundation		Static	Combined Static/Seismic
	ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 1.27, factored bearing load = 6423 lb/ft².

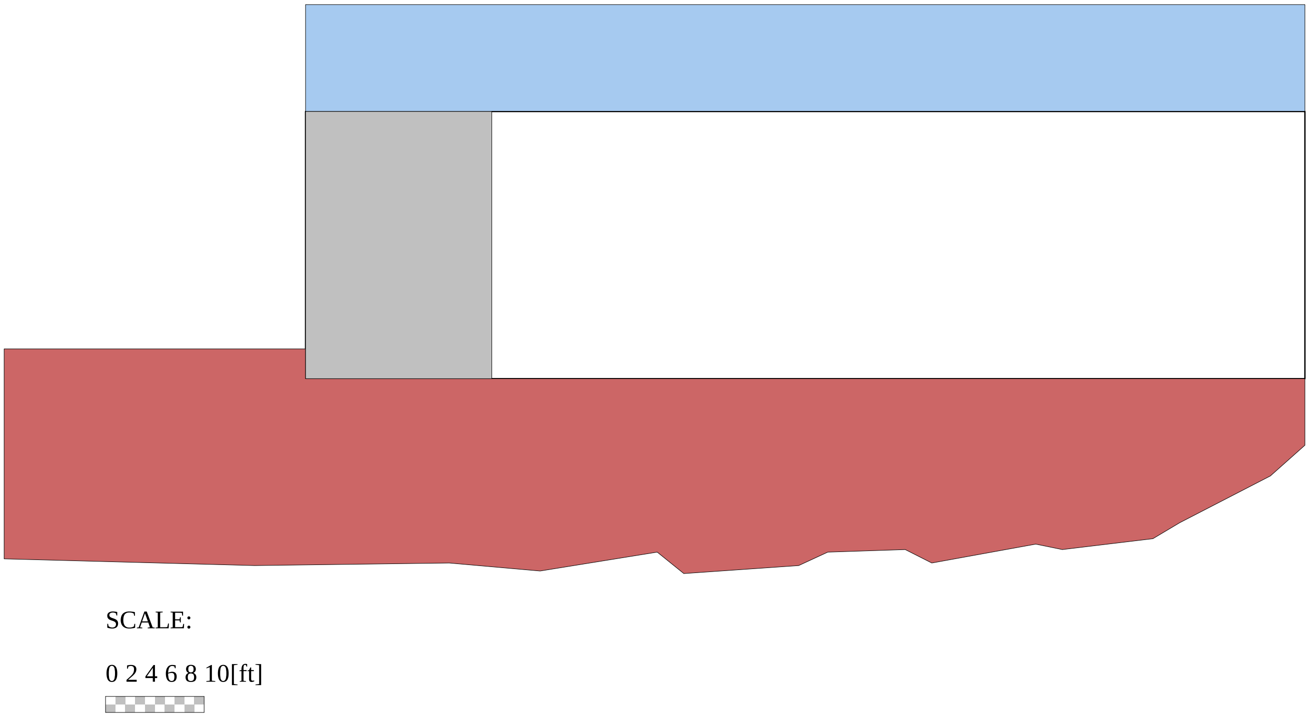
Foundation Interface: Direct sliding, CDR = 1.353, Eccentricity, e/L = 0.1323, CDR-overturning = 2.94

METAL STRIP				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	CDR [connection break]	CDR Strength	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	1.35	18.90	1	0.99	1.10	1.097	1.101	1.882	0.1187	---
2	4.05	18.90	1	1.09	1.21	1.213	0.991	2.044	0.0934	---
3	6.75	18.90	1	1.21	1.34	1.343	0.873	2.241	0.0707	---
4	9.45	18.90	1	1.32	1.46	1.462	0.884	2.498	0.0506	---
5	12.15	18.90	1	1.45	1.61	1.609	0.878	2.812	0.0332	---
6	14.85	18.90	1	1.64	1.82	1.823	0.891	3.225	0.0187	---
7	17.55	18.90	1	1.90	2.11	2.108	0.922	3.793	0.0070	---
8	20.25	18.90	1	2.32	2.58	2.580	0.911	4.627	-0.0017	---
9	22.95	18.90	1	3.13	3.48	3.483	0.823	5.965	-0.0073	---
10	25.65	18.90	1	5.04	5.60	5.602	0.487	8.466	-0.0098	---

BEARING CAPACITY for GIVEN LAYOUT – Using AASHTO 2017-2020 method

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	8129	N/A	[lb/ft ^{2}]
Factored bearing load, σ_V	6423.4	N/A	[lb/ft ^{2}]
Eccentricity, e	1.75	N/A	[ft]
Eccentricity, e/L	0.093	N/A	
CDR calculated	1.27	N/A	
Base length	18.90	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 71173.46 [lb/ft], L = 18.90, Unfactored e = 1.57 [ft], and Sigma = 4513.56 [lb/ft ^{2}]



DIRECT SLIDING for GIVEN LAYOUT (for METAL STRIPS reinforcements)

Along reinforced and foundation soils interface: CDR-static = 1.353

#	Metal strip Elevation [ft]	Metal strip Length [ft]	CDR Static	CDR Seismic	Metal strip Type #	Product name
1	1.35	18.90	1.882	N/A	1	---
2	4.05	18.90	2.044	N/A	1	---
3	6.75	18.90	2.241	N/A	1	---
4	9.45	18.90	2.498	N/A	1	---
5	12.15	18.90	2.812	N/A	1	---
6	14.85	18.90	3.225	N/A	1	---
7	17.55	18.90	3.793	N/A	1	---
8	20.25	18.90	4.627	N/A	1	---
9	22.95	18.90	5.965	N/A	1	---
10	25.65	18.90	8.466	N/A	1	---

ECCENTRICITY for GIVEN LAYOUT (for Simplified Method)

At interface with foundation: e/L static = 0.1323; Overturning: CDR-static = 2.94

#	Metal strip Elevation [ft]	Metal strip Length [ft]	e / L Static	e / L Seismic	Metal strip Type #	Product name
1	1.35	18.90	0.1187	N/A	1	---
2	4.05	18.90	0.0934	N/A	1	---
3	6.75	18.90	0.0707	N/A	1	---
4	9.45	18.90	0.0506	N/A	1	---
5	12.15	18.90	0.0332	N/A	1	---
6	14.85	18.90	0.0187	N/A	1	---
7	17.55	18.90	0.0070	N/A	1	---
8	20.25	18.90	-0.0017	N/A	1	---
9	22.95	18.90	-0.0073	N/A	1	---
10	25.65	18.90	-0.0098	N/A	1	---

AASHTO 2002 ASD DESIGN METHOD
HAM-264-10.42 Permanent Wall

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title:	HAM-264-10.42 Permanent Wall
Project Number:	N1205396
Client:	ODOT- District 8
Designer:	MP
Station Number:	551+50

Description:

Company's information:

Name: Terracon Consultants, Inc.
Street: 611 Lunken Park Dr

Cincinnati, Ohio 45226
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\mpandey\OneDrive - Terracon\OneDrive - Terraco.....
.....Wall STA 552+00.BENp

Original date and time of creating this file: 5/9/2025 4:50 P.M.

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	26.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	120.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	26.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	50.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.4622 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 22.25 $N\gamma = 12.54$

SEISMICITY

Not Applicable

INPUT DATA: Metal strips
(Analysis)

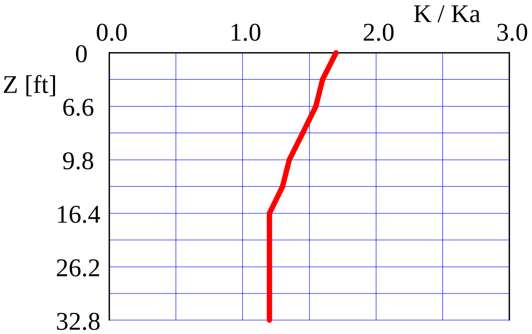
D A T A	Metal strip type #1	Metal strip type #2	Metal strip type #3	Metal strip type #4	Metal strip type #5
Yield strength of steel, Fy [kips/in ²]	65.3	N/A	N/A	N/A	N/A
Gross width of strip, b [in]	2.0	N/A	N/A	N/A	N/A
Vertical spacing, Sv [ft]	Varies	N/A	N/A	N/A	N/A
Design cross section area, Ac [in ²]	0.232	N/A	N/A	N/A	N/A

Ribbed steel strips.
Uniformity Coefficient of reinforced soil, Cu = D60/D10 = 4.0

Friction angle along reinforcement-soil interface,	ρ				
@ the top	60.97	N/A	N/A	N/A	N/A
@ 19.7 ft or below	32.00	N/A	N/A	N/A	N/A
Pullout resistance factor, F*					
@ the top	1.80	N/A	N/A	N/A	N/A
@ 19.7 ft or below	0.62	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.00	N/A	N/A	N/A	N/A

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.70
3.3 ft	1.60
6.6 ft	1.55
9.8 ft	1.45
13.1 ft	1.35
16.4 ft	1.30
19.7 ft	1.20



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 17.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 14.00 ft }

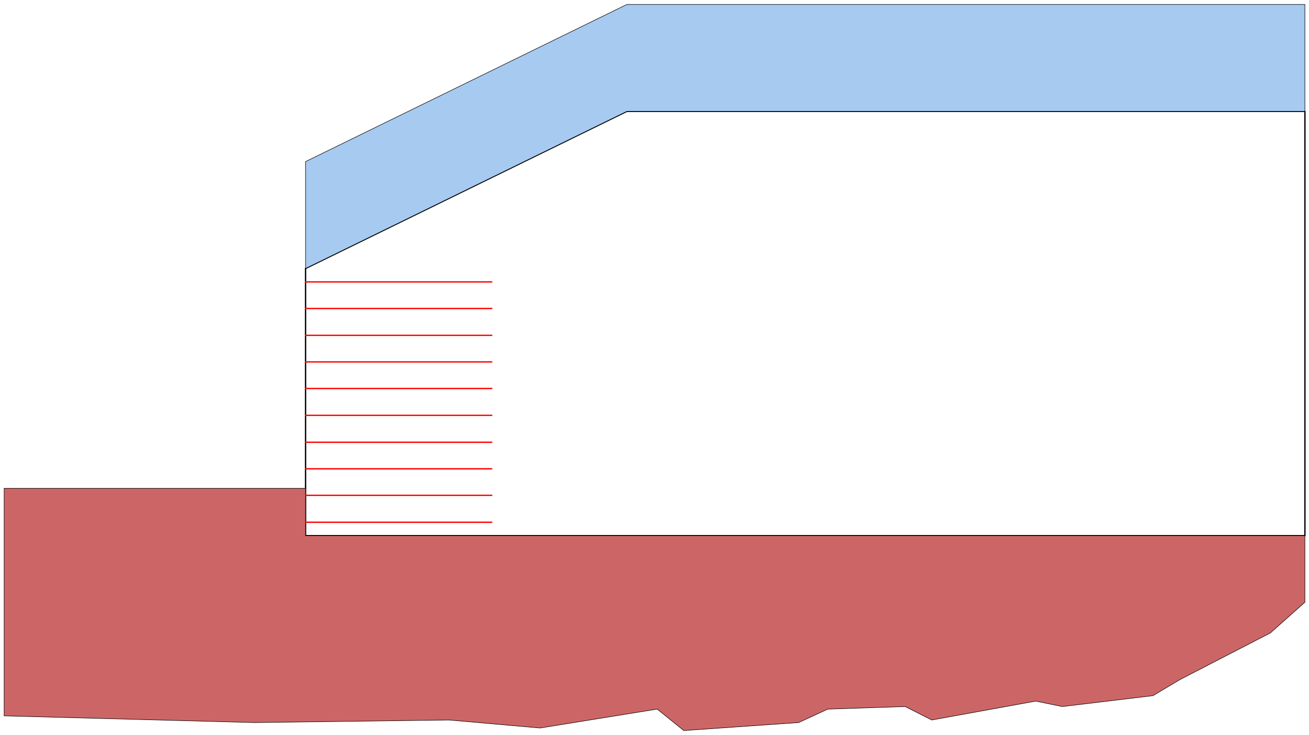
Soil in front of wall is Horizontal.

Batter, ω	0.0	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	10.0	[ft]	Broken back equivalent angle, I = 16.39° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE

🟦 Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

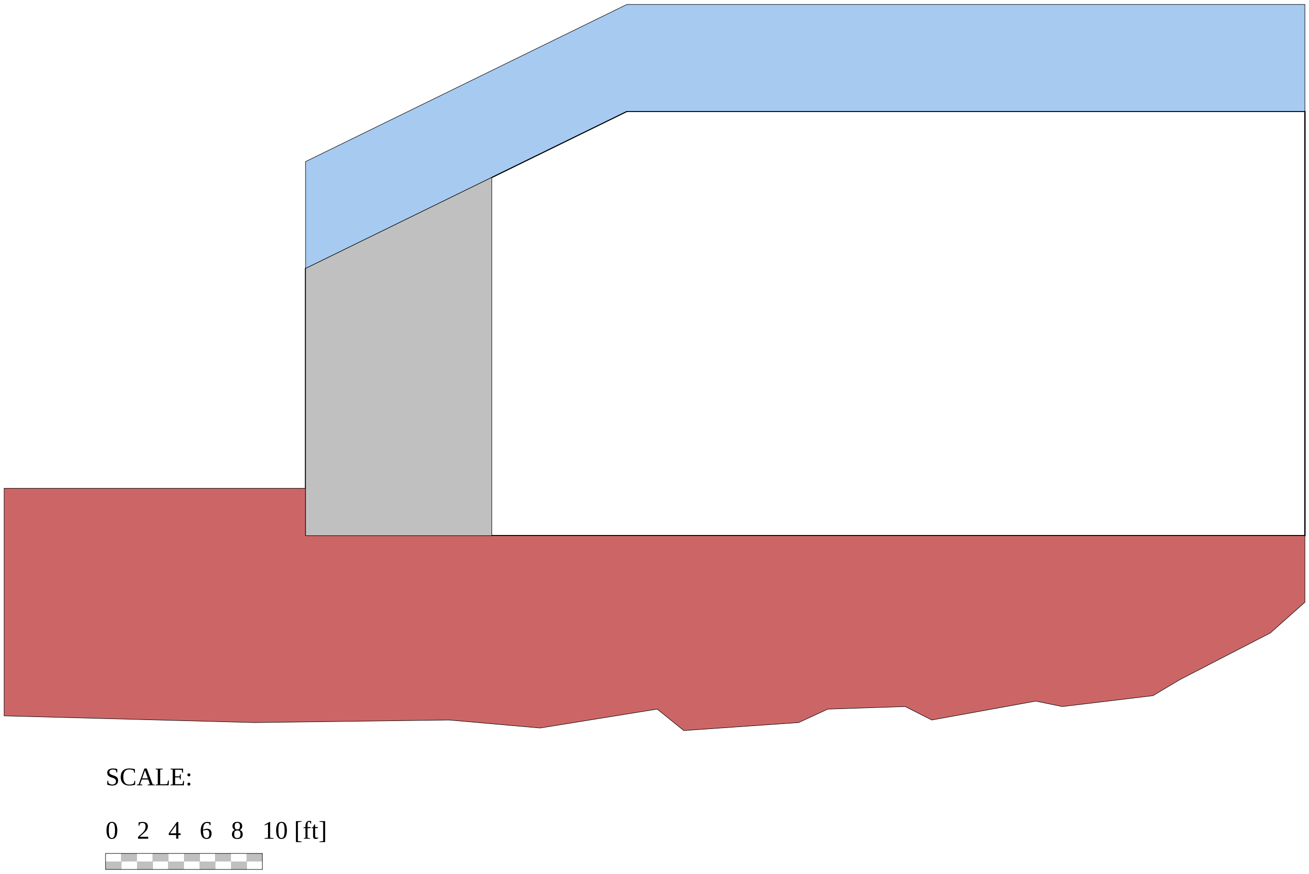
Bearing capacity, Fs = 1.09, Meyerhof stress = 5541 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.027, Eccentricity, e/L = 0.2456, Fs-overturning = 1.75

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [metal strip strength]	Metal strip strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.85	11.90	1	N/A	3.50	3.89	3.888	1.845	1.401	0.2271	---
2	2.55	11.90	1	N/A	3.72	4.13	4.131	1.850	1.468	0.1912	---
3	4.25	11.90	1	N/A	3.97	4.41	4.412	1.813	1.542	0.1569	---
4	5.95	11.90	1	N/A	4.24	4.71	4.714	1.726	1.624	0.1240	---
5	7.65	11.90	1	N/A	4.58	5.09	5.087	1.605	1.713	0.0923	---
6	9.35	11.90	1	N/A	5.02	5.57	5.575	1.460	1.810	0.0614	---
7	11.05	11.90	1	N/A	5.64	6.27	6.271	1.440	1.911	0.0306	---
8	12.75	11.90	1	N/A	6.57	7.30	7.295	1.497	2.009	-0.0019	---
9	14.45	11.90	1	N/A	7.87	8.74	8.740	1.534	2.085	-0.0396	---
10	16.15	11.90	1	N/A	9.85	10.95	10.949	1.538	2.085	-0.0923	---

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	6029	N/A	[lb/ft ²]
Meyerhof stress, σ_V	5541.4	N/A	[lb/ft ²]
Eccentricity, e	2.68	N/A	[ft]
Eccentricity, e/L	0.225	N/A	
Fs calculated	1.09	N/A	
Base length	11.90	N/A	[ft]



DIRECT SLIDING for GIVEN LAYOUT (for METAL STRIPS reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.027

#	Metal strip Elevation [ft]	Metal strip Length [ft]	Fs Static	Fs Seismic	Metal strip Type #	Product name
1	0.85	11.90	1.401	N/A	1	---
2	2.55	11.90	1.468	N/A	1	---
3	4.25	11.90	1.542	N/A	1	---
4	5.95	11.90	1.624	N/A	1	---
5	7.65	11.90	1.713	N/A	1	---
6	9.35	11.90	1.810	N/A	1	---
7	11.05	11.90	1.911	N/A	1	---
8	12.75	11.90	2.009	N/A	1	---
9	14.45	11.90	2.085	N/A	1	---
10	16.15	11.90	2.085	N/A	1	---

ECCENTRICITY for GIVEN LAYOUT (for Simplified Method)

At interface with foundation: e/L static = 0.2456; Overturning: Fs-static = 1.75

#	Metal strip Elevation [ft]	Metal strip Length [ft]	e / L Static	e / L Seismic	Metal strip Type #	Product name
1	0.85	11.90	0.2271	N/A	1	---
2	2.55	11.90	0.1912	N/A	1	---
3	4.25	11.90	0.1569	N/A	1	---
4	5.95	11.90	0.1240	N/A	1	---
5	7.65	11.90	0.0923	N/A	1	---
6	9.35	11.90	0.0614	N/A	1	---
7	11.05	11.90	0.0306	N/A	1	---
8	12.75	11.90	-0.0019	N/A	1	---
9	14.45	11.90	-0.0396	N/A	1	---
10	16.15	11.90	-0.0923	N/A	1	---

AASHTO 2017-2020
HAM-264-10.42 Temporary Wall

MSEW+: Update # 2023.21

PROJECT IDENTIFICATION

Title:	HAM-264-10.42 Temporary Wall
Project Number:	N1205396
Client:	ODOT- District 8
Designer:	MP
Station Number:	552+00

Description:

Company's information:

Name: Terracon Consultants, Inc.
Street: 611 Lunken Park Dr

Cincinnati, Ohio 45226
Telephone #:
Fax #:
E-Mail:

File path and name: C:\Users\mpandey\OneDrive - Terracon\OneDrive - Terraco.....
.....Wall STA 552+00.BENp
Original date and time of creating this file: 5/9/2025 4:20 P.M.

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	26.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	120.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	26.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	50.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3472 (eq. 17 is utilized to calculate Ka for all batters)
(For external stability user specified $\delta = 17.30°$)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 22.25 $N\gamma$= 12.54

SEISMICITY

Not Applicable

FOR EXTERNAL STABILITY

Ka = 0.3472	In Coulomb equation for Ka, Omega was taken as ZERO and backslope inclined at angle I.

INPUT DATA: Metal strips
(Analysis)

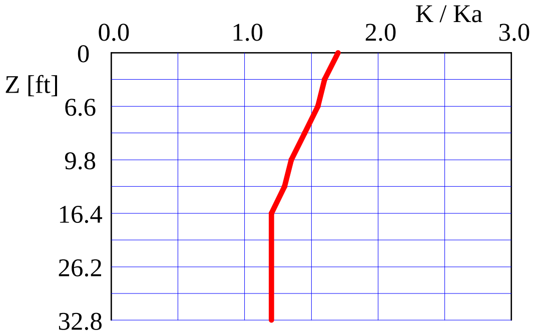
DATA	Metal strip type #1	Metal strip type #2	Metal strip type #3	Metal strip type #4	Metal strip type #5
Yield strength of steel, Fy [kips/in ^{2}]	65.3	N/A	N/A	N/A	N/A
Gross width of strip, b [in]	2.0	N/A	N/A	N/A	N/A
Vertical spacing, Sv [ft]	Varies	N/A	N/A	N/A	N/A
Design cross section area, Ac [in ^{2}]	0.232	N/A	N/A	N/A	N/A

Ribbed steel strips.
Uniformity Coefficient of reinforced soil, Cu = D60/D10 = 4.0

Friction angle along reinforcement-soil interface,	ρ				
@ the top	60.97	N/A	N/A	N/A	N/A
@ 19.7 ft or below	32.00	N/A	N/A	N/A	N/A
Pullout resistance factor, F*					
@ the top	1.80	N/A	N/A	N/A	N/A
@ 19.7 ft or below	0.62	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.00	N/A	N/A	N/A	N/A

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.70
3.3 ft	1.60
6.6 ft	1.55
9.8 ft	1.45
13.1 ft	1.35
16.4 ft	1.30
19.7 ft	1.20



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 23.00 [ft] { Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 20.00 ft }

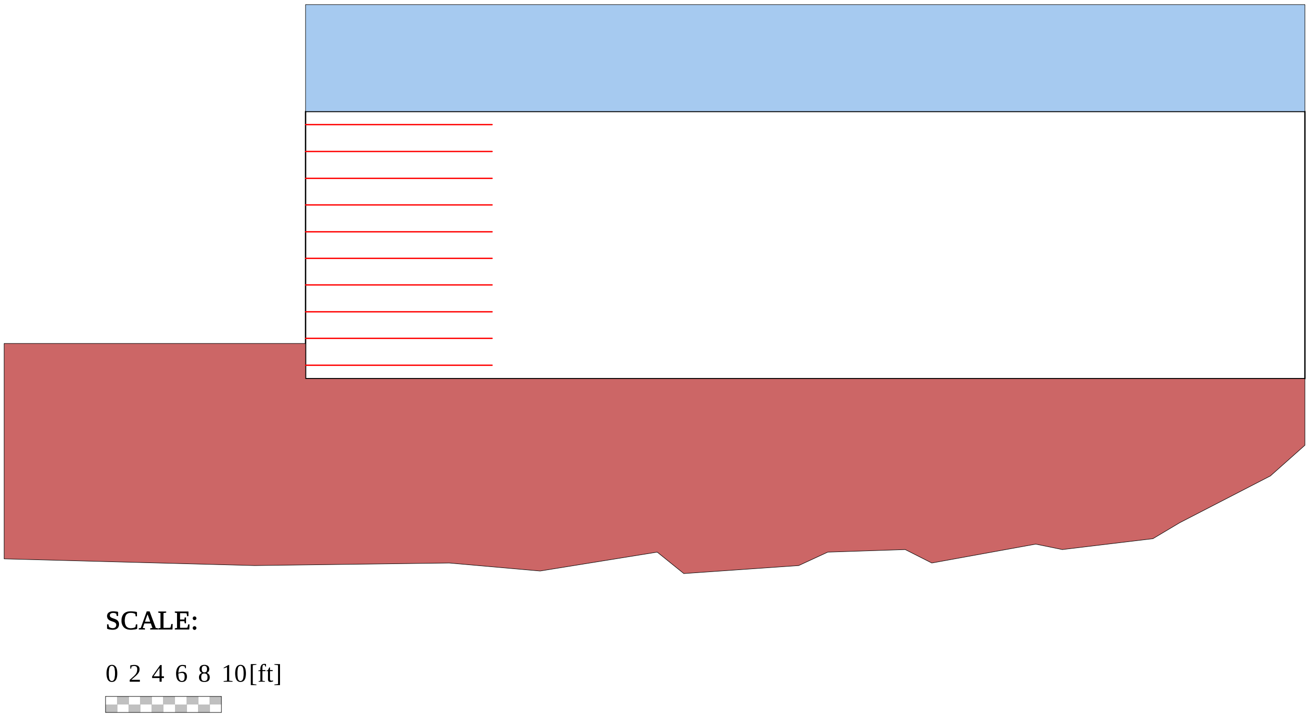
Soil in front of wall is Horizontal.

Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

UNIFORM SURCHARGE

🟦 Uniformly distributed dead load is 0.0 [lb/ft ^{2}], and live load is 250.0 [lb/ft ^{2}]

ANALYZED REINFORCEMENT LAYOUT:



AASHTO 2017-2020 – Load and Resisting Factors

INTERNAL STABILITY

Load factor for vertical earth pressure, EV:		γ_{p-EV}	1.35	
Load factor for earthquake loads, EQ:		γ_{p-EQ}	1.00	
Load factor for live load surcharge, LS:		γ_{p-LS}	1.75	
(Same as in External Stability).				
Load factor for dead load surcharge, ES:		γ_{p-ES}	1.50	
(Same as in External Stability).				
Resistance factor for reinforcement tension		ϕ	Static	Combined static/seismic
	Metal Strips:		0.75	1.00
Resistance factor for reinforcement tension in connectors		ϕ	Static	Combined static/seismic
	Metal Strips:		0.75	1.00
Resistance factor for Metal Strips pullout		ϕ	1.00	1.00

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV			Static	Combined Static/Seismic	
	Sliding and Eccentricity	γ_{p-EV}	1.00	γ_{p-EQ}	1.00
	Bearing Capacity	γ_{p-EV}	1.35	γ_{p-EQ}	1.35

Load factor of active lateral earth pressure, EH	γ_{p-EH}	1.50
Load factor for earthquake loads, EQ (multiplies P_{AE} and P_{IR}):	γ_{p-EQ}	1.00
Load factor for live load surcharge under seismic conditions:	$(\gamma_{p-LS})_{EQ}$	1.00
Load factor for dead load surcharge under seismic conditions:	$(\gamma_{p-ES})_{EQ}$	1.00

Resistance factor for shear resistance along common interfaces			Static	Combined Static/Seismic
	Reinforced Soil and Foundation	ϕ_{τ}	1.00	1.00
	Reinforced Soil and Reinforcement	ϕ_{τ}	1.00	1.00
Resistance factor for bearing capacity of shallow foundation			Static	Combined Static/Seismic
		ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

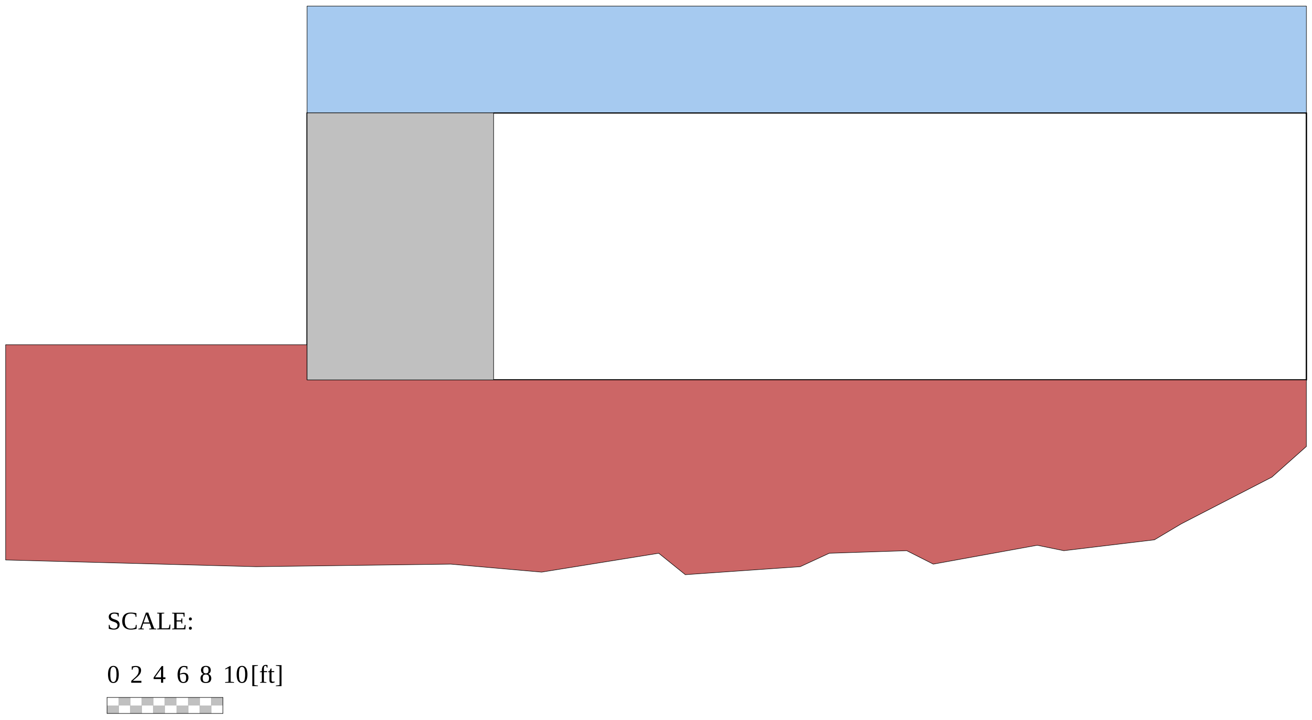
Bearing capacity, CDR = 1.27, factored bearing load = 5594 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.328, Eccentricity, e/L = 0.1373, CDR-overturning = 2.85

METAL STRIP				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	CDR [connection break]	CDR Strength	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	1.15	16.10	1	1.34	1.49	1.487	1.084	1.836	0.1235	---
2	3.45	16.10	1	1.45	1.62	1.616	0.972	1.991	0.0976	---
3	5.75	16.10	1	1.56	1.73	1.730	1.007	2.186	0.0743	---
4	8.05	16.10	1	1.69	1.88	1.879	0.996	2.415	0.0536	---
5	10.35	16.10	1	1.88	2.09	2.088	0.947	2.705	0.0355	---
6	12.65	16.10	1	2.11	2.35	2.346	0.916	3.082	0.0203	---
7	14.95	16.10	1	2.44	2.72	2.716	0.921	3.594	0.0079	---
8	17.25	16.10	1	3.00	3.33	3.330	0.891	4.327	-0.0015	---
9	19.55	16.10	1	4.01	4.45	4.452	0.782	5.466	-0.0078	---
10	21.85	16.10	1	6.19	6.88	6.879	0.437	7.477	-0.0110	---

BEARING CAPACITY for GIVEN LAYOUT – Using AASHTO 2017-2020 method

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	7103	N/A	[lb/ft ^{2}]
Factored bearing load, σ_V	5594.1	N/A	[lb/ft ^{2}]
Eccentricity, e	1.53	N/A	[ft]
Eccentricity, e/L	0.095	N/A	
CDR calculated	1.27	N/A	
Base length	16.10	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 52331.38 [lb/ft], L = 16.10, Unfactored e = 1.36 [ft], and Sigma = 3913.94 [lb/ft ^{2}]



DIRECT SLIDING for GIVEN LAYOUT (for METAL STRIPS reinforcements)

Along reinforced and foundation soils interface: CDR-static = 1.328

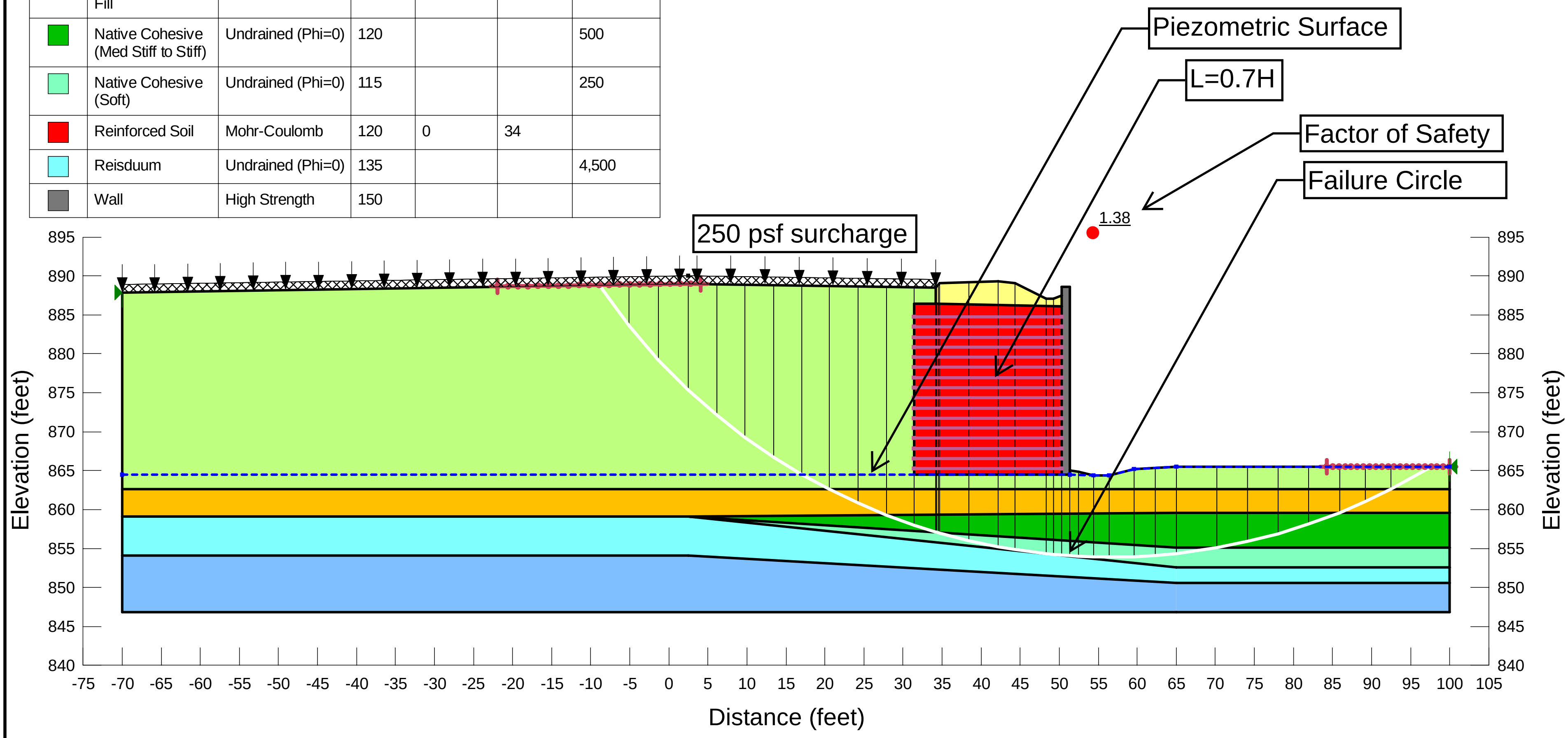
#	Metal strip Elevation [ft]	Metal strip Length [ft]	CDR Static	CDR Seismic	Metal strip Type #	Product name
1	1.15	16.10	1.836	N/A	1	---
2	3.45	16.10	1.991	N/A	1	---
3	5.75	16.10	2.186	N/A	1	---
4	8.05	16.10	2.415	N/A	1	---
5	10.35	16.10	2.705	N/A	1	---
6	12.65	16.10	3.082	N/A	1	---
7	14.95	16.10	3.594	N/A	1	---
8	17.25	16.10	4.327	N/A	1	---
9	19.55	16.10	5.466	N/A	1	---
10	21.85	16.10	7.477	N/A	1	---

ECCENTRICITY for GIVEN LAYOUT (for Simplified Method)

At interface with foundation: e/L static = 0.1373; Overturning: CDR-static = 2.85

#	Metal strip Elevation [ft]	Metal strip Length [ft]	e / L Static	e / L Seismic	Metal strip Type #	Product name
1	1.15	16.10	0.1235	N/A	1	---
2	3.45	16.10	0.0976	N/A	1	---
3	5.75	16.10	0.0743	N/A	1	---
4	8.05	16.10	0.0536	N/A	1	---
5	10.35	16.10	0.0355	N/A	1	---
6	12.65	16.10	0.0203	N/A	1	---
7	14.95	16.10	0.0079	N/A	1	---
8	17.25	16.10	-0.0015	N/A	1	---
9	19.55	16.10	-0.0078	N/A	1	---
10	21.85	16.10	-0.0110	N/A	1	---

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Undrained Shear Strength (psf)
🟦	Bedrock	Bedrock (Impenetrable)				
🟨	Engineered Fill	Undrained (Phi=0)	125			2,000
🟩	Existing Cohesive Fill	Undrained (Phi=0)	118			1,000
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33	
🟩	Native Cohesive (Med Stiff to Stiff)	Undrained (Phi=0)	120			500
🟩	Native Cohesive (Soft)	Undrained (Phi=0)	115			250
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34	
🟦	Reisduum	Undrained (Phi=0)	135			4,500
⬛	Wall	High Strength	150			



Global Stability - Short Term Conditions

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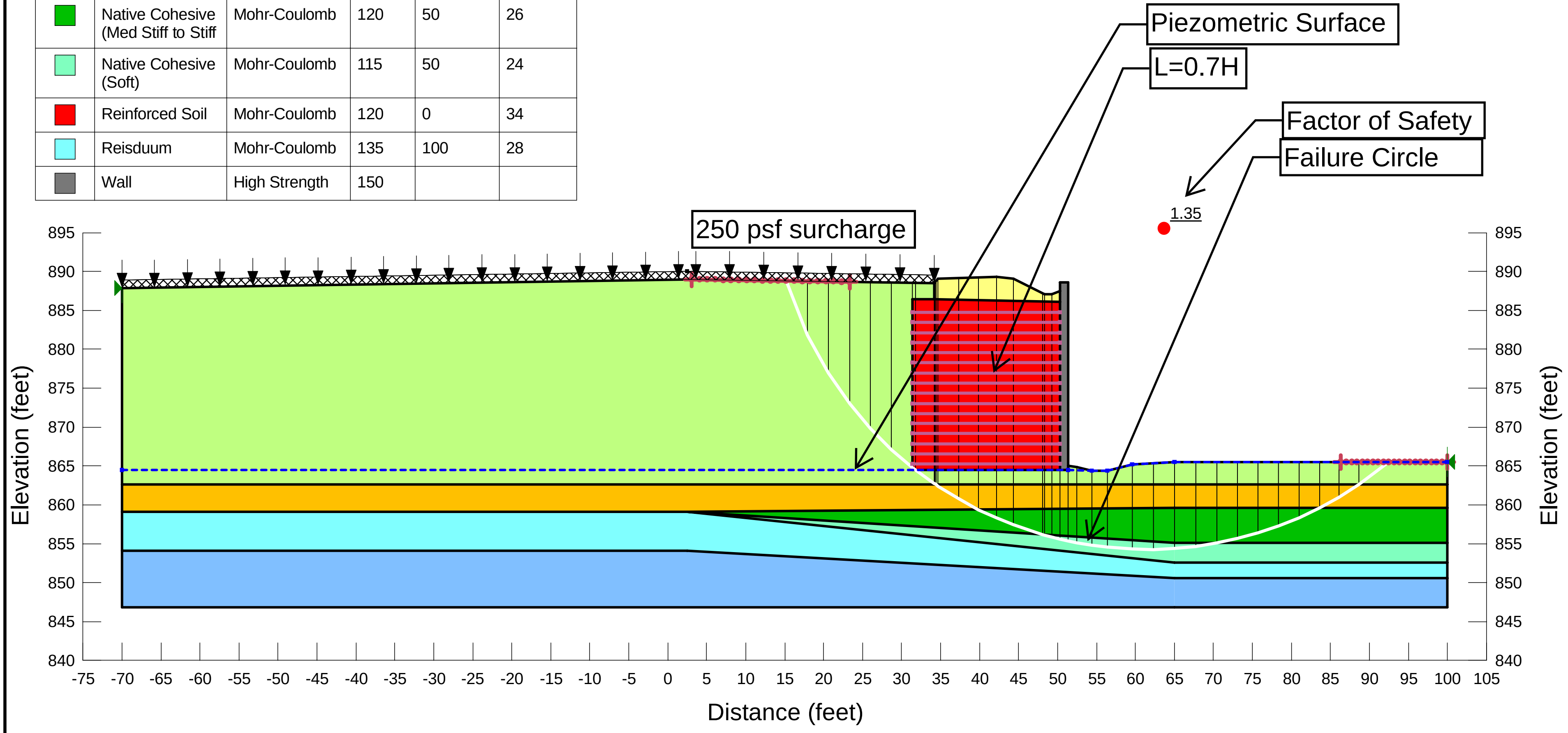
05/13/2025

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟦	Bedrock	Bedrock (Impenetrable)			
🟨	Engineered Fill	Mohr-Coulomb	125	200	26
🟩	Existing Cohesive Fill	Mohr-Coulomb	118	50	26
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33
🟩	Native Cohesive (Med Stiff to Stiff	Mohr-Coulomb	120	50	26
🟩	Native Cohesive (Soft)	Mohr-Coulomb	115	50	24
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34
🟦	Reisduum	Mohr-Coulomb	135	100	28
⬛	Wall	High Strength	150		

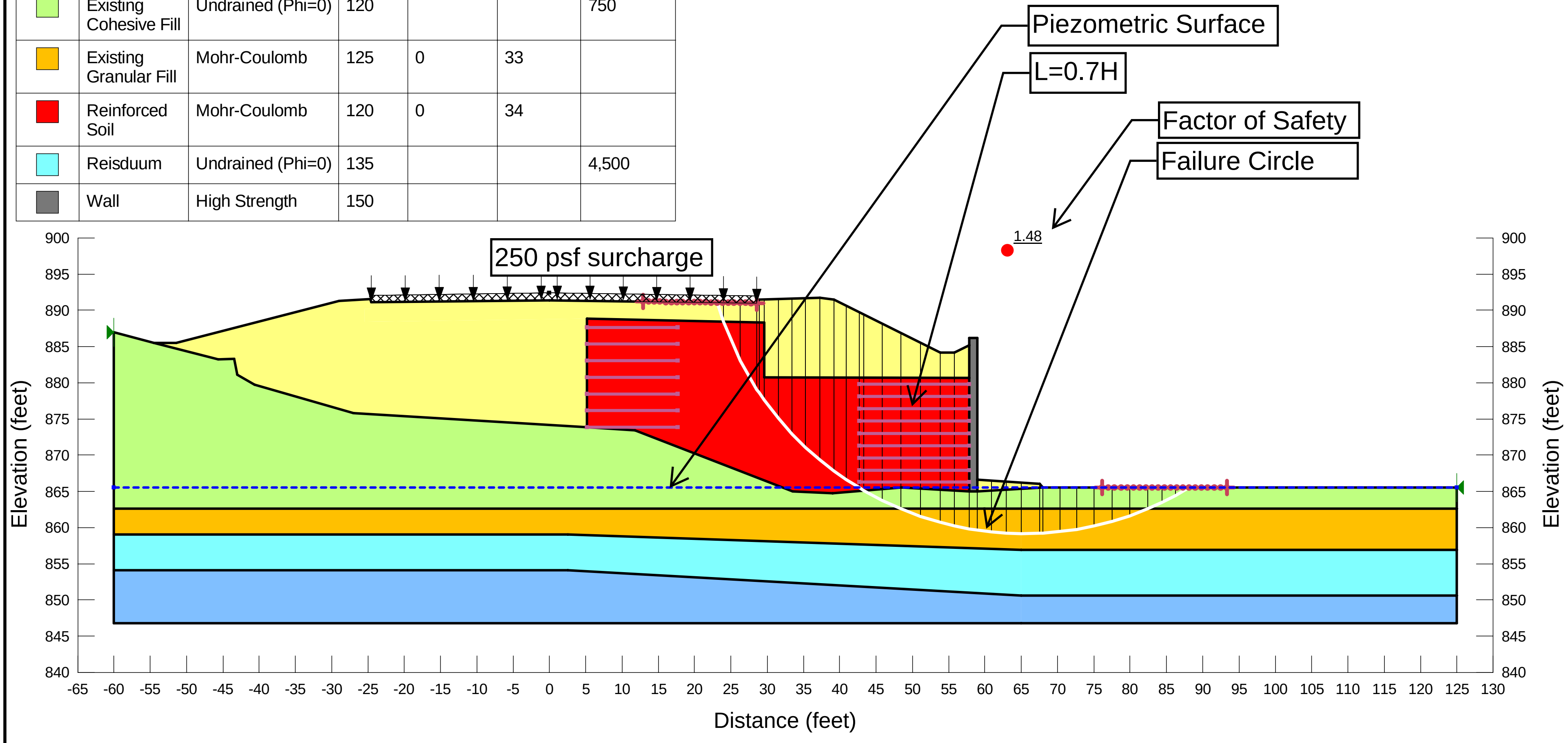


Global Stability - Long Term Conditions

Sta 550+75

05/13/2025

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Undrained Shear Strength (psf)
🟦	Bedrock	Bedrock (Impenetrable)				
🟨	Engineered Fill	Undrained (Phi=0)	125			2,000
🟩	Existing Cohesive Fill	Undrained (Phi=0)	120			750
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33	
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34	
🟦	Reisduum	Undrained (Phi=0)	135			4,500
⬛	Wall	High Strength	150			

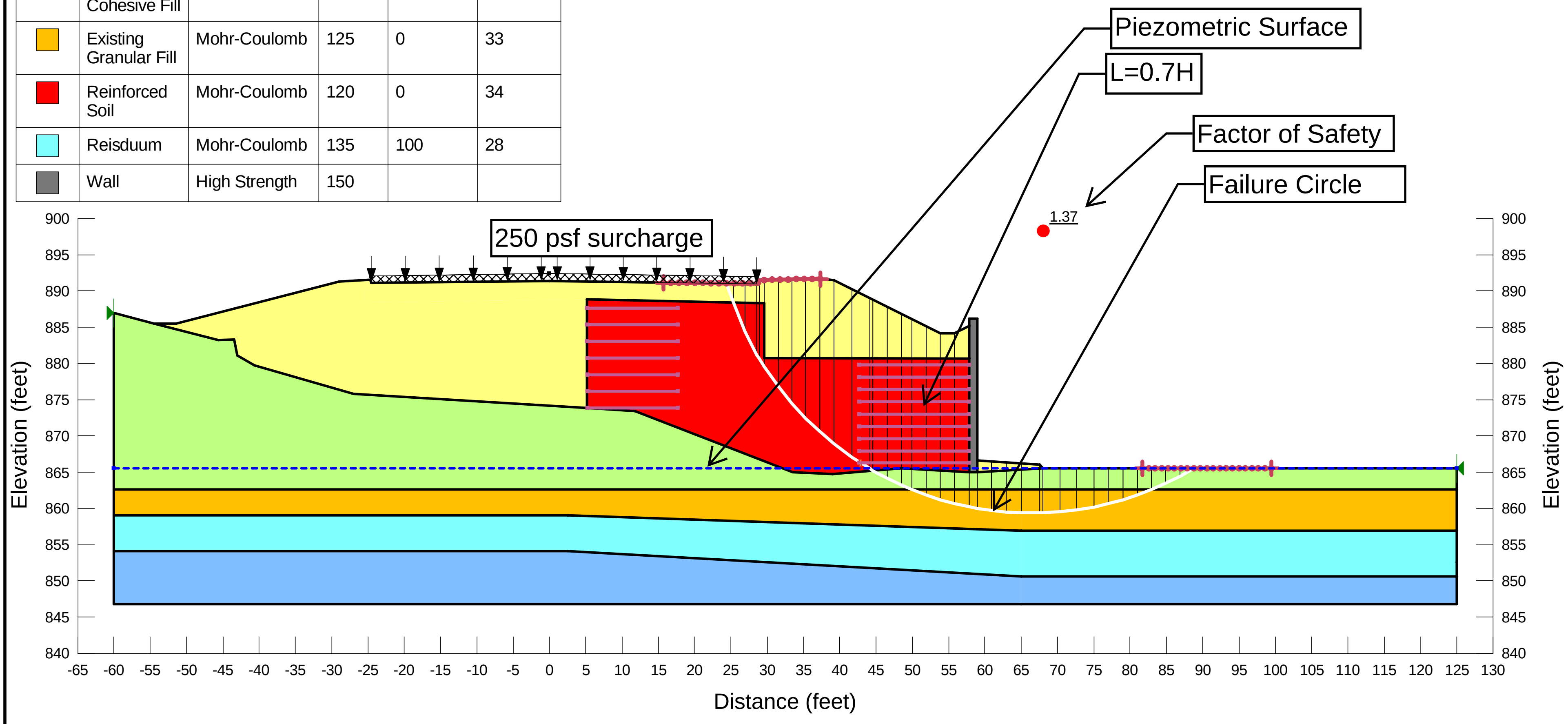


Global Stability - Short Term Conditions

Sta 551+50

05/13/2025

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟦	Bedrock	Bedrock (Impenetrable)			
🟨	Engineered Fill	Mohr-Coulomb	125	200	26
🟩	Existing Cohesive Fill	Mohr-Coulomb	120	50	26
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34
🟦	Reisduum	Mohr-Coulomb	135	100	28
⬛	Wall	High Strength	150		

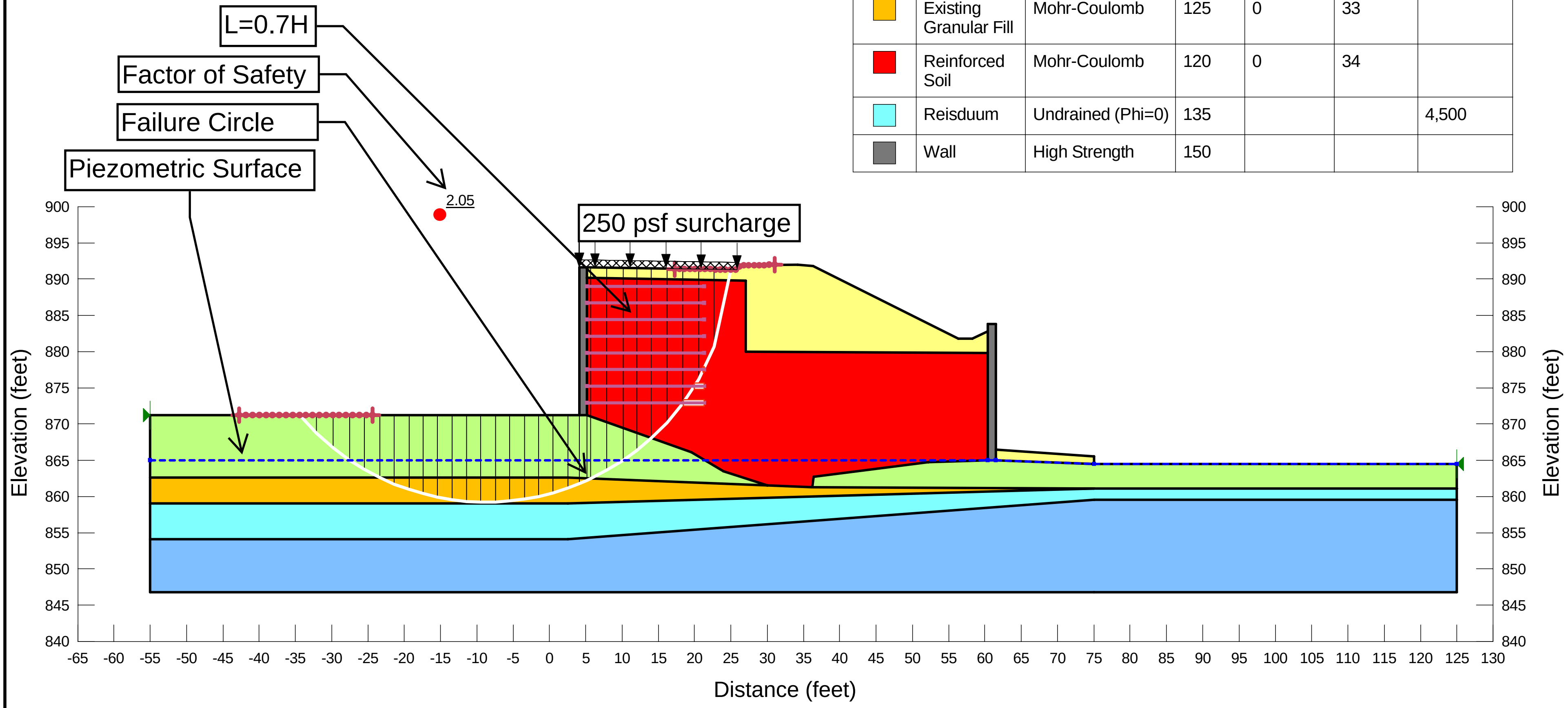


Global Stability - Long Term Conditions

Sta 551+50

05/13/2025

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Undrained Shear Strength (psf)
🟦	Bedrock	Bedrock (Impenetrable)				
🟨	Engineered Fill	Undrained (Phi=0)	125			2,000
🟩	Existing Cohesive Fill	Undrained (Phi=0)	120			750
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33	
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34	
🟦	Reisduum	Undrained (Phi=0)	135			4,500
⬛	Wall	High Strength	150			



Global Stability - Short Term Conditions

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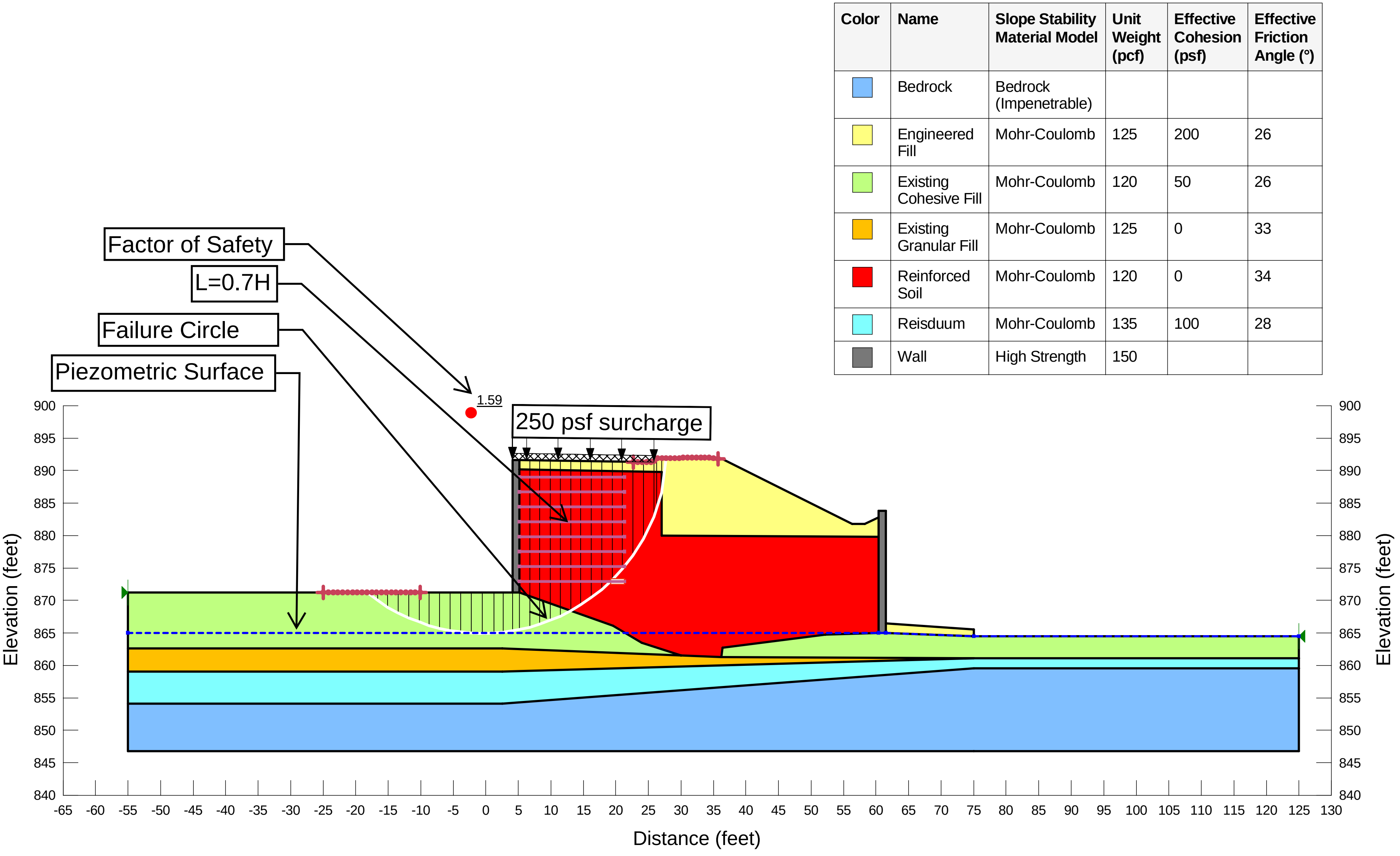

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟦	Bedrock	Bedrock (Impenetrable)			
🟨	Engineered Fill	Mohr-Coulomb	125	200	26
🟩	Existing Cohesive Fill	Mohr-Coulomb	120	50	26
🟧	Existing Granular Fill	Mohr-Coulomb	125	0	33
🟥	Reinforced Soil	Mohr-Coulomb	120	0	34
🟦	Reisduum	Mohr-Coulomb	135	100	28
⬛	Wall	High Strength	150		

Global Stability - Long Term Conditions

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