FRA-LIC-SR 161-22.10-0.00
Roadway Improvements
PID 117878

RETAINING WALL JUSTIFICATION STUDY

Cobbs Road
Johnstown, OH

November 2025

WOOLPERT
ARCHITECTURE | ENGINEERING | GEOSPATIAL

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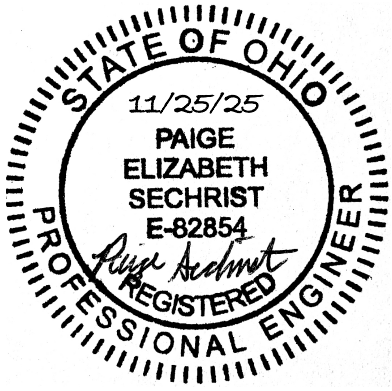

1. INTRODUCTION AND PROJECT DESCRIPTION

The FRA-LIC SR 161 22.10-0.00 (PID 117878) project is evaluating roadway improvements to approximately 15 miles of State Route (SR) 161/SR-37, from the US Route (US) 62 interchange in the City of New Albany to the Village of Granville. In addition, the project will assess if infrastructure improvements are needed at the existing interchanges within this corridor, at Beech Road, Mink Street, SR-310 (Hazelton-Etna Road), and SR-37 (Johnstown-Alexandria Road/York Road).

The purpose of this study is to evaluate the need for a retaining wall at the northwest corner of the Mink St. interchange, between the proposed roadway (Cobbs Road) and the existing Wilson's Lawncare & Landscaping business site. This study evaluates three alternatives for the retaining wall which are outlined as follows:

Alternative A – Install a new mechanically stabilized earth (MSE) retaining wall.

Alternative B – Install a new cantilever retaining wall on spread footing.

Alternative C – No wall required. Regrade slopes to maintain a minimum slope of 2:1 with a preferred slope of 3:1.

This report is organized into several sections, with Sections 1, 2, and 3 providing basic background information on the project, geotechnical conditions, and right of way, respectively. Sections 4-5 provide details on each alternative and Section 6 summarizes the report and compares costs and impacts between the alternatives.

2. GEOTECHNICAL EVALUATION

DLZ Ohio, Inc. (DLZ) performed a subsurface exploration at the site including three borings (B-043-1-25, B-043-3-25, B-044-1-25) near the proposed Cobbs Road re-alignment. The provided boring logs indicate medium stiff to very stiff cohesive soils up to the drilled boring depths of 30-ft below surface grades. Boring B-043-1-25 encountered a zone of soft cohesive soils from 11-ft to 23-ft below grade. Bedrock was not encountered within the drilled boring depths, and no groundwater was encountered.

No geotechnical testing was completed at the time of this study. Presumptive values were used for preliminary wall design, based on the soil information available. Should a retaining wall be recommended for this site location, design will be finalized after completion of geotechnical analysis. Boring logs are attached in Appendix 3.

3. RIGHT OF WAY

The existing Wilson's Lawncare & Landscaping property line extends into the proposed roadway limits and will require a temporary easement. According to the Licking County Tax Parcel Viewer, SR-161 and Cobbs Rd. are owned by the state and the existing right-of-way limits are about 400-ft wide at the project location. For the retaining wall alternatives A and B, a majority of the wall could be constructed within the ODOT R/W limits with a small encroachment at the access drive tie-in. For alternative C, the proposed re-grading of the embankments to a 3H:1V slope will require a permanent easement extending about 0.32 acres into the Wilson's Lawncare & Landscaping property limits. Figure 1 shows the ODOT right of way limits in red and the landscaping business property limits in blue.

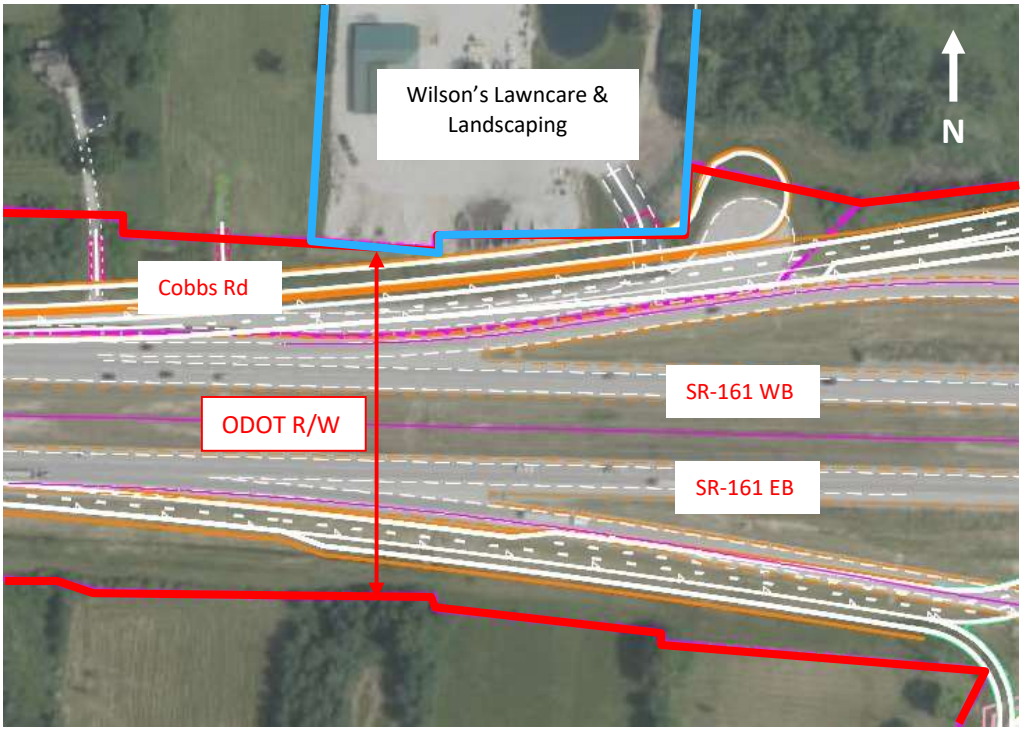

Figure 1: Right of Way Schematic

4. EXISTING CONDITIONS

The SR-161 project includes lane widening and realignment of the SR-161 and Mink Street interchange ramps on the westbound (WB) side, which will impact the existing Cobbs Road access road. The existing road will be shifted north while maintaining an access drive into the Wilson's Lawncare property. Google Earth imagery shows existing masonry block walls on the business property used for maintaining soil stockpiles. Pending selected alternative, all or portions of these block walls will need to be relocated. A photo of these site conditions can be seen in **Error! Reference source not found.** below.

Figure 2: Wilson's Lawncare Property

There are multiple overhead and underground utilities located in the site area that will be relocated as part of this project. Figure 3 shows the locations of the existing gas (purple), fiber optic (orange), telecommunication (orange), and electric (red) lines. Utility coordination will be ongoing for the duration of the project.

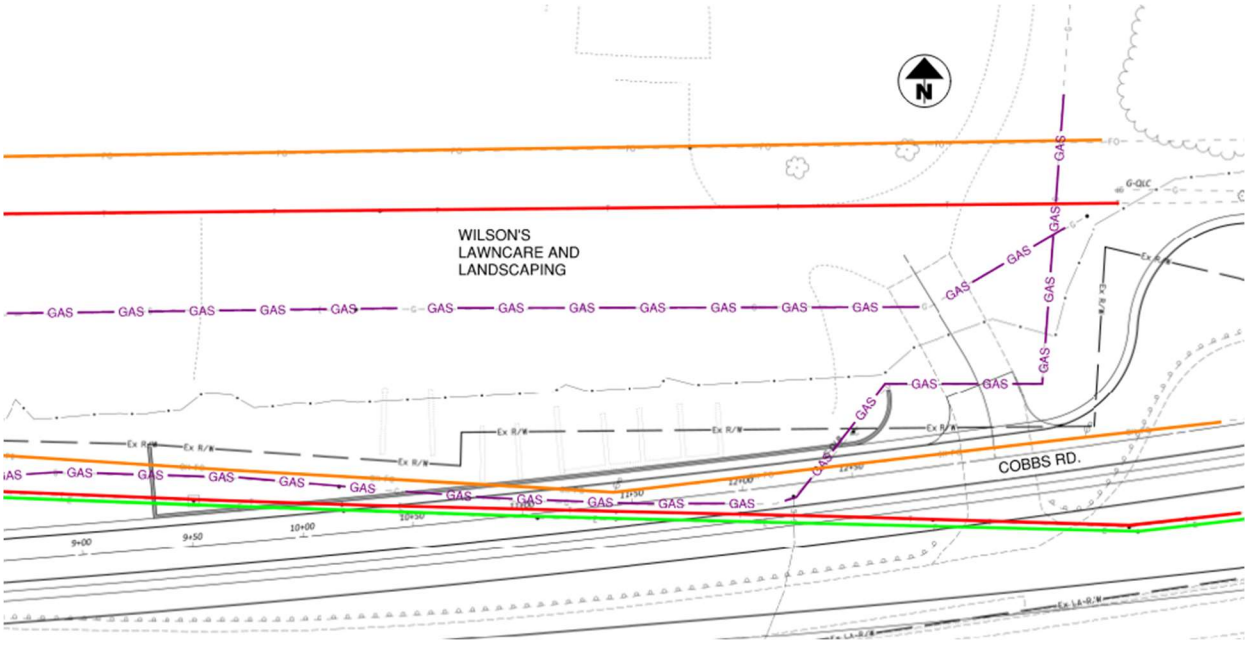

Figure 3: Existing Utilities at Wilson's Lawncare Property

5. RETAINING WALL ALTERNATIVES

5.1 Alternative A – Mechanically Stabilized Earth Wall

Alternative A consists of installing a mechanically stabilized earth (MSE) wall. Installation would include a leveling pad extended to a minimum of 3-ft below existing surface grades and a moment slab and parapet at the top of the wall along Cobbs Road. The length of required retaining wall can be shortened by turning the wall 90-degrees and terminating at the edge of the property line for Wilson's Lawncare. The approximate total length of wall required would be 371-ft with a maximum wall height of 19-ft. A typical section for Alternative A is shown in Figure 4.

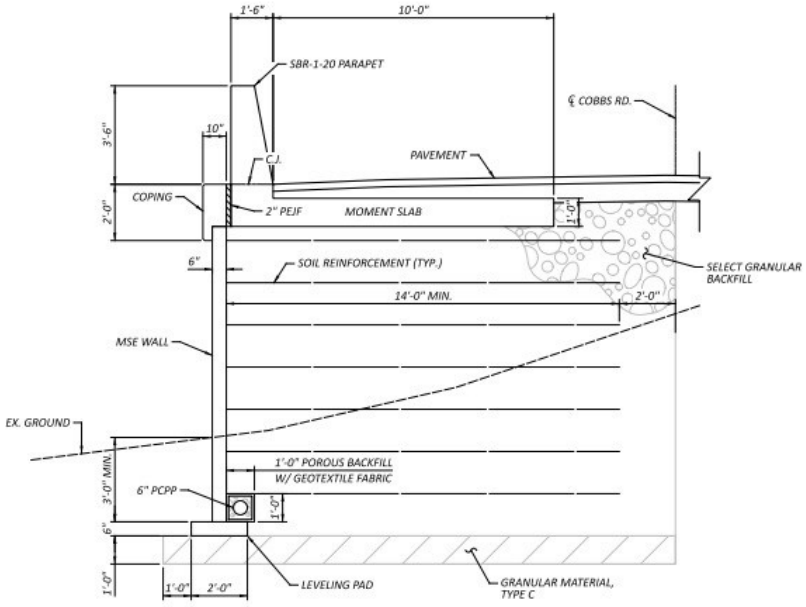

Figure 4: MSE Wall Typical Section

5.2 Alternative B – Cantilever Retaining Wall

Alternative B consists of installing a standard concrete cantilever retaining wall on spread footing. The footing would be extended to 4-ft below existing surface grades and a parapet would be attached to the top of the wall along Cobbs Rd. The wall layout would be similar to Alternative A with approximately 371-ft of wall needed and a maximum wall height of 20-ft. Preliminary design shows an 18-in thick wall with 10-ft wide footing could be utilized with a factored bearing resistance of 5.10-ksf. A typical section for Alternative B is shown in Figure 5.

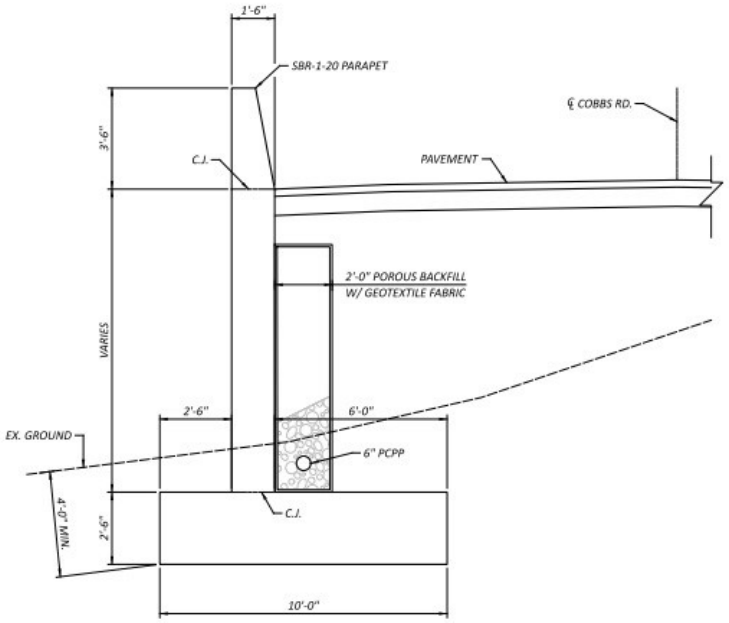

Figure 5: Cantilever Wall Typical Section

5.3 Alternative C – No-Build (Grading)

Alternative C would re-grade the slope at the edge of Cobbs Rd. to a minimum of 2H:1V, with a preferred slope of 3H:1V. A new drainage ditch would be installed at the bottom of the slope. Proposed grading limits along Cobbs Road would extend from the Wilson's Lawncare access drive to an approximate length of 1300-ft. However, for the purpose of comparing the grading limits to the retaining wall options, the project limits were taken to the edge of the Wilson's Lawncare property line. The grading alternative would require a larger amount of earthwork but offers significant savings without the wall construction items. As seen in Figure 6, grading will require relocation of the masonry blocks and stockpiles to a new location on the Wilson's Lawncare property.

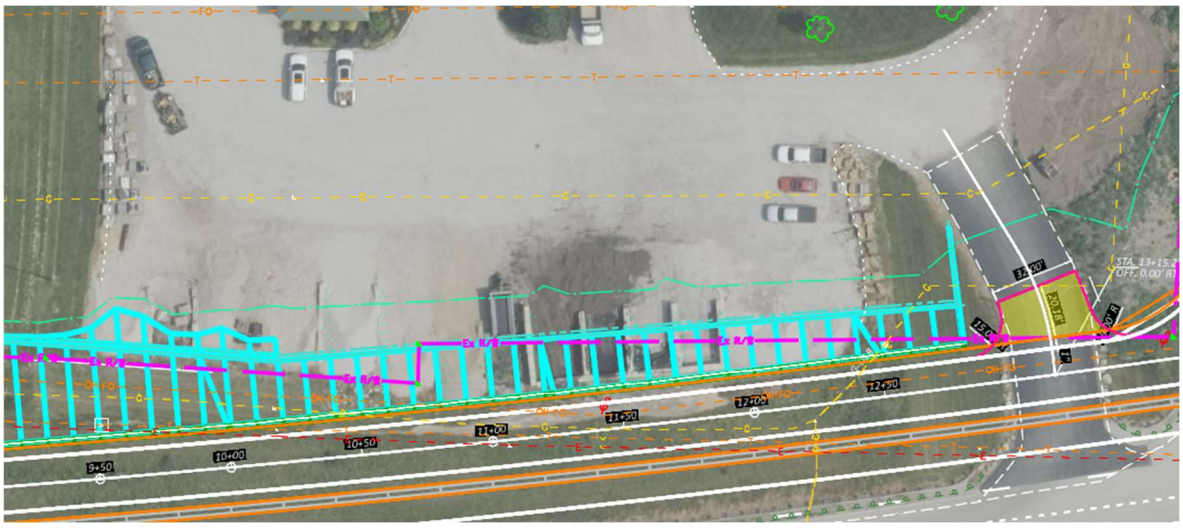

Figure 6: Grading Limits

6. COST SUMMARY AND COMPARISONS

Estimated construction costs were developed by preliminary quantity takeoffs for the three alternatives evaluated in this study with the use of ODOT Estimator and ODOT Historic Bid Tabs. Based on the comparison matrix below, **Alternative C (grading with no wall) is recommended**.

Other common costs including mobilization, utility relocation, and other incidentals are not included and are assumed to be borne by the overall project. These costs should be similar regardless of wall or grading alternative. The costs are summarized in Table 1 below with the preferred option in bold text and overall preferred alternative highlighted in green.

Table 1: Alternatives Comparison Summary

Item Description	Alternative A MSE Wall	Alternative B Cantilever Retaining Wall	Alternative C No-Build (Grading)
Wall Cost	$576,600	$527,300	$0
Earthwork Cost	$348,300	$137,600	$150,100
R/W Cost	$18,000	$18,000	$64,000
TOTAL	$942,900	$682,900	**$214,100**

A Retaining Wall Site Plan and Grading Plan is provided in Appendix 1, with preliminary wall designs in Appendix 2. Appendix 3 contains the detailed cost estimates used in this study. Costs for the preferred Alternative C have been carried to the Stage 1 estimated quantities.

APPENDIX 1: Preliminary Plans

RETAINING WALL PLAN

COBBS RD. RETAINING WALL PLAN

SFN

DESIGN AGENCY

WOOLPERT

DESIGNER	CHECKER
JYM	PES

REVIEWER
TML 11-26-25

PROJECT ID
117878

SUBSET	TOTAL
7	12

SHEET	TOTAL
P.7	12

FRA/LIC-161-22.10/0.00

MODEL: Wall Plan PAPERSIZE: 34x22 (in.) DATE: 11/13/2025 TIME: 10:47:27 AM PLTDRV: OHDOT_PDF.pltcfg PENTBL: OHDOT_Pen.tbl USER: Jennifer.Rivera@Woolpert.com WORKSPACE: OHDOTCEv02 WORKSET: 117878 PRODUCT: OpenRoadsDesigner 24.00.00.205
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GRADING PLAN

COBBS RD. GRADING PLAN

FRA/LIC-161-22.10/0.00

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SFN

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WOOLPERT

DESIGNER	CHECKER
JYM	PES

REVIEWER
TML 11-26-25

PROJECT ID
117878

SUBSET	TOTAL
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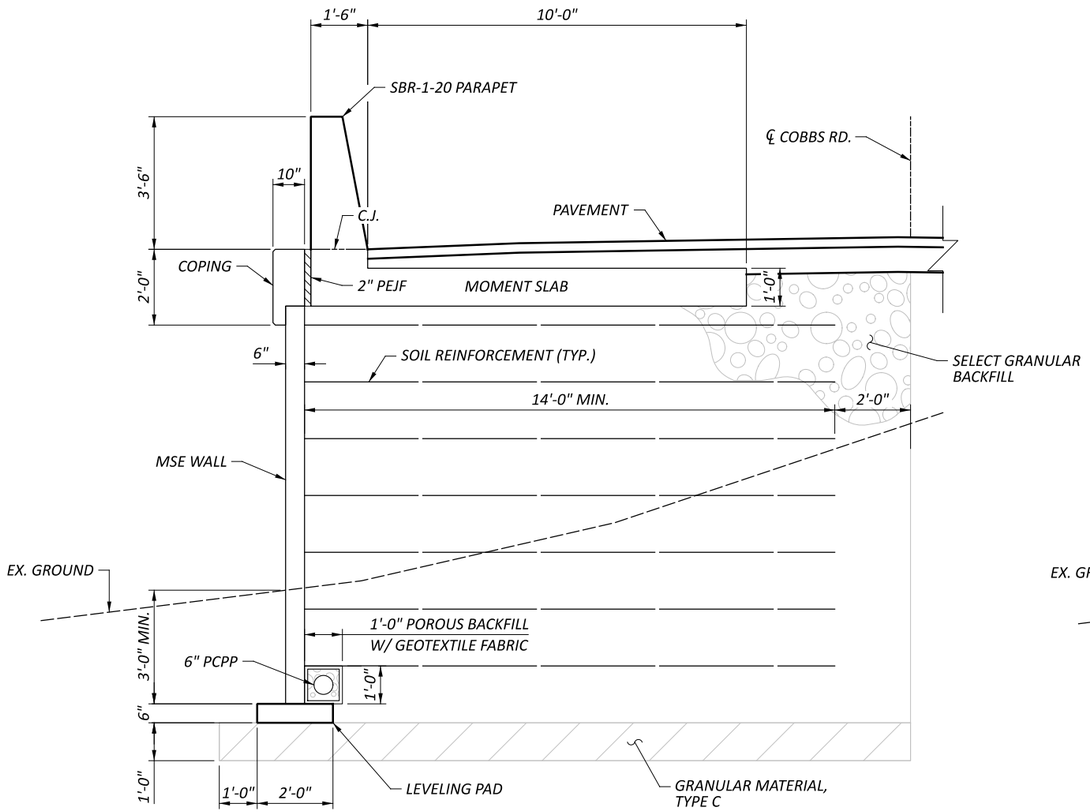
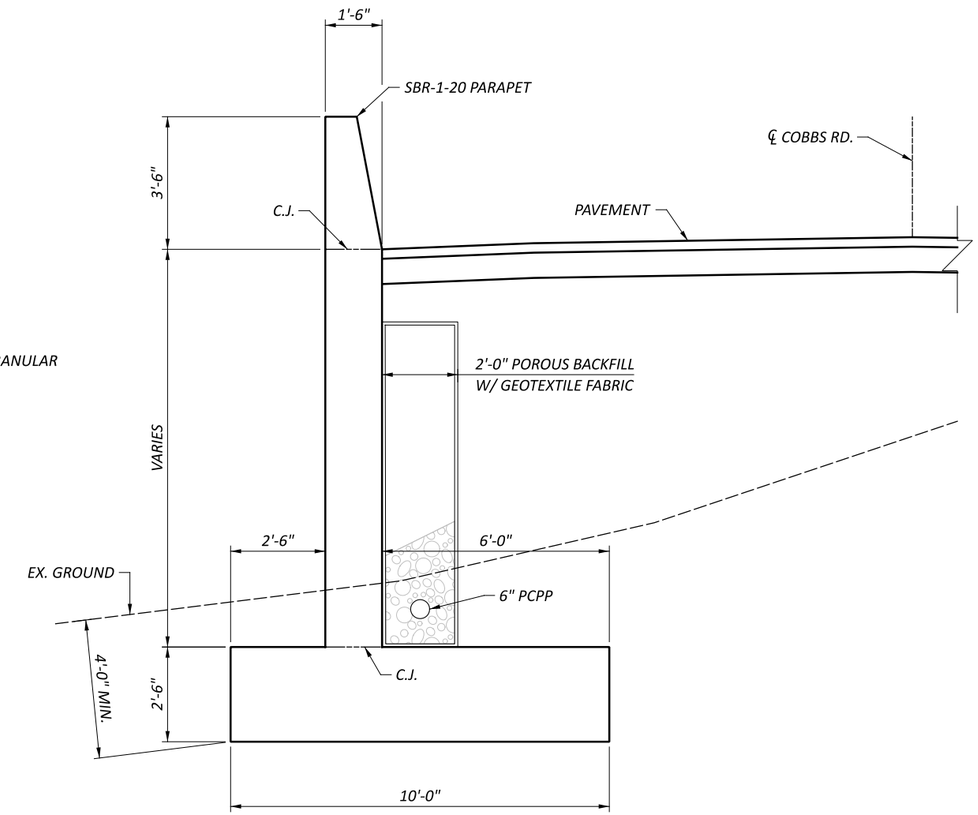
SHEET	TOTAL
P.7	12



MSE WALL TYPICAL SECTION



CANTILEVER WALL TYPICAL SECTION

RETAINING WALL SECTIONS

SFN

DESIGN AGENCY

WOOLPERT

DESIGNER	CHECKER
JYM	PES

REVIEWER: TML 11-26-25

PROJECT ID: 117878

SUBSET	TOTAL
7	12

SHEET	TOTAL
P.7	12

FRA/LIC-161-22.10/0.00

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APPENDIX 2: Wall Preliminary Designs

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Bearing Pressure Calculations

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Code Used: *AASHTO LRFD Bridge Design Specifications, 2020* & *ODOT BDM 2021*

Input

ϕ_f =	30.00	degrees	Effective Friction Angle
c =	0.00	ksf	Cohesion
B =	8.50	ft	Width
θ =	90.00	degrees	Projected Force Direction
L =	30.00	ft	Length
D_f =	4.00	ft	Footing Depth
E_{ftg} =	100.00	ft	Footing Elevation
E_{GW} =	100.00	ft	Ground Water Elevation
$D_w = E_{GW} - E_{ftg}$ =	0.00	ft	Depth to Ground Water
γ =	0.120	kcf	Unit Weight of Soil
	Theoretical, Clay		Soil Condition

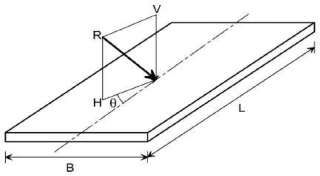


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

Output

From AASHTO Table 10.6.3.1.2a-1:

N_c =	30.1	Cohesion Term Capacity Factor
N_q =	18.4	Surcharge Term Capacity Factor
N_γ =	22.4	Unit Weight Term Capacity Factor

From AASHTO Table 10.6.3.1.2a-3:

$s_c = 1 + (B/L)(N_q / N_c)$ =	1.17	Cohesion Term
$s_\gamma = 1 - 0.4(B/L)$ =	0.89	Unit Weight Term
$s_q = 1 + (B/L)\tan\phi_f$ =	1.16	Surcharge Term

Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

From AASHTO Table 10.6.3.1.2a-2:

C_{wq} =	0.50	Surcharge Correction Factor
$C_{w\gamma}$ =	0.50	Unit Wt Correction Factor

Table 10.6.3.1.2a-2

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
4.0	1.0	0.5
16.8	1.0	1.0

d_q =	1.00	Assumed Depth Correction Factor
L/B =	3.53	Aspect Ratio
$n = [(2+L/B)/(1+L/B)]\cos^2\theta +$ $[(2+B/L)/(1+B/L)]\sin^2\theta +$	1.78	AASHTO Eq 10.6.3.1.2a-9
i_c =	1.00	Assumed load inclination factor
i_q =	1.00	Assumed load inclination factor
i_γ =	1.00	Assumed load inclination factor
$N_{cm} = N_c s_c i_c$ =	35.31	AASHTO Eq. 10.6.3.1.2a-2
$N_{qm} = N_q s_q d_q i_q$ =	21.41	AASHTO Eq. 10.6.3.1.2a-3
$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ =	19.86	AASHTO Eq. 10.6.3.1.2a-4
$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$ =	10.20 ksf	AASHTO Eq. 10.6.3.1.2a-1
$\emptyset_b$ =	0.50	Resistance Factor (AASHTO Table 10.5.5.2.2-1)
$\emptyset_b q_n$ =	**5.10 ksf**	**Strength Bearing Capacity (AASHTO Eq. 10.6.3.1.1-1)**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

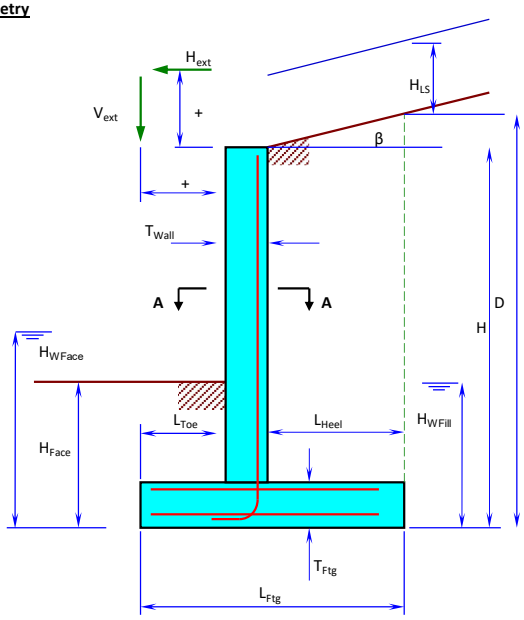
Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,
US Army Corps of Engineers (USACE), *EM 1110-2-2502 Flood Walls & Other Hydraulic Retaining Walls, 2022,*
& US Navy, Naval Facilities Engineering Command (NAVFAC), *Design Manual 7.2 (DM 7.2), 1986.*
Design based on 1-ft Strip Width Method

Input

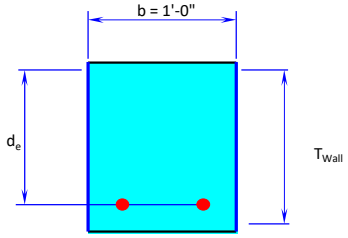
General Assumptions

f_c' =	4	ksi		(AASHTO, 5.4.2.1)
f_y =	60	ksi		
Weight of Concrete, w_c =	150	pcf		
Exposure Factor =	0.75			(AASHTO, 5.6.7)
Wall Cover =	2.00	in		
Footing Cover =	3.00	in		
$\alpha_1 = 0.85 - 0.02\,(f'_c - 10.0) \le 0.85 \,\&\, \ge 0.75$ =	0.85			(AASHTO, 5.6.2.2)
$\beta_1 = 0.85 - 0.05\,(f'_c - 4.0) \le 0.85 \,\&\, \ge 0.65$ =	0.85			(AASHTO, 5.6.2.2)
λ =	1.00		Concrete density modification factor	(AASHTO, 5.4.2.8)
$f_r = 0.24\,\lambda\,(f_c')^{0.5}$ =	0.48	ksi	Concrete modulus of rupture	(AASHTO, 5.4.2.6)

Geometry



SECTION
NTS
Showing Geometry



SECTION A-A
Showing Geometry

H =	20.00	ft	T_{Wall} =	18.00	in
H_{Face} =	4.00	ft	T_{Ftg} =	30.00	in
H_{Frost} =	2.67	ft	L_{Toe} =	2.50	ft 0.325
H_{LS} =	2.00	ft	L_{Heel} =	6.00	ft
$D = H + L_{heel}\tan\beta$ =	20.00	ft	L_{Ftg} =	10.00	ft 0.5
$H_{W,Face}$ =	0.00	ft	$H_{W,Heel}$ =	0.00	ft

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Suite 400
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LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Reinforcing

Wall Steel, Heel =	#8	@	8	in	A_s/s =	1.185 in^2/ft	**OK**
Wall Steel, Face =	#5	@	8	in	A_s/s =	0.465 in^2/ft	**OK**
Wall Steel, Secondary =	#5	@	12	in	A_s/s =	0.310 in^2/ft	**OK**
Footing Steel, Bottom =	#10	@	8	in	A_s/s =	1.905 in^2/ft	**OK**
Footing Steel, Top =	#5	@	8	in	A_s/s =	0.465 in^2/ft	**OK**
Footing Steel, Secondary =	#5	@	12	in	A_s/s =	0.310 in^2/ft	**OK**

Soil Data

Bearing Pressure

q_{all} = 10.00 ksf — Allowable unfactored (service) bearing pressure

Active soil pressure used. (ODOT, *BDM,* 307.1.1)

γ =	120 pcf	Unit weight of soil.		(ODOT, *BDM,* T307-1)
γ_{sat} =	125 pcf	Saturated unit weight of soil.		
β =	0.00 °	Angle of backslope.	Backslope is level.	
Φ_f =	32.0 °	Angle of internal friction.		(ODOT, *BDM,* T307-1)
δ_{Wall} =	15.0 °	Wall friction angle. ($\delta \le \Phi/2$)		(AASHTO, Table C3.11.5.3-1; & NAVFAC, p. 63)
θ =	90.0 °	Angle of back face to vertical.		
k_o =	$[1 - \sin(\Phi_f)] [1 + \sin(\beta)]$			(AASHTO, 3.11.5.2-1)
	0.470	At-rest soil pressure coefficient.	Not used.	
Γ =	$\left[1+\sqrt{\frac{\sin(\phi_f+\delta)\sin(\phi_f-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right]^{-2}$			(AASHTO, 3.11.5.3-2)
	2.668			
k_a =	$\frac{\sin^2(\theta+\Phi_f)}{\Gamma\,[\sin^2\theta\,\sin(\theta-\delta)]}$			(AASHTO, 3.11.5.3-1)
	0.279	Active soil pressure coefficient.	Used.	
k_p =	$\tan^2(45° + \Phi_f/2)$			
	3.25	Passive soil pressure coefficient.		

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DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Output

Summary of Design Checks

Geotechnical Adequacy					
Check	Required	Provided	Check		
Bearing Resistance (Strength)	5.00 ksf	4.65 ksf	**0.93**	**OK**	Governs
Sliding (Strength)	17.08 kip/ft	11.87 kip/ft	**0.70**	**OK**	.
Overturning Resistance/Eccentricity (Strength)	3.33 ft	1.54 ft	**0.46**	**OK**	.
Wall Design					
Check	Required	Provided	Check		
Maximum Moment Design	60.92 kip-ft/ft	72.67 kip-ft/ft	**0.84**	**OK**	.
Minimum Reinforcement	27.79 kip-ft/ft	72.67 kip-ft/ft	**0.38**	**OK**	.
Tension Controlled Section	0.375	0.14	**0.38**	**OK**	
Crack Control	9.23 in	8.00 in	**0.87**	**OK**	Governs
Shear	9.8 kip/ft	16.8 kip/ft	**0.58**	**OK**	
Wall Face Temperature/Shrinkage - Minimum	0.11 in^2/ft	0.465 in^2/ft	**0.24**	**OK**	
Wall Face Temperature/Shrinkage - Maximum	0.60 in^2/ft	0.465 in^2/ft	**0.78**	**OK**	
Longitudinal Temperature/Shrinkage - Minimum	0.11 in^2/ft	0.310 in^2/ft	**0.35**	**OK**	
Longitudinal Temperature/Shrinkage - Maximum	0.60 in^2/ft	0.310 in^2/ft	**0.52**	**OK**	
Interface Shear - Wall to Footing	9.77 kip/ft	70.166 kip/ft	**0.14**	**OK**	
Footing Design - Toe					
Check	Required	Provided	Check		
Maximum Moment Design	27.57 kip-ft/ft	204.45 kip-ft/ft	**0.13**	**OK**	.
Minimum Reinforcement	36.67 kip-ft/ft	204.45 kip-ft/ft	**0.18**	**OK**	.
Tension Controlled Section	0.375	0.13	**0.35**	**OK**	Governs
Crack Control	87.95 in	8.00 in	**0.09**	**OK**	.
Shear	11.0 kip/ft	58.4 kip/ft	**0.19**	**OK**	.
Footing Design - Heel					
Check	Required	Provided	Check		
Maximum Moment Design	65.48 kip-ft/ft	204.45 kip-ft/ft	**0.32**	**OK**	.
Minimum Reinforcement	77.18 kip-ft/ft	204.45 kip-ft/ft	**0.38**	**OK**	Governs
Tension Controlled Section	0.375	0.13	**0.35**	**OK**	.
Crack Control	50.53 in	8.00 in	**0.16**	**OK**	.
Shear	10.9 kip/ft	49.0 kip/ft	**0.22**	**OK**	.
Footing Design - Sides					
Check	Required	Provided	Check		
Top Face Temperature/Shrinkage - Minimum	0.11 in^2/ft	0.465 in^2/ft	**0.24**	**OK**	
Top Face Temperature/Shrinkage - Maximum	0.60 in^2/ft	0.465 in^2/ft	**0.78**	**OK**	
Side Face Temperature/Shrinkage - Minimum	0.11 in^2/ft	0.310 in^2/ft	**0.35**	**OK**	
Side Face Temperature/Shrinkage - Maximum	0.60 in^2/ft	0.310 in^2/ft	**0.52**	**OK**	

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LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Loads and Load Combinations

Critical Load Cases

The following load cases are applicable to retaining walls: DC, EH, EV, LS, WA

$\gamma_{p,EH}$ =	1.50	(AASHTO, Table 3.4.1-2)
$\gamma_{p,EV}$ =	1.50	(AASHTO, Table 3.4.1-2)
$\gamma_{p,LS}$ =	1.75	(AASHTO, Table 3.4.1-1)
$\gamma_{p,DC,max}$ =	1.25	(AASHTO, Table 3.4.1-2)
$\gamma_{p,DC,STR\ IV}$ =	1.50	(AASHTO, Table 3.4.1-2, Strength IV)
$\gamma_{p,DC,min}$ =	0.90	(AASHTO, Table 3.4.1-2)
$\gamma_{p,WA}$ =	1.00	(AASHTO, Table 3.4.1-1)

By Inspection the following combinations will govern:

Strength Design I:

$U = \gamma_{p,DC} + \gamma_{p,EH}EH + \gamma_{p,EV}EV + \gamma_{p,LS}LS + \gamma_{p,WA}WA$

Strength Design IV:

$U = \gamma_{p,DC,max}DC + \gamma_{p,EH}EH + \gamma_{p,EV}EV + \gamma_{p,WA}WA$

Service Design I:

$U = DC + EH + EV + LS + WA$

Dead Load (DC)

Wall Weight

w_c =	150	pcf	Unit weight of concrete.
H =	20.00	ft	Total height of wall including footing.
T_{Ftg} =	2.50	ft	Footing thickness.
T_{Wall} =	1.50	ft	Wall thickness.
L_{Toe} =	2.50	ft	Length of footing toe.
L_{Ftg} =	10.00	ft	Length of footing.
$H_{Wall} = H - T_{Ftg}$ =	17.50	ft	Wall height
$DC_{V,Wall} = w_c T_{Wall} H_{Wall}$ =	**3.94**	**kip/ft**	**Wall weight per foot of wall.**
@ x = L_{Ftg} / 2 - L_{Toe} - T_{Wall}/2 - =	**1.75**	**ft**	**Eccentricity of wall weight.**

Footing Weight

$DC_{V,Ftg} = w_c T_{Ftg} L_{Ftg}$ =	**3.75**	**kip/ft**	**Footing weight per foot of wall.**
@ x =	**0.00**	**ft**	**Eccentricity of footing weight.**

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At-Rest or Active Soil Loads on the Wall (EH)

At-Rest Soil Loads	Not used.			For Entire wall including footing:
k_o		0.470		Soil pressure coefficient.
γ		120	pcf	Unit weight of soil.
γ_w		62.4	pcf	Unit weight of water.
γ_{sat}		125.0	pcf	Saturated unit weight of soil.
D =		20.00	ft	Depth of soil at heel of wall.
$H_{W,Heel}$ =		0.00	ft	Height of retained water.
T_{Ftg} =		2.50	ft	Height of footing.
$\gamma' = \gamma_{sat} - \gamma_w$ =		62.60	pcf	Effective additional saturated soil weight.
$H_1 = D - H_{w,Heel}$ =		20.00	ft	Depth of unsaturated soil
$H_2 = H_{w,Heel}$ =		0.00	ft	Depth of saturated soil
$P_{o1} = (k_o \gamma H_1^2)/2$ =		11.28	kip/ft	At-Rest soil force / foot width of wall (above water table).
@ $y = H_2 + H_1 / 3$ =		6.67	ft	Location of at-rest soil force above water table.
$P_{o2} = k_o \gamma H_1 H_2$ =		0.00	kip/ft	At-Rest soil force / foot width of wall (soil below water table).
@ $y = H_2 / 2$ =		0.00	ft	Location of at-rest soil force below water table.
$P_{o3} = (k_o \gamma' H_2^2)/2$ =		0.00	kip/ft	At-Rest saturation force / foot width of wall.
@ $y = H_2 / 3$ =		0.00	ft	Location of at-rest soil saturation force.
$P_{o4} = \gamma_w H_2^2 / 2$ =		0.000	kip/ft	At-Rest pore pressure force / foot width of wall.
@ $y = H_2 / 3$ =		0.00	ft	
$P_o = P_{o1} + P_{o2} + P_{o3} + P_{o4}$ =		11.28	kip/ft	
@ $y = \Sigma P_{oi}\gamma_i / \Sigma P_{oi}$ =		6.67	ft	
$EH_{oH} = P_{oH} = P_o \cos(\delta)$ =		**10.90**	**kip/ft**	**Horizontal at-rest soil force / foot width of wall at bot. of ftg.**
$EH_{oV} = P_{oV} = P_o \sin(\delta)$		**2.92**	**kip/ft**	**Vertical at-rest soil force / foot width of wall at bot. of ftg.**

Similarly, for Wall Base:

$H_1 = \min(D - H_{w,Heel} ; D - T_{Ftg})$ =	17.50	ft			
$H_2 = D - T_{Ftg} - H_{w,Heel}$ =	0.00				
$P_{o1} = (k_o \gamma H_1^2)/2$ =	8.64	kip/ft	@ $y = H_2 + H_1 / 3$ =	5.83	ft
$P_{o2} = k_o \gamma H_1 H_2$ =	0.00	kip/ft	@ $y = H_2 / 2$ =	0.00	ft
$P_{o3} = (k_o \gamma' H_2^2)/2$ =	0.00	kip/ft	@ $y = H_2 / 3$ =	0.00	ft
$P_{o4} = \gamma_w H_2^2 / 2$ =	0.00	kip/ft	@ $y = H_2 / 3$ =	0.00	ft
$P_o = P_{o1} + P_{o2} + P_{o3} + P_{o4}$ =	8.64	kip/ft	@ $y = \Sigma P_{oi}\gamma_i / \Sigma P_{oi}$ =	5.83	ft
$EH_{oH} = P_{oH} = P_o \cos(\delta)$ =	**8.34**	**kip/ft**	**Horizontal at-rest soil force / foot width of wall at bot. of wall**		
$EH_{oV} = P_{oV} = P_o \sin(\delta)$	**2.24**	**kip/ft**	**Vertical at-rest soil force / foot width of wall at bot. of wall**		

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Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Active Soil Loads — Used.

k_a =	0.279		Soil pressure coefficient.
γ =	120	pcf	Unit weight of soil.
γ_w =	62.4	pcf	Unit weight of water.
γ_{sat} =	125.0	pcf	Saturated unit weight of soil.
D =	20.00	ft	Depth of soil at heel of wall.
$H_{W,Heel}$ =	0.00	ft	Height of retained water.
T_{Ftg} =	2.50	ft	Height of footing.
$\gamma' = \gamma_{sat} - \gamma_w$ =	62.60	pcf	Effective additional saturated soil weight.
$H_1 = D - H_{w,Heel}$ =	20.00	ft	Depth of unsaturated soil
$H_2 = H_{w,Heel}$ =	0.00	ft	Depth of saturated soil
$P_{a1} = (k_o \gamma H_1^2)/2$ =	6.70	kip/ft	Active soil force / foot width of wall (above water table).
@ $y = H_2 + H_1 / 3$ =	6.67	ft	Location of active soil force above water table.
$P_{a2} = k_o \gamma H_1 H_2$ =	0.00	kip/ft	Activesoil force / foot width of wall (soil below water table).
@ $y = H_2 / 2$ =	0.00	ft	Location of active soil force below water table.
$P_{a3} = (k_o \gamma' H_2^2)/2$ =	0.00	kip/ft	Active saturation force / foot width of wall.
@ $y = H_2 / 3$ =	0.00	ft	Location of active soil saturation force.
$P_{a4} = \gamma_w H_2^2 / 2$ =	0.000	kip/ft	Active pore pressure force / foot width of wall.
@ $y = H_2 / 3$ =	0.00	ft	
$P_a = P_{a1} + P_{a2} + P_{a3} + P_{a4}$ =	6.70	kip/ft	
@ $y = \Sigma P_{ai} y_i / \Sigma P_{ai}$ =	6.67	ft	
$EH_{aH} = P_{aH} = P_a \cos(\delta)$ =	**6.47**	**kip/ft**	**Horzontal active soil force / foot width of wall.**
$EH_{aV} = P_{aV} = P_a \sin(\delta)$	**1.73**	**kip/ft**	**Vertical active soil force / foot width of wall.**

Similarly, for Wall Base:

$H_1 = \min(D - H_{w,Heel} ; D - T_{Ftg})$ =	17.50	ft		
$H_2 = D - T_{Ftg} - H_{w,Heel}$ =	0.00			
$P_{a1} = (k_a \gamma H_1^2)/2$ =	5.13	kip/ft	@ $y = H_2 + H_1 / 3$ =	5.83 ft
$P_{a2} = k_a \gamma H_1 H_2$ =	0.00	kip/ft	@ $y = H_2 / 2$ =	0.00 ft
$P_{a3} = (k_a \gamma' H_2^2)/2$ =	0.00	kip/ft	@ $y = H_2 / 3$ =	0.00 ft
$P_{a4} = \gamma_w H_2^2 / 2$ =	0.00	kip/ft	@ $y = H_2 / 3$ =	0.00 ft
$P_a = P_{a1} + P_{a2} + P_{a3} + P_{a4}$ =	5.13	kip/ft	@ $y = \Sigma P_{oi} y_i / \Sigma P_{oi}$ =	5.83 ft
$EH_{aH} = P_{aH} = P_a \cos(\delta)$ =	**4.95**	**kip/ft**	**Horizontal active soil force / foot width of wall at bot. of wall**	
$EH_{aV} = P_{aV} = P_a \sin(\delta)$	**1.33**	**kip/ft**	**Vertical active soil force / foot width of wall at bot. of wall**	

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Live Load Surcharge Loads on the Wall (LS)

k =	0.279		Soil pressure coefficient.
γ =	120	pcf	Unit weight of soil.
H_{eq} =	2.00	ft	Equivalent live load surcharge.
L_{Heel} =	6.00	ft	Length of footing heel.
L_{Ftg} =	10.00	ft	Length of footing.
D =	20.00	ft	Depth of soil at heel of wall.
$LS_H = k \gamma H_{eq} D$ =	**1.34**	**kip/ft**	**Horizontal surcharge force / foot width of wall.**
@ y = D / 2 =	**10.00**	**ft**	**Location of surcharge force.**
$LS_V = \gamma H_{eq} L_{Heel}$ =	**1.44**	**kip/ft**	**Vertical surcharge force / foot width of wall.**
@ x = $(L_{Heel} - L_{Ftg}) / 2$ =	**-2.00**	**ft**	**Eccentricity of load from center of footing.**

Passive Soil Loads on the Wall (EH_p)

k_p =	3.25		Soil pressure coefficient.
γ =	120	pcf	Unit weight of soil.
H_{Face} =	4.00	ft	Height of fill on face of wall.
H_{frost} =	2.67	ft	Frost line depth.
$D_p = H_{Face} - H_{frost}$ =	1.333	ft	Passive pressure height.
$EH_p = P_p = -(k_p \gamma D_p^2)/2$ =	**-0.347**	**kip/ft**	**Passive soil force / foot width of wall.**
@ y = D_p / 2 =	**0.667**	**ft**	**Location of passive soil force.**

Vertical Soil Weight (EV)

γ =	120	pcf	Unit weight of soil.
L_{Ftg} =	10.00	ft	Length of footing.
L_{Toe} =	2.50	ft	Length of footing toe.
H_{Face} =	4.00	ft	Height of fill at toe.
L_{Heel} =	6.00	ft	Length of footing heel.
H_{Wall} =	17.50	ft	Wall height
D =	20.00	ft	Depth of soil at heel of wall.
T_{Wall} =	1.50	ft	Wall thickness.
T_{Ftg} =	2.50	ft	Height of footing.
$D_{Wall} = D - T_{Ftg}$ =	17.50	ft	Depth of soil above footing at heel of wall.
$D_{ave} = (H_{Wall} + D_{Wall}) / 2$ =	17.50	ft	Average depth retained fill.
$EV_{Heel} = \gamma D_{ave} L_{Heel}$ =	**12.60**	**kip/ft**	**Soil weight/foot width of wall.**
$e_{EV} = L_{Heel} [H_{Wall} + 2D_{Wall} / 3(H_{Wall} + D_{Wall})]$ =	3.00	ft	Eccentricity of load from back of wall.
@ x = $L_{Ftg} / 2 - e_{EV} - L_{Toe} - T_{Wall}$ =	**-2.00**	**ft**	**Eccentricity of load from center of footing.**
$D_{Toe} = H_{Face} - T_{Ftg}$ =	1.50	ft	Depth of soil above footing toe.
$EV_{Toe} = \gamma D_{Toe} L_{Toe}$ =	**0.45**	**kip/ft**	**Soil weight/foot width of wall.**
@ x = $(L_{Ftg} - L_{Toe}) / 2$ =	**3.75**	**ft**	**Eccentricity of load from center of footing.**

Vertical Water Pressure on Footing (WA)

γ_w =	62.4	pcf	Unit weight of water.
γ_{sat} =	125.0	pcf	Saturated unit weight of soil.
$\gamma' = \gamma_{sat} - \gamma_w$ =	62.6	pcf	Effective additional saturated soil weight.
$H_{W,Heel}$ =	0.00	ft	Height of retained water.
H_{WFace} =	0.00	ft	Height of water on face.
T_{Ftg} =	2.50	ft	Height of footing.
L_{Heel} =	6.00	ft	Length of footing heel.
L_{Toe} =	2.50	ft	Length of footing toe.
L_{Ftg} =	10.00	ft	Length of footing.
$D_{w,Heel} = H_{w,Heel} - T_{Ftg}$ =	0.00	ft	Water depth on heel.
$D_{w,Face} = H_{w,Face} - T_{Ftg}$ =	0.00	ft	Water depth on toe.

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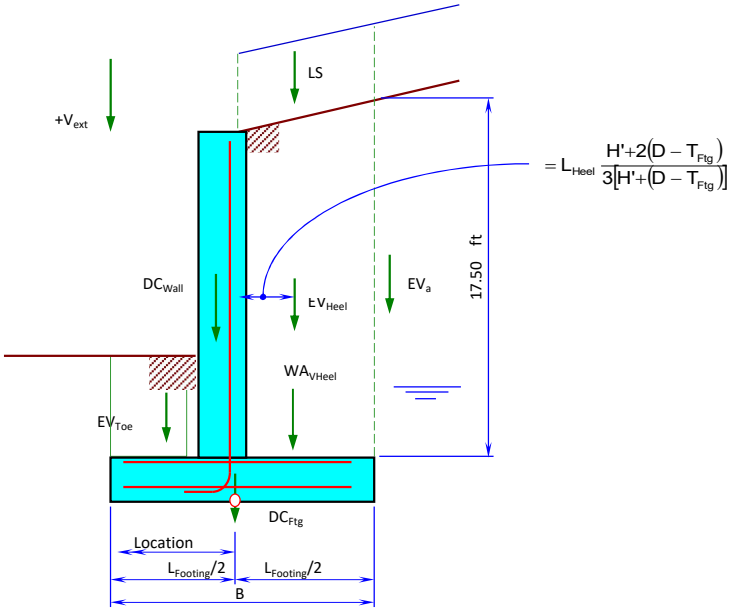
$WA_{V,Heel} = (\gamma'+\gamma_w)D_{w,heel}L_{Heel}$ =	**0.00 kip/ft**	**Weight of water on heel.**
@ x = (L_{Heel} - L_{Ftg}) / 2 =	**-2.00 ft**	**Eccentricity of load from center of footing.**
$WA_{V,Toe} = (\gamma'+\gamma_w)D_{w,toe}L_{Toe}$ =	**0.00 kip/ft**	**Weight of water on toe.**
@ x = (L_{Ftg} - L_{Toe}) / 2 =	**3.75 ft**	**Eccentricity of load from center of footing.**

Vertical Loads / Foot Width of Wall

Origin is @ the middle of the footing. Positive is towards the toe.
Positive loads are down. Negative loads are up.



SECTION
NTS
Showing Vertical Loads

Strength I Combination - Max DC							
Item	**V** *kip/ft*	**γ_i**	**γ_iV** *kip/ft*	**x** *ft*	**γ_iVx** *kip-ft/ft*	**Description**	
DC_{Wall}	+3.938	1.25	+4.922	+1.750	+8.613	Wall stem weight.	
$DC_{Ftg.}$	+3.750	1.25	+4.688	+0.000	+0.000	Footing weight.	
EH_o	+0.000	1.50	+0.000	-2.000	+0.000	Vert. comp. of at-rest soil.	Not used.
EH_a	+1.733	1.50	+2.600	-2.000	-5.200	Vert. comp. of active soil.	Used.
EV_{Heel}	+12.600	1.50	+18.900	-2.000	-37.800	Weight of soil on the heel.	
EV_{Toe}	+0.450	1.50	+0.675	+3.750	+2.531	Weight of soil on the toe.	
LS_V	+1.440	1.75	+2.520	-2.000	-5.040	Surcharge on the heel.	
WA_{VHeel}	+0.000	1.00	+0.000	-2.000	+0.000	Groundwater weight on heel.	
WA_{VToe}	+0.000	1.00	+0.000	+3.750	+0.000	Groundwater weight on toe.	
V_{ext}	+0.612	1.25	+0.766	+1.750	+1.340	Exterior vertical load.	Parapet
Σ			**+35.07**		**-35.56**		

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Strength I Combination - Min DC

Item	V *kip/ft*	γ_i	$\gamma_i V$ *kip/ft*	x *ft*	$\gamma_i Vx$ *kip-ft/ft*	Description	
DC_{Wall}	+3.938	0.90	+3.544	+1.750	+6.202	Wall stem weight.	
$DC_{Ftg.}$	+3.750	0.90	+3.375	+0.000	+0.000	Footing weight.	
EH_o	+0.000	1.50	+0.000	-2.000	+0.000	Vert. comp. of at-rest soil.	Not used.
EH_a	+1.733	1.50	+2.600	-2.000	-5.200	Vert. comp. of active soil.	Used.
EV_{Heel}	+12.600	1.50	+18.900	-2.000	-37.800	Weight of soil on the heel.	
EV_{Toe}	+0.450	1.50	+0.675	+3.750	+2.531	Weight of soil on the toe.	
LS_V	+1.440	1.75	+2.520	-2.000	-5.040	Surcharge on the heel.	
WA_{VHeel}	+0.000	1.00	+0.000	-2.000	+0.000	Groundwater weight on heel.	
WA_{VToe}	+0.000	1.00	+0.000	+3.750	+0.000	Groundwater weight on toe.	
V_{ext}	+0.612	0.90	+0.551	+1.750	+0.965	Exterior vertical load.	Parapet
Σ			**+32.17**		**-38.34**		

Strength IV Combination

Item	V *kip/ft*	γ_i	$\gamma_i V$ *kip/ft*	x *ft*	$\gamma_i Vx$ *kip-ft/ft*	Description	
DC_{Wall}	+3.938	1.50	+5.906	+1.750	+10.336	Wall stem weight.	
$DC_{Ftg.}$	+3.750	1.50	+5.625	+0.000	+0.000	Footing weight.	
EH_o	+0.000	1.50	+0.000	-2.000	+0.000	Vert. comp. of at-rest soil.	Not used.
EH_a	+1.733	1.50	+2.600	-2.000	-5.200	Vert. comp. of active soil.	Used.
EV_{Heel}	+12.600	1.50	+18.900	-2.000	-37.800	Weight of soil on the heel.	
EV_{Toe}	+0.450	1.50	+0.675	+3.750	+2.531	Weight of soil on the toe.	
WA_{VHeel}	+0.000	1.00	+0.000	-2.000	+0.000	Groundwater weight on heel.	
WA_{VToe}	+0.000	1.00	+0.000	+3.750	+0.000	Groundwater weight on toe.	
V_{ext}	+0.612	1.50	+0.000	+1.750	+0.000	Exterior vertical load.	Parapet
Σ			**+33.71**		**-30.13**		

Service I Combination

Item	V *kip/ft*	γ_i	$\gamma_i V$ *kip/ft*	x *ft*	$\gamma_i Vx$ *kip-ft/ft*	Description	
DC_{Wall}	+3.938	1.00	+3.938	+1.750	+6.891	Wall stem weight.	
$DC_{Ftg.}$	+3.750	1.00	+3.750	+0.000	+0.000	Footing weight.	
EH_o	+0.000	1.00	+0.000	-2.000	+0.000	Vert. comp. of at-rest soil.	Not used.
EH_a	+1.733	1.00	+1.733	-2.000	-3.467	Vert. comp. of active soil.	Used.
EV_{Heel}	+12.600	1.00	+12.600	-2.000	-25.200	Weight of soil on the heel.	
EV_{Toe}	+0.450	1.00	+0.450	+3.750	+1.688	Weight of soil on the toe.	
LS_V	+1.440	1.00	+1.440	-2.000	-2.880	Surcharge on the heel.	
WA_{VHeel}	+0.000	1.00	+0.000	-2.000	+0.000	Groundwater weight on heel.	
WA_{VToe}	+0.000	1.00	+0.000	+3.750	+0.000	Groundwater weight on toe.	
V_{ext}	+0.612	1.00	+0.000	+1.750	+0.000	Exterior vertical load.	Parapet
Σ			**+23.91**		**-22.97**		

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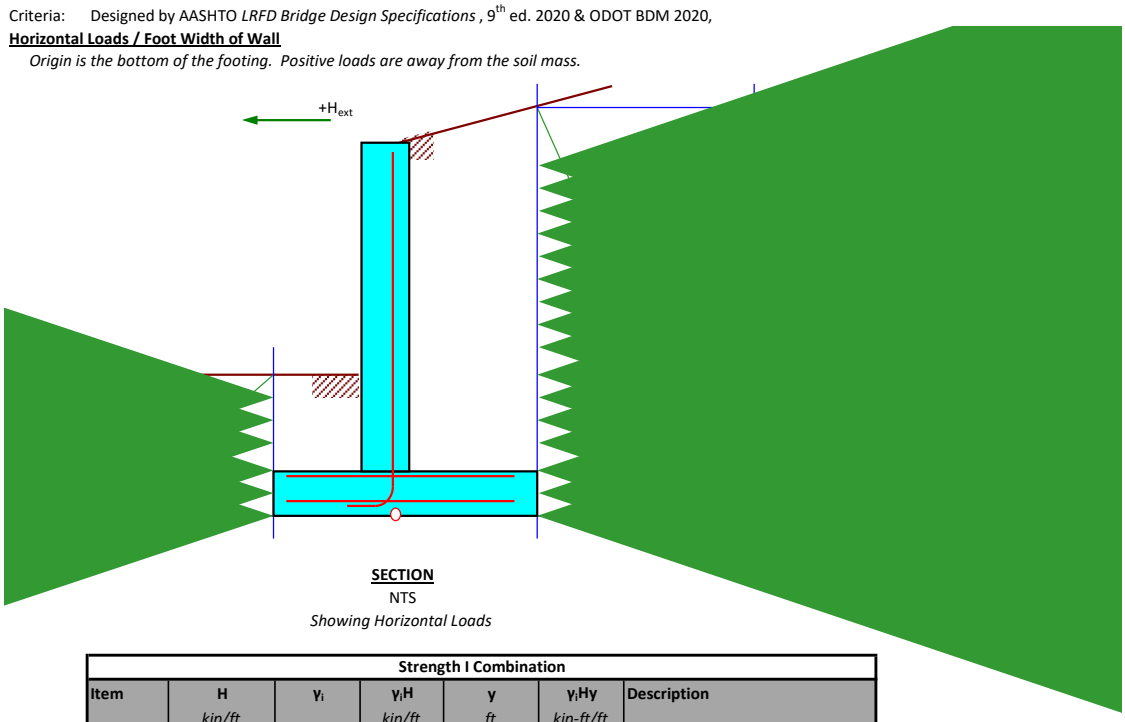
Horizontal Loads / Foot Width of Wall

Origin is the bottom of the footing. Positive loads are away from the soil mass.



SECTION
NTS
Showing Horizontal Loads

Strength I Combination							
Item	**H** *kip/ft*	**γ_i**	**γ_iH** *kip/ft*	**y** *ft*	**γ_iHy** *kip-ft/ft*	**Description**	
EH_o	+0.000	1.50	+0.000	6.667	+0.000	Horiz. comp. of at-rest soil.	Not used.
EH_a	+6.469	1.50	+9.704	6.667	+64.692	Horiz. comp. of active soil.	Used.
LS	+1.339	1.75	+2.344	10.000	+23.441	Surcharge: Active soil.	
EH_p	-0.347	0.50	-0.174	0.667	-0.116	Passive soil.	
H_{ext}	+0.000	0.00	+0.000	0.000	+0.000	Exterior horizontal load.	
Σ			**+11.87**		**+88.02**		

Strength IV Combination							
Item	**H** *kip/ft*	**γ_i**	**γ_iH** *kip/ft*	**y** *ft*	**γ_iHy** *kip-ft/ft*	**Description**	
EH_o	+0.000	1.50	+0.000	6.667	+0.000	Horiz. comp. of at-rest soil.	Not used.
EH_a	+6.469	1.50	+9.704	6.667	+64.692	Horiz. comp. of active soil.	Used.
EH_p	-0.347	1.50	-0.521	0.667	-0.347	Passive soil.	
H_{ext}	+0.000	0.00	+0.000	0.000	+0.000	Exterior horizontal load.	
Σ			**+9.18**		**+64.35**		

Service I Combination							
Item	**H** *kip/ft*	**γ_i**	**γ_iH** *kip/ft*	**y** *ft*	**γ_iHy** *kip-ft/ft*	**Description**	
EH_o	+0.000	1.00	+0.000	6.667	+0.000	Horiz. comp. of at-rest soil.	Not used.
EH_a	+6.469	1.00	+6.469	6.667	+43.128	Horiz. comp. of active soil.	Used.
EH_p	-0.347	1.00	-0.347	0.667	-0.231	Passive soil.	
H_{ext}	+0.000	0.00	+0.000	0.000	+0.000	Exterior horizontal load.	
Σ			**+6.12**		**+42.90**		

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One Easton Oval
Suite 400
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LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Load Combination Summary

Combination	V_u *kip/ft*	H_u *kip/ft*	M_u *kip-ft/ft*	e *ft*	H_u / V_u
Strength I Max	+35.07	+11.87	+52.46	1.50	0.34
Strength I Min	+32.17	+11.87	+49.67	1.54	0.37
Strength IV	+33.71	+9.18	+34.21	1.02	0.27
Service I	+23.91	+6.12	+19.93	0.83	0.26

where e = Mu / Vu

Geotechnical Adequacy

Bearing Resistance (Strength)

Soil Type and Method =	Theoretical, Clay		(AASHTO Table 10.5.5.2.2-1)
$Ø_b$ =	0.5	Bearing resistance value	
Strength Case with Highest Eccentricity Governs.		**Strength I Min**	
V_u =	32.17 kip/ft	Ultimate factored vertical load.	
H_u =	11.87 kip/ft	Ultimate factored horizontal load.	
M_u =	49.67 kip-ft/ft	Ultimate factored moment.	
e =	1.54 ft	Eccentricity of factored loading to center of footing.	

Per AASHTO 10.6.1.4 the bearing stress distribution for footings on soil will be uniform on the effective area.

L_{Ftg} =	10.00 ft	Length of footing.	
$L' = L_{Ftg} - 2e$ =	6.91 ft	Effective length of footing.	(AASHTO 10.6.1.3-1)
B =	1.00 ft	Unit width.	
$q_u = V_u / BL'$ =	4.65 ksf	Factored bearing pressure.	
q_{all} =	10.00 ksf	Allowable unfactored (service) bearing pressure.	
$Ø_b\ q_{all}$ =	5.00 ksf	Allowable factored (strength) bearing pressure.	
	0.93 OK		(AASHTO 10.6.3.1.1-1)
e_{ser} =	0.83 ft	Service load eccentricity.	
$L_{ser}' = L_{Ftg} - 2e_{ser}$ =	8.33 ft	Effective length of footing for service combination.	
$q_{ser} = V_{uSer} / BL_{ser}'$ =	2.87 ksf	Service load combination bearing pressure.	

Sliding (Strength)

Strength Case with Highest Ratio of Horizontal Load to Vertical Load Governs.			**Strength I Min**
V_u =	32.17 kip/ft	Ultimate factored vertical load.	
Soil Type =	All Concrete on Clay		
Concrete Type =	Cast in Place		
$Ø_t$ =	0.85	Sliding resistance value	(AASHTO Table 10.5.5.2.2-1)
C =	1.00	Sliding friction adjustment factor	(AASHTO 10.6.3.4)
$Φ_f$ =	32.00 °	Angle of internal friction.	
$\mu = C \tan(\phi_f)$ =	0.62	Friction factor.	(AASHTO 10.6.3.4)
$Ø_t R_t = Ø_t \mu V_u$ =	17.08 kip/ft		(AASHTO 10.6.3.4-1 & 10.6.3.4-2)
H_u =	11.87 kip/ft	Ultimate factored horizontal load.	
	0.70 OK		

Overturning Resistance/Eccentricity (Strength)

Per AASHTO C11.6.3.3 eccentricity limitations have replaced the investigation of the ratio of stabilizing moment to overturning moment. The reaction eccentricity must be within the middle 2/3 of the footing.

e =	1.54 ft		
L_{Ftg} =	10.00 ft	Length of footing.	
$e_{max} = L_{Ftg} / 3$ =	3.33 ft	Maximum allowable eccentricity.	
	0.46 OK		

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Structural Design Checks

Load Combination, Strength I Design Governs, see above

Strength I Combination							
Item	**H** *kip/ft*	**γ_i**	**γ_iH** *kip/ft*	**y** *ft*	**γ_iHy** *kip-ft/ft*	**Description**	
EH_o	+0.000	1.50	+0.000	5.833	+0.000	Horiz. comp. of at-rest soil.	Not used.
EH_a	+4.953	1.50	+7.430	5.833	+43.339	Horiz. comp. of active soil.	Used.
LS	+1.339	1.75	+2.344	7.500	+17.581	Surcharge: Active soil.	
H_{ext}	+0.000	0.00	+0.000	0.000	+0.000	Exterior horizontal load.	
Σ			**+9.77**		**+60.92**		

Service I Combination							
Item	**H** *kip/ft*	**γ_i**	**γ_iH** *kip/ft*	**y** *ft*	**γ_iHy** *kip-ft/ft*	**Description**	
EH_o	+0.000	1.00	+0.000	5.833	+0.000	Horiz. comp. of at-rest soil.	Not used.
EH_a	+4.953	1.00	+4.953	5.833	+28.893	Horiz. comp. of active soil.	Used.
LS	+1.339	1.00	+1.339	7.500	+10.046	Surcharge: Active soil.	
H_{ext}	+0.000	0.00	+0.000	0.000	+0.000	Exterior horizontal load.	
Σ			**+6.29**		**+38.94**		

Wall @ Base/Anchorage Bar

Use temperature reinforcement on the front face.

T_{wall} =	18.00	in	Section thickness.
Cover =	2.00	in	Clear cover to reinforcement.
d_b =	1.00	in	Bar diameter
$d_e = d_s$	14.50	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*
$d_{e,embed}$ =	25.50	in	Maximum depth of embedment in footing *(Includes ½" tol.)*
b =	1.00	ft	Width of section.
$S_c = bT_{Wall}^2 / 6$ =	648.00	in^3/ft	Section modulus.
A/s =	1.185	in^2/ft	Steel area/ft

$l_{dh}^{Req} = 38\, d_b\, f_y / 60(f'_c)^{1/2} \geq 8d_b \geq 6"$ (AASHTO, 5.10.8.2.4a)

	0.80		Side cover ≥ 2.5'' & end cover ≥ 2'' (AASHTO, 5.10.8.2.4b)
	1.20		Epoxy coated factor. (AASHTO, 5.10.8.2.4b)
	18.24	in	Development in the footing is adequate. (AASHTO, 5.10.8.2.1)
$A_s' = A_s\, d / l_{dh} \leq A_s$ =	1.185	in^2 / ft	Effective area of tension steel at the base of the wall.
Dim. J =	16	in	90° Hook standard leg dim. (ODOT, BDM, Fig. 304-7)
Clr. =	6	in	Clear space between vertical bars in a lap at the base of the wall.

Check Moment Capacity

Φ =	0.90		Resistance factor. (AASHTO, 5.5.4.2)
$c = A_s f_y / \alpha_1 f'_c \beta_1 b$ =	2.05	in	Depth of the neutral axis. (AASHTO, 5.6.3.1.1-4)
$a = c\, \beta_1$ =	1.74	in	Depth of rectangular stress block. (AASHTO, 5.6.2.2)
$\Phi M_n = \Phi\, A_s f_y (d_e - a/2)$ =	72.67	kip-ft/ft	Factored moment capacity. (AASHTO, 5.6.3.2.2-1)
M_u =	60.92	kip-ft/ft	Factored demand moment.
	0.84	**OK**	

Check Reinforcement to Ensure Tension Controlled Section (AASHTO, 5.6.2.1)

ε_c =	0.003	Limiting strain in concrete.
ε_s =	0.005	Minimum strain in reinf. for "tension controlled" behavior.
$c / \varepsilon_c = d_s / (\varepsilon_c + \varepsilon_s)$		Strain relationship by similar triangles.
$c / d_s \leq$ 0.003 /(0.003 + 0.005) =	0.375	(AASHTO, 5.6.2.1-1)
c / d_s =	0.14	**0.38 OK**

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LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Check Minimum Reinforcement (AASHTO, 5.6.3.3)

S_c =	648.00	in^3/ft	Section modulus.
f_r =	0.48	ksi	Modulus of rupture.
γ_1 =	1.60		All non-precast segmental structures (AASHTO, 5.6.3.3)
γ_3 =	0.67		A615, Gr. 60 Reinforcement (AASHTO, 5.6.3.3)
$M_{cr} = \gamma_3\gamma_1 f_r S_c$	27.79	kip-ft/ft	Cracking moment. (AASHTO, 5.6.3.3-1)
$1.33M_u$ =	81.02	kip-ft/ft	
M_{min} = min{ M_{cr}, $1.33M_u$ } =	27.79	kip-ft/ft	**0.38 OK** (AASHTO, 5.6.3.3)

Check Crack Control

h =	18.00	in	Depth of wall
d_c = cover + $d_b/2$ =	2.50	in	Depth of bottom steel
d_s =	14.50	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*
$\beta_s = 1 + d_c / 0.7(h - d_c)$ =	1.230		(AASHTO 5.6.7-2)
$\rho = A_s/bd_s$ =	0.00681		Reinforcement ratio
n =	8		Modular ratio
$k = \sqrt{[(\rho n)^2 + 2\rho n]} - \rho n$ =	0.280		
j = 1 - k/3 =	0.907		
M_{SERI} =	38.94	kip-ft/ft	Service combination moment
$f_s = M_{SERI} / A_s j d_s$ =	30.0	ksi	
$s \le (700\gamma_e / \beta_s f_s) - 2d_c$ =	9.23	in	Spacing (AASHTO 5.6.7-1)
s_{prov} =	8.00	in	**0.87 OK**

Shear Strength Provided by Concrete

Φ =	0.90		Resistance factor. (AASHTO, 5.5.4.2)
b_v =	12.00	in	(AASHTO, 5.7.2.8)
$d_v = d_e - a/2 \ge 0.9\, d_e \ge 0.72\, h$ =	13.63	in	Effective shear depth. (AASHTO, 5.7.2.8)
M_U =	60.92	kip-ft/ft	Factored moment.
V_U =	9.77	kip/ft	Factored shear force.
$M_U / V_U d_v$ =	5.49	≥ 1.0	**OK**
$\varepsilon_s = (M_U / d_v + V_U) / E_s A_s$ =	0.0022		Strain in flexural reinforcing steel. (AASHTO, 5.7.3.4.2-4)
$\beta = 4.8 / (1 + 750\varepsilon_s)$ =	1.81		(AASHTO, 5.7.3.4.2-1)
$V_c = 0.0316\, \beta\, f'^{1/2}_c\, b_v\, d_v$ =	18.68	kip/ft	Shear concrete nominal capacity (AASHTO, 5.7.3.3-3)
ΦV_c =	16.8	kip	**> Vu No min. reinforcement required.** (AASHTO, 5.7.2.3-1)
V_u =	9.8	kip/ft	Factored shear force
	0.58 OK		

Note: designed as a slab/continuous member. Since not a discrete (beam) element, does not need to meet $0.5\Phi V_c$

Wall Face Steel - Design for Temperature/Shrinkage

$A_{s,\,prov}$ =	0.465	in^2/ft	**OK**
$A_{s,\,min}$ =	0.11	in^2/ft	Minimum steel (AASHTO 5.10.6-2)
$A_{s,\,max}$ =	0.60	in^2/ft	Maximum steel (AASHTO 5.10.6-2)
f_y =	60.00	ksi	Steel yield strength
b =	12.00	in	Width of section
h =	18.00	in	Depth of section
$A_s \ge 1.3bh / 2(b + h)f_y$ =	0.078	in	(AASHTO 5.10.6-1)

Wall Longitudinal Steel - Design for Temperature/Shrinkage

$A_{s,\,prov}$ =	0.310	in^2/ft	**OK**
$A_{s,\,min}$ =	0.11	in^2/ft	Minimum steel (AASHTO 5.10.6-2)
$A_{s,\,max}$ =	0.60	in^2/ft	Maximum steel (AASHTO 5.10.6-2)
f_y =	60.00	ksi	Steel yield strength
b =	12.00	in	Width of section
h =	18.00	in	Depth of section
$A_s \ge 1.3bh / 2(b + h)f_y$ =	0.078	in	(AASHTO 5.10.6-1)

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Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Interface Shear Transfer - Wall to Footing

General

b_{vi} =	12.000	in	Interface width engaged in shear transfer
$L_{vi} = T_{Wall}$ =	18.000	in	Interface length engaged in shear transfer

Surface Condition: (AASHTO 5.7.4.4)

Normal weight concrete, not intentionally roughened

c =	0.075	ksi	Cohesion factor
μ =	0.600		Friction factor
K_1 =	0.200		Concrete strength fraction available for interface shear
K_2 =	0.800	ksi	Limiting interface shear resistance
P_c =	3.938	kip/ft	Permanent compressive force normal to shear plane (DL)
A_{vf} =	1.650	in^2 / ft	Area of steel crossing the shear plane

Concrete Capacity

A_{cv} = $b_{vi}L_{vi}$ = 216.000 in^2 — Area of concrete engaged in shear transfer (AASHTO 5.7.4.3-6)

V_{ni} = $cA_{cv} + \mu (A_{vf} f_y + P_c)$ = 77.963 kip/ft (AASHTO 5.7.4.3-3)

$K_1 f_c' A_{cv}$ = 172.800 (AASHTO 5.7.4.3-4)

$K_2 A_{cv}$ = 172.800 (AASHTO 5.7.4.3-5)

V_{ni} =	77.963	kip/ft	
Φ =	0.900		(AASHTO 5.5.4.2)
ΦV_{ni} =	**70.166**	kip/ft	
V_u =	9.774	kip/ft	**0.14 OK**

Footing Toe Design

Treat the toe of the footing as a cantilever beam with distributed loading from the factored bearing pressure, offset by soil weight.

q_u =	4.654	ksf	Factored bearing pressure (see geotechnical design).
q_{Ser} =	2.869	ksf	Service load bearing pressure (see geotechnical design).
L_{Toe} =	2.50	ft	Length of footing toe.
EV_{Toe} =	0.45	kip/ft	Soil weight/foot width of wall.
$WA_{V,Toe}$ =	0.00	kip/ft	Water weight/foot width of wall.
q_{Ser}^{-} =(EV_{Toe} + $WA_{V,Toe}$) / L_{Toe} =	0.180	ksf	Service downward pressure.
q_u^{-} =(1.35EV_{Toe}+1.0$WA_{V,Toe}$)/L_{Toe} =	0.243	ksf	Factored downward pressure.
$q_{u,net} = q_u - q_u^{-}$ =	4.411	ksf	Net factored bearing pressure.
$q_{Ser,net} = q_{Ser} - q_{Ser}^{-}$ =	2.689	ksf	Net service bearing pressure.
$M_u = q_{u,net}L_{Toe}^2/2$ =	27.57	kip-ft/ft	Factored moment.
$V_u = q_{u,net}L_{Toe}$ =	11.03	kip/ft	Factored shear.
$M_{Ser} = q_{Ser,net}L_{Toe}^2/2$ =	16.81	kip-ft/ft	Service load moment.
$V_{Ser} = q_{Ser,net}L_{Toe}$ =	6.72	kip/ft	Service load shear.

Use temperature reinforcement on the front face.

T_{Ftg} =	30.00	in	Section thickness.
Cover =	3.00	in	Clear cover to reinforcement.
d_b =	1.250	in	Bar diameter
$d_e = d_s$	25.25	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*
b =	1.00	ft	Width of section.
$S_c = bT_{Wall}^2/6$ =	1800.00	in^3/ft	Section modulus.
A/s =	1.905	in^2/ft	Steel area/ft
Clr. =	5 1/2	in	Clear space between vertical bars in a lap at the base of the wall.

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Check Moment Capacity

Φ =	0.90		Resistance factor.	(AASHTO, 5.5.4.2)
$c = A_s f_y / \alpha_1 f'_c \beta_1 b$ =	3.30	in	Depth of the neutral axis.	(AASHTO, 5.6.3.1.1-4)
$a = c \beta_1$ =	2.80	in	Depth of rectangular stress block.	(AASHTO, 5.6.2.2)
$\Phi M_n = \Phi A_s f_y (d_e - a/2)$ =	204.45	kip-ft/ft	Factored moment capacity.	(AASHTO, 5.6.3.2.2-1)
M_u =	27.57	kip-ft/ft	Factored demand moment.	
	0.13	**OK**		

Check Reinforcement to Ensure Tension Controlled Section

(AASHTO, 5.6.2.1)

ε_c =	0.003	Limiting strain in concrete.	
ε_s =	0.005	Minimum strain in reinf. for "tension controlled" behavior.	
$c / \varepsilon_c = d_s / (\varepsilon_c + \varepsilon_s)$		Strain relationship by similar triangles.	
$c / d_s \leq$ 0.003 /(0.003 + 0.005) =	0.375		(AASHTO, 5.6.2.1-1)
c / d_s =	0.13	**0.35 OK**	

Check Minimum Reinforcement

(AASHTO, 5.6.3.3)

S_c =	1800.00	in^3/ft	Section modulus.	
f_r =	0.48	ksi	Modulus of rupture.	
γ_1 =	1.60		All non-precast segmental structures	(AASHTO, 5.6.3.3)
γ_3 =	0.67		A615, Gr. 60 Reinforcement	(AASHTO, 5.6.3.3)
$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	77.18	kip-ft/ft	Cracking moment.	(AASHTO, 5.6.3.3-1)
$1.33 M_u$ =	36.67	kip-ft/ft		
$M_{min} = \min\{ M_{cr}, 1.33 M_u \}$ =	36.67	kip-ft/ft	**0.18 OK**	(AASHTO, 5.6.3.3)

Check Crack Control

h =	30.00	in	Depth of wall	
d_c = cover + $d_b/2$ =	3.63	in	Depth of bottom steel	
d_s =	25.25	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*	
$\beta_s = 1 + d_c / 0.7(h - d_c)$ =	1.196			(AASHTO 5.6.7-2)
$\rho = A_s / b d_s$ =	0.00629		Reinforcement ratio	
n =	8		Modular ratio	
$k = \sqrt{[(\rho n)^2 + 2\rho n]} - \rho n$ =	0.271			
j = 1 - k/3 =	0.910			
M_{SERI} =	16.81	kip-ft/ft	Service combination moment	
$f_s = M_{SERI} / A_s j d_s$ =	4.6	ksi		
$s \leq (700 \gamma_e / \beta_s f_s) - 2 d_c$ =	87.95	in	Spacing	(AASHTO 5.6.7-1)
s_{prov} =	8.00	in	**0.09 OK**	

Shear Strength Provided by Concrete

Φ =	0.90		Resistance factor.	(AASHTO, 5.5.4.2)
b_v =	12.00	in		(AASHTO, 5.7.2.8)
$d_v = d_e - a/2 \geq 0.9 d_e \geq 0.72 h$ =	23.85	in	Effective shear depth.	(AASHTO, 5.7.2.8)
M_U =	27.57	kip-ft/ft	Factored moment.	
V_U =	11.03	kip/ft	Factored shear force.	
$M_U / V_U d_v$ =	1.26	≥ 1.0	**OK**	
$\varepsilon_s = (M_U / d_v + V_U) / E_s A_s$ =	0.0005		Strain in flexural reinforcing steel.	(AASHTO, 5.7.3.4.2-4)
$\beta = 4.8 / (1 + 750 \varepsilon_s)$ =	3.59			(AASHTO, 5.7.3.4.2-1)
$V_c = 0.0316 \beta f'^{1/2}_c b_v d_v$ =	64.89	kip/ft	Shear concrete nominal capacity	(AASHTO, 5.7.3.3-3)
ΦV_c =	58.4	kip	**> Vu No min. reinforcement required.**	(AASHTO, 5.7.2.3-1)
V_u =	11.0	kip/ft	Factored shear force	
	0.19	**OK**		

Note: designed as a slab/continuous member. Since not a discrete (beam) element, does not need to meet $0.5\Phi V_c$

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Footing Heel Design

Treat the toe of the footing as a cantilever beam with distributed loading from the factored bearing pressure.

q_u =	4.654	ksf	Factored bearing pressure (see geotechnical design).
q_{Ser} =	2.869	ksf	Service load bearing pressure (see geotechnical design).
L_{Heel} =	6.00	ft	Length of footing toe.
EV_{Heel} =	12.60	kip/ft	Soil weight/foot width of wall.
$WA_{V,Heel}$ =	0.00	kip/ft	Water weight/foot width of wall.
$q_{Ser}^{'}$ =(EV_{Heel} + $WA_{V,Heel}$) / L_{Heel} =	2.100	ksf	Service downward pressure.
$q_u^{'}$ =(1.35EV_{Heel}+1.0$WA_{V,Heel}$)/L_{Heel} =	2.835	ksf	Factored downward pressure.
$q_{u,net}$ = q_u - $q_u^{'}$ =	1.819	ksf	Net factored bearing pressure.
$q_{Ser,net}$ = q_{Ser} - $q_{Ser}^{'}$ =	0.769	ksf	Net service bearing pressure.
M_u = $q_u L_{Heel}^2$ /2 =	65.48	kip-ft/ft	Factored moment.
V_u = $q_u L_{Heel}$ =	10.91	kip/ft	Factored shear.
M_{Ser} = $q_{Ser} L_{Toe}^2$ /2 =	27.70	kip-ft/ft	Service load moment.
V_{Ser} = $q_{Ser} L_{Toe}$ =	4.62	kip/ft	Service load shear.
			Use temperature reinforcement on the front face.
T_{Ftg} =	30.00	in	Section thickness.
Cover =	3.00	in	Clear cover to reinforcement.
d_b =	1.250	in	Bar diameter
d_e = d_s	25.25	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*
b =	1.00	ft	Width of section.
S_c = bT_{Wall}^2 / 6 =	1800.00	in^3/ft	Section modulus.
A/s =	1.905	in^2/ft	Steel area/ft
Clr. =	5 1/2	in	Clear space between vertical bars in a lap at the base of the wall.

Check Moment Capacity

Φ =	0.90		Resistance factor.	(AASHTO, 5.5.4.2)
$c = A_s f_y / \alpha_1 f'_c \beta_1 b$ =	3.30	in	Depth of the neutral axis.	(AASHTO, 5.6.3.1.1-4)
$a = c \beta_1$ =	2.80	in	Depth of rectangular stress block.	(AASHTO, 5.6.2.2)
$\Phi M_n = \Phi A_s f_y (d_e - a/2)$ =	204.45	kip-ft/ft	Factored moment capacity.	(AASHTO, 5.6.3.2.2-1)
M_u =	65.48	kip-ft/ft	Factored demand moment.	
	0.32	**OK**		

Check Reinforcement to Ensure Tension Controlled Section (AASHTO, 5.6.2.1)

ε_c =	0.003		Limiting strain in concrete.
ε_s =	0.005		Minimum strain in reinf. for "tension controlled" behavior.
$c / \varepsilon_c = d_s / (\varepsilon_c + \varepsilon_s)$			Strain relationship by similar triangles.
$c / d_s \leq$ 0.003 /(0.003 + 0.005) =	0.375		(AASHTO, 5.6.2.1-1)
c / d_s =	0.13	**0.35 OK**	

Check Minimum Reinforcement (AASHTO, 5.6.3.3)

S_c =	1800.00	in^3/ft	Section modulus.	
f_r =	0.48	ksi	Modulus of rupture.	
γ_1 =	1.60		All non-precast segmental structures	(AASHTO, 5.6.3.3)
γ_3 =	0.67		A615, Gr. 60 Reinforcement	(AASHTO, 5.6.3.3)
$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	77.18	kip-ft/ft	Cracking moment.	(AASHTO, 5.6.3.3-1)
$1.33 M_u$ =	87.09	kip-ft/ft		
M_{min} = min{ M_{cr}, $1.33 M_u$ } =	77.18	kip-ft/ft	**0.38 OK**	(AASHTO, 5.6.3.3)

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

LRFD Cantilever Retaining Wall Design on Spread Footings - no WA

Calculated By:	JYM	Date:	10/30/25	Woolpert Number:	10008863
Checked By:	PES	Date:	11/10/25	Job No.:	
Project:	Cobbs Rd Ret Wall			Bridge:	

Criteria: Designed by AASHTO *LRFD Bridge Design Specifications* , 9th ed. 2020 & ODOT BDM 2020,

Check Crack Control

h =	30.00	in	Depth of wall	
d_c = cover + $d_b/2$ =	3.63	in	Depth of bottom steel	
d_s =	25.25	in	Depth of reinforcement. *(Includes ½" tolerance on d.)*	
$\beta_s = 1 + d_c / 0.7(h - d_c)$ =	1.196			(AASHTO 5.6.7-2)
$\rho = A_s/bd_s$ =	0.00629		Reinforcement ratio	
n =	8		Modular ratio	
$k = \sqrt{[(\rho n)^2 + 2\rho n]} - \rho n$ =	0.271			
$j = 1 - k/3$ =	0.910			
M_{SERI} =	27.70	kip-ft/ft	Service combination moment	
$f_s = M_{SERI} / A_s j d_s$ =	7.6	ksi		
$s \le (700\gamma_e / \beta_s f_s) - 2d_c$ =	50.53	in	Spacing	(AASHTO 5.6.7-1)
s_{prov} =	8.00	in	**0.16 OK**	

Shear Strength Provided by Concrete

Φ =	0.90		Resistance factor.	(AASHTO, 5.5.4.2)
b_v =	12.00	in		(AASHTO, 5.7.2.8)
$d_v = d_e - a/2 \ge 0.9\, d_e \ge 0.72\, h$ =	23.85	in	Effective shear depth.	(AASHTO, 5.7.2.8)
M_U =	65.48	kip-ft/ft	Factored moment.	
V_U =	10.91	kip/ft	Factored shear force.	
$M_U / V_U d_v$ =	3.02	≥ 1.0	**OK**	
$\varepsilon_s = (M_U / d_v + V_U) / E_s A_s$ =	0.0008		Strain in flexural reinforcing steel.	(AASHTO, 5.7.3.4.2-4)
$\beta = 4.8 / (1 + 750\varepsilon_s)$ =	3.01			(AASHTO, 5.7.3.4.2-1)
$V_c = 0.0316\, \beta\, f'_c{}^{1/2}\, b_v\, d_v$ =	54.42	kip/ft	Shear concrete nominal capacity	(AASHTO, 5.7.3.3-3)
ΦV_c =	49.0	kip	**> Vu No min. reinforcement required.**	(AASHTO, 5.7.2.3-1)
V_u =	10.9	kip/ft	Factored shear force	
	0.22	**OK**		

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Note: designed as a slab/continuous member. Since not a discrete (beam) element, does not need to meet $0.5\Phi V_c$

Footing Top Steel - Design for Temperature/Shrinkage

$A_{s,\,prov}$ =	0.465	in^2/ft	**OK**	
$A_{s,\,min}$ =	0.11	in^2/ft	Minimum steel	(AASHTO 5.10.6-2)
$A_{s,\,max}$ =	0.60	in^2/ft	Maximum steel	(AASHTO 5.10.6-2)
f_y =	60.00	ksi	Steel yield strength	
b =	12.00	in	Width of section	
h =	18.00	in	Depth of section	
$A_s \ge 1.3bh / 2(b + h)f_y$ =	0.078	in		(AASHTO 5.10.6-1)

Footing Side Steel - Design for Temperature/Shrinkage

$A_{s,\,prov}$ =	0.310	in^2/ft	**OK**	
$A_{s,\,min}$ =	0.11	in^2/ft	Minimum steel	(AASHTO 5.10.6-2)
$A_{s,\,max}$ =	0.60	in^2/ft	Maximum steel	(AASHTO 5.10.6-2)
f_y =	60.00	ksi	Steel yield strength	
b =	12.00	in	Width of section	
h =	18.00	in	Depth of section	
$A_s \ge 1.3bh / 2(b + h)f_y$ =	0.078	in		(AASHTO 5.10.6-1)

APPENDIX 3: Boring Logs

PROJECT: FRA-161-22.10/LIC-161-0.00
TYPE: SUBGRADE
PID: 117878 SFN:
START: 10/8/25 END: 10/8/25

DRILLING FIRM / OPERATOR: DLZ / K. CONRAD
SAMPLING FIRM / LOGGER: DLZ / K. CONRAD
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: '23 CME 75-KC-777
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 7/27/23
ENERGY RATIO (%): 72.5

STATION / OFFSET:
ALIGNMENT: LIC-161
ELEVATION: 1000.0 (MSL) EOB: 30.0 ft.
COORD: Not Recorded

EXPLORATION ID B-043-1-25

MATERIAL DESCRIPTION AND NOTES	ELEV. 1000.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
TOPSOIL - 5"	999.6																		
VERY STIFF, BROWN, **SILT AND CLAY**, DAMP			7 6 6	15	83	SS-1	3.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
			3 3 6	11	67	SS-2	2.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	994.0																		
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE GRAVEL, DAMP			4 2 4	7	100	SS-3	2.00	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
			4 4 5	11	89	SS-4	2.50	-	-	-	-	-	-	-	-	-	A-6b (V)	-	
	989.0																		
SOFT TO MEDIUM STIFF, GRAY, **SILT AND CLAY**, DAMP TO MOIST			2 3 3	7	56	SS-5	1.50	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
			1 1 1	2	67	SS-6	0.50	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	984.0																		
SOFT, GRAY, **SILT**, MOIST			1 3 3	7	89	SS-7	0.50	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
			2 2 3	6	67	SS-8	0.50	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
			3 3 3	7	50	SS-9	1.00	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
	976.5																		
STIFF, GRAY, **SILT AND CLAY**, DAMP			3 4 5	11	33	SS-10	2.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
			2 4 7	13	67	SS-11	2.50	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
			5 7 8	18	61	SS-12	3.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	970.0	EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PROJECT: FRA-161-22.10/LIC-161-0.00
TYPE: SUBGRADE
PID: 117878 SFN:
START: 10/8/25 END: 10/8/25

DRILLING FIRM / OPERATOR: DLZ / K. CONRAD
SAMPLING FIRM / LOGGER: DLZ / K. CONRAD
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: '23 CME 75-KC-777
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 7/27/23
ENERGY RATIO (%): 72.5

STATION / OFFSET:
ALIGNMENT: LIC-161
ELEVATION: 1000.0 (MSL) EOB: 30.0 ft.
COORD: Not Recorded

EXPLORATION ID B-043-3-25

MATERIAL DESCRIPTION AND NOTES	ELEV. 1000.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
TOPSOIL - 5"	999.6																		
SOFT TO MEDIUM STIFF, BROWN, **CLAY**, DAMP			2 3 3	7	89	SS-1	1.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			2 3 3	7	100	SS-2	0.75	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
	994.0																		
STIFF, BROWN, **SILT AND CLAY**, DAMP			5 6 7	16	78	SS-3	2.50	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
@8.5-10.0', little gravel.			2 3 5	10	83	SS-4	2.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	989.0																		
MEDIUM STIFF, GRAY, **SILT**, MOIST			3 5 5	12	67	SS-5	0.50	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
	986.5																		
STIFF, GRAY, **SILT AND CLAY**, DAMP			3 5 7	15	89	SS-6	2.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	984.0																		
MEDIUM STIFF TO STIFF, GRAY, **CLAY**, DAMP			2 2 2	5	67	SS-7	1.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			3 3 5	10	89	SS-8	2.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			2 3 4	8	78	SS-9	1.50	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
	976.5																		
STIFF, GRAY, **SILT**, LITTLE GRAVEL, DAMP			2 3 4	8	100	SS-10	2.00	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
	974.0																		
STIFF, GRAY, **SILT AND CLAY**, DAMP			2 3 4	8	67	SS-11	2.00	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
	970.0	EOB	1 2 4	7	78	SS-12	1.50	-	-	-	-	-	-	-	-	-	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PROJECT: FRA-161-22.10/LIC-161-0.00
TYPE: SUBGRADE
PID: 117878 SFN:
START: 9/26/25 END: 9/26/25

DRILLING FIRM / OPERATOR: DLZ / K. CONRAD
SAMPLING FIRM / LOGGER: DLZ / K. CONRAD
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: '23 CME 75-KC-777
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 7/27/23
ENERGY RATIO (%): 72.5

STATION / OFFSET:
ALIGNMENT: LIC-161
ELEVATION: 0.0 (MSL) EOB: 30.0 ft.
COORD: Not Recorded

EXPLORATION ID B-044-1-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	ABAN-DONED
TOPSOIL - 7"	-0.6																		
VERY STIFF, BROWN, **SANDY SILT**, DAMP	-3.5		5 7 6	16	89	S-1	3.00	-	-	-	-	-	-	-	-	-	A-4b (V)	-	
STIFF TO VERY STIFF, BROWN AND GRAY, **CLAY**, DAMP			5 5 7	15	78	S-2	2.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			4 6 7	16	100	S-3	3.25	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			5 7 7	17	100	S-4	3.75	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			5 7 8	18	100	S-5	2.75	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
@13.5-15.0', some gravel.			3 10 10	24	89	S-6	3.75	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			3 5 6	13	100	S-7	2.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
@18.5'-20.0', hard.			4 5 8	16	100	S-8	4.5+	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			3 4 5	11	100	S-9	2.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			3 4 7	13	100	S-10	2.50	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
			3 5 6	13	89	S-11	2.75	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
@28.5-30.0', some sand.			6 8 9	21	67	S-12	4.00	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
	-30.0 EOB																		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

APPENDIX 4: Estimates

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - MSE Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

ESTIMATED QUANTITIES

ITEM	EXT	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL
EXCAVATION						
840	21000	**1388**	**CY**	**WALL EXCAVATION**	**$ 32.50**	**$ 45,110.00**
EMBANKMENT						
203	20000	1291	CY	EMBANKMENT	$ 28.00	$ 36,148.00
203	35120	251	CY	GRANULAR MATERIAL, TYPE C	$ 100.00	$ 25,100.00
840	23000	2749	CY	SELECT GRANULAR BACKFILL	$ 88.00	$ 241,912.00
		3000	**CY**	**EMBANKMENT TOTAL**	**$ 101.05**	**$ 303,160.00**
MSE WALL ITEMS						
509	10000	35,108	LB	EPOXY COATED STEEL REINFORCEMENT	$ 2.00	$ 70,216.00
511	53010	217	CY	CLASS QC1 CONCRETE, MISC.: MOMENT SLABS AND PARAPETS	$ 450.00	$ 97,650.00
512	10100	673	SY	SEALING OF CONCRETE SURFACES (EPOXY-URETHANE)	$ 34.44	$ 23,178.12
518	21200	14	CY	POROUS BACKFILL WITH GEOTEXTILE FABRIC	$ 140.00	$ 1,960.00
840	20000	4661	SF	MECHANICALLY STABILIZED EARTH WALL	$ 51.10	$ 238,177.10
840	22000	753	SY	FOUNDATION PREPARATION	$ 32.00	$ 24,096.00
840	25010	371	FT	6" DRAINAGE PIPE, PERFORATED	$ 10.00	$ 3,710.00
840	25020	20	FT	6" DRAINAGE PIPE, NON-PERFORATED	$ 24.26	$ 485.20
840	26000	371	FT	CONCRETE COPING	$ 225.00	$ 83,475.00
840	26050	4661	SF	AESTHETIC SURFACE TREATMENT	$ 1.34	$ 6,245.74
840	27000	30	DAY	ON-SITE ASSISTANCE	$ 350.00	$ 10,500.00
840	28000	1	LS	SGB INSPECTION AND COMPACTION TESTING	$ 16,850.00	$ 16,850.00
		5,936	**SF**	**RETAINING WALLS**	**$ 97.13**	**$ 576,543.16**
RIGHT OF WAY						
		0.09	**ACRE**	**R/W COST**	**$ 200,000.00**	**$ 18,000.00**
				OVERALL TOTAL		**$ 942,813.16**

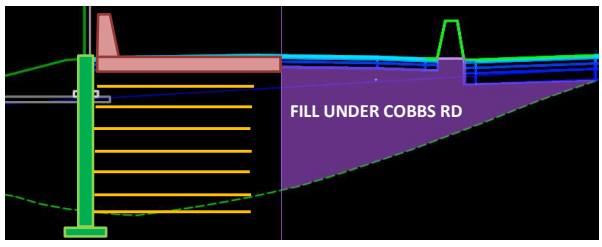
WALL DATA

Backfill Width =	16 ft	soil reinf. max 8ft or 70% wall height + 2ft backfill	BDM 307.4A
Max Wall Height =	19 ft		
Wall Thickness =	0.5 ft		
Parapet Height =	3.5 ft		
Footing Depth =	3 ft		

Cobbs Rd Station	Wall Station	Prop Surface El	Exist Surface El	Top Wall El	Bott Wall El	Height (ft)	Exposed Height (ft)	Length (ft)
9+33.	0	1169.5	1169.5	1170	1166.5	3.5	0.5	--
9+33.	+32.	1183.3	1167.5	1183.3	1164.5	19	16	32.0
9+50.	+49.	1183.2	1167.7	1183.2	1164.7	18.5	15.5	17
10+00.	+99.	1183.1	1169.1	1183.1	1166.1	17	14	50
10+50.	1+49.	1182.6	1171.5	1182.6	1168.5	14.5	11.5	50
11+00.	1+99.	1182.2	1173.5	1182.2	1170.5	12	9	50
11+50.	2+49.	1181.7	1173.6	1181.7	1170.6	11.5	8.5	50
12+00.	2+99.	1181	1175.5	1181	1172.5	8.5	5.5	50
12+50.	3+49.	1180.4	1174.9	1180.4	1171.9	8.5	5.5	50
12+72.	3+71.	1176.2	1176.2	1176.7	1173.2	3.5	0.5	22
							86	**371.0**

203 20000 1291 CY EMBANKMENT

	Station	Length (ft)	Fill Area under Cobbs Rd (sf)	Embankment - Average End Area (cf)
start of wall	9+33.	--	121.19	--
	9+50.	17.00	135.04	2177.96
	10+00.	50.00	158.11	7328.75
	10+50.	50.00	120.72	6970.75
	11+00.	50.00	110.36	5777.00
	11+50.	50.00	95.91	5156.75
	12+00.	50.00	90.02	4648.25
	12+50.	50.00	19.21	2730.75
driveway	12+80.54	30.54	2.17	66.27



34856.48 cu ft volume
1291.00 cu yd total

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - MSE Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

203	**35120**	**251**	**CY**	**GRANULAR MATERIAL, TYPE C**
		371.00	ft	wall length
		16.00	ft	backfill width
		0.50	ft	wall thickness
		2.00	ft	leveling pad width
		1.00	ft	extend granular material 1ft in front of leveling pad
		18.25	ft	granular material width
		1.00	ft	granular material thickness
		6770.75	cu ft	volume
		251.00	**cu yd**	**total**
509	**10000**	**35108**	**LB**	**EPOXY COATED STEEL REINFORCEMENT**
		5,851	cu ft	moment slab and parapet volume
		6.00	lb/cu ft	factor
		35108.00	**lb**	**total**
511	**53010**	**217**	**CY**	**CLASS QC1 CONCRETE, MISC.: MOMENT SLABS AND PARAPETS**
		1.25	ft	moment slab depth
		11.50	ft	moment slab width
		4.083	sq ft	SBR area
		18.46	sq ft	moment slab and parapet area
		317.00	ft	wall length along roadway
		5851.29	cu ft	concrete volume
		217.00	**cu yd**	**total**
512	**10100**	**673**	**SY**	**SEALING OF CONCRETE SURFACES (EPOXY-URETHANE)**
		7.90	ft	parapet perimeter
		317.00	ft	wall length along roadway
		2504.3	sq ft	surface area parapet

Station	Exposed Height (ft)	Length (ft)	Exposed Surface Area (sf)	
9+33.	0.5	--	--	
9+33.	16	32	264	
9+50.	15.5	17	267.75	
10+00.	14	50	737.5	
10+50.	11.5	50	637.5	
11+00.	9	50	512.5	
11+50.	8.5	50	437.5	
12+00.	5.5	50	350	
12+50.	5.5	50	275	
12+72.	0.5	22	66	
			3548	surface area exposed wall

6052.30	sq ft	total
673.00	**sq yd**	**total**

518	**21200**	**14**	**CY**	**POROUS BACKFILL WITH GEOTEXTILE FABRIC**
		1.00	ft	width
		1.00	ft	depth
		371.00	ft	wall length
		371.00	cu ft	volume
		14.00	**cu yd**	**total**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

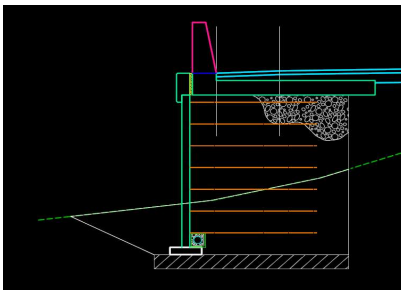
Estimated Quantities - MSE Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

840	20000	4661	SF	MECHANICALLY STABILIZED EARTH WALL

Station	Wall Height (ft)	Length (ft)	Wall Surface Area (sf)	Wall Volume (cf)
9+33.	3.50	--	--	--
9+33.	19.00	32.0	360	180
9+50.	18.50	17.0	318.75	159.375
10+00.	17.00	50.0	887.5	443.75
10+50.	14.50	50.0	787.5	393.75
11+00.	12.00	50.0	662.5	331.25
11+50.	11.50	50.0	587.5	293.75
12+00.	8.50	50.0	500	250
12+50.	8.50	50.0	425	212.5
12+72.	3.50	22.0	132	66
		371	**4661**	**total**

840	21000	1388	CY	WALL EXCAVATION
		101	sq ft	approx. excavation XS area
		371	ft	length of wall
		37471	cu ft	volume
		1388	**cu yd**	**total**



840	22000	753.00	SY	FOUNDATION PREPARATION
		16.00	ft	backfill width
		2.25	ft	additional width for granular material type C
		18.25	ft	total width
		371.00	ft	wall length
		6770.75	sq ft	area
		753.00	**sq yd**	**area**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - MSE Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

840	**23000**	**2749.00**	**CY**	**SELECT GRANULAR BACKFILL**
		16.00	ft	backfill width

Station	Wall Height (ft)	Length (ft)	XS Area (sf)	Average End Area (cf)	
9+33.	3.50	--	56	--	
9+33.	19.00	32.00	304	5760	
9+50.	18.50	17.00	296	5100	
10+00.	17.00	50.00	272	14200	
10+50.	14.50	50.00	232	12600	
11+00.	12.00	50.00	192	10600	
11+50.	11.50	50.00	184	9400	
12+00.	8.50	50.00	136	8000	
12+50.	8.50	50.00	136	6800	
12+72.	3.50	22.00	56	2112	
				74572	total volume

74572.00	cu ft	volume SGB
371.00	cu ft	porous backfill
74201.00	cu ft	total
2749.00	**cu yd**	**total**

840	**25010**	**371.00**	**FT**	**6" DRAINAGE PIPE, PERFORATED**
		371.00	ft	wall length
		371.00	**ft**	**total**

840	**25020**	**20.00**	**FT**	**6" DRAINAGE PIPE, NON-PERFORATED**
		10.00	ft	length
		1.00	ea	no. corners
		2.00	ea	each end of wall
		20.00	**ft**	**total**

840	**26000**	**371.00**	**FT**	**CONCRETE COPING**
		371.00	ft	wall length
		371.00	**ft**	**total**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - Cantilever Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

ESTIMATED QUANTITIES

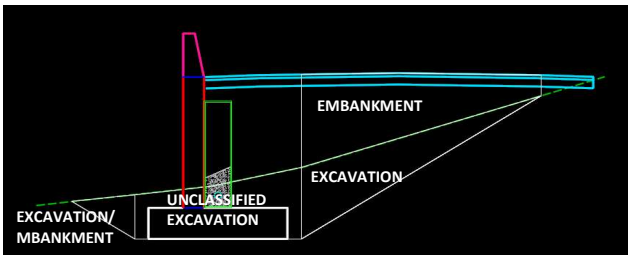
ITEM	EXT	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL
EXCAVATION						
203	10000	797	CY	EXCAVATION	$ 31.04	$ 24,738.88
503	21100	756	CY	UNCLASSIFIED EXCAVATION	$ 79.00	$ 59,724.00
		1553	**CY**	**EXCAVATION TOTAL**	**$ 54.39**	**$ 84,462.88**
EMBANKMENT						
203	20000	**1897**	**CY**	**EMBANKMENT**	**$ 28.00**	**$ 53,116.00**
RETAINING WALL ITEMS						
509	10000	92,592	LB	EPOXY COATED STEEL REINFORCEMENT	$ 2.00	$ 185,184.00
511	46000	229	CY	CLASS QC1 CONCRETE, RETAINING/WINGWALL NOT INCLUDING FOOTING	$ 1,175.00	$ 269,075.00
511	46510	344	CY	CLASS QC1 CONCRETE, FOOTING	$ 792.50	
512	10100	673	SY	SEALING OF CONCRETE SURFACES (EPOXY-URETHANE)	$ 34.44	$ 23,178.12
512	33000	51	SY	TYPE 2 WATERPROOFING	$ 35.00	
518	21200	321	CY	POROUS BACKFILL WITH GEOTEXTILE FABRIC	$ 140.00	$ 44,940.00
518	40000	371	FT	6" PERFORATED CORRUGATED PLASTIC PIPE	$ 12.00	$ 4,452.00
518	40010	20	FT	6" NON-PERFORATED CORRUGATED PLASTIC PIPE, INCLUDING SPECIALS	$ 20.00	$ 400.00
		3,710	**SF**	**RETAINING WALLS**	**$ 142.11**	**$ 527,229.12**
RIGHT OF WAY						
		0.09	**ACRE**	**R/W COST**	**$ 200,000.00**	**$ 18,000.00**
				OVERALL TOTAL		**$ 682,808.00**

WALL DATA

Max Wall Height =	20 ft	Parapet Height =	3.5 ft
Wall Thickness =	18 in	Parapet Area =	4.083 sq ft
Footing Depth =	4 ft	Concrete Unit Wt =	150 pcf
Footing Width =	10 ft	Parapet Wt =	612.5 plf
Footing Thickness =	2.5 ft		

Cobbs Rd Station	Wall Station	Prop Surface El	Exist Surface El	Top Wall El	Bott Ftg El	Height (ft)	Exposed Height (ft)	Length (ft)
9+33.	0	1169.5	1169.5	1170	1165.5	4.5	0.5	--
9+33.	+32.	1183.3	1167.5	1183.3	1163.5	20	16	32.0
9+50.	+49.	1183.2	1167.7	1183.2	1163.7	19.5	15.5	17
10+00.	+99.	1183.1	1169.1	1183.1	1165.1	18	14	50
10+50.	1+49.	1182.6	1171.5	1182.6	1167.5	15.5	11.5	50
11+00.	1+99.	1182.2	1173.5	1182.2	1169.5	13	9	50
11+50.	2+49.	1181.7	1173.6	1181.7	1169.6	12.5	8.5	50
12+00.	2+99.	1181	1175.5	1181	1171.5	9.5	5.5	50
12+50.	3+49.	1180.4	1174.9	1180.4	1170.9	9.5	5.5	50
12+72.	3+71.	1176.2	1176.2	1176.7	1172.2	4.5	0.5	22
							86	**371**

203	**10000**	**797**	**CY**	**EXCAVATION**
		8	sq ft	approx. excavation in front of wall
		50	sq ft	approx. excavation behind wall
		371	ft	length of wall
		21518	cu ft	volume
		797	**cu yd**	**total**



203	**20000**	**1897**	**CY**	**EMBANKMENT**
		8	sq ft	approx. embankment in front of wall
		130	sq ft	approx. embankment behind wall
		371	ft	length of wall
		51198	cu ft	volume
		1897	**cu yd**	**total**

503	**21100**	**756**	**CY**	**UNCLASSIFIED EXCAVATION**
		55	sq ft	approx. excavation XS area
		371	ft	length of wall
		20405	cu ft	volume
		756	**cu yd**	**total**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - Cantilever Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

509	**10000**	**92592**	**LB**	**EPOXY COATED STEEL REINFORCEMENT**
		6,157	cu ft	wall
		6.00	lb/cu ft	factor
		36942.00	lb	total
		9,275	cu ft	footing
		6.00	lb/cu ft	factor
		55650.00	lb	total
		92592.00	**lb**	**total**

511	**46000**	**229**	**CY**	**CLASS QC1 CONCRETE, RETAINING/WINGWALL NOT INCLUDING FOOTING**

Station	Wall Height (ft)	Length (ft)	Wall Surface Area (sf)	Wall Volume (cf)
9+33.	2	--	--	--
9+33.	17.5	32	312	468.00
9+50.	17	17	293.25	439.88
10+00.	15.5	50	812.5	1218.75
10+50.	13	50	712.5	1068.75
11+00.	10.5	50	587.5	881.25
11+50.	10	50	512.5	768.75
12+00.	7	50	425	637.50
12+50.	7	50	350	525.00
12+72.	2	22	99	148.50
		371		**6157** total

6157.00	cu ft	total
229.00	**cu yd**	**total**

511	**46510**	**344**	**CY**	**CLASS QC1 CONCRETE, FOOTING**
		371	ft	wall length
		10	ft	footing width
		2.5	ft	footing thickness
		9275	cu ft	volume
		344	**cu yd**	**total**

512	**10100**	**673**	**SY**	**SEALING OF CONCRETE SURFACES (EPOXY-URETHANE)**
		7.90	ft	parapet perimeter
		317.00	ft	wall length along roadway
		2504.3	sq ft	surface area parapet

Station	Exposed Height (ft)	Length (ft)	Exposed Surface Area (sf)
9+33.	0.5	--	--
9+33.	16	32.0	264
9+50.	15.5	17	267.75
10+00.	14	50	737.5
10+50.	11.5	50	637.5
11+00.	9	50	512.5
11+50.	8.5	50	437.5
12+00.	5.5	50	350
12+50.	5.5	50	275
12+72.	0.5	22	66
			3548 surface area exposed wall

6052.30	sq ft	total
673.00	**sq yd**	**total**

512	**33000**	**51.00**	**SY**	**TYPE 2 WATERPROOFING**
		371	ft	wall length
		30.00	ft	expansion joint spacing
		12.00	ea	number of locations
		12.65	ft	average wall height
		3.00	ft	waterproofing width
		455.40	sq ft	area
		51.00	**sq yd**	**total**

518	**21200**	**321**	**CY**	**POROUS BACKFILL WITH GEOTEXTILE FABRIC**
		2.00	ft	width
		11.65	ft	average wall height - 1ft
		371.00	ft	wall length
		8644.30	cu ft	volume
		321.00	**cu yd**	**total**

518	**40000**	**371.00**	**FT**	**6" PERFORATED CORRUGATED PLASTIC PIPE**
		371	ft	wall length
		371.00	**ft**	**total**

518	**40010**	**20.00**	**FT**	**6" NON-PERFORATED CORRUGATED PLASTIC PIPE, INCLUDING SPECIALS**
		10.00	ft	length
		1.00	ea	no. corners
		2.00	ea	each end of wall
		20.00	**ft**	**total**

WOOLPERT
DESIGN | GEOSPATIAL | INFRASTRUCTURE

One Easton Oval
Suite 400
Columbus, OH 43219
614-476-6000

Estimated Quantities - No Wall

Calculated By:	JYM	Date:	10/27/2025	Job No.:	10008863
Checked By:	PES	Date:	11/11/2025	Bridge No.:	
Project:	Cobbs Rd Retaining Wall			SFN:	

ESTIMATED QUANTITIES

ITEM	EXT	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL
EXCAVATION						
203	10000	**370**	**CY**	**EXCAVATION**	**$ 31.04**	**$ 11,484.80**
EMBANKMENT						
203	20000	**4950**	**CY**	**EMBANKMENT**	**$ 28.00**	**$ 138,600.00**
RIGHT OF WAY						
		0.32	**ACRE**	**R/W COST**	**$ 200,000.00**	**$ 64,000.00**
TOTAL						**$ 214,084.80**

WALL DATA

Proposed 3:1 Slopes

From KM302 Cross Sections

	Cobbs Rd Station	Length (ft)	Cut Area (sf)	Fill Area (sf)	Excavation - Average End Area (cf)	Embankment - Average End Area (cf)	Fill Area under Cobbs Rd (sf)	Embankment - Average End Area (cf)
property line	9+33.	--	1	313.88	--	--	330.1	--
	9+50.	17.0	2.02	294.55	25.67	5171.66	342.92	5720.67
	10+00.	50.0	15.42	227.54	436.00	13052.25	357.4	17508.00
	10+50.	50.0	16.19	153.98	790.25	9538.00	290.53	16198.25
	11+00.	50.0	5.78	136.71	549.25	7267.25	253.26	13594.75
	11+50.	50.0	30.31	89.73	902.25	5661.00	228.82	12052.00
	12+00.	50.0	0.45	82.12	769.00	4296.25	194.97	10594.75
	12+50.	50.0	2.58	68.41	75.75	3763.25	78.36	6833.25
driveway	12+80.54	30.5	418.38	7.32	6428.06	1156.40	2.17	1229.69

203	**10000**	**370.00**	**CY**	**EXCAVATION**
		9976.23	cu ft	volume graded slopes
		370.00	**cu yd**	**total**

203	**20000**	**4950.00**	**CY**	**EMBANKMENT**
		49906.05	cu ft	volume graded slopes
		83731.36	cu ft	volume under roadway
		133637.42	cu ft	total volume
		4950.00	**cu yd**	**total**