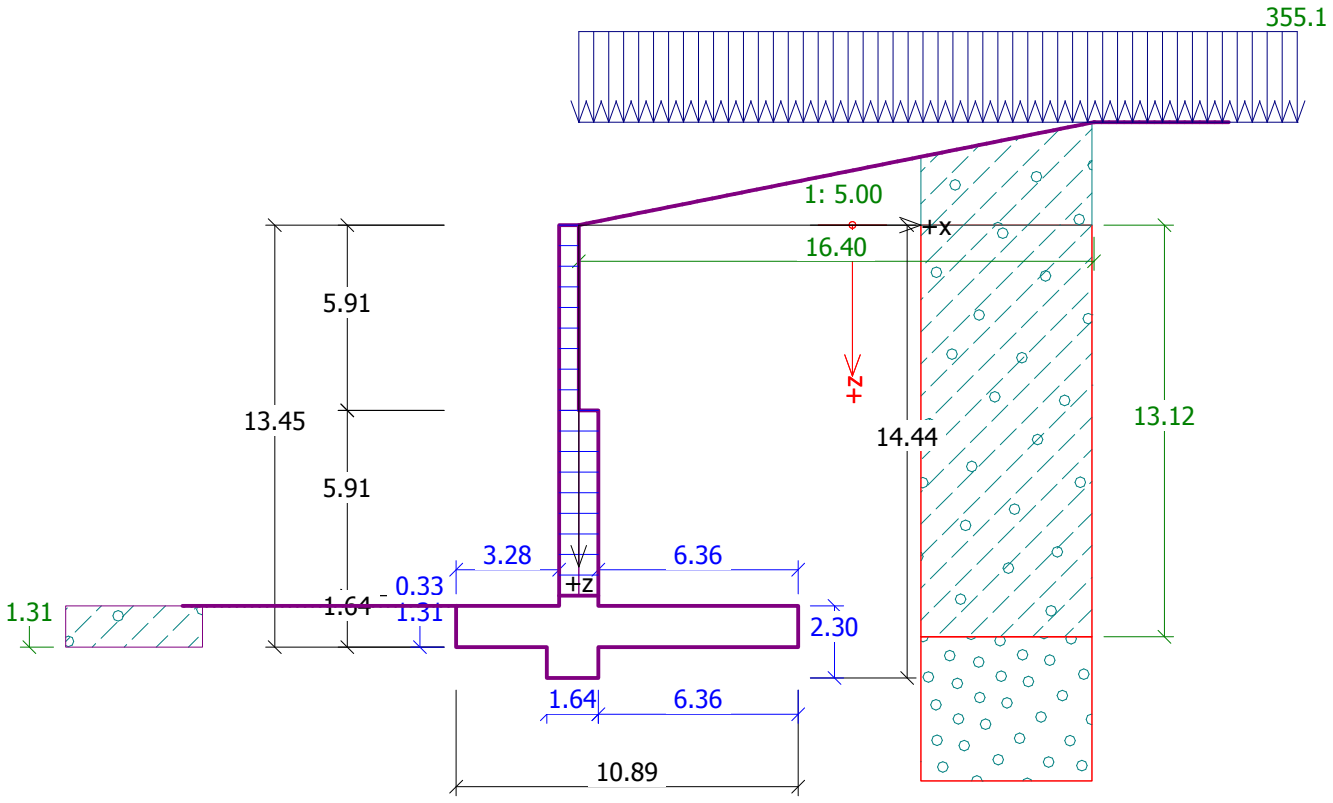
Verification of reinforced masonry wall

Input data

Project

Date : 10/2/2009

Name : Project	Stage : 1



Material of structure

Unit weight γ = 146.4 pcf
Analysis of concrete structures carried out according to the standard EN 1992 1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck}	= 2900.8 psi
Tensile strength	f_{ct}	= 319.1 psi
Elasticity modulus	E_{cm}	= 4206.1 ksi

Longitudinal steel : B420

Yield strength	f_{yk}	= 60915.8 psi
Elasticity modulus	E	= 29007.5 ksi

Types of blocks

Numbe	Name block	Width b [ft]	Height h [ft]
1	140 x 200	0.46	0.66
2	190 x 200	0.62	0.66
3	290 x 200	0.95	0.66

Geometry

No.	Coordinate X [ft]	Depth Z [ft]
1	0.00	0.00

No.	Coordinate X [ft]	Depth Z [ft]
2	0.00	5.91
3	0.62	5.91
4	0.62	12.14
5	6.99	12.14
6	6.99	13.45
7	0.62	13.45
8	0.62	14.44
9	-1.02	14.44
10	-1.02	13.45
11	-3.90	13.45
12	-3.90	12.14
13	-0.62	12.14
14	-0.62	0.00

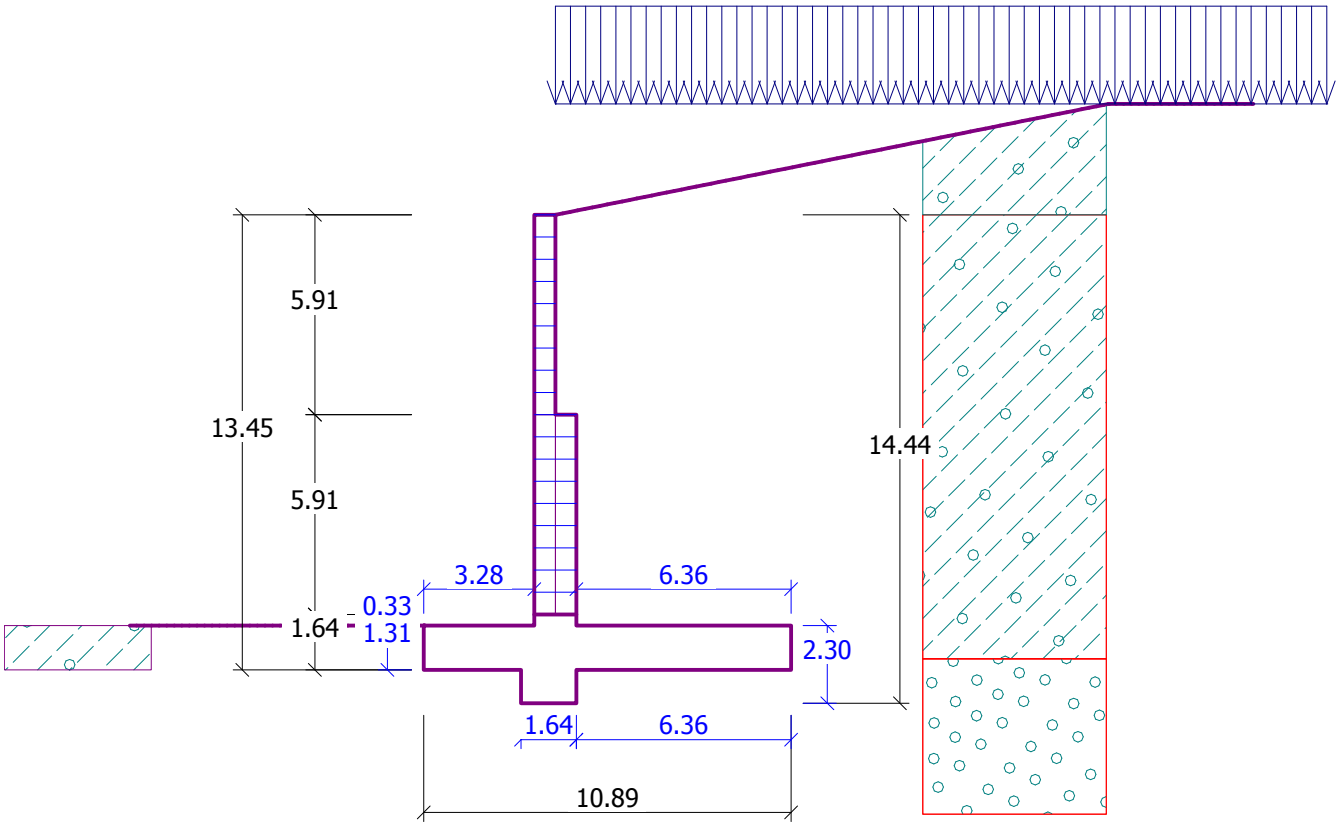
The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 27.36 ft^2.

Geometry of masonry

Number of blocks in 1.row : 9 (type: 190 x 200)
Number of blocks in 2. rowe : 9 (type: 190 x 200)
Distance between blocks = 0.00 ft
Number of blocks in upper part of wall: 9 (type: 190 x 200)

Characteristic compressive strength f_k = 2175.6 psi
Characteristic shear strength f_{vk} = 46.4 psi

Name : Geometry **Stage : 1**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Soil No. 1		27.00	62.7	121.0	58.5	14.00
2	Soil No. 2		34.00	0.0	121.0	58.5	17.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

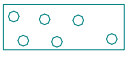
Soil No. 1

Unit weight : γ = 121.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 27.00 °
Cohesion of soil : c_{ef} = 62.7 psf
Angle of friction struc.-soil : δ = 14.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 121.0 pcf

Soil No. 2

Unit weight : γ = 121.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 17.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 121.0 pcf

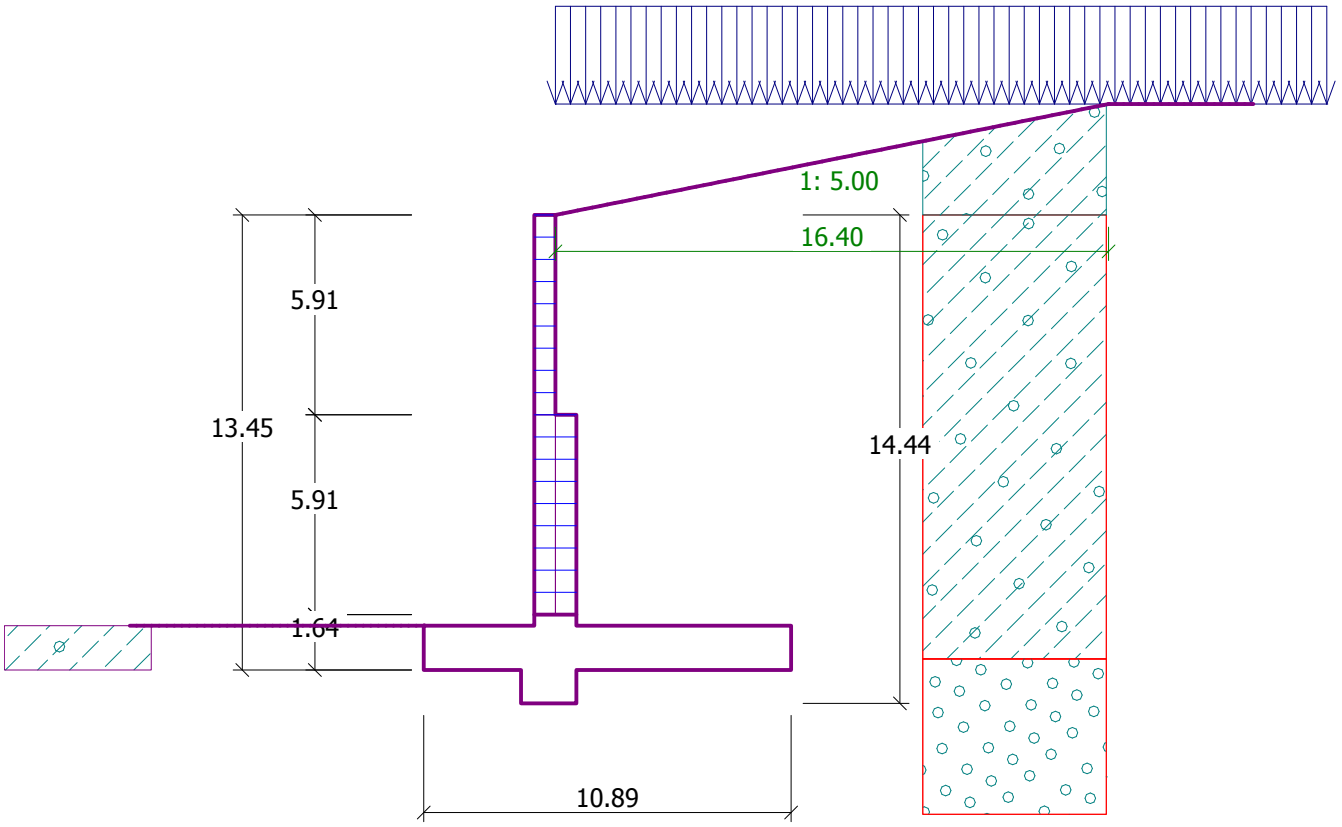
Geological profile and assigned soils

No.	Layer [ft]	Assigned soil	Pattern
1	13.12	Soil No. 1	
2	-	Soil No. 2	

Terrain profile

Terrain behind construction has the slope 1: 5.00 (slope angle is 11.31 °).
Embankment height is 3.28 ft, embankment length is 16.40 ft.

Name : Terrain | **Stage : 1**



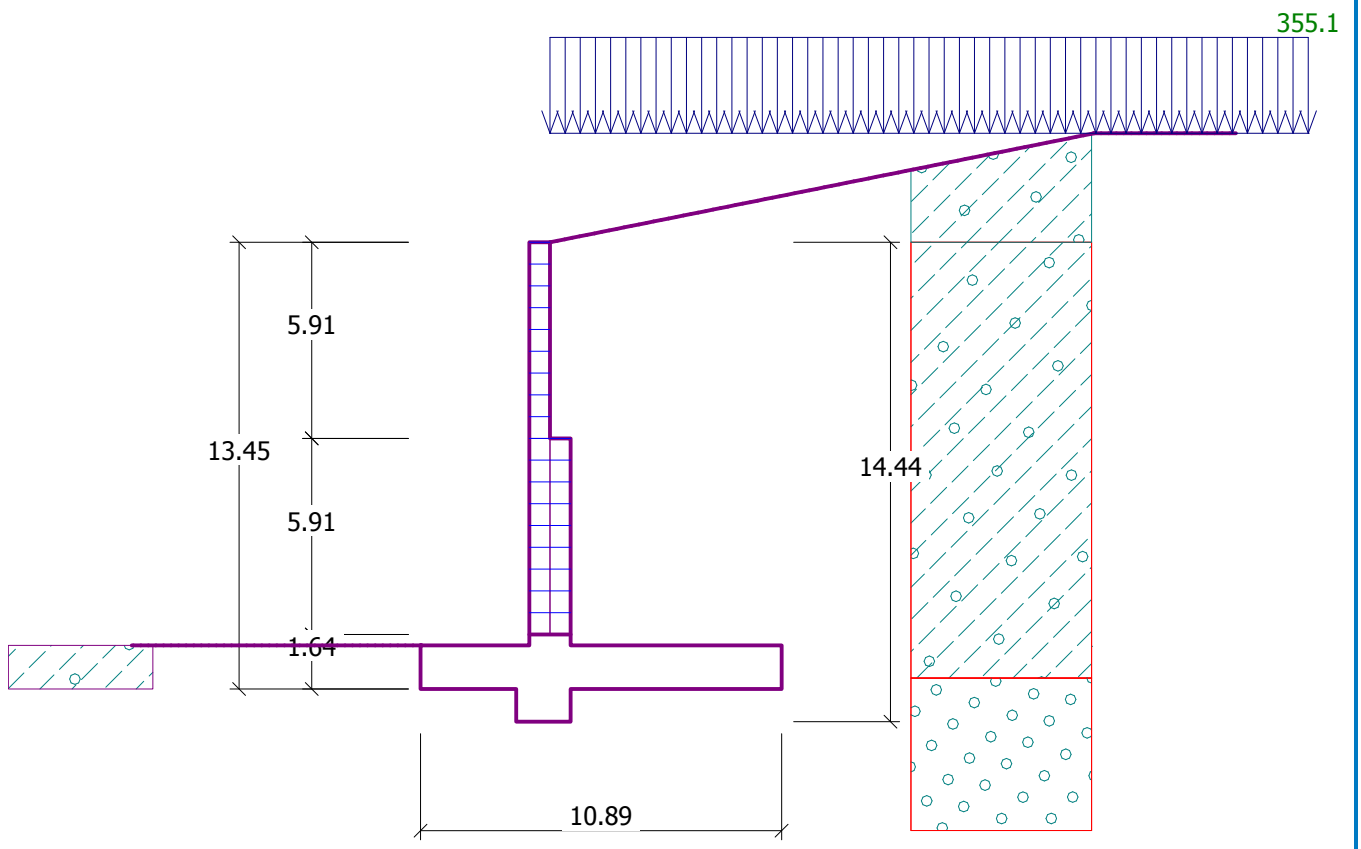
Water influence

Ground water table is located below the structure.

Inserted surface loads

No.	Surcharge new	Surcharge change	Name	Action	Mag.1 [lbf/ft2]	Mag.2 [lbf/ft2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	YES		Surcharge No. 1	permanent	355.1				on terrain

Name : Surcharge | **Stage : 1**



Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Soil No. 1
Soil thickness in front of structure h = 1.31 ft
Terrain in front of structure is flat.

Global settings

Verification methodology : Classical way
Active earth pressure calculation - Coulomb
Passive earth pressure calculation - Caqout-Kerisel
Analysis standard for reinforced masonry - EN 1992 1-1
Standard for concrete structures - EN 1992 1-1 (EC2)

Settings of the stage of construction

Analysis carried out according to classical theory (safety factor)

Safety factor for slip = 1.50
Safety factor for overturning = 1.50
Factor of safety for bearing capacity = 1.00

The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. Z [ft]	F_{vert} [lbf/ft]	App.Pt. X [ft]	Design coefficient
Weight - wall	0.0	-2.98	4006.2	4.66	1.000

Name	F_{hor} [lbf/ft]	App.Pt. Z [ft]	F_{vert} [lbf/ft]	App.Pt. X [ft]	Design coefficient
FF resistance	-174.2	0.22	0.0	0.00	1.000
Weight - earth wedge	0.0	-6.24	5780.2	6.49	1.000
Active pressure	5060.0	-4.08	5212.3	9.05	1.000
Surcharge No. 1	2101.7	-6.89	2386.5	6.56	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 118989.7 lbfft/ft
Overturning moment M_{ovr} = 35145.0 lbfft/ft

Safety factor = 3.39 > 1.50
Wall for overturning is SATISFACTORY

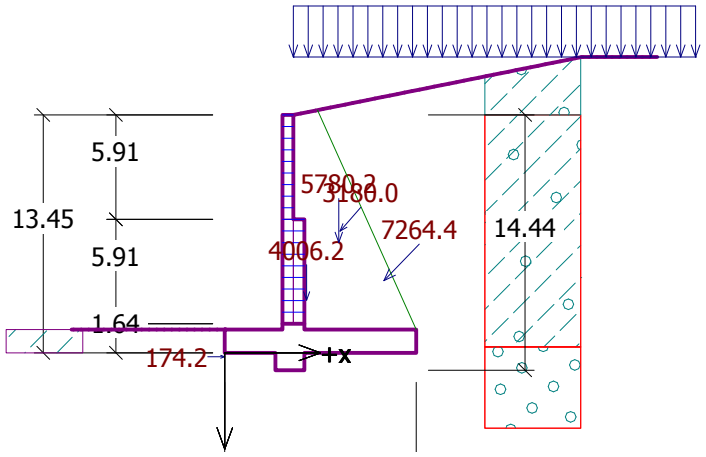
Check for slip
Resisting horizontal force H_{res} = 11726.4 lbf/ft
Active horizontal force H_{act} = 6987.6 lbf/ft

Safety factor = 1.68 > 1.50
Wall for slip is SATISFACTORY

Forces acting at the centre of footing bottom
Overall moment M = 10838.2 lbfft/ft
Normal force N = 17385.2 lbf/ft
Shear force Q = 6987.6 lbf/ft

Overall check - WALL is SATISFACTORY

Name : Verification | **Stage : 1; Analysis : 1**



Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

Numbe	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [ft]	Stress [psf]
1	10838.2	17385.2	6987.6	0.62	1802.4

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 7.48 in

Maximum allowable eccentricity e_{alw} = 43.13 in

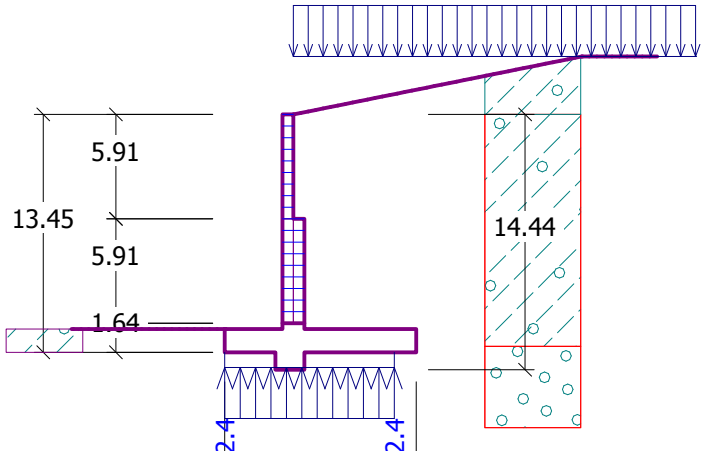
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 1802.4 psf
Bearing capacity of foundation soil R_d = 2506.3 psf

Safety factor = 1.39 > 1.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.	Stage : 1



Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. Z [ft]	F_{vert} [lbf/ft]	App.Pt. X [ft]	Design coefficient
Weight - wall	0.0	-4.92	1616.8	0.52	1.000
Weight - earth wedge	0.0	-6.36	51.9	0.83	1.000
Active pressure	2597.3	-3.57	1002.9	1.08	1.000
Surcharge No. 1	1610.2	-5.74	644.9	0.96	1.000

Verification of the joint, 38.75 ft from the top.

Back face reinforcement :
Diameter = 0.79 in
Spacing = 11.81 in
Cover = 1.18 in

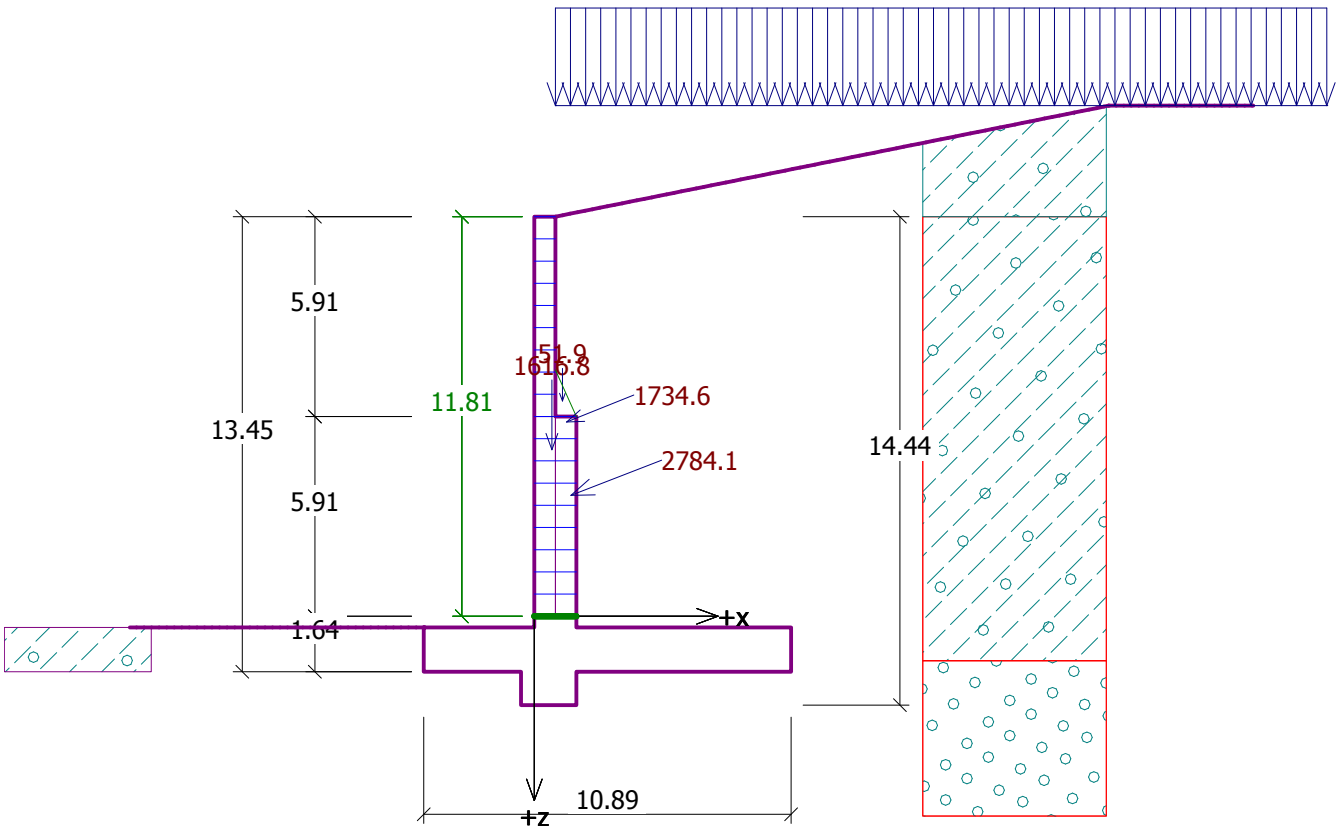
There is no reinforcement on the front face.
Wall aspect ratio: 9.47

Verification of cross section in compression:
Ultimate normal force N_{Rd} = 234522.6 lbf/ft > 3316.5 lbf/ft = N_{Ed}
Cross section is SATISFACTORY

Verification of cross section in bending:
Ultimate bending momenti M_{Rd} = 28387.5 lbfft/ft > 18002.0 lbfft/ft = M_{Ed}
Cross section is SATISFACTORY.

Verification of cross section in shear:
Ultimate shear force V_{Rd} = 4443.9 lbf/ft > 4207.5 lbf/ft = V_{Ed}
Cross section is SATISFACTORY.

Name : Dimensioning | **Stage : 1; Dimensioning : 1**



Dimensioning No. 2

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. Z [ft]	F_{vert} [lbf/ft]	App.Pt. X [ft]	Design coefficient
Weight - wall	0.0	-2.62	479.0	0.31	1.000
Active pressure	326.1	-1.24	81.3	0.62	1.000
Surcharge No. 1	667.7	-2.45	179.9	0.62	1.000

Verification of the joint, 17.22 ft from the top.

Back face reinforcement :
Diameter = 0.63 in
Spacing = 11.81 in
Cover = 1.18 in

There is no reinforcement on the front face.
Wall aspect ratio: 9.47

Verification of cross section in compression:
Ultimate normal force N_{Rd} = 120931.6 lbf/ft > 740.2 lbf/ft = N_{Ed}
Cross section is SATISFACTORY

Verification of cross section in bending:
Ultimate bending momenti M_{Rd} = 7310.1 lbfft/ft > 1962.0 lbfft/ft = M_{Ed}
Cross section is SATISFACTORY.

Verification of cross section in shear:
Ultimate shear force V_{Rd} = 2221.9 lbf/ft > 993.7 lbf/ft = V_{Ed}

Cross section is SATISFACTORY.