GENERAL NOTES:

1. EV STUDIO, INC. IS THE ENGINEER OF RECORD AND HEREAFTER REFERENCED AS THE EOR FOR THE RETAINING WALLS ONLY.
2. THE MSE WALLS WERE DESIGNED AS PERMANENT STRUCTURES.
3. MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF STANDARD PRACTICE AND THESE PLANS.
4. THE RETAINING WALL SUB CONTRACTOR IS RESPONSIBLE FOR FIELD LOCATING ALL UTILITIES AND EXISTING ABUTMENT PILES.
5. NO EXCAVATION OPEN CUTS STEEPER THAN 1.5H:1.0V SHALL BE MADE WITHIN 10 FEET OF THE FRONT OF THE RETAINING WALLS WITHOUT APPROVAL OF EOR.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL EROSION AND SEDIMENTATION CONTROL DURING AND AFTER PROJECT, SURVEYING LOCATIONS AS NEED TO LOCATE RETAINING WALLS, AND COORDINATION OF ALL UTILITIES TO BE BUILT BEFORE OR AFTER RETAINING WALLS.
7. ALL MANUFACTURED ITEMS SHALL BE INSTALLED PER MANUFACTURERS GUIDELINES AND SPECIFICATIONS.
8. THE RETAINING WALL SUBCONTRACTOR SHALL VERIFY ALL DIMENSIONS AND SITE CONDITIONS PRIOR TO COMMENCING WORK. ANY ERRORS, OMISSIONS, OR UNUSUAL CONDITIONS ARE TO BE REPORTED TO THE EOR IMMEDIATELY.
9. GEOTECHNICAL ENGINEER SHALL BE RETAINED BY CONTRACTOR FOR ALL OBSERVATIONS AND APPROVAL OF BEARING SOIL PRIOR TO STARTING RETAINING WALL CONSTRUCTION.

DESIGN PARAMETERS:

1. A SURCHARGE OF 100PSF WAS APPLIED TO SIDEWALK AREAS. (THE SOIL SLOPE OF 1:4 TYPICALLY CONTROLS)
2. THE SURCHARGE FROM THE BUILDING DOES NOT IMPACT THE RETAINING WALLS.

DESIGN GUIDELINES

1. INTERNATIONAL BUILDING CODE (IBC/IRC), 2018
2. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA), TRENCHING AND EXCAVATION SAFETY, OSHA 2226-10R-2015
3. CORROSION/DEGRADATION OF SOIL REINFORCEMENTS FOR MECHANICALLY STABILIZED EARTH WALLS AND REINFORCED SOIL SLOPES, NATIONAL HIGHWAY INSTITUTE (NHI) COURSE NO. 132042 AND 132043, U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION, PUBLICATION NO. FHWA-NHI-09-087, NOVEMBER 2009

PROJECT DOCUMENTS

COMPARK VILLAGE SOUTH GRADING PLANS BY MERRICK & COMPANY, INC. DATED 12/02/2022.

FACTORS OF SAFETY

GEOGRID PULLOUT AND STRENGTH, BLOCK CONNECTION, SLIDING	1.5
BEARING CAPACITY	1.3
OVERTURNING	2.0
GLOBAL STABILITY	
NON-CRITICAL INTERNAL/EXTERNAL STABILITY	1.3
CRITICAL INTERNAL/EXTERNAL STABILITY	1.5

GEOTECHNICAL DOCUMENTS

GEOTECHNICAL STUDY BY NINYO & MOORE GEOTECHNICAL & ENVIROMENTAL SCIENCES CONSULTANTS DATED APRIL 7, 2022 PROJECT NUMBER 502090003.

ON-SITE SOIL USED TO BACKFILL BEHIND THE WALLS WITHIN THE REINFORCED GEOGRID LENGTHS MUST HAVE THE PROPERTIES OF THE MATERIAL DESCRIBED IN THE TABLE BELOW AND REWORKED PER THE GEOTECH REPORT TO CONDITION THE SOIL AND HAVE PROPERTIES EQUAL TO OR BETTER THAN LISTED IN THE TABLE BELOW.
RECYCLED CONCRETE IS AN APPROVED ALTERNATIVE.

SIEVE SIZE	PERCENT PASSING	PH	LL	PI
2"	100%	BETWEEN 3 AND 9	< 30	< 20
3/4"	75-100%			
No. 4	20-100%			
No. 200	0-30%			

THE FOLLOWING GEOTECHNICAL DESIGN PARAMETERS WERE UTILIZED IN DESIGN OF THE PERMANENT RETAINING WALL.

GEOTECHNICAL DESIGN PARAMETERS				
SOILS	COHESION C (PSF)	FRICTION ANGLE Φ (DEG)	UNIT WEIGHT (PCF)	SATURATED UNIT WEIGHT (PCF)
ON SITE RETAINED SOIL (CLAYEY SAND)	100	25	120	125
CDOT CLASS I	0	34	125	130

*WATER IS NOT EXPECTED TO BE ENCOUNTERED DURING EXCAVATION AND CONSTRUCTION OF THE RETAINING WALL. WATER ENCOUNTERED DURING EXCAVATION OR DRILLING OPERATIONS SHALL BE REPORTED TO THE EOR.

DRAINAGE

1. DRAINS SHALL BE CONTINUOUS FROM 12" BELOW TOP OF WALL TO THE TOE DRAIN

INSPECTION AND MONITORING:

1. PRIOR TO COMMENCING WORK, THE RETAINING WALL CONTRACTOR SHALL EXAMINE THE AREAS AND CONDITIONS UNDER WHICH THE RETAINING WALL SYSTEM IS TO BE ERECTED, AND NOTIFY THE EOR IN WRITING OF CONDITIONS DETRIMENTAL TO THE PROPER AND TIMELY COMPLETION OF THE WORK. DO NOT PROCEED WITH THE WORK UNTIL UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
2. PROMPTLY NOTIFY THE WALL DESIGN ENGINEER OF SITE CONDITIONS WHICH MAY AFFECT WALL PERFORMANCE, SOIL CONDITIONS OBSERVED OTHER THAN THOSE ASSUMED, OR OTHER CONDITIONS THAT MAY REQUIRE A REEVALUATION OF THE WALL DESIGN.
3. VERIFY THE LOCATION OF EXISTING STRUCTURES AND UTILITIES PRIOR TO EXCAVATION.

MATERIALS:

1. SRW UNITS: KEYSTONE BLOCK CLASSIC WALL UNITS AS MANUFACTURED UNDER LICENSE FROM KEYSTONE BLOCK RETAINING WALL SYSTEMS.
   1.1. PHYSICAL REQUIREMENTS
      1.1.1. MEET REQUIREMENTS OF ASTM C1372, EXCEPT THE UNIT HEIGHT DIMENSIONS SHALL NOT VARY MORE THAN PLUS OR MINUS $\frac{1}{16}$ INCH FROM THAT SPECIFIED IN THE ASTM REFERENCE, NOT INCLUDING TEXTURED FACE.
      1.1.2. UNIT FACE AREA: NOT LESS THAN 1.0 SQUARE FOOT.
      1.1.3. FACE PATTERN GEOMETRY: PER CLIENT
      1.1.4. TEXTURE: PER CLIENT.
      1.1.5. BATTER: INCLUDE AN INTEGRAL CONCRETE SHEAR CONNECTION FLANGE. LOCATOR TO PROVIDE A 1 INCH SETBACK FOR EACH WALL COURSE, UNLESS NOTED TO BE BUILT NEAR VERTICAL.
2. GEOSYNTHETIC REINFORCEMENT: POLYESTER FIBER GEOGRID OR GEOTEXTILE, OR POLYPROPYLENE WOVEN GEOTEXTILE, AS SHOWN ON THE DRAWINGS. STRATAGRID 60, 80 AND 100 ARE NOTED IN THE PLANS. APPROVED ALTERNATES ARE ALLOWED FOR MATCHING OR EXCEEDING THE STRENGTH OF THE GEOGRID SPECIFIED.
3. LEVELING PAD
   3.1. AGGREGATE BASE: CRUSHED STONE OR GRANULAR FILL MEETING THE FOLLOWING GRADUATION AS DETERMINED IN ACCORDANCE WITH ASTM D448:

SIEVE SIZE	PERCENT PASSING
1 INCH	100
NO. 4	35 TO 70
NO. 40	10 TO 35
NO. 200	3 TO 10

   3.2. CONCRETE BASE: NON-REINFORCED LEAN CONCRETE BASE.
      3.2.1. COMPRESSIVE STRENGTH: 3,000 PSI
      3.2.2. BASE THICKNESS: 6 INCHES

INSTALLATION:

1. GENERAL: ERECT SRW UNITS IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS, AND AS SPECIFIED HEREIN.
2. PLACE FIRST COURSE OF CONCRETE WALL UNITS ON THE PREPARED BASE MATERIAL. CHECK UNITS FOR LEVEL AND ALIGNMENT. MAINTAIN THE SAME ELEVATION AT THE TOP OF EACH UNIT WITHIN EACH SECTION OF THE BASE COURSE.
3. ENSURE THAT FOUNDATION UNITS ARE IN FULL CONTACT WITH THE LEVELING PAD.
4. PLACE CONCRETE WALL UNITS SIDE-BY-SIDE FOR FULL LENGTH OF WALL ALIGNMENT. ALIGNMENT MAY BE DONE BY USING A STRING LINE MEASURED FOR THE BACK OF THE BLOCK. GAPS ARE NOT ALLOWED BETWEEN THE FOUNDATION CONCRETE WALL UNITS.
5. PLACE DRAINAGE AGGREGATE BETWEEN AND DIRECTLY BEHIND THE SRW. FILL ANY VOIDS IN SRW UNITS WITH DRAINAGE AGGREGATE. PROVIDE A DRAINAGE ZONE BEHIND THE SRW UNITS A MINIMUM OF 12 INCHES WIDE TO WITHIN 8 INCHES OF THE FINAL GRADE. CAP THE BACKFILL AND DRAINAGE AGGREGATE ZONE WITH SEPARATION FABRIC AND THEN 8 INCHES OF LOW PERMEABILITY SOIL.
6. INSTALL DRAINAGE PIPE AT THE LOWEST ELEVATION POSSIBLE TO MAINTAIN GRAVITY FLOW OF WATER TO OUTSIDE OF THE REINFORCED ZONE. SLOPE THE MAIN COLLECTION DRAINAGE PIPE 2 PERCENT (MINIMUM) TO PROVIDE GRAVITY FLOW TO THE DAYLIGHTED AREAS. DAYLIGHT THE MAIN COLLECTION DRAINAGE PIPE THROUGH THE FACE OF THE WALL, AND/OR TO AN APPROPRIATE LOCATION AWAY FROM THE WALL SYSTEM AT EACH LOW POINT OR AT 50 FOOT (MAXIMUM) INTERVALS ALONG THE WALL. ALTERNATELY, THE DRAINAGE PIPE CAN BE CONNECTED TO A STORM SEWER AT 50 FOOT (MAXIMUM) INTERVALS.
7. REMOVE EXCESS FILL FROM TOP OF SRW UNITS AND INSTALL NEXT COURSE. ENSURE DRAINAGE AGGREGATE AND BACKFILL ARE COMPACTED BEFORE INSTALLATION OF NEXT COURSE.
8. CHECK EACH COURSE FOR LEVEL AND ALIGNMENT. ADJUST SRW UNITS AS NECESSARY TO MAINTAIN LEVEL AND ALIGNMENT PRIOR TO PROCEEDING WITH EACH ADDITIONAL COURSE.
9. INSTALL GEOSYNTHETIC REINFORCEMENT IN ACCORDANCE WITH GEOSYNTHETIC MANUFACTURER'S RECOMMENDATIONS AND THE SHOP DRAWINGS.
   9.1. ORIENT GEOSYNTHETIC REINFORCEMENT WITH THE HIGHEST STRENGTH AXIS PERPENDICULAR TO THE WALL FACE.
   9.2. PRIOR TO GEOSYNTHETIC REINFORCEMENT PLACEMENT, PLACE THE BACKFILL AND COMPACT TO THE ELEVATION OF THE TOP OF THE WALL UNITS AT THE ELEVATION OF THE GEOSYNTHETIC REINFORCEMENT.
   9.3. PLACE GEOSYNTHETIC REINFORCEMENT AT THE ELEVATIONS AND TO THE LENGTHS SHOWN ON THE DRAWINGS.
   9.4. LAY GEOSYNTHETIC REINFORCEMENT HORIZONTALLY ON TOP OF THE SRW UNITS AND THE COMPACTED BACKFILL SOILS. PLACE THE GEOSYNTHETIC REINFORCEMENT WITHIN ONE INCH OF THE FACE OF THE SRW UNITS. PLACE THE NEXT COURSE OF SRW UNITS ON TOP OF THE GEOSYNTHETIC REINFORCEMENT.
   9.5. THE GEOSYNTHETIC REINFORCEMENT SHALL BE IN TENSION AND FREE FROM WRINKLES PRIOR TO PLACEMENT OF THE BACKFILL SOILS. PULL GEOSYNTHETIC REINFORCEMENT HAND-TAUT AND SECURE IN PLACE WITH STAPLES, STAKES OR BY HAND-TENSIONING UNTIL THE GEOSYNTHETIC REINFORCEMENT IS COVERED BY 6 INCHES OF LOOSE FILL.
   9.6. THE GEOSYNTHETIC REINFORCEMENTS SHALL BE CONTINUOUS THROUGHOUT THEIR EMBEDMENT LENGTHS. SPLICES IN THE GEOSYNTHETIC REINFORCEMENT STRENGTH DIRECTION ARE NOT ALLOWED. DO NOT OPERATE TRACKED CONSTRUCTION EQUIPMENT DIRECTLY ON THE GEOSYNTHETIC REINFORCEMENT. AT LEAST 6 INCHES OF COMPACTED BACKFILL SOIL IS REQUIRED PRIOR TO OPERATION OF TRACKED VEHICLES OVER THE GEOSYNTHETIC REINFORCEMENT. KEEP TURNING OF TRACKED CONSTRUCTION EQUIPMENT TO A MINIMUM.

DISCOVERY:

1. DURING CONSTRUCTION, THE CONTRACTOR MAY ENCOUNTER EXISTING CONDITIONS. WHICH ARE NOT NOW KNOWN OR ARE AT VARIANCE WITH PROJECT DOCUMENTATION. SUCH CONDITIONS MAY INTERFERE WITH NEW CONSTRUCTION, OR MAY CONSIST OF DAMAGE OR DETERIORATION TO STRUCTURAL MATERIALS OR COMPONENTS WHICH COULD JEOPARDIZE THE STRUCTURAL INTEGRITY OF THE BUILDING.
2. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ALL DISCOVERIES HE BELIEVES MAY INTERFERE WITH PROPER EXECUTION OF THE WORK OR JEOPARDIZE THE INTEGRITY OF THE BUILDING PRIOR TO PROCEEDING WITH WORK RELATED TO SUCH DISCOVERIES.

CONTRACTOR TO COORDINATE ALL UNDERGROUND UTILITIES PRIOR TO CONSTRUCTION

CONTRACTOR TO REFER TO THE GEOTECHNICAL REPORT TO ENSURE ALL SUBGRADE PREPARATION REQUIREMENTS, PAVEMENT RECOMMENDATIONS, MINIMUM SLOPE REQUIREMENTS , AND ALL OTHER APPLICABLE REQUIREMENTS ARE MET.

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07/31/2024
PARKER COLORADO

INTEGRATED WALL SOLUTIONS
COMPARK VILLAGE SOUTH-APARTMENTS
PARKER, DOUGLAS COUNTY, CO

22A252

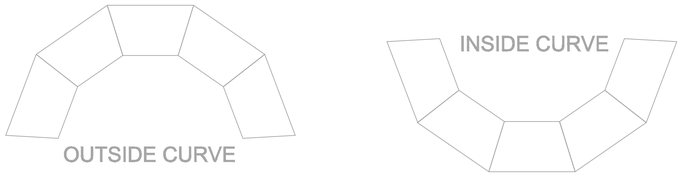
COLORADO REGISTERED
JAMES W. HOULTON
39776
07/30/2024
PROFESSIONAL ENGINEER

1 WALL REVISIONS 07/14/2023
2 WALL REVISIONS 02/28/2024

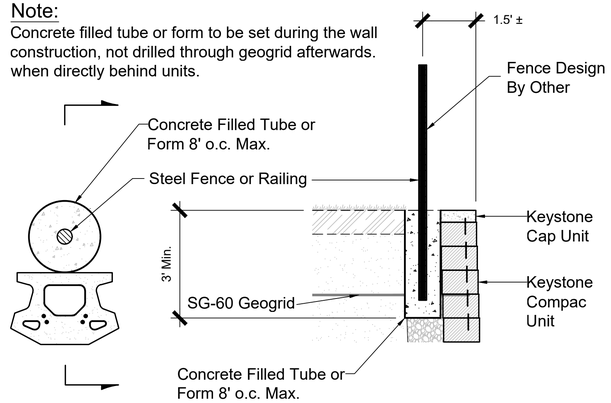
PERMIT PHASE
DATE: 07/14/2023
DRAWN BY: BTB
CHECKED BY: JNH

NOTES

S0.0



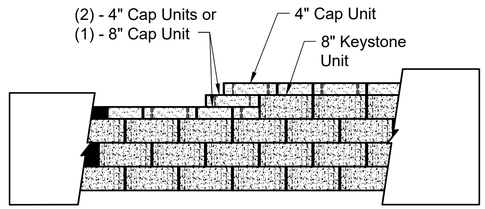
Note:
Concrete filled tube or form to be set during the wall construction, not drilled through geogrid afterwards. when directly behind units.



Fence Plan Detail

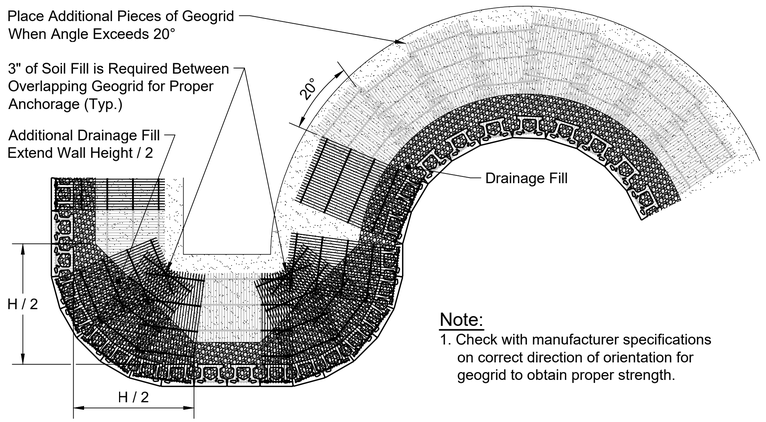
Fence Section & Plan Detail

Keystone Unit - Near Vertical Setback



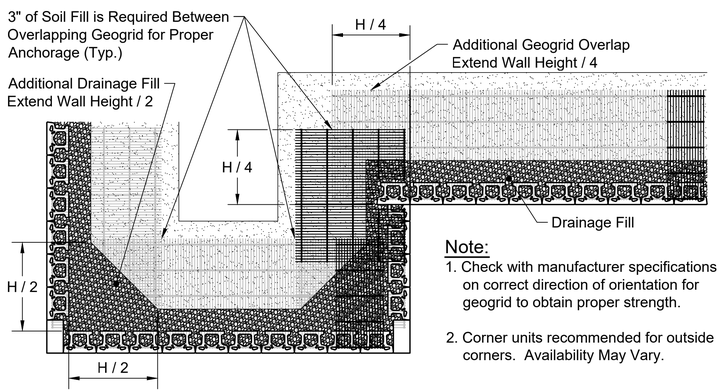
Note:
1. Secure all cap units with Keystone Kapseal or equal.

Top of Wall Steps



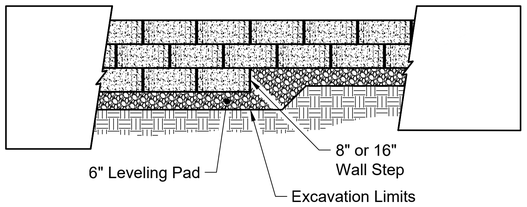
Note:
1. Check with manufacturer specifications on correct direction of orientation for geogrid to obtain proper strength.

Geogrid Installation on Curves



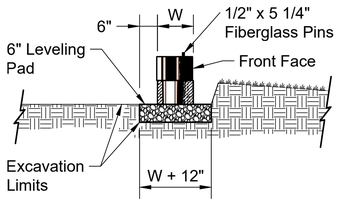
Note:
1. Check with manufacturer specifications on correct direction of orientation for geogrid to obtain proper strength.
2. Corner units recommended for outside corners. Availability May Vary.

Geogrid Installation at Corners



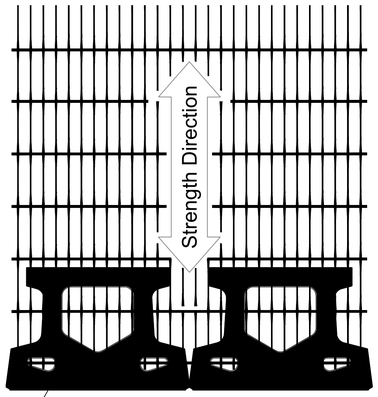
Elevation

Note:
1. The leveling pad is to be constructed of crushed stone or 2000 psi ± unreinforced concrete.



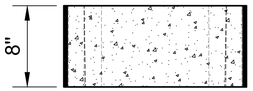
Section

Leveling Pad Detail

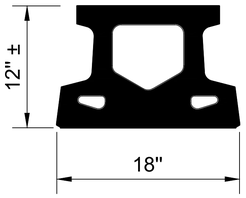


Geogrid is to be Placed on Level Backfill and Extended Over the Fiberglass Pins. Place Next Unit. Pull Grid Taught and Backfill. Stake as required.

Grid & Pin Connection



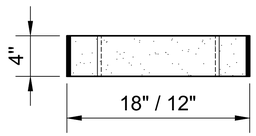
Compac III Elevation



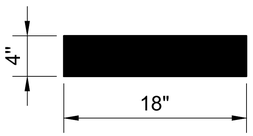
Compac III Plan

Compac III Unit

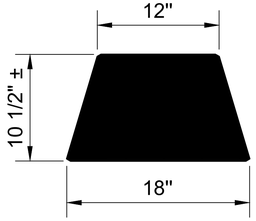
✳ Dimensions May Vary by Region



Cap Unit Elevation



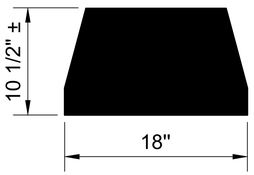
Cap Unit Elevation



Cap Unit Plan

Universal
Cap Unit Option

✳ Dimensions & Availability Will Vary by Region



Cap Unit Plan

Straight Split
Cap Unit Option

✳ Dimensions & Availability Will Vary by Region

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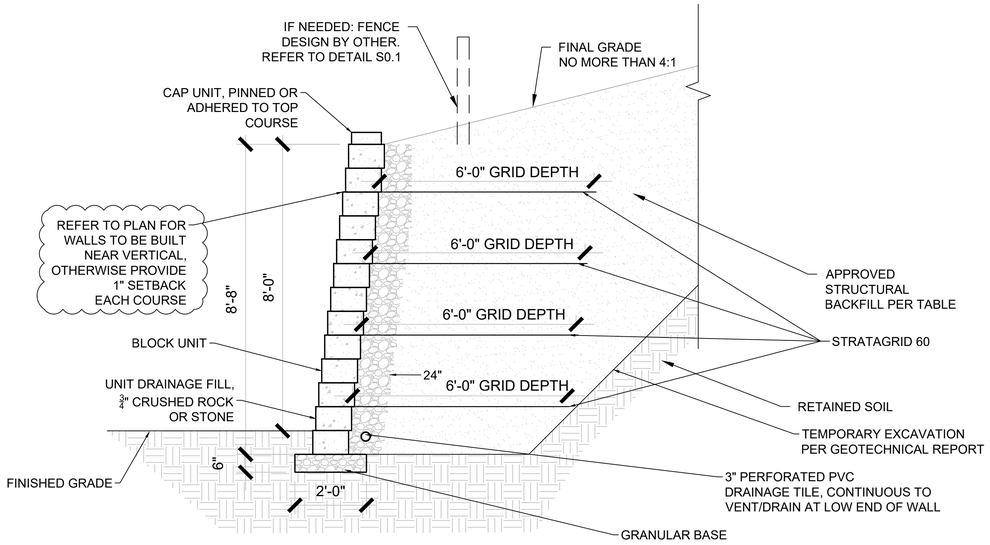
07/30/2024
PROFESSIONAL ENGINEER

REV 7-28-22 CLIENT CHANGES

PERMIT PHASE
DATE: 07/14/2023
DRAWN BY: BTB
CHECKED BY: JNH

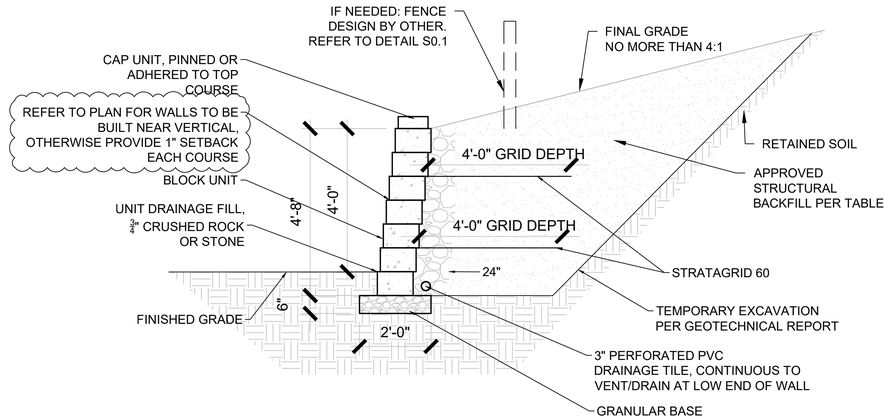
WALL DETAILS

S0.1



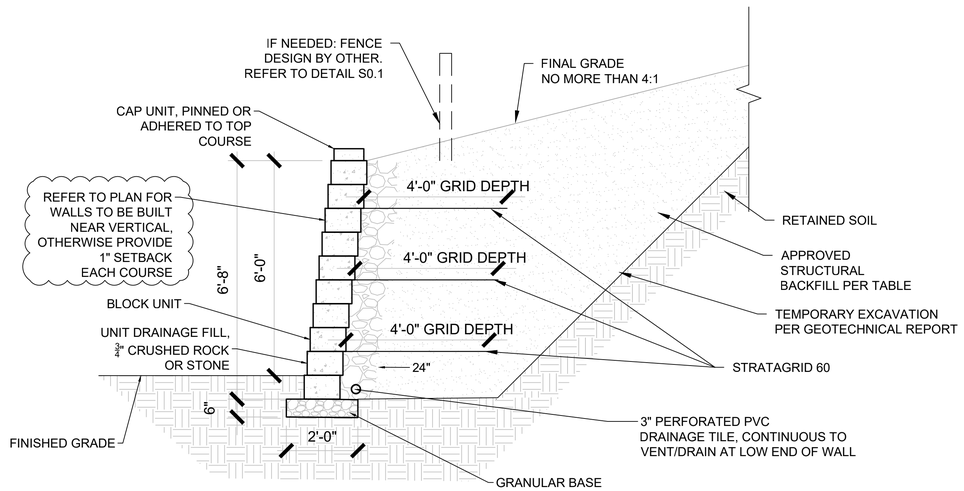
8'-0" OR LESS GRADE DIFFERENCE
DH = 8'-8" MAX MSE WALL

4 SCALE: 1/2" = 1'-0"



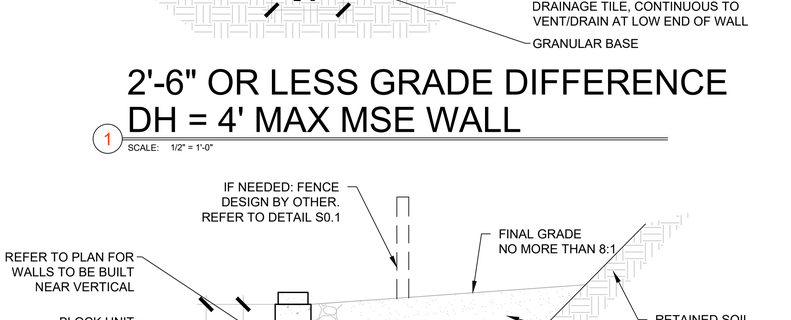
4'-0" OR LESS GRADE DIFFERENCE
DH = 4'-8" MAX MSE WALL

2 SCALE: 1/2" = 1'-0"



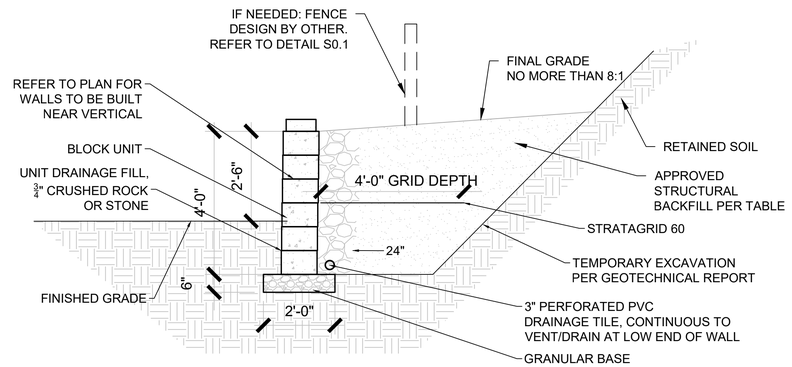
6'-0" OR LESS GRADE DIFFERENCE
DH = 6'-8" MAX MSE WALL

3 SCALE: 1/2" = 1'-0"



2'-6" OR LESS GRADE DIFFERENCE
DH = 4' MAX MSE WALL

1 SCALE: 1/2" = 1'-0"



2'-6" OR LESS GRADE DIFFERENCE
DH = 4' MAX MSE WALL - VERTICAL

1A SCALE: 1/2" = 1'-0"

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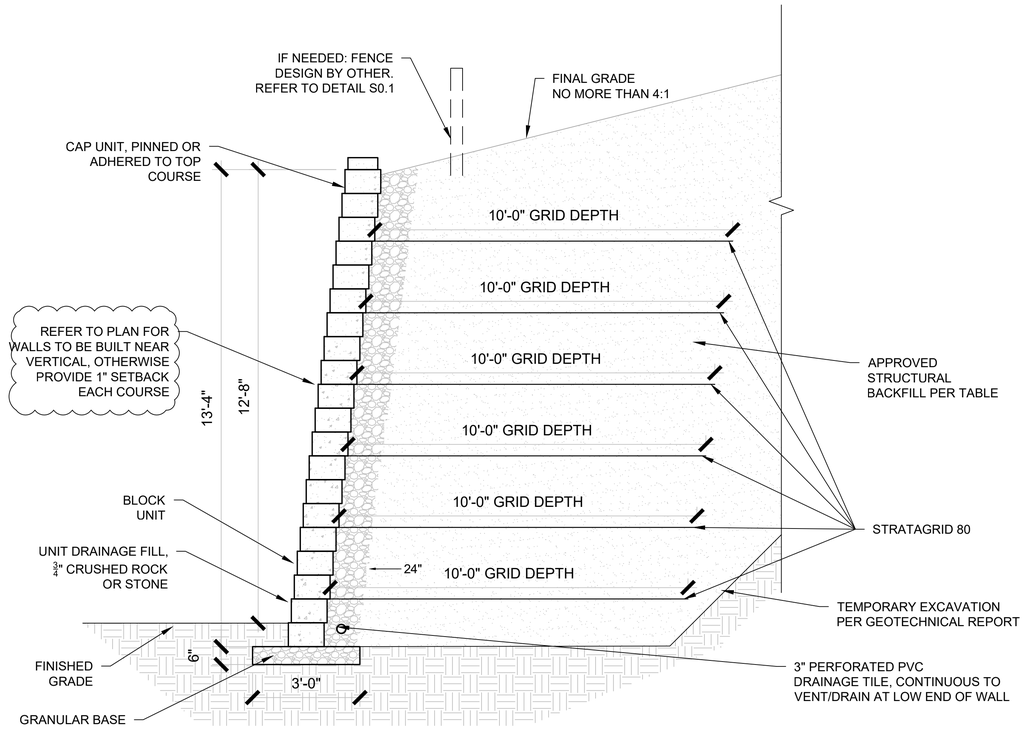
JAMES N. HOULE
39776
07/30/2024
PROFESSIONAL ENGINEER

PERMIT PHASE
DATE: 07/14/2023
DRAWN BY: BTB
CHECKED BY: JNH

WALL SECTIONS

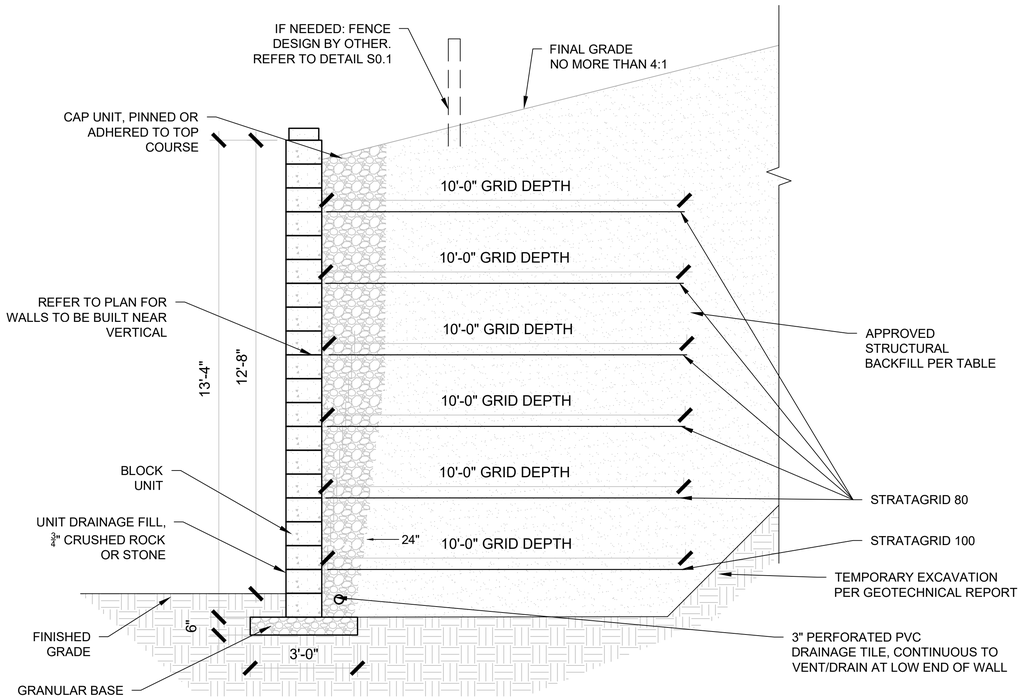
RETAINING WALLS

S0.2



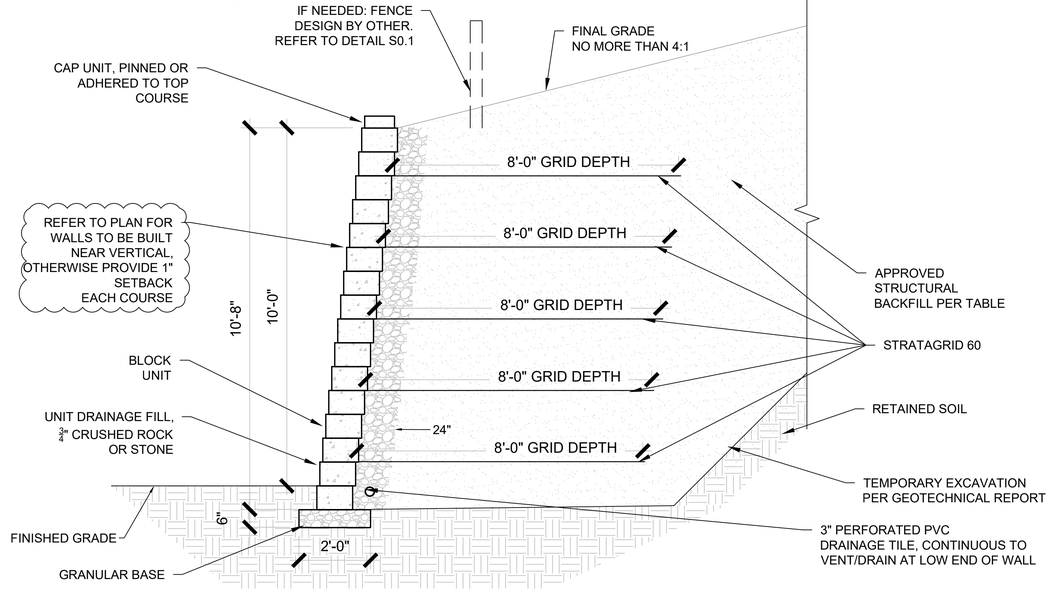
12'-8" OR LESS GRADE DIFFERENCE
DH = 13'-4" MAX MSE WALL

6 SCALE: 1/2" = 1'-0"



12'-8" OR LESS GRADE DIFFERENCE - VERTICAL
DH = 13'-4" MAX MSE WALL

6A SCALE: 1/2" = 1'-0"



10'-0" OR LESS GRADE DIFFERENCE
DH = 10'-8" MAX MSE WALL

5 SCALE: 1/2" = 1'-0"

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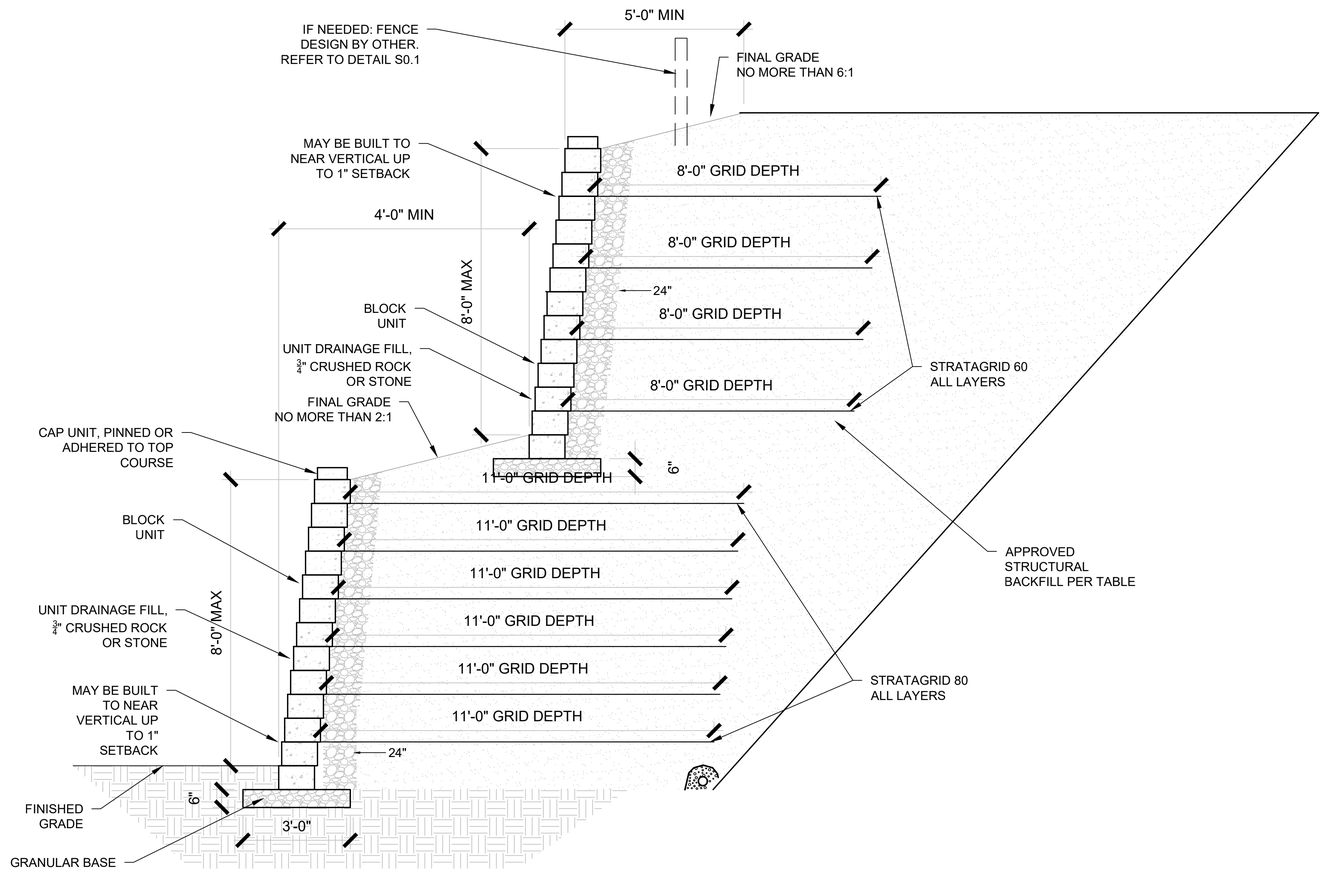
PERMIT PHASE
DATE: 07/14/2023
DRAWN BY: BTB
CHECKED BY: JNH

WALL SECTIONS

RETAINING WALLS

S0.3



WALLS 1 AND 2 TIERED VERTICAL
DH = 8'-8" / 8'-8" MAX MSE WALL

7 SCALE: 1/2" = 1'-0"

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PARKER COLORADO

INTEGRATED WALL SOLUTIONS
COMPARK VILLAGE
SOUTH-APARTMENTS
PARKER, DOUGLAS COUNTY, CO

22A252

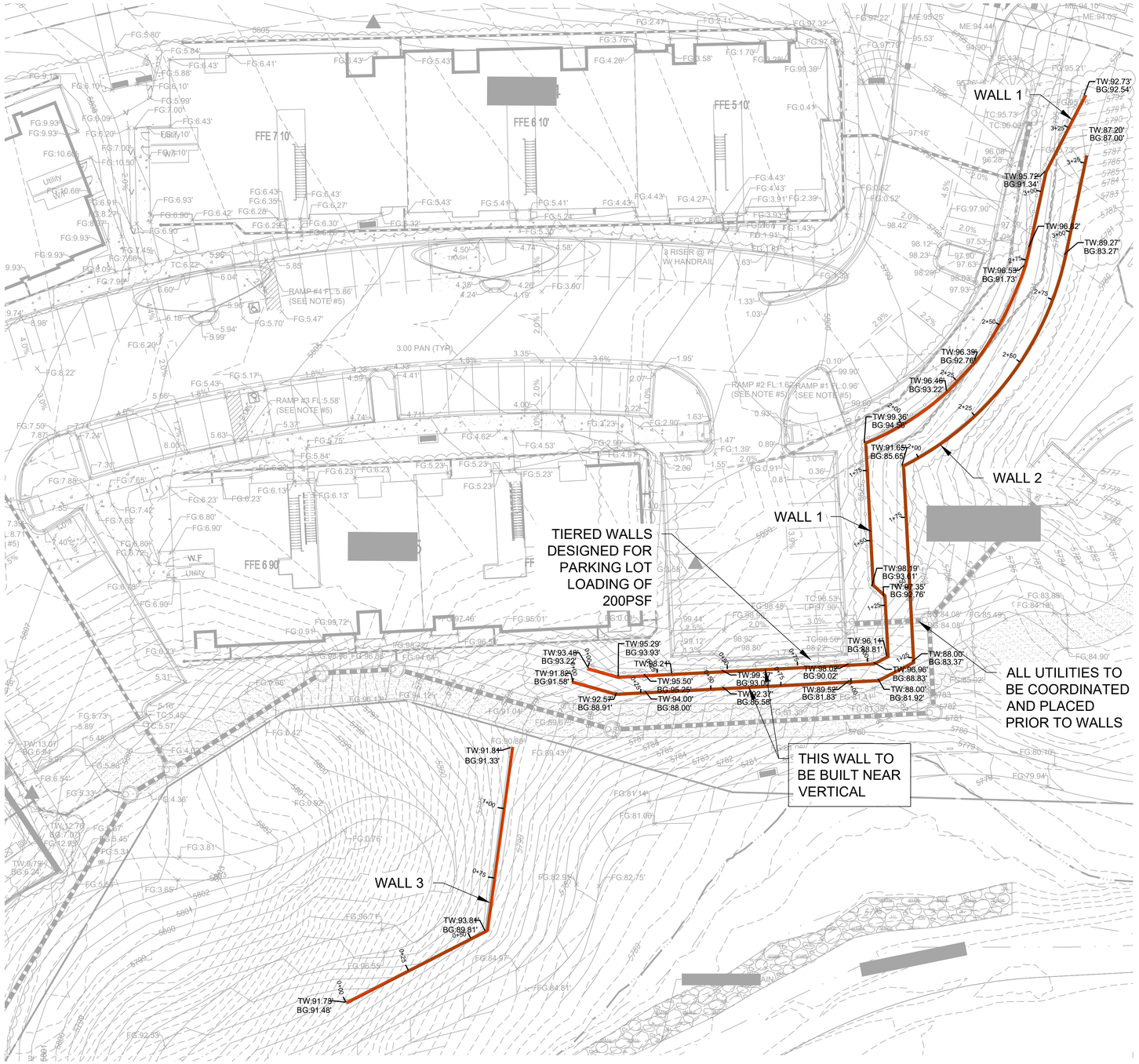
COLORADO REGISTERED
JAMES N. HOULE
39776
07/30/2024
PROFESSIONAL ENGINEER

PERMIT PHASE
DATE: 07/14/2023
DRAWN BY: BTB
CHECKED BY: JNH

WALL SECTIONS

RETAINING WALLS

S0.4



N

20' 0 10' 20' 40'

1" = 20' HOR.

1 SITE PLAN

SCALE: 1" = 20'-0"

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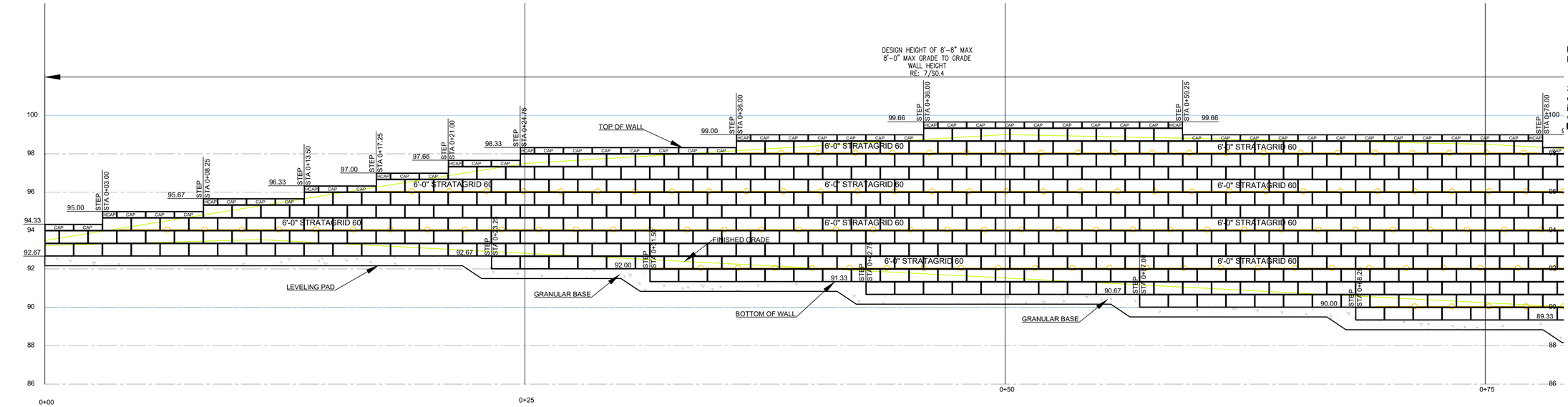
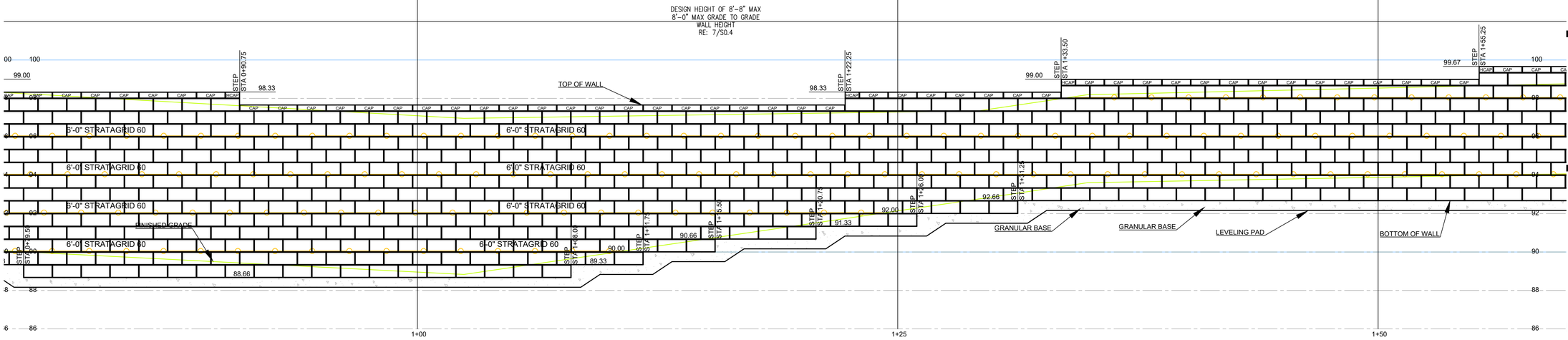
RETAINING WALL
WALLS 1. 2. 3
SITE PLAN

S1.0





WALL 1 PROFILE

1 SCALE: 3/8" = 1'-0"

S1.1

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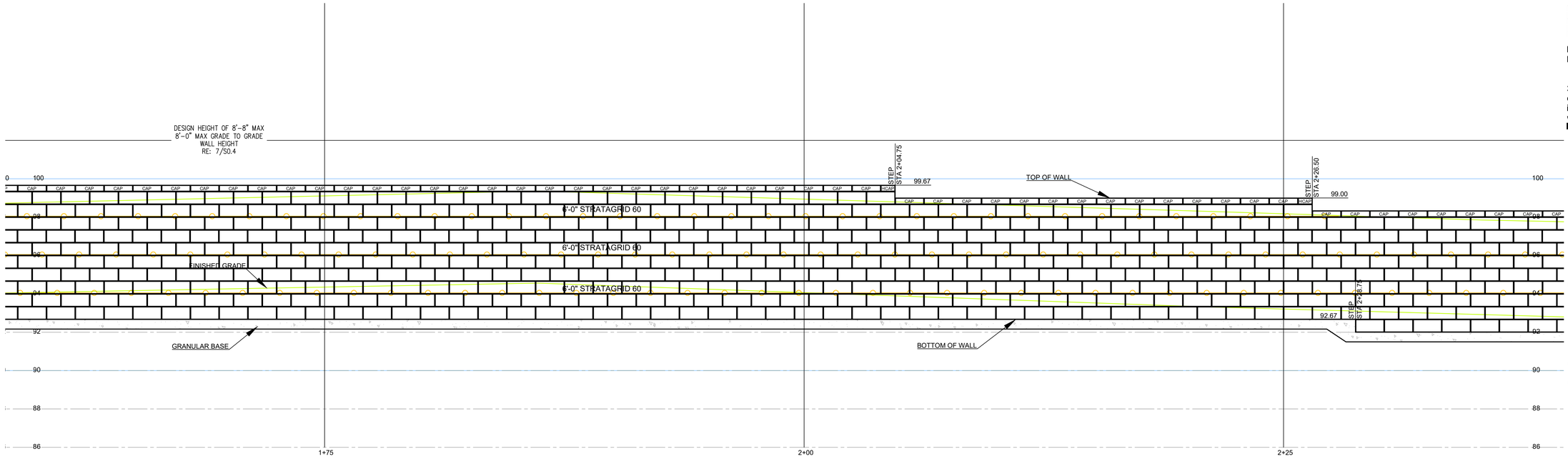
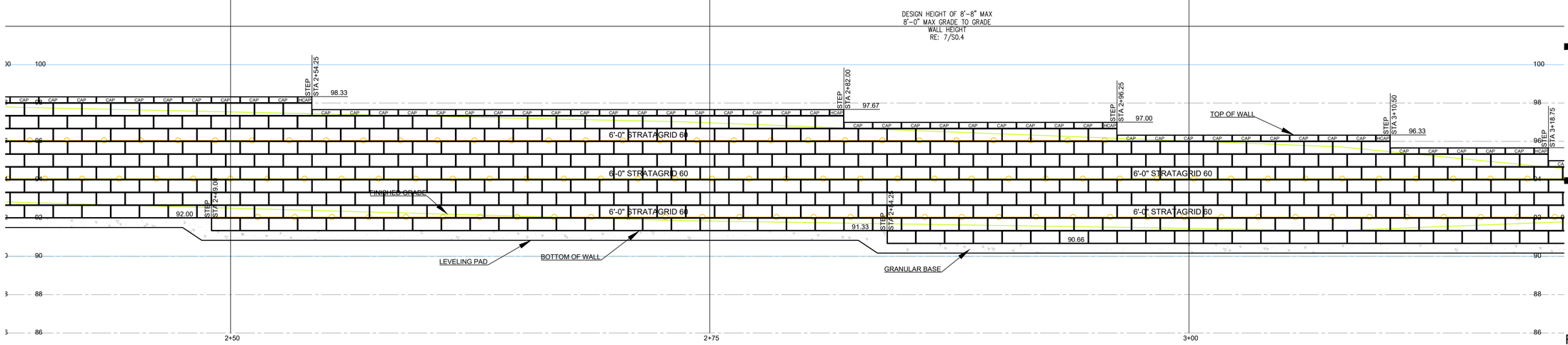
RETAINING WALL 1
PROFILE





WALL 1 PROFILE

1 SCALE: 3/8" = 1'-0"

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RETAINING WALL 1 PROFILE

S1.2

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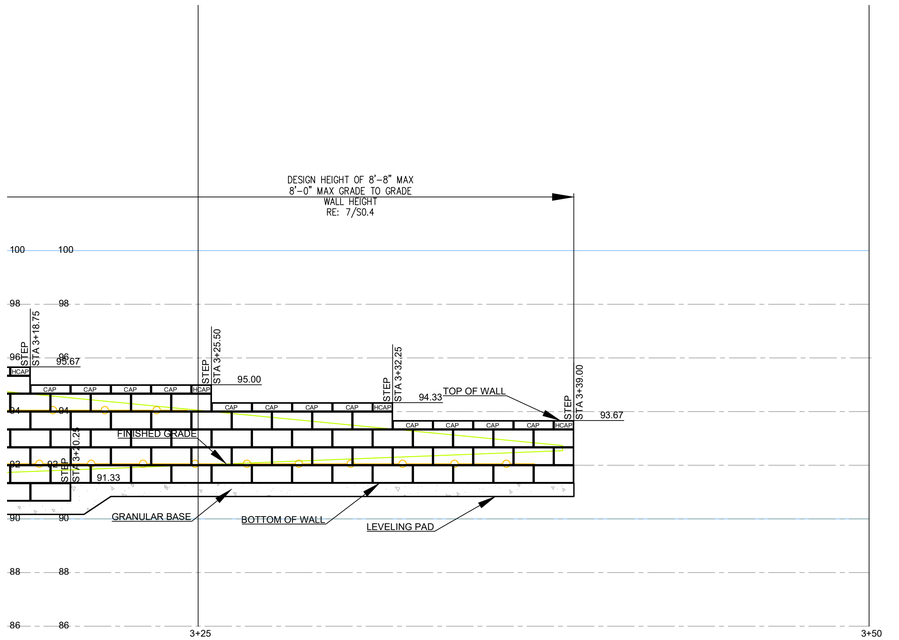

1 WALL 1 PROFILE
SCALE: 3/8" = 1'-0"

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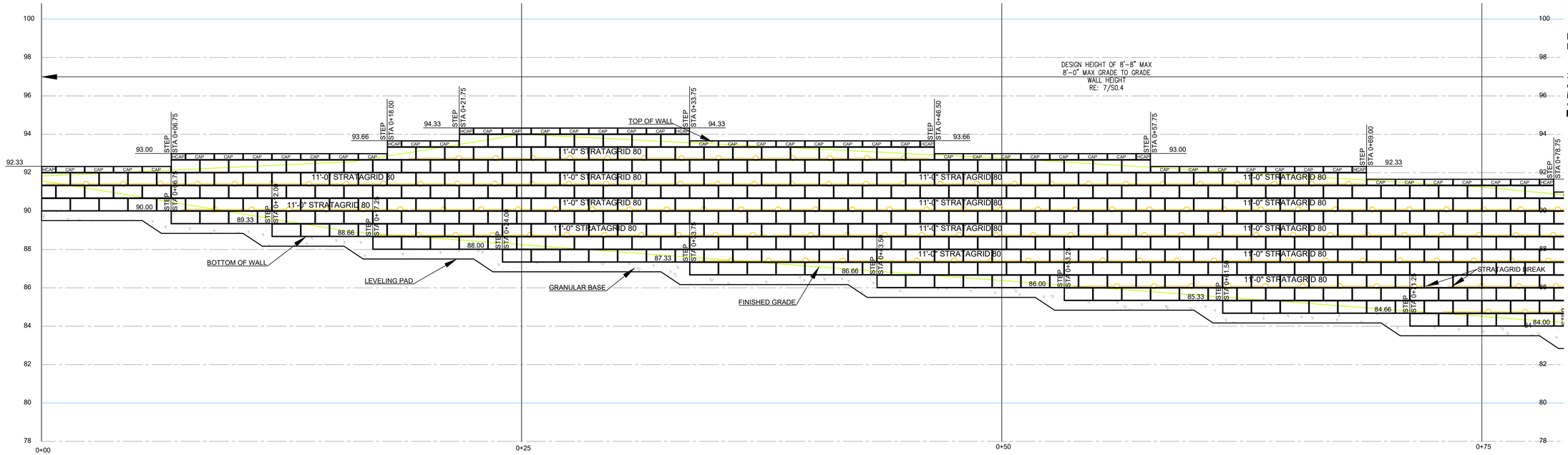
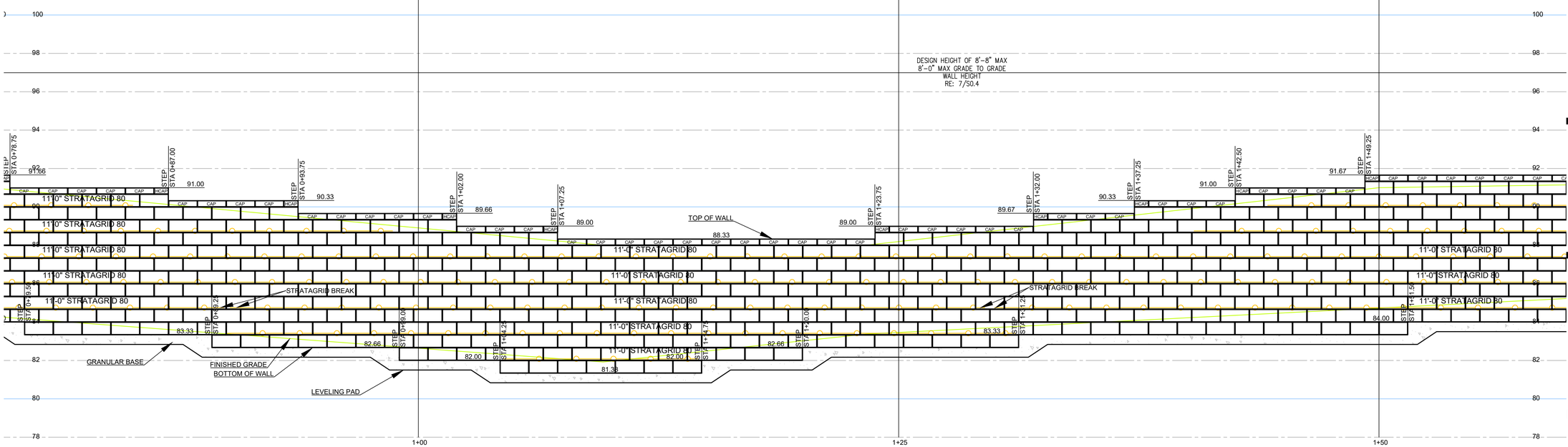
RETAINING WALL 1 PROFILE

S1.3





WALL 2 PROFILE

1 SCALE: 3/8" = 1'-0"

S2.1

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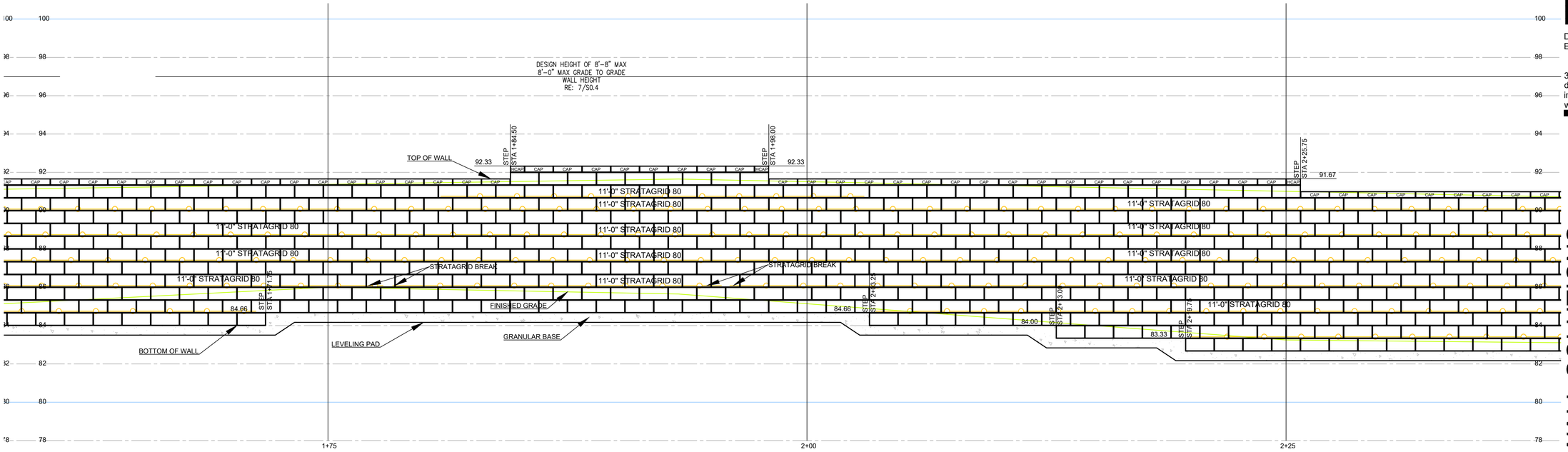
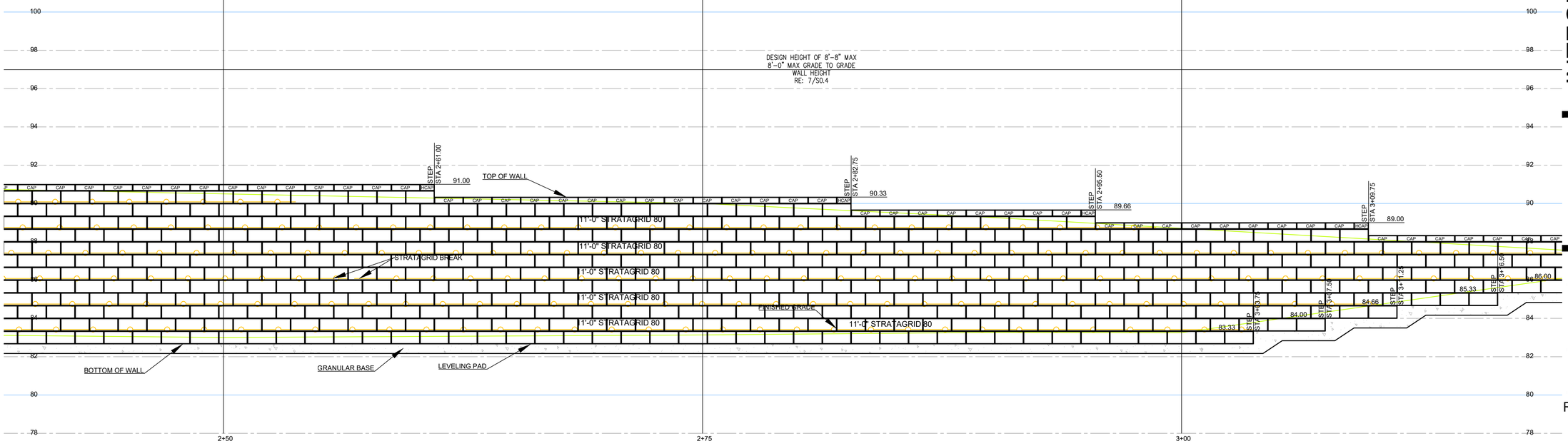
RETAINING WALL 2
PROFILE





WALL 2 PROFILE

1 SCALE: 3/8" = 1'-0"

S2.2

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RETAINING WALL 2
PROFILE

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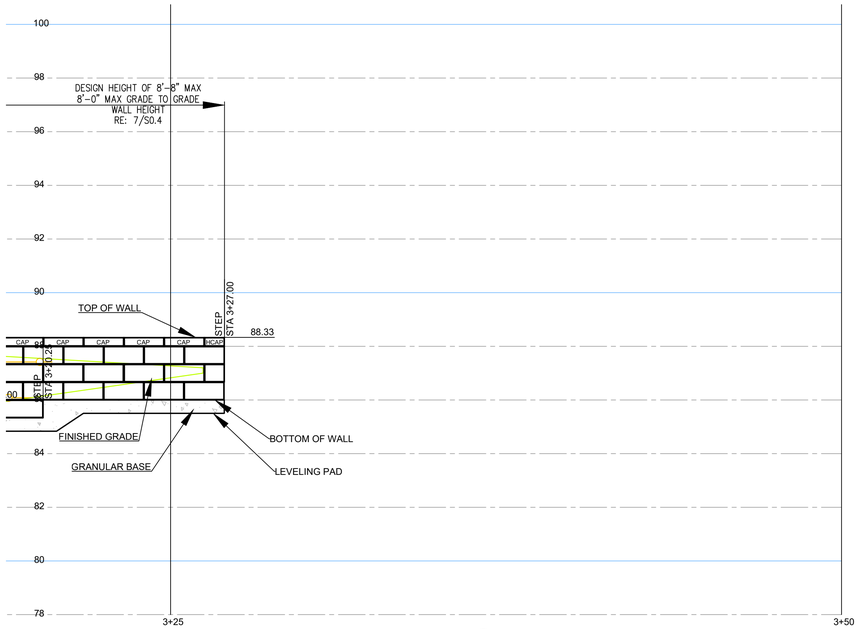

1 WALL 2 PROFILE
SCALE: 3/8" = 1'-0"

PERMIT PHASE
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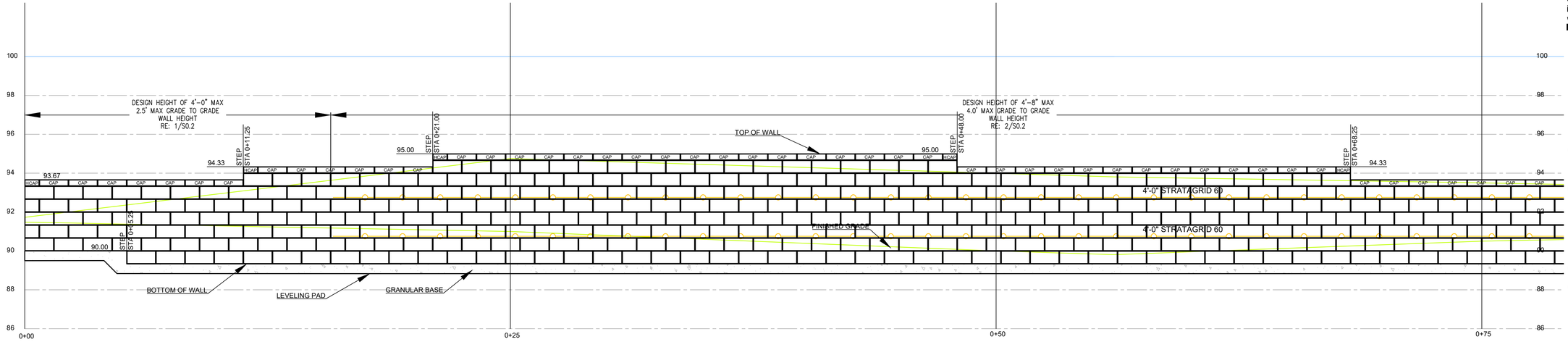
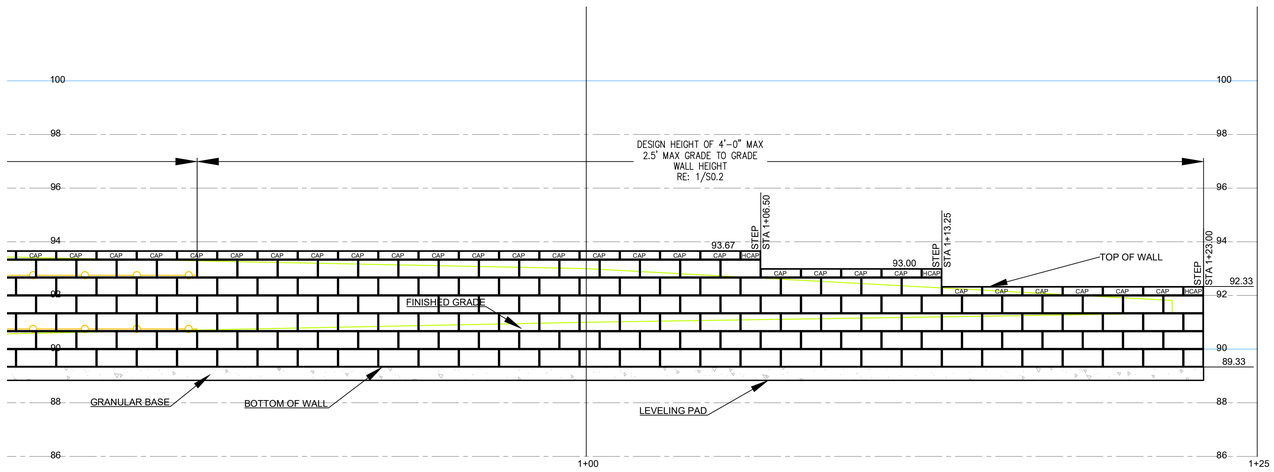
RETAINING WALL 2 PROFILE

S2.3





WALL 3 PROFILE

1 SCALE: 3/8" = 1'-0"

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PROFESSIONAL ENGINEER

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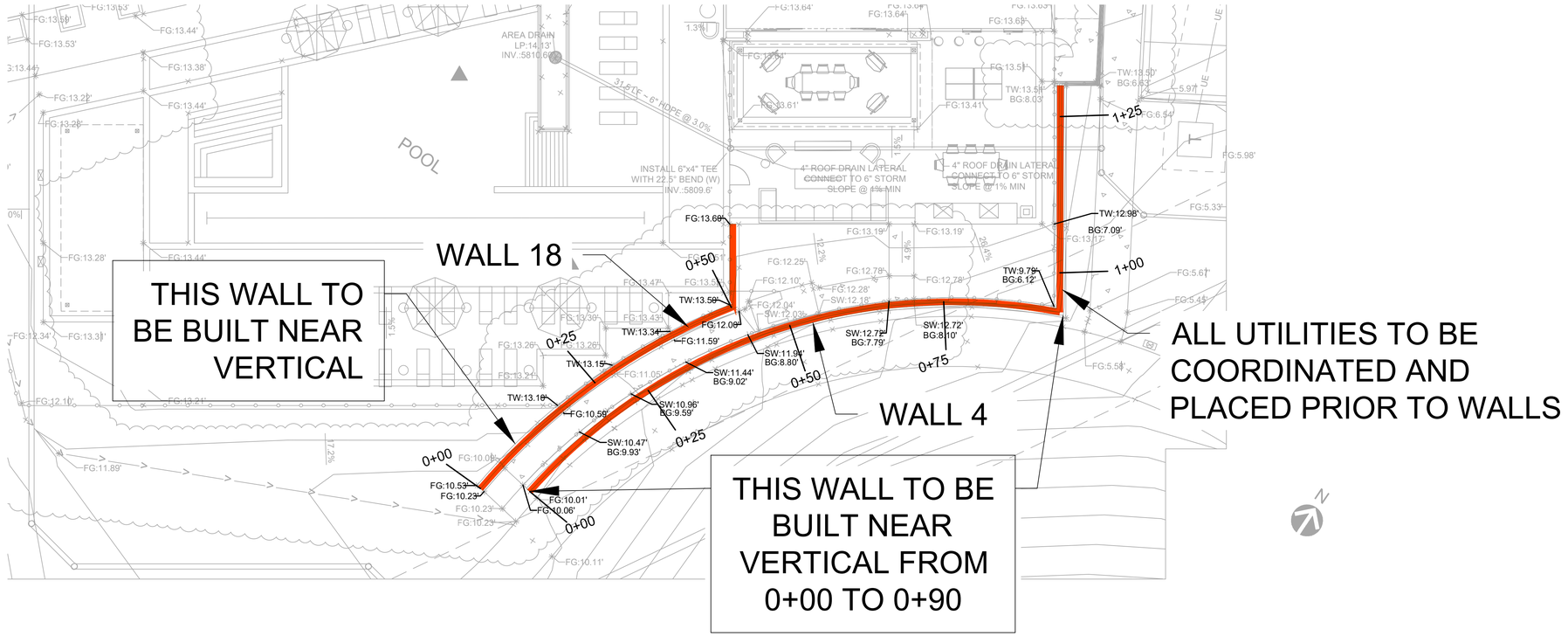
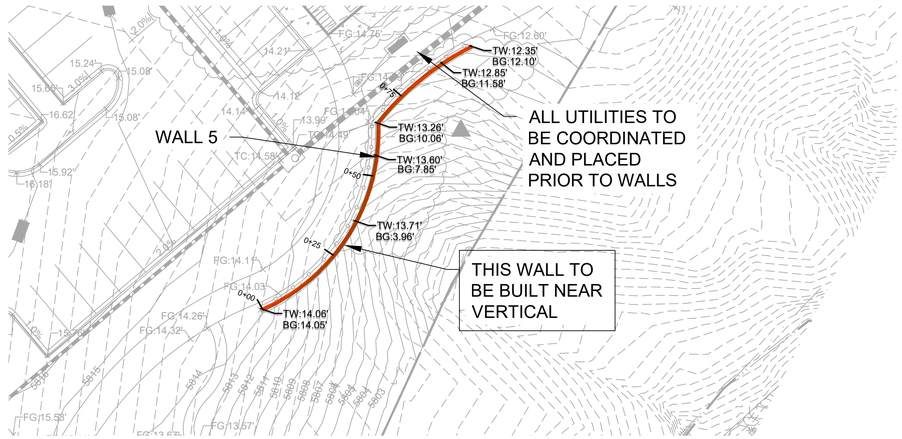
RETAINING WALL 3 PROFILE

S3.1



2 SITE PLAN

SCALE: 1" = 10'-0"



1 SITE PLAN

SCALE: 1" = 20'-0"

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2 WALL REVISIONS 02/28/2024

PERMIT PHASE
DATE: 07/14/2023
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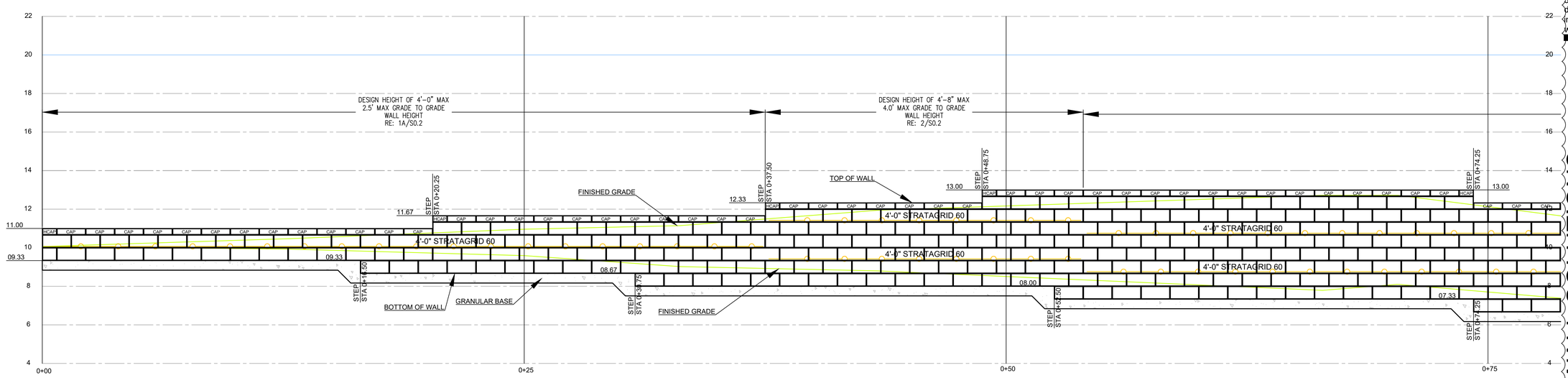
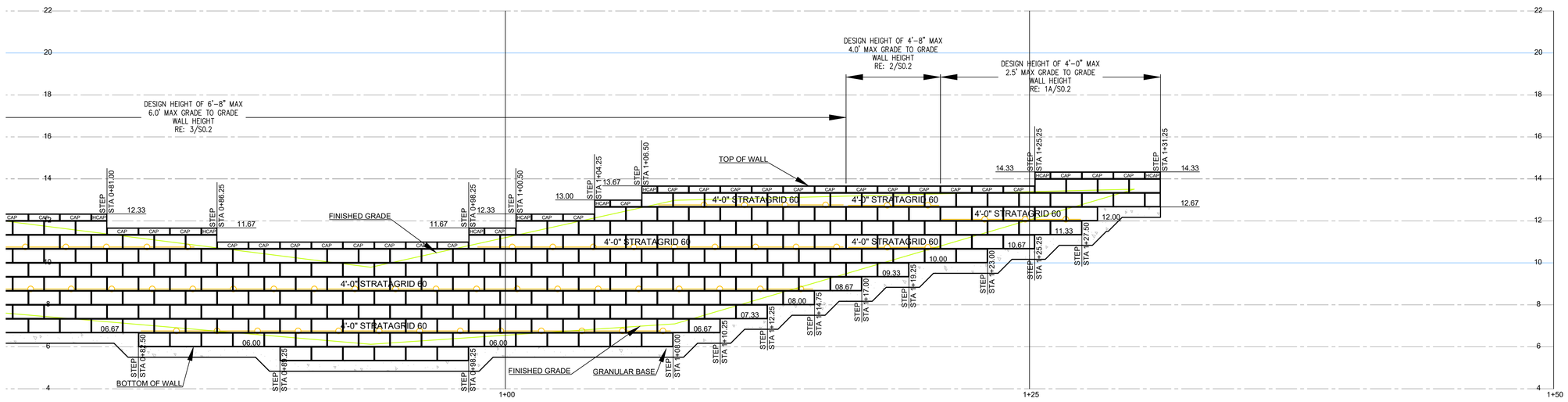
RETAINING WALL
WALLS 4. 5
SITE PLAN

S4.0





WALL 4 PROFILE

1 SCALE: 3/8" = 1'-0"

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PARKER, DOUGLAS COUNTY, CO

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COLORADO REGISTERED
JAMIE W. HOUSTON
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07/30/2024
PROFESSIONAL ENGINEER

2 WALL REVISIONS 02/28/2024

PERMIT PHASE
DATE: 07/14/2023
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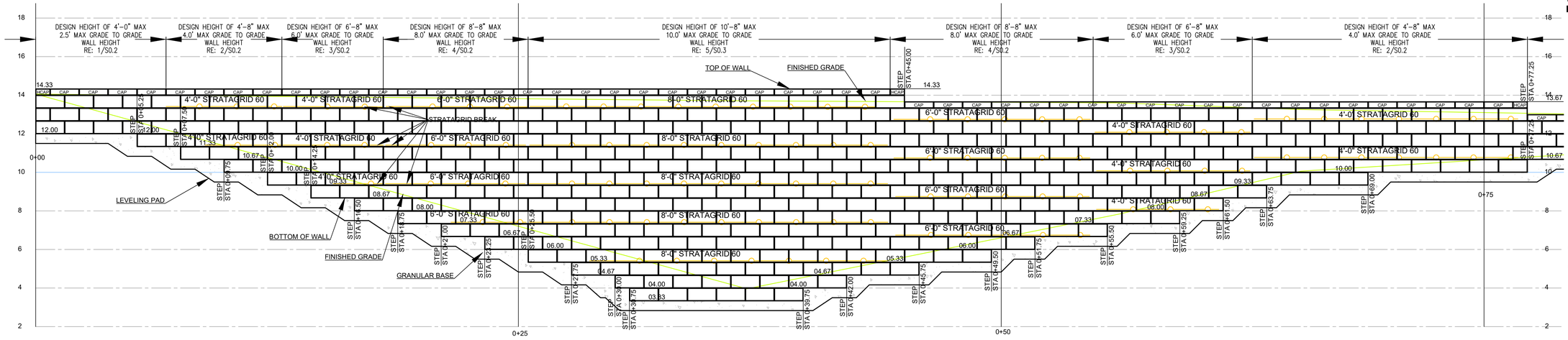
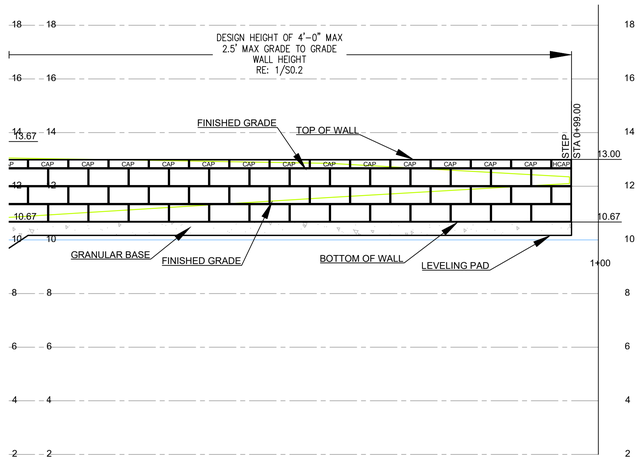
RETAINING WALL 4
PROFILE

S4.1





WALL 5 PROFILE

1 SCALE: 3/8" = 1'-0"

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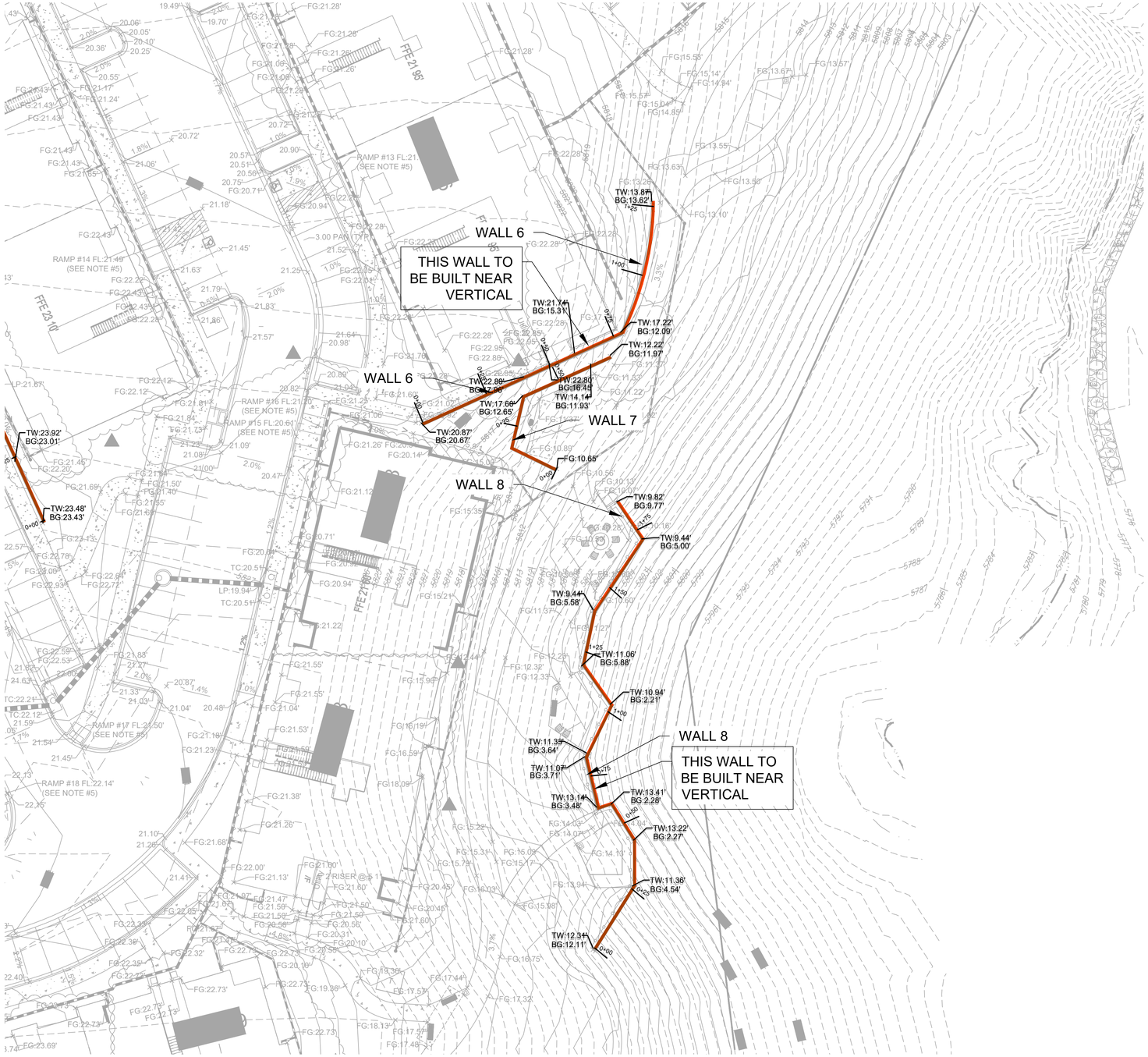
RETAINING WALL 5 PROFILE

S5.1



1 SITE PLAN

SCALE: 1" = 20'-0"

N

20' 0 10' 20' 40'

1" = 20' HOR.

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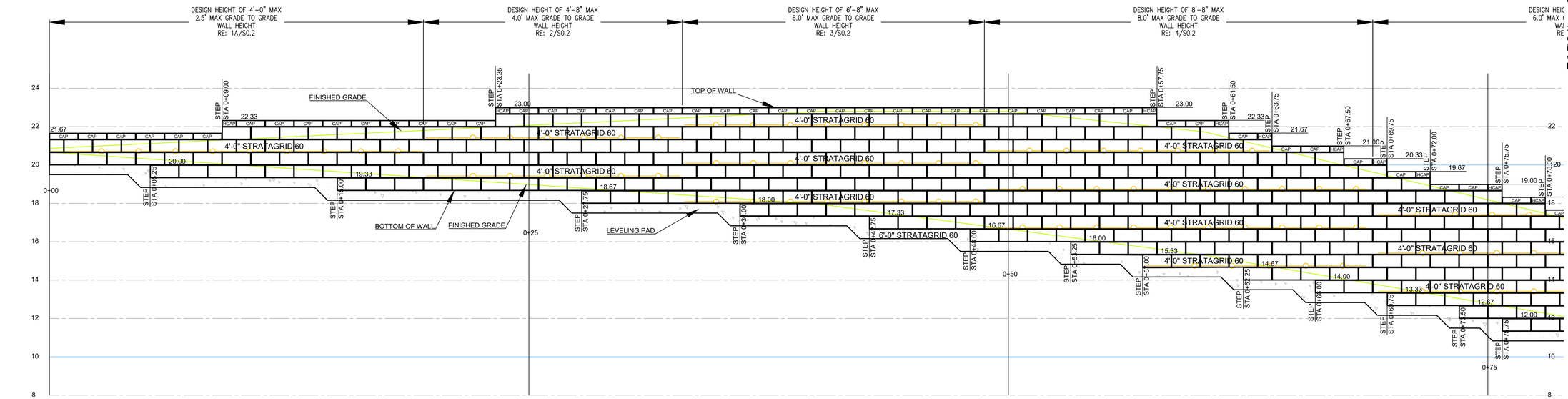
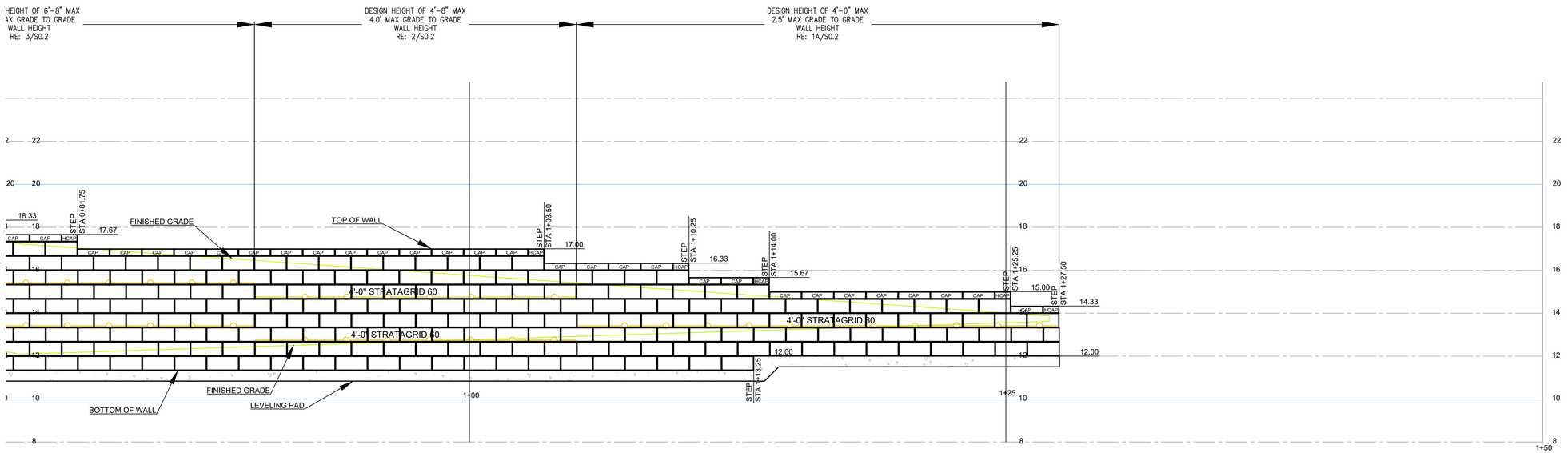
RETAINING WALL
WALLS 6, 7, 8
SITE PLAN

S6.0





WALL 6 PROFILE

1 SCALE: 3/8" = 1'-0"

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RETAINING WALL 6 PROFILE

S6.1

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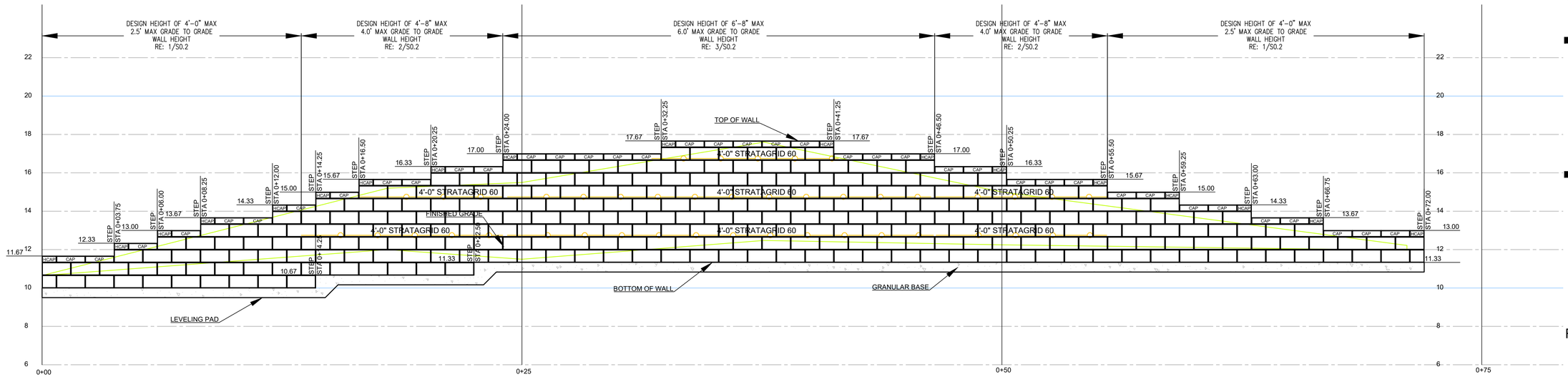

1 WALL 7 PROFILE
SCALE: 3/8" = 1'-0"

PERMIT PHASE
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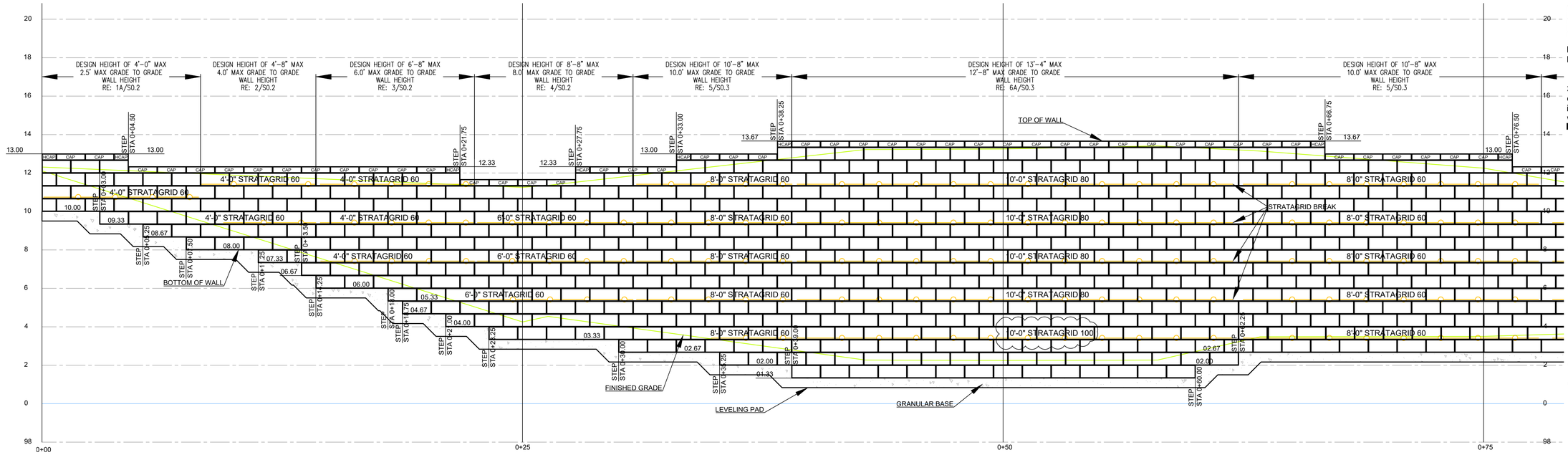
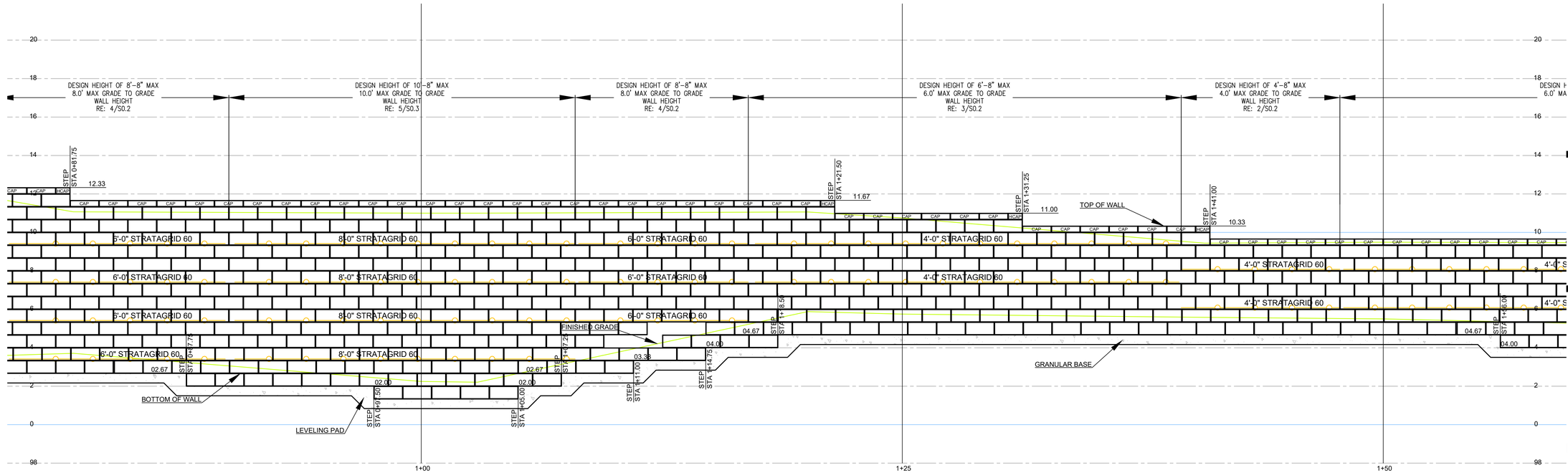
CHECKED BY: JNH

RETAINING WALL 7 PROFILE

S7.1





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RETAINING WALL 8 PROFILE

1 WALL 8 PROFILE
SCALE: 3/8" = 1'-0"

S8.1

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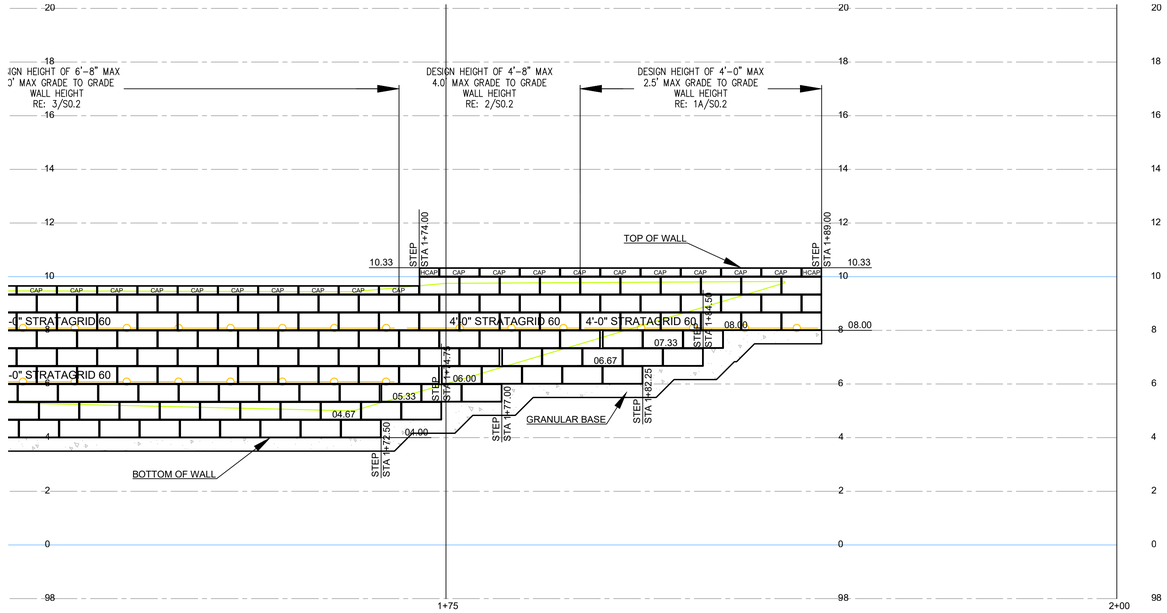
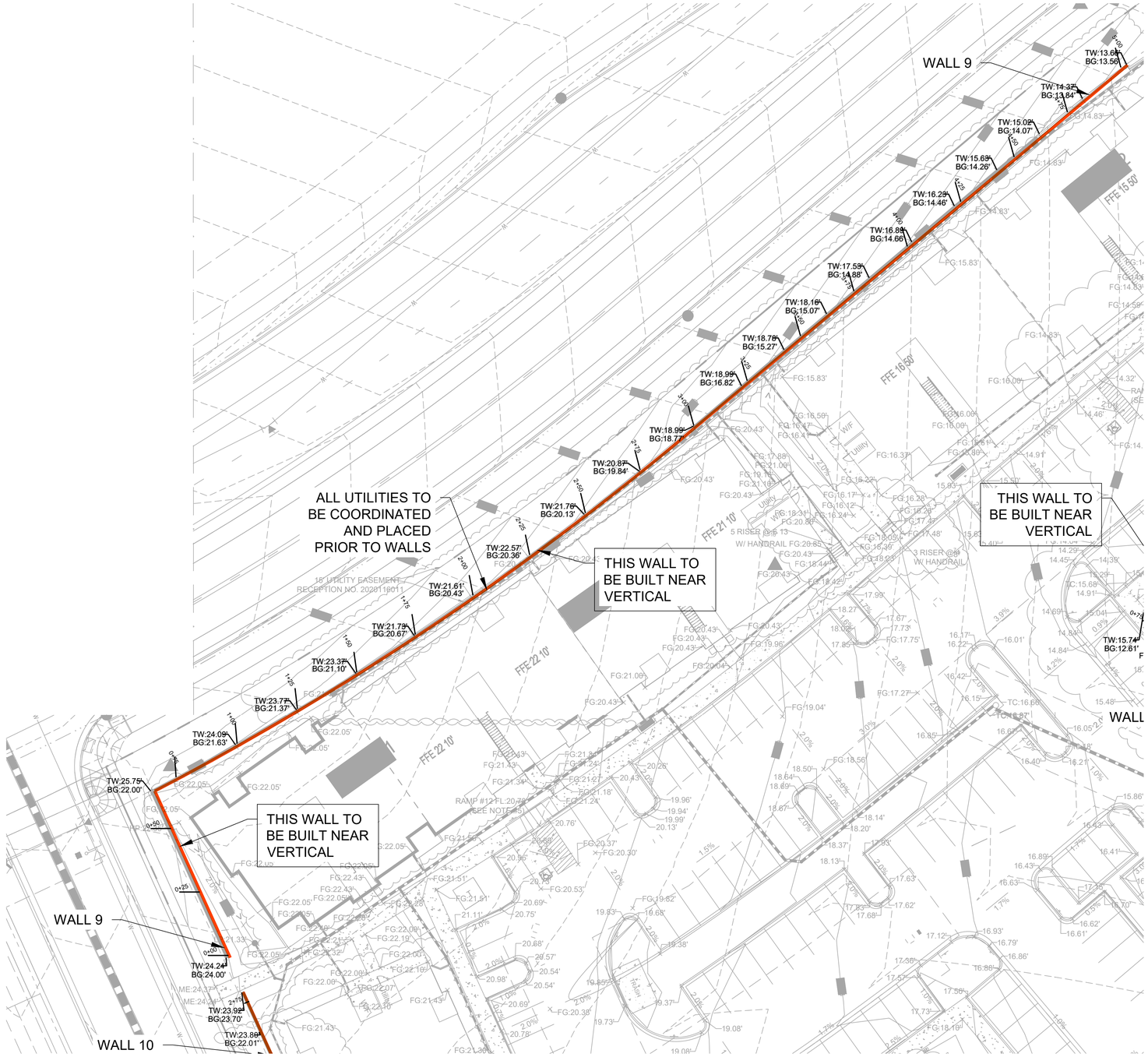
RETAINING WALL 8 PROFILE



1 WALL 8 PROFILE
SCALE: 3/8" = 1'-0"

S8.2



1 SITE PLAN

SCALE: 1" = 20'-0"

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COLORADO REGISTERED JAMES N. HOOLEY 39776 07/30/2024 PROFESSIONAL ENGINEER

N

20' 0 10' 20' 40'
1" = 20' HOR.

PERMIT PHASE
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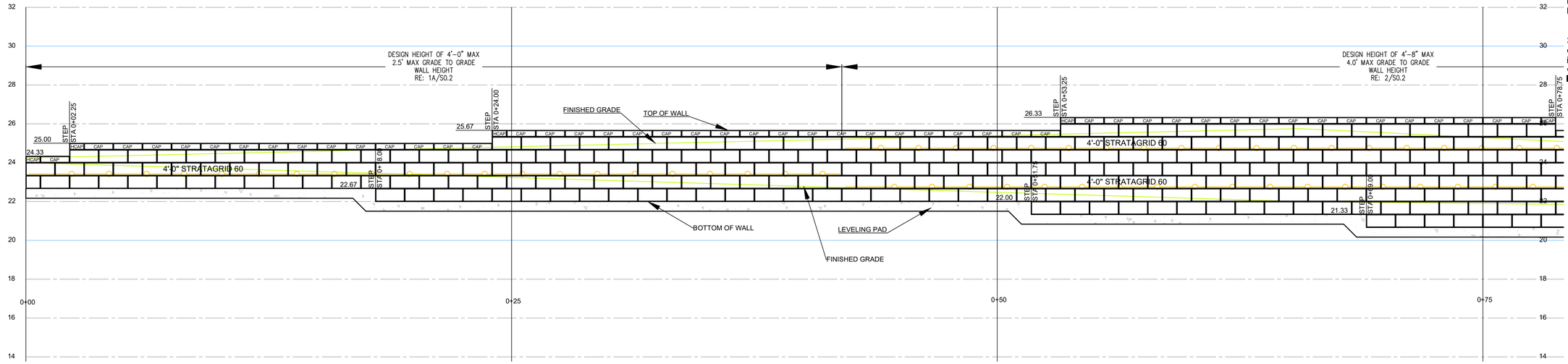
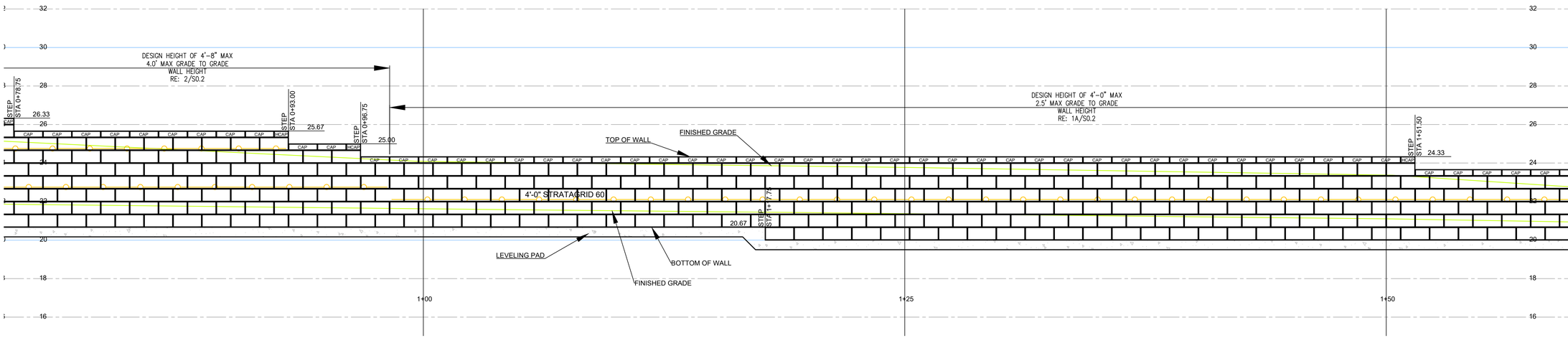
RETAINING WALL
WALL 9
SITE PLAN

S9.0





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7/30/2024
PROFESSIONAL ENGINEER

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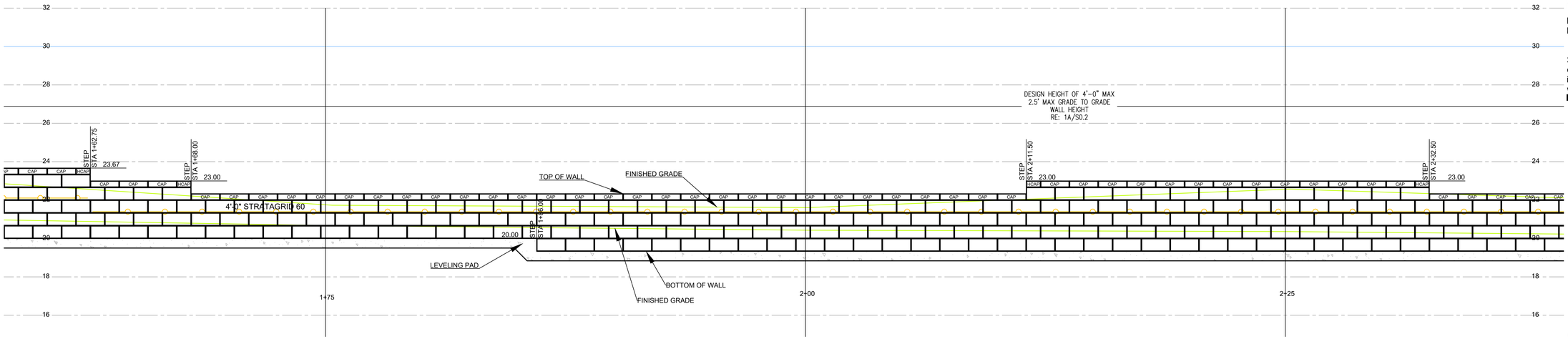
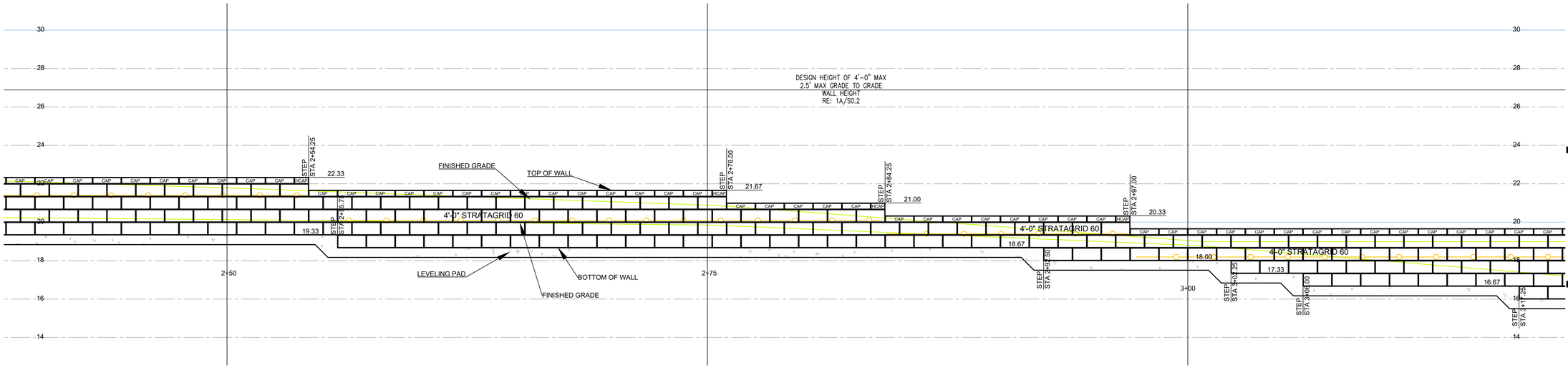
RETAINING WALL 9 PROFILE

1 WALL 9 PROFILE

SCALE: 3/8" = 1'-0"

S9.1





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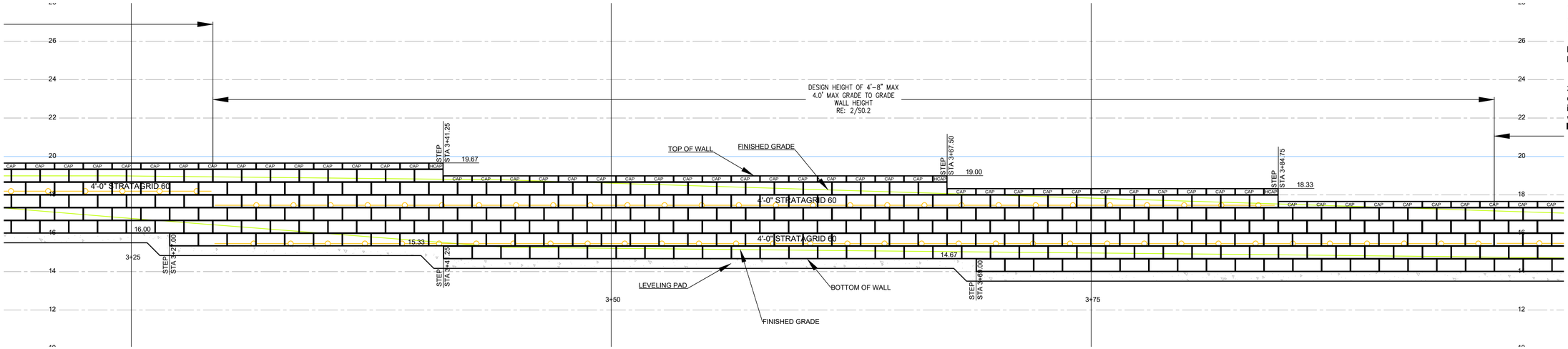
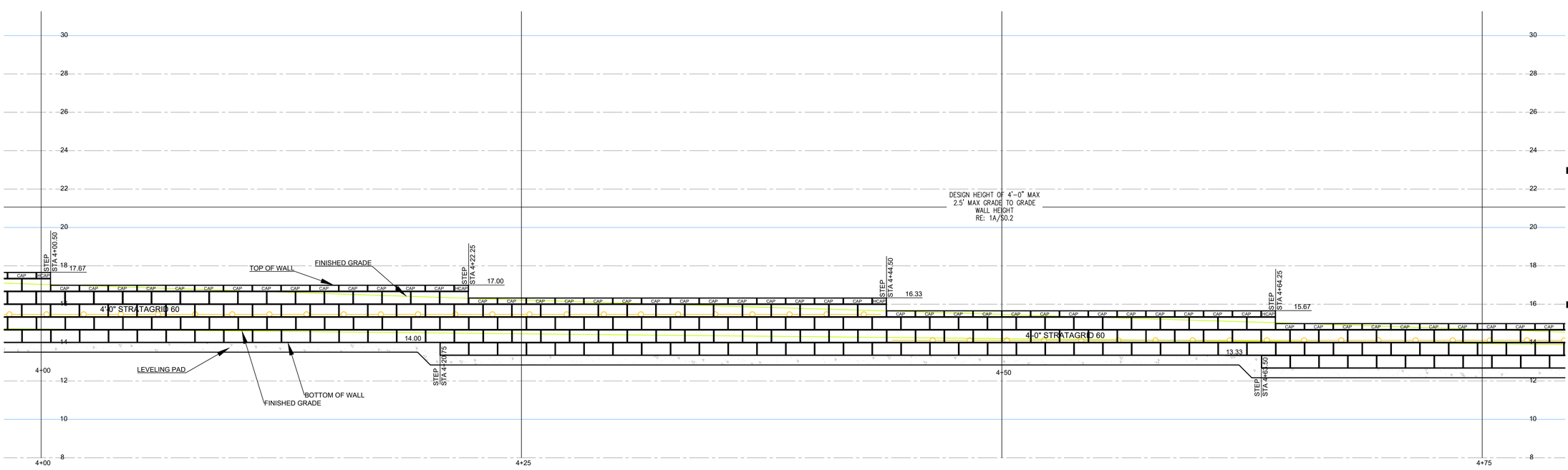
RETAINING WALL 9 PROFILE

1 WALL 9 PROFILE
SCALE: 3/8" = 1'-0"

S9.2





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RETAINING WALL 9 PROFILE

1 WALL 9 PROFILE
SCALE: 3/8" = 1'-0"

S9.3

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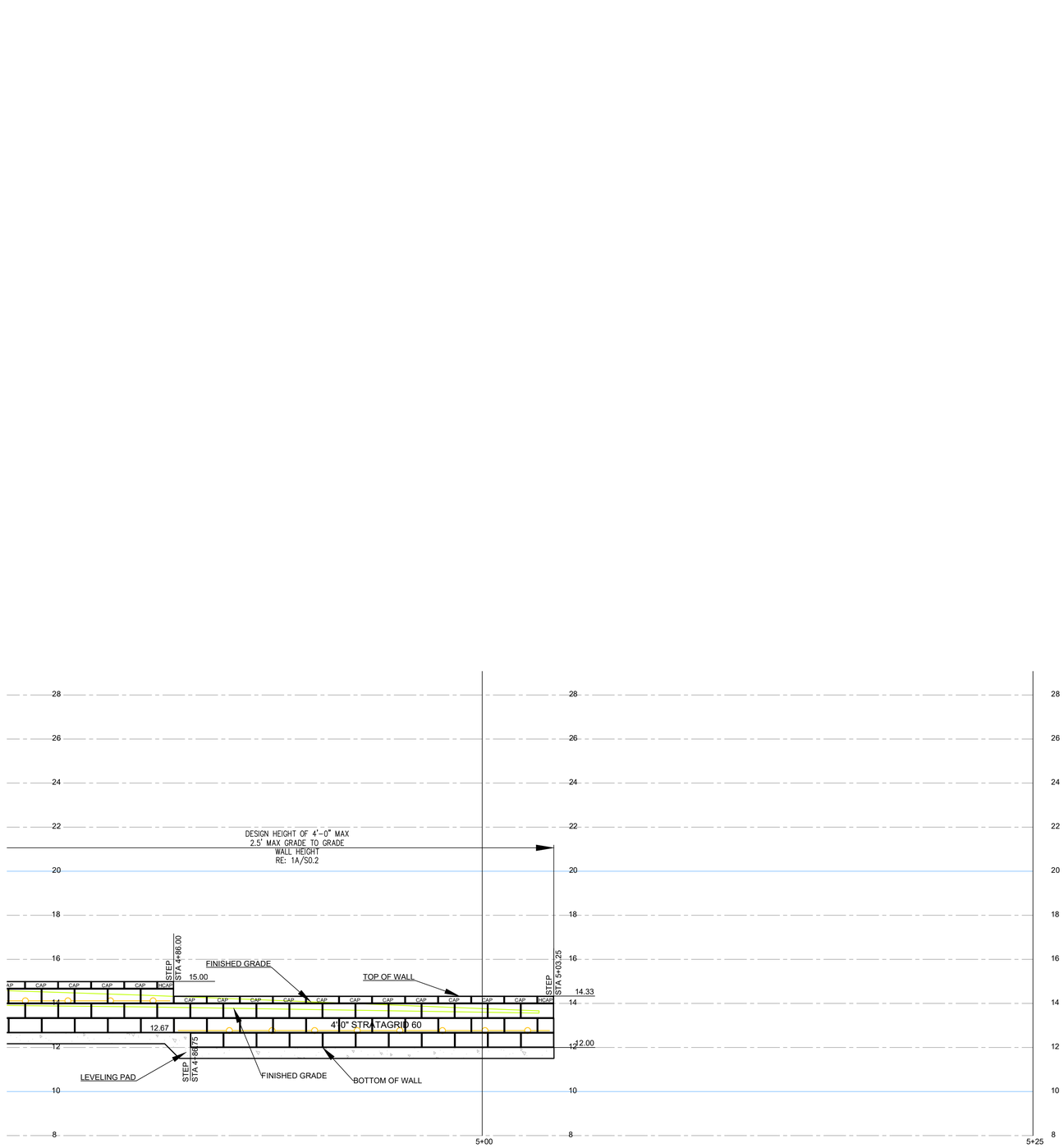
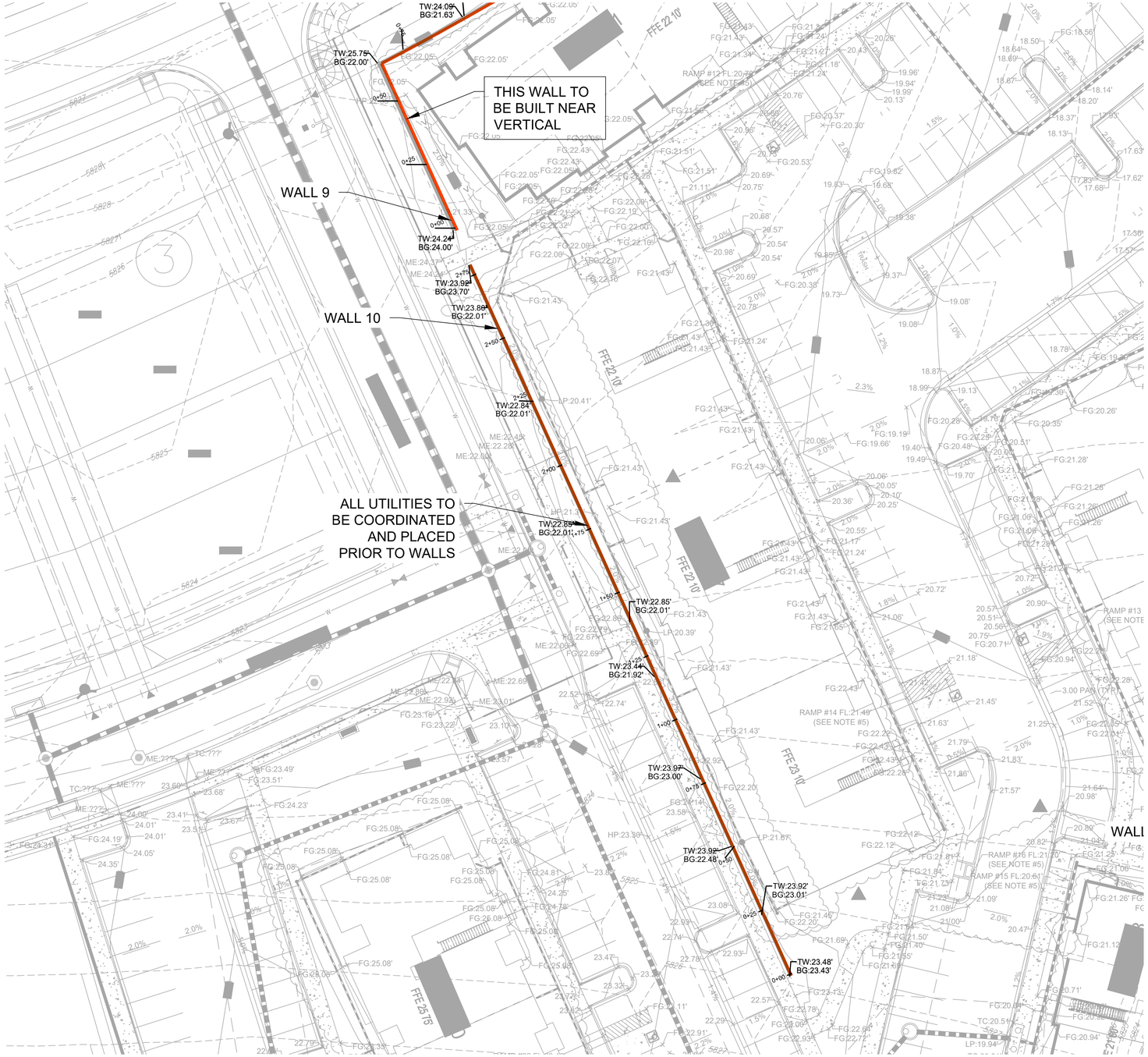
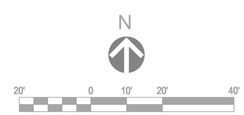


1 WALL 9 PROFILE
SCALE: 3/8" = 1'-0"

S9.4





1 SITE PLAN
SCALE: 1" = 20'-0"

S10.0

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RETAINING WALL
WALL 10
SITE PLAN

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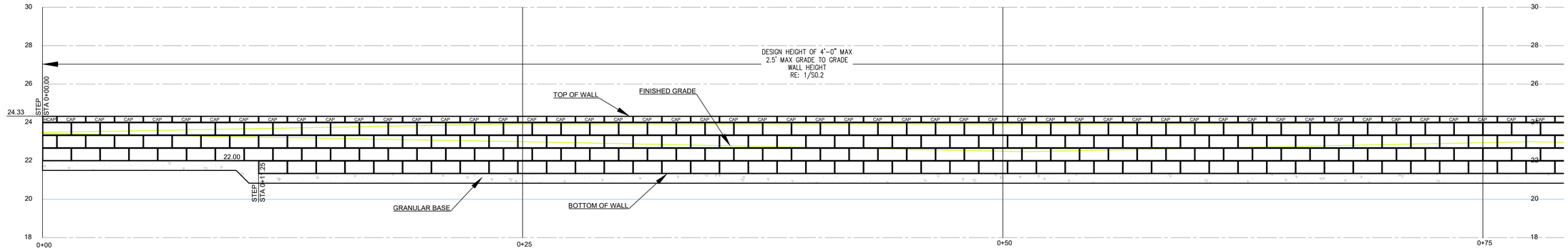

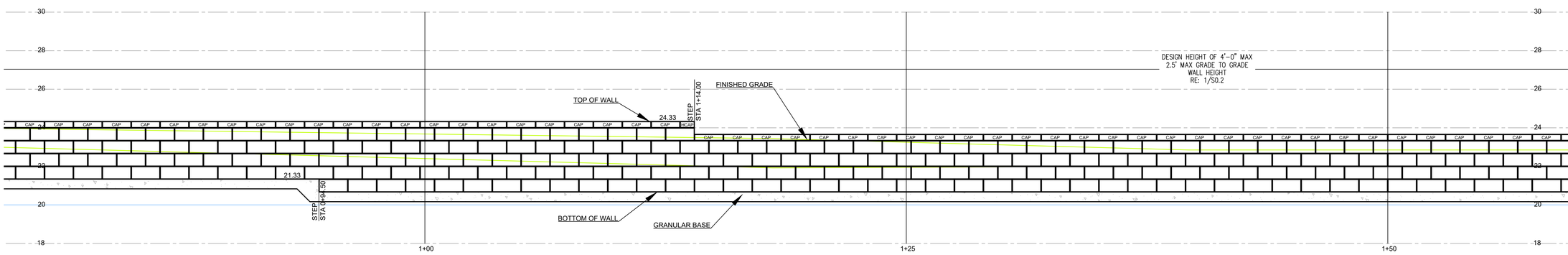

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RETAINING WALL 10 PROFILE

⚠1

1 WALL 10 PROFILE

SCALE: 3/8" = 1'-0"

S10.1

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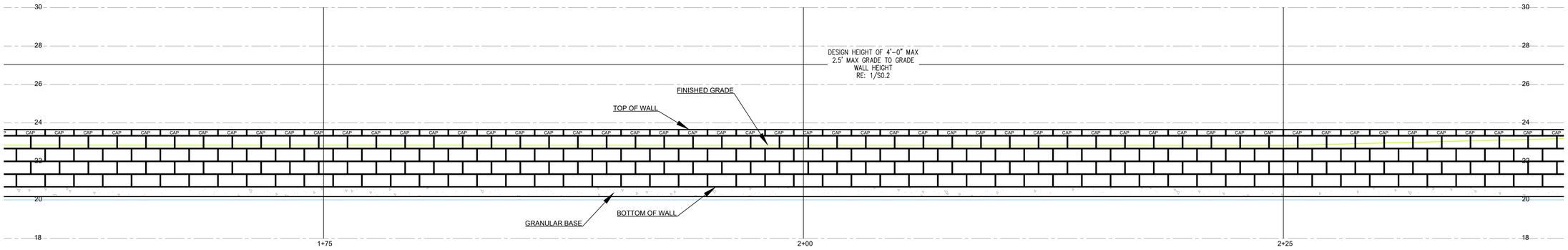

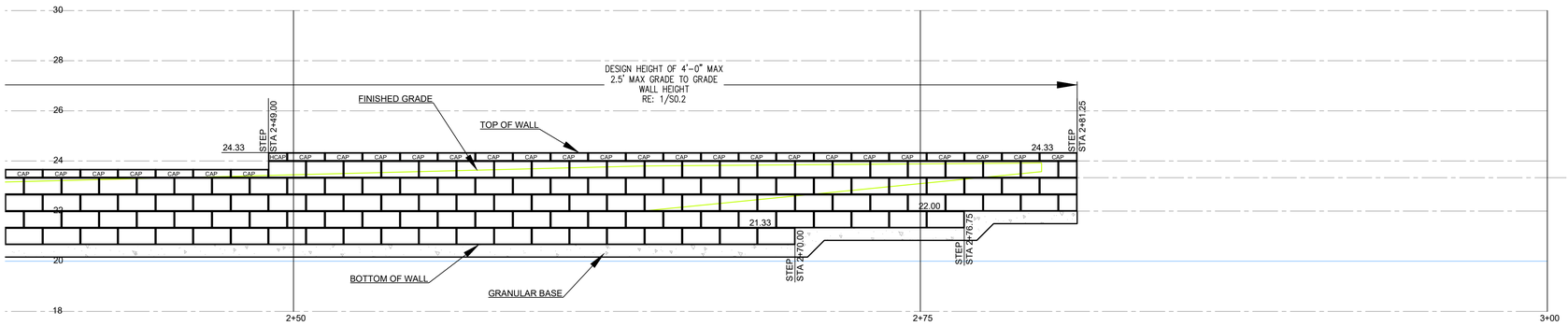

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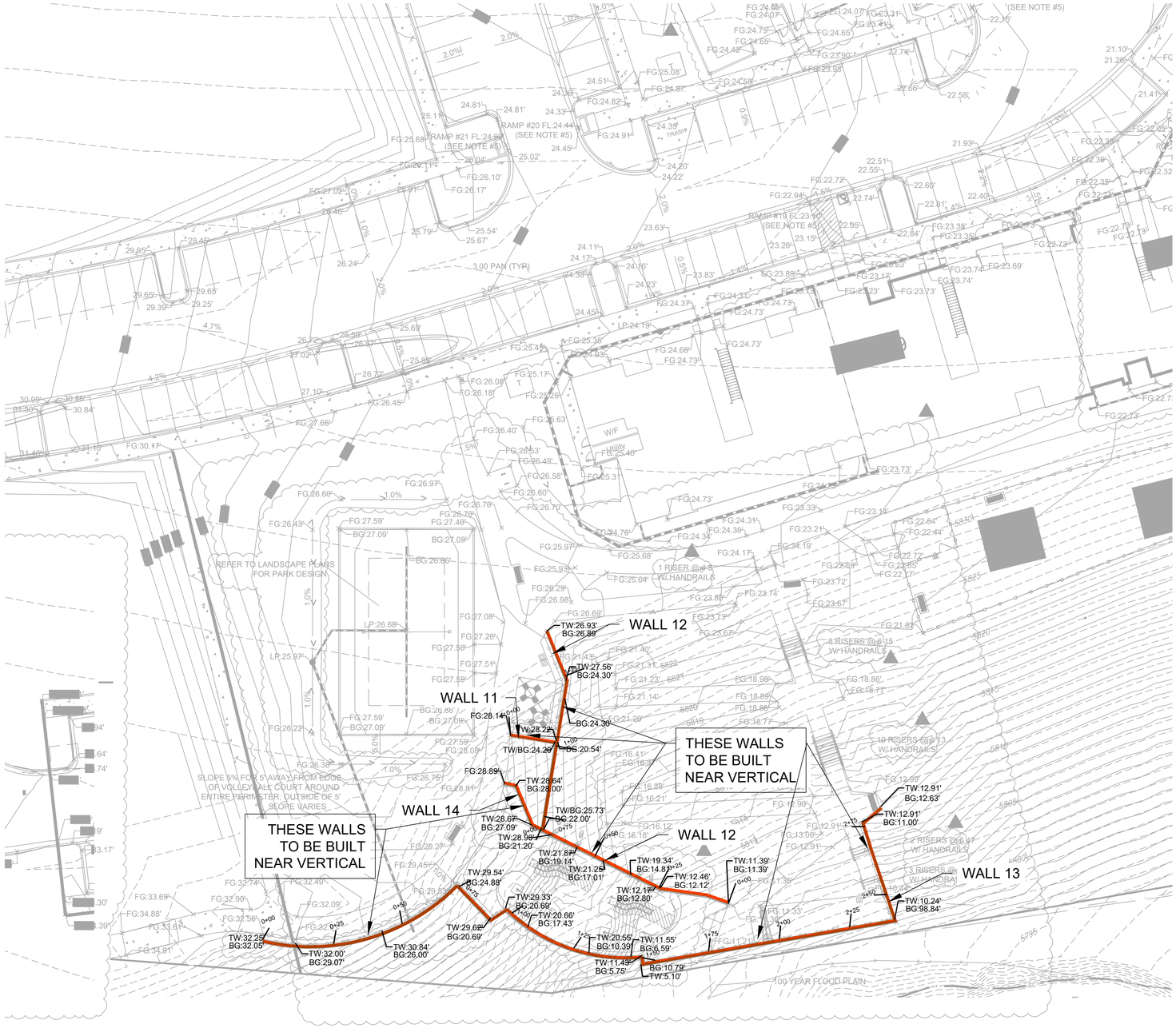
RETAINING WALL 10 PROFILE

⚠1 WALL 10 PROFILE
1 SCALE: 3/8" = 1'-0"

S10.2



N

20' 0 10' 20' 40'

1" = 20' HOR.

1 SITE PLAN

SCALE: 1" = 20'-0"

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RETAINING WALL
WALLS 11. 12. 13.
AND 14. SITE PLAN

S11.0

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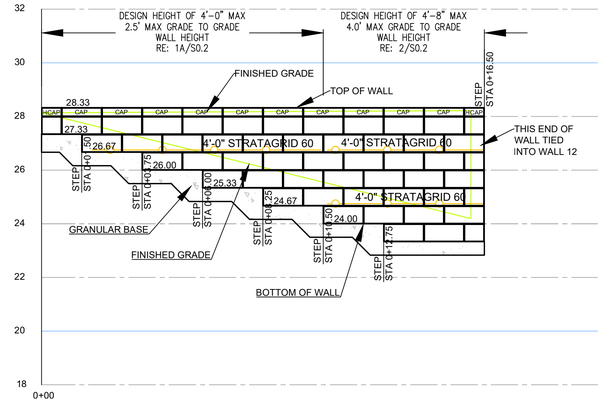

1 WALL 11 PROFILE
SCALE: 3/8" = 1'-0"

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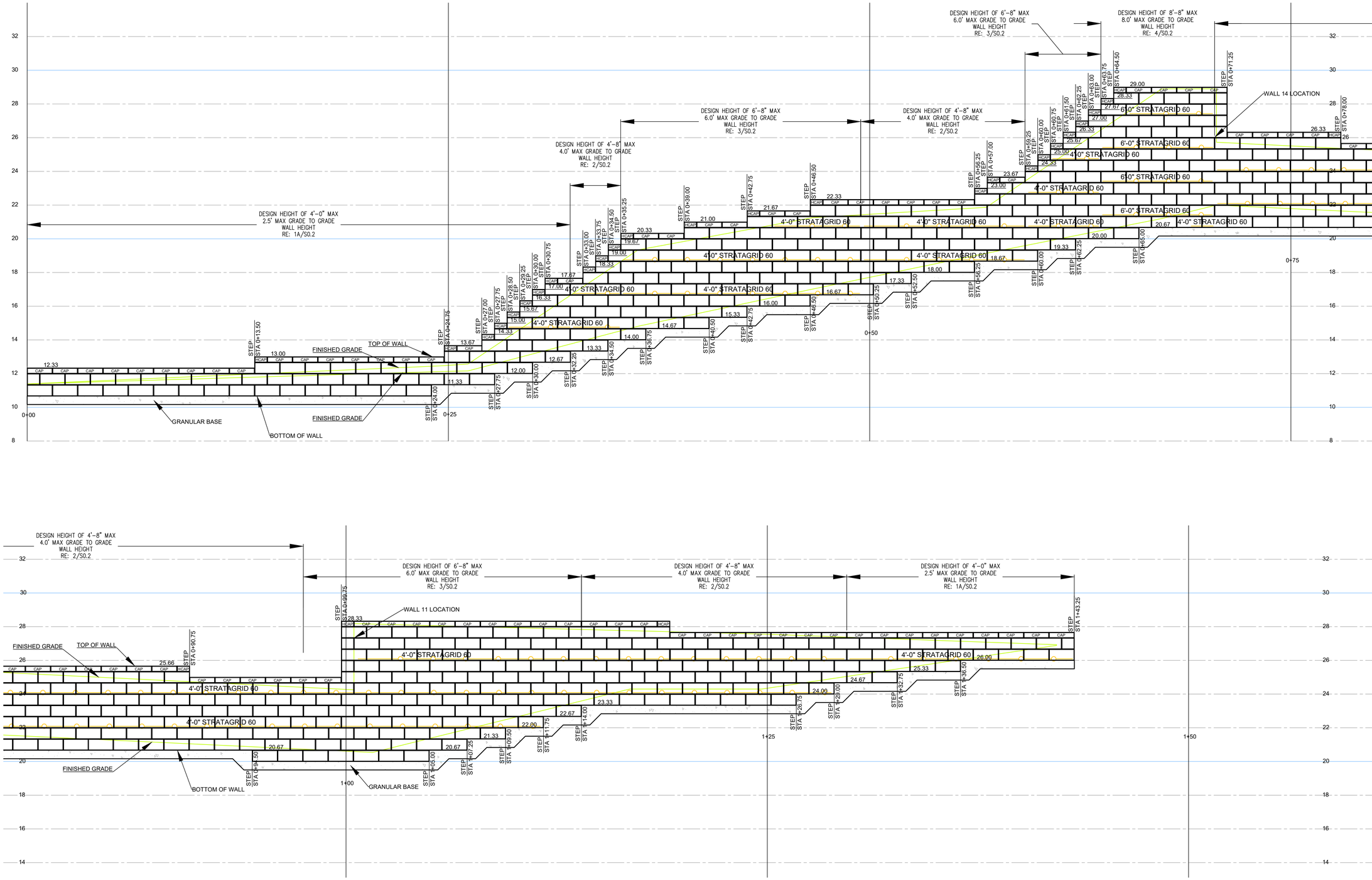
RETAINING WALL 11 PROFILE

S11.1



WALL 12 PROFILE

1 SCALE: 3/8" = 1'-0"

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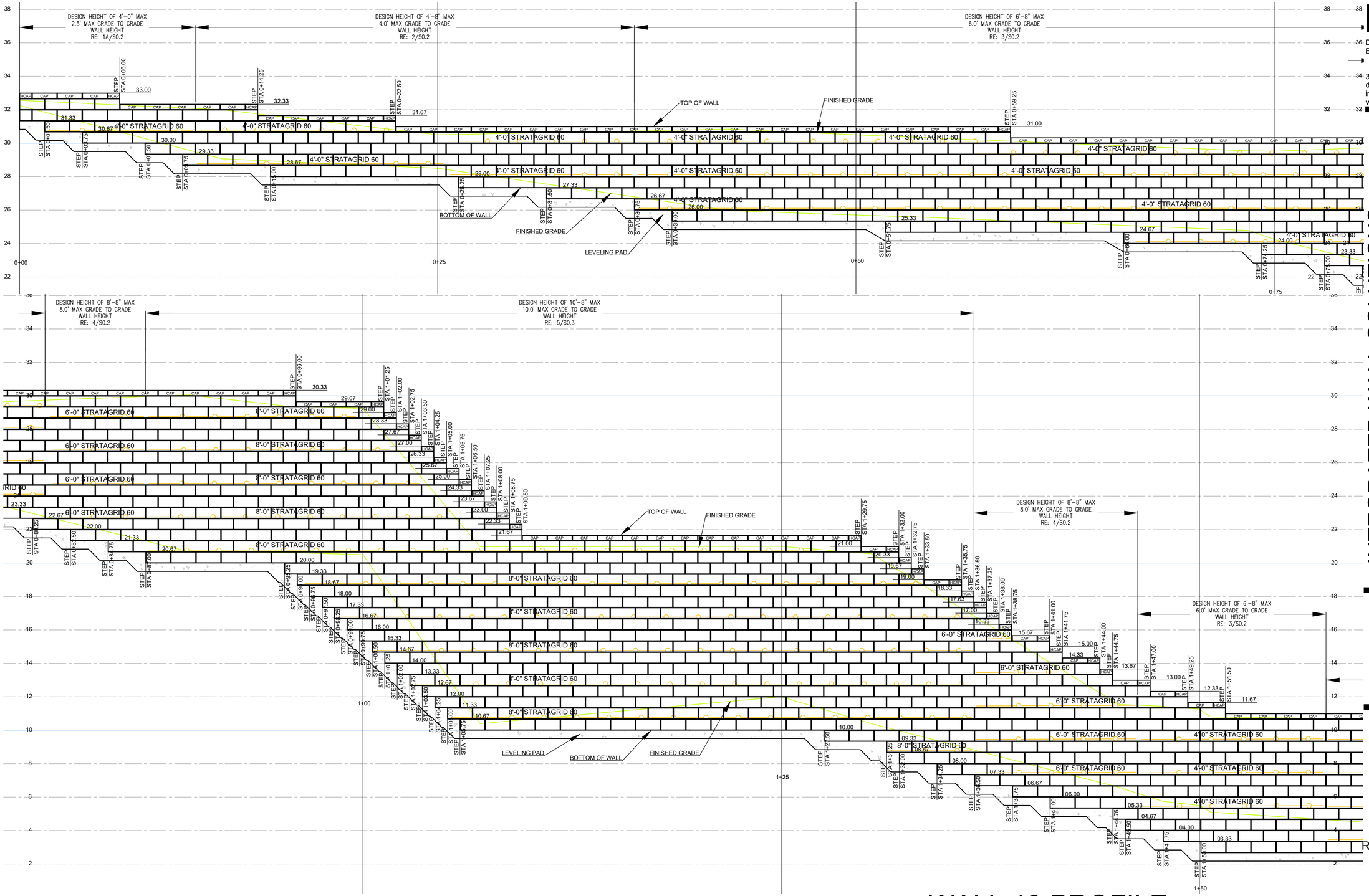
RETAINING WALL 12 PROFILE

S12.1



WALL 13 PROFILE

1 SCALE: 3/8" = 1'-0"

S13.1

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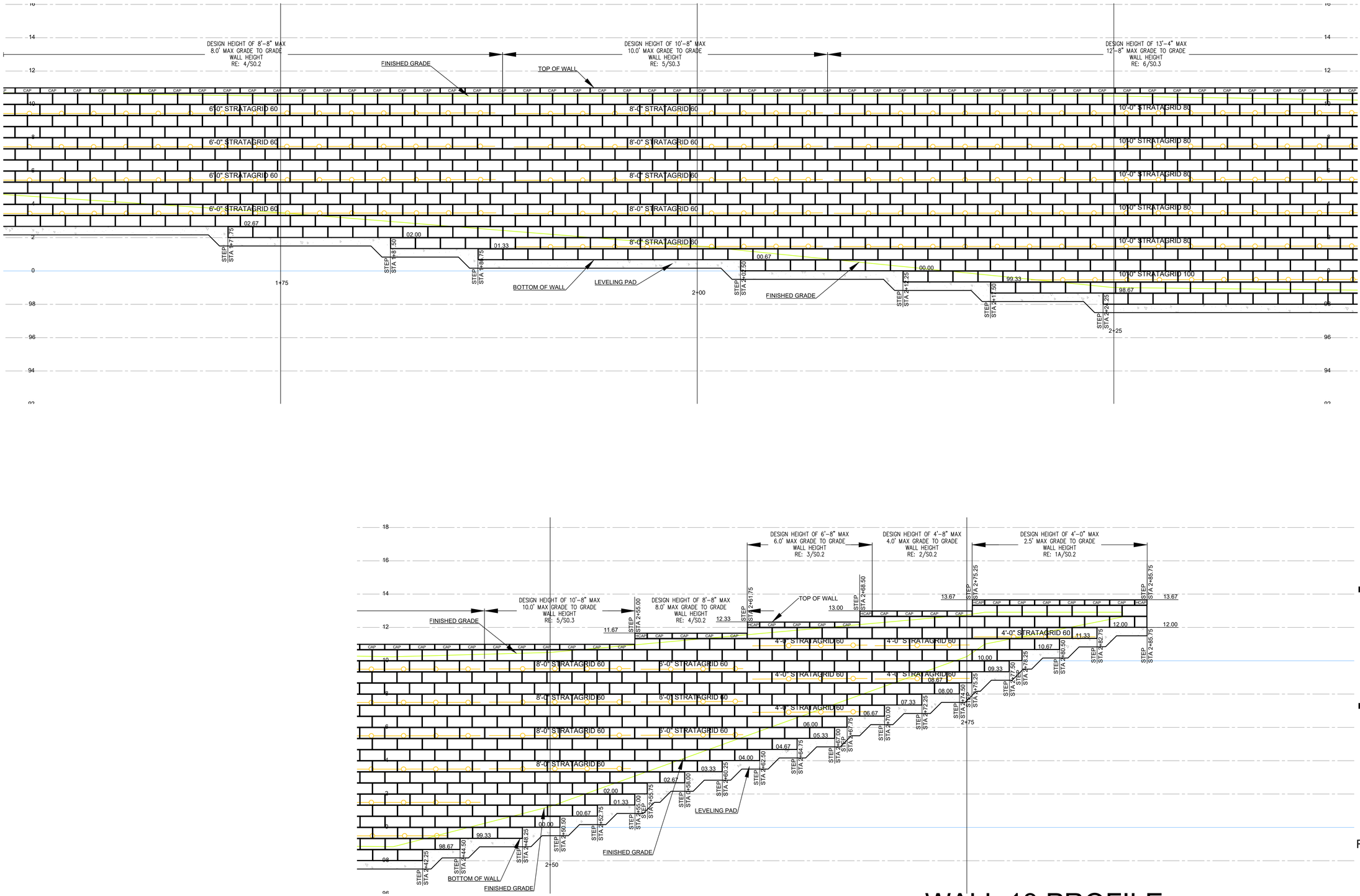
RETAINING WALL 13
PROFILE



WALL 13 PROFILE

1 SCALE: 3/8" = 1'-0"

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RETAINING WALL 13 PROFILE

S13.2

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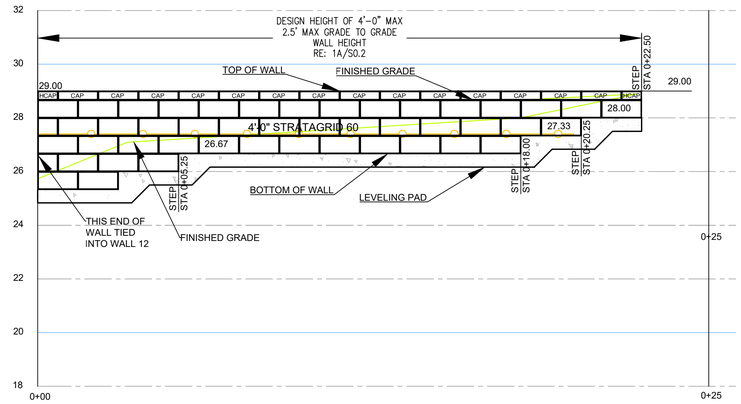

1 WALL 14 PROFILE
SCALE: 3/8" = 1'-0"

RETAINING WALL 14
PROFILE

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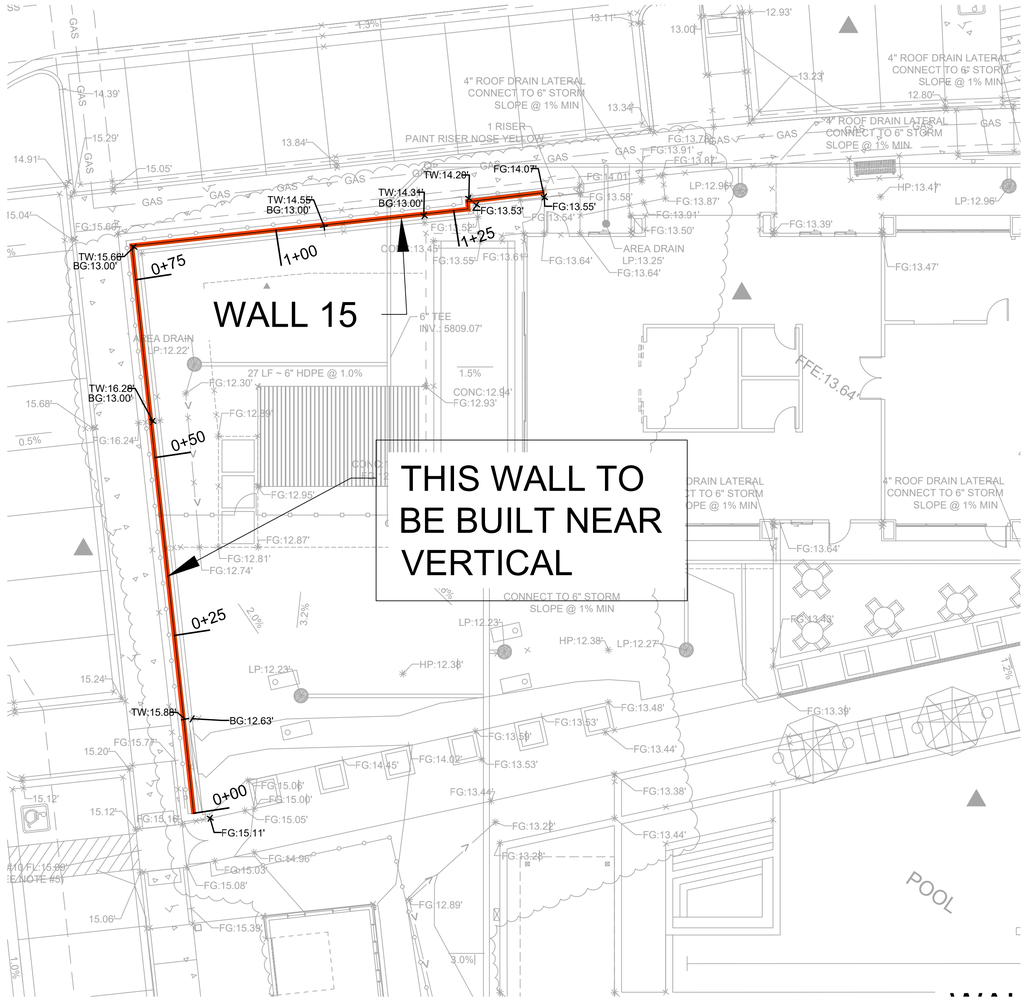
S14.1



1 SITE PLAN

SCALE: 1" = 10'-0"

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RETAINING WALL
WALLS 15
SITE PLAN

S15.0

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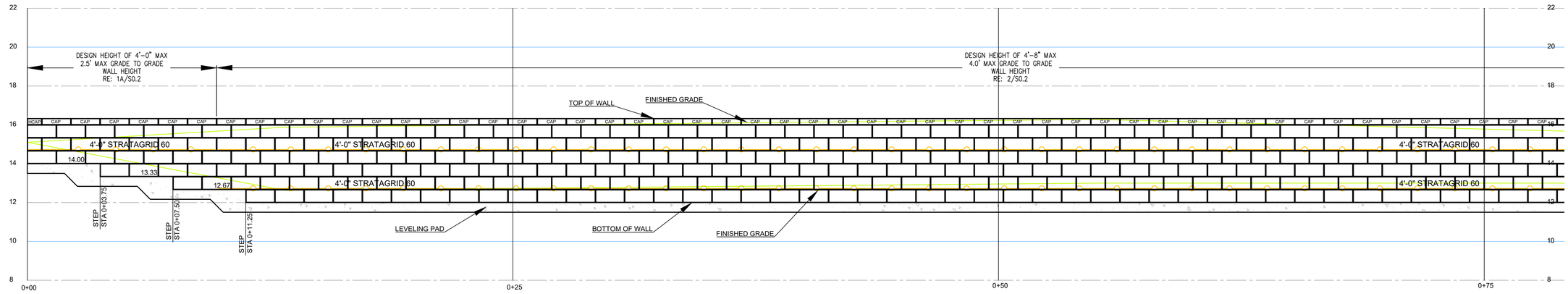
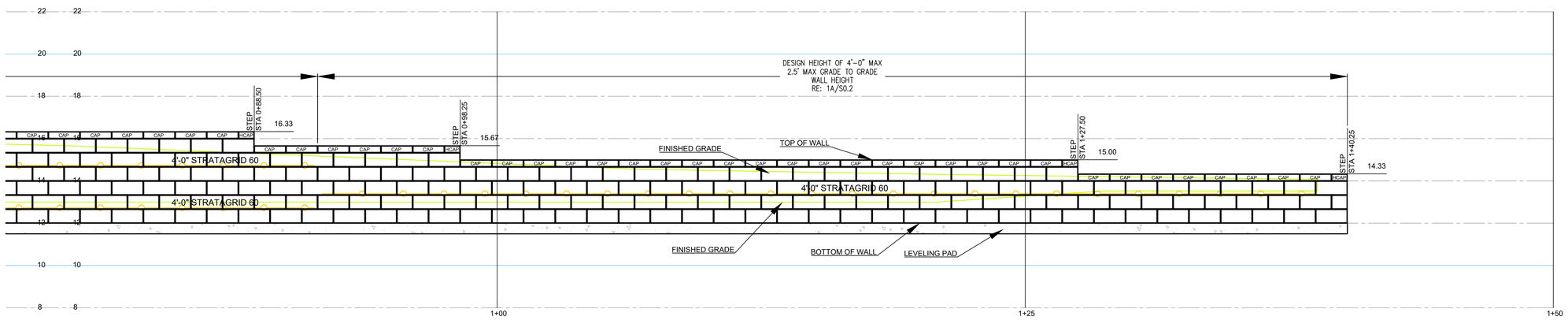


1 WALL 15 PROFILE

SCALE: 3/8" = 1'-0"



2 WALL 15 PROFILE

SCALE: 3/8" = 1'-0"

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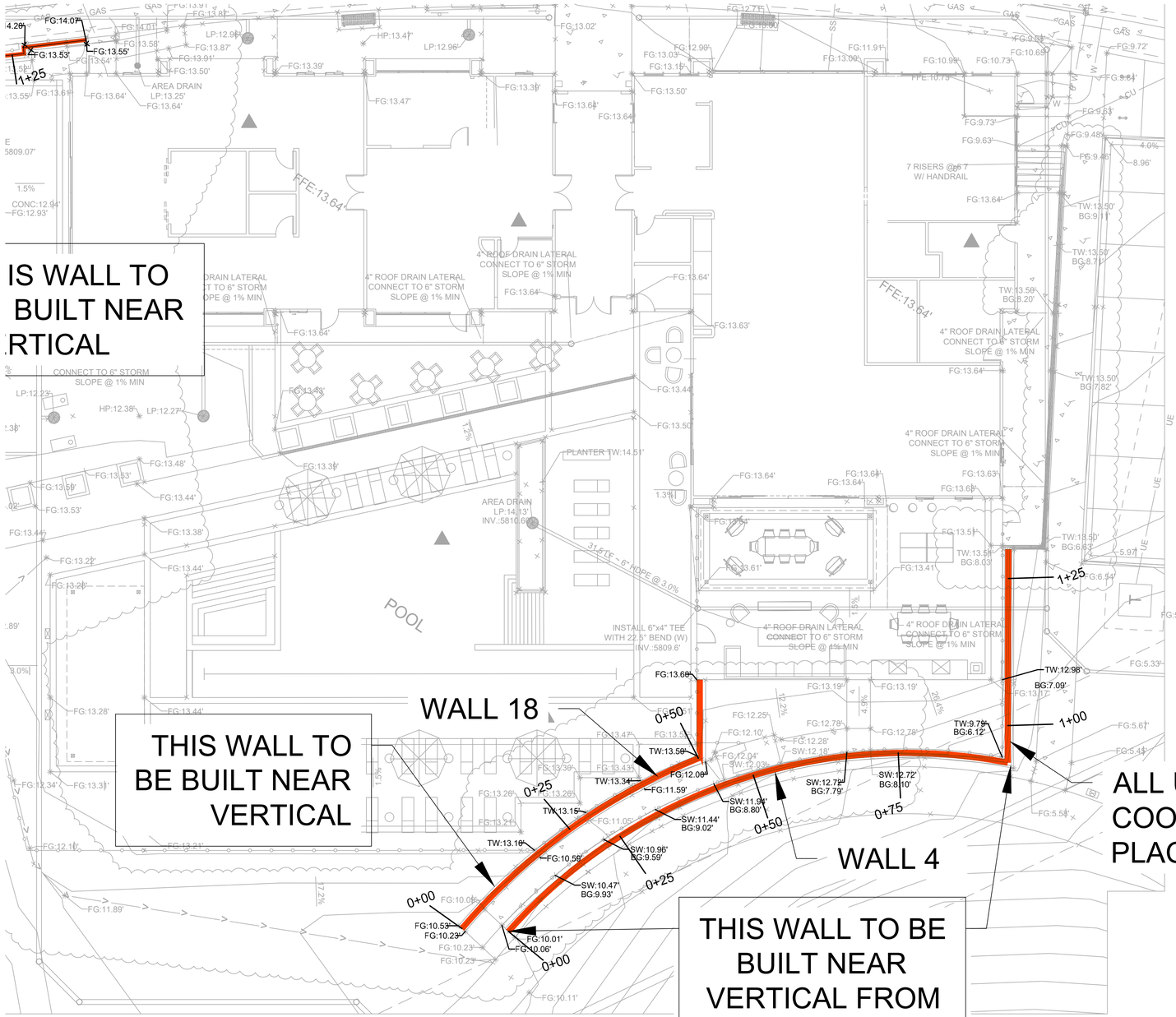
RETAINING WALL 15 PROFILE

S15.1



1 SITE PLAN

SCALE: 1" = 20'-0"

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RETAINING WALL
WALLS 18
SITE PLAN

S16.0

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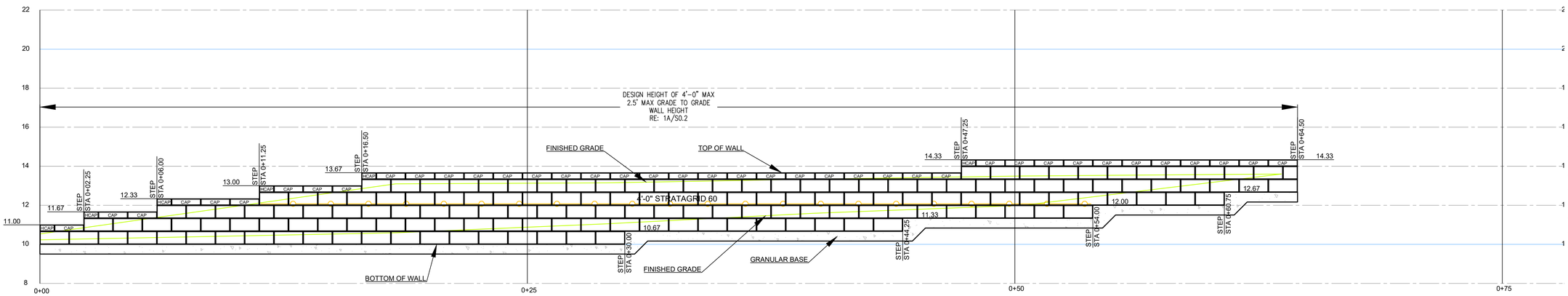

1 WALL 18 PROFILE
SCALE: 3/8" = 1'-0"

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RETAINING WALL 18 PROFILE

S16.1

Calculation Package

For

INTEGRATED WALL COMPARK VILLAGE SOUTH - APARTMENTS

DOUGLAS COUNTY, COLORADO

1/3/2023

Prepared By:
Zuhuri H Manley
Shoring Designer

Reviewed By:
Jim N. Houlette, P.E.
Director of Structural Engineering

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303.679.1862 fax
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Prefab wall analysis

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 3' Max Wall Height
Customer : Integrated Walls
Author : ZHM
Date : 12/2/2022
Project number : 22A252

Settings

USA - Safety factor

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]

Geometry of structure

Slope of wall = 0.00 °

No.	Width b [ft]	Height h [ft]	Offset k [ft]	Offs.(L) o_1 [ft]	Offs.(R) o_2 [ft]	Merge	Self w. [pcf]	Friction [–]	Cohesion [psf]	Shear bear.cap. R_s [lbf/ft]
6	1.00	0.67	0.08	0.00	0.00	No	88.60	0.533	50.0	200.00
5	1.00	0.67	0.08	0.00	0.00	No	88.60	0.533	50.0	200.00
4	1.00	0.67	0.08	0.00	0.00	No	88.60	0.533	50.0	200.00
3	1.00	0.67	0.08	0.00	0.00	No	88.60	0.533	50.0	200.00
2	1.00	0.67	0.08	0.00	0.00	No	88.60	0.533	50.0	200.00
1	1.00	0.67	0.00	0.00	0.00	-	88.60	-	-	-

Note: Blocks are ordered from bottom to the top

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	On Site Soil		25.00	100.0	120.00	62.50	18.00

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	CDOT Class I strcutural fill		34.00	0.0	125.00	67.50	17.00

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

Soil parameters

On Site Soil

Unit weight : $\gamma = 120.0$ pcf
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 25.00$ °
Cohesion of soil : $c_{ef} = 100.0$ psf
Angle of friction struc.-soil : $\delta = 18.00$ °
Soil : cohesionless
Saturated unit weight : $\gamma_{sat} = 125.0$ pcf

CDOT Class I strcutural fill

Unit weight : $\gamma = 125.0$ pcf
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 34.00$ °
Cohesion of soil : $c_{ef} = 0.0$ psf
Angle of friction struc.-soil : $\delta = 17.00$ °
Soil : cohesionless
Saturated unit weight : $\gamma_{sat} = 130.0$ pcf

Backfill

Assigned soil : CDOT Class I strcutural fill
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Foundation

Type of foundation : strip foundation
Soil of foundation - CDOT Class I strcutural fill

Geometry

Foundation thickness $h = 0.50$ ft
Offset left $b_l = 0.50$ ft
Offset right $b_p = 0.50$ ft

Terrain profile

Terrain behind construction has the slope 1: 28.64 (slope angle is 2.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - CDOT Class I strcutural fill
Soil thickness in front of structure $h = 1.50$ ft

Terrain in front of structure is flat.

Global settings

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.
Reduction of soil/soil friction angle : do not reduce

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	-2.01	356.2	0.70	1.000
FF resistance	-497.4	-0.50	0.0	0.00	1.000
Active pressure	252.9	-1.34	77.3	1.12	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 336.1 lbfft/ft
Overturning moment M_{ovr} = 90.3 lbfft/ft

Safety factor = 3.72 > 1.50
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 292.40 lbf/ft
Active horizontal force H_{act} = -244.51 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-29.0	433.49	-244.51	0.000	433.5

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-29.0	433.49	-244.51

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 433.5 psf

Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 4.61 > 2.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

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	-0.34	59.4	0.50	1.000
Active pressure	7.0	-0.22	2.1	1.00	1.000

Verification of construction joint above the block No.: 5

Check for overturning stability
Resisting moment M_{res} = 31.8 lbfft/ft
Overturning moment M_{ovr} = 1.6 lbfft/ft

Safety factor = 20.27 > 1.50
Joint for overturning stability is SATISFACTORY

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 278.78 lbf/ft
Active horizontal force H_{act} = 6.99 lbf/ft

Safety factor = 39.90 > 1.50
Joint for slip is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

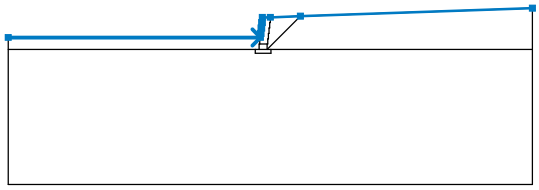
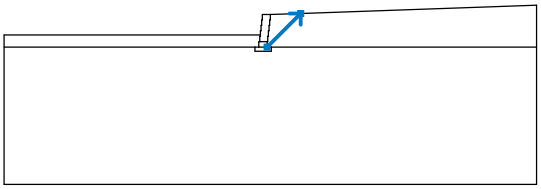
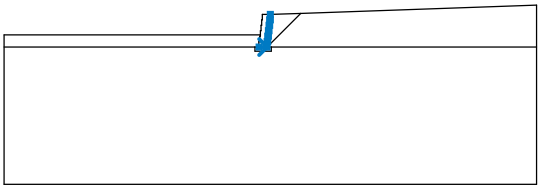
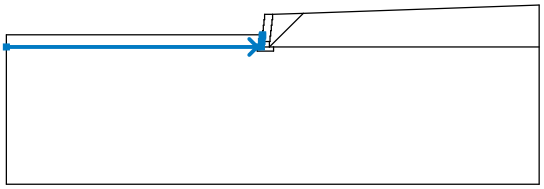
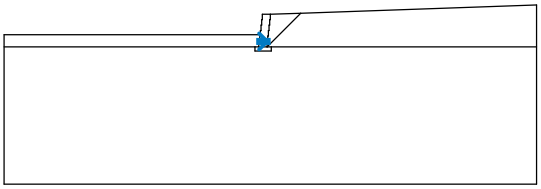
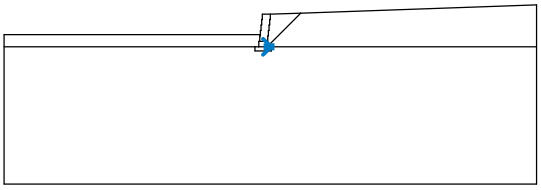
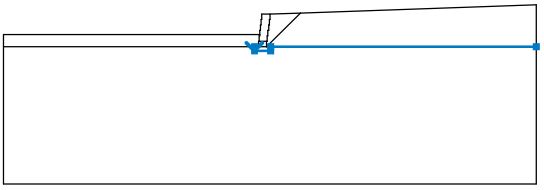
USA - Safety factor

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-2.52	-1.24	-2.52	-1.24	-2.01
		-1.16	-2.01	-1.16	-1.34	-1.08	-1.34
		-1.08	-0.67	-1.00	-0.67	-1.00	0.00
		0.00	0.00	3.75	0.13	32.80	1.15
2		-0.40	-4.02	3.75	0.13		
3		-1.40	-4.02	-0.40	-4.02	-0.40	-3.35
		-0.32	-3.35	-0.32	-2.68	-0.24	-2.68
		-0.24	-2.01	-0.16	-2.01	-0.16	-1.34
		-0.08	-1.34	-0.08	-0.67	0.00	-0.67
		0.00	0.00				
4		-32.80	-4.02	-1.90	-4.02	-1.40	-4.02
		-1.40	-3.35	-1.32	-3.35	-1.32	-2.68
		-1.24	-2.68	-1.24	-2.52		
5		-1.32	-3.35	-0.40	-3.35		
6		-0.40	-4.02	0.10	-4.02		
7		-1.90	-4.02	-1.90	-4.52	0.10	-4.52
		0.10	-4.02	32.80	-4.02		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

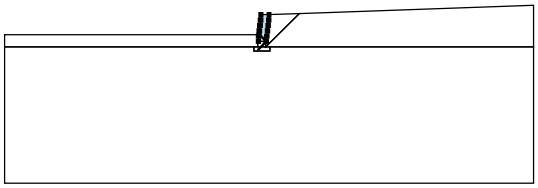
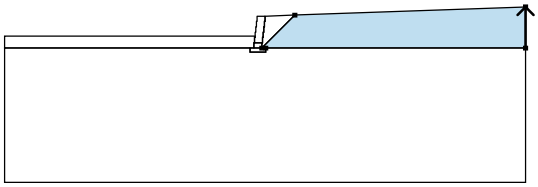
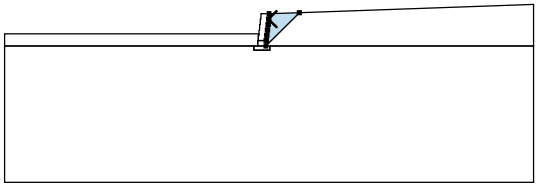
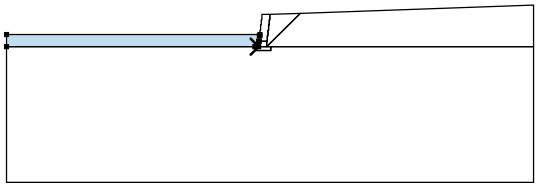
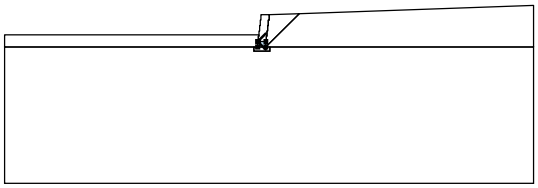
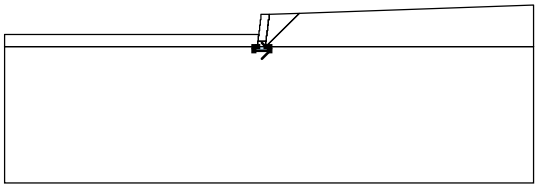
CDOT Class I strcutural fill

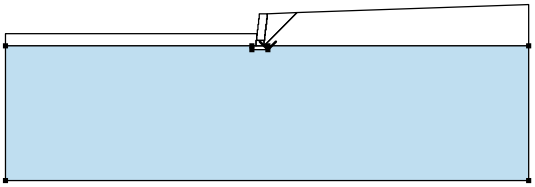
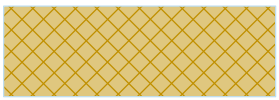
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.40	-3.35	-0.32	-3.35	Material of structure
		-0.32	-2.68	-0.24	-2.68	
		-0.24	-2.01	-0.16	-2.01	
		-0.16	-1.34	-0.08	-1.34	
		-0.08	-0.67	0.00	-0.67	
		0.00	0.00	-1.00	0.00	
		-1.00	-0.67	-1.08	-0.67	
		-1.08	-1.34	-1.16	-1.34	
		-1.16	-2.01	-1.24	-2.01	
		-1.24	-2.52	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
2		32.80	-4.02	32.80	1.15	On Site Soil
		3.75	0.13	-0.40	-4.02	
		0.10	-4.02			
3		0.00	-0.67	-0.08	-0.67	CDOT Class I strcutural fill
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	
		-0.40	-4.02	3.75	0.13	
		0.00	0.00			
4		-1.90	-4.02	-1.40	-4.02	CDOT Class I strcutural fill
		-1.40	-3.35	-1.32	-3.35	
		-1.32	-2.68	-1.24	-2.68	
		-1.24	-2.52	-32.80	-2.52	
		-32.80	-4.02			
5		-1.32	-3.35	-1.40	-3.35	Material of structure
		-1.40	-4.02	-0.40	-4.02	
		-0.40	-3.35			
6		-1.90	-4.52	0.10	-4.52	CDOT Class I strcutural fill
		0.10	-4.02	-0.40	-4.02	
		-1.40	-4.02	-1.90	-4.02	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		0.10	-4.02	0.10	-4.52	On Site Soil
		-1.90	-4.52	-1.90	-4.02	
		-32.80	-4.02	-32.80	-20.92	
		32.80	-20.92	32.80	-4.02	

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.22	[ft]	Angles :	α_1 =	-50.51	[°]
	z =	0.24	[ft]		α_2 =	88.26	[°]
Radius :	R =	4.34	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 559.6 lbf/ft
Sum of passive forces : F_p = 1655.8 lbf/ft

Sliding moment : M_a = 2428.6 lbfft/ft
Resisting moment : M_p = 7186.0 lbfft/ft

Factor of safety = 2.96 > 1.50

Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 4' Max MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 7
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 2XT	Miragrid 2XT	————	2000.84	505.26	0.70	0.70

Reinforcement details

1. Miragrid 2XT

Short-term char. strength	T_{ult}	=	2000.84	lbf/ft
Long-term design strength	R_t	=	505.26	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.50

Reinforcement

Total number of input reinforcements : 2.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 2XT	-0.32	3.68	1.34	4.00
6	Miragrid 2XT	-0.08	3.92	3.35	4.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0	pcf
Angle of internal friction :	φ_{ef}	=	25.00	°
Cohesion of soil :	c_{ef}	=	100.0	psf
Angle of friction struc.-soil :	δ	=	18.00	°
Saturated unit weight :	γ_{sat}	=	125.0	pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0	pcf
Angle of internal friction :	φ_{ef}	=	34.00	°
Cohesion of soil :	c_{ef}	=	0.0	psf
Angle of friction struc.-soil :	δ	=	17.00	°
Saturated unit weight :	γ_{sat}	=	130.0	pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-2.49	2507.7	3.30	1.000
Active pressure	140.4	-0.88	46.1	5.11	1.000
Weight - wall	0.0	-2.35	415.5	0.74	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 8815.6 lbfft/ft
Overturning moment M_{ovr} = -217.7 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1884.62 lbf/ft
Active horizontal force H_{act} = -483.03 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-2.35	415.5	0.74	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	374.0	-1.56	114.3	1.15	1.000
Reinforcement	-505.3	-1.34	0.0	1.80	1.000
Reinforcement	-447.9	-3.35	0.0	3.00	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability

Resisting moment M_{res} = 2616.4 lbfft/ft
Overturning moment M_{ovr} = 475.6 lbfft/ft

Safety factor = 5.50 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 1485.61 lbf/ft
Active horizontal force H_{act} = 55.37 lbf/ft

Safety factor = 26.83 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2318.3	809.42	-1020.10	0.000	404.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2318.3	809.42	-1020.10

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 404.7 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 4.94 > 1.30

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-1.67	296.8	-0.26	1.000
Active pressure	67.4	-0.58	31.4	4.08	1.000
Weight - reinforced soil	0.0	-1.79	1741.9	2.13	1.000
Reinforcement	-70.8	0.00	0.0	3.92	1.000
Reinforcement	-86.0	-2.01	0.0	3.92	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 1773.35 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.70
Resistance along geo-reinforcement = 837.30 lbf/ft
Wall resistance = 404.20 lbf/ft
Overall bearing capacity of reinforcements = 156.85 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 1398.35 lbf/ft
Active horiz. force H_{act} = 67.42 lbf/ft

Factor of safety = 20.74 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 505.26 lbf/ft
Force in reinforcement F_x = 242.53 lbf/ft

Safety factor = 2.08 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 1447.32 lbf/ft
Force in reinforcement F_x = 242.53 lbf/ft

Safety factor = 5.97 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-1.41;-2.24) ft
Radius r = 7.58 ft
Angle α_1 = -35.38 °
α_2 = 80.28 °

Slope stability check (Bishop)

FS = 2.37 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

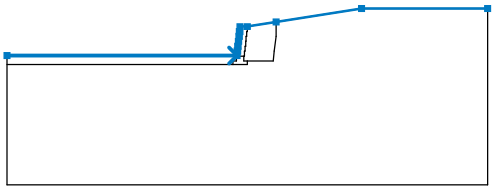
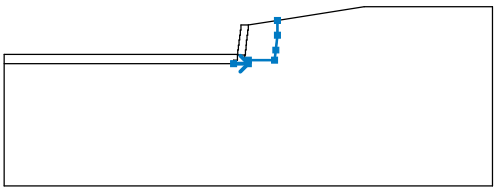
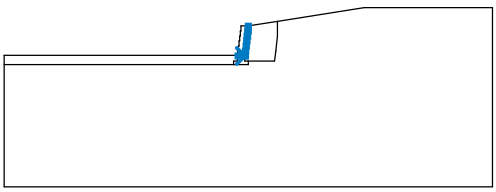
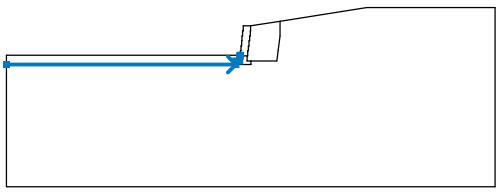
(input for current task)

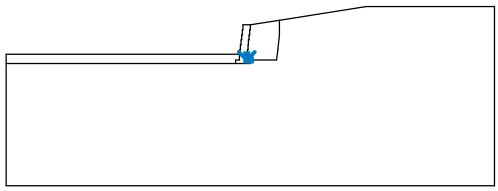
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-3.94	-1.40	-3.94	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	3.92	0.62
		15.57	2.47	32.80	2.47		
2		-1.98	-5.19	0.02	-5.19	0.02	-4.69
		3.52	-4.69	3.68	-3.35	3.92	-1.34
		3.92	0.62				
3		-1.40	-4.02	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		
4		-32.80	-5.19	-1.98	-5.19	-1.98	-4.69
		-1.48	-4.69	-1.48	-4.02	-1.40	-4.02
		-1.40	-3.94				

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-0.48	-4.02	-0.48	-4.69	0.02	-4.69

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

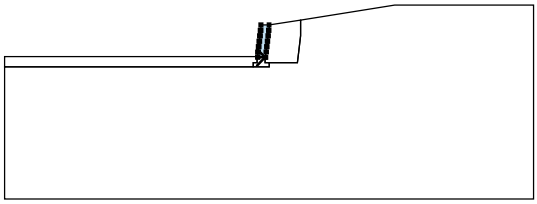
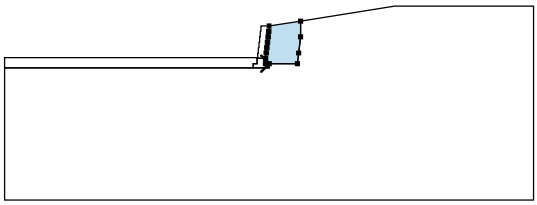
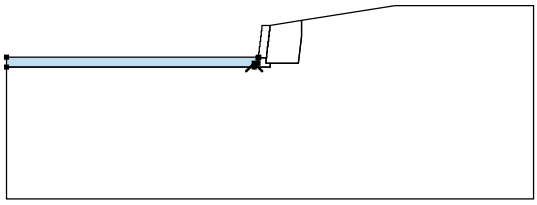
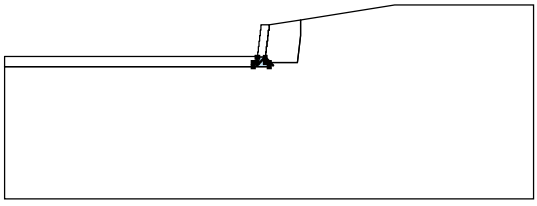
CDOT Class I strcutural fill

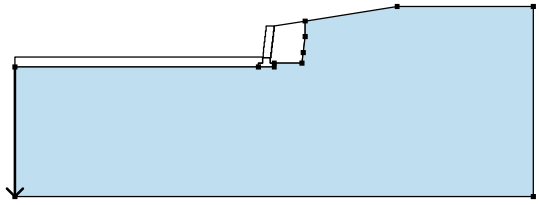
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-1.40	-4.02	-0.48	-4.02	Material of structure
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-3.94	
2		-0.48	-4.69	0.02	-4.69	CDOT Class I strcutural fill
		3.52	-4.69	3.68	-3.35	
		3.92	-1.34	3.92	0.62	
		0.00	0.00	0.00	-0.67	
		-0.08	-0.67	-0.08	-1.34	
		-0.16	-1.34	-0.16	-2.01	
		-0.24	-2.01	-0.24	-2.68	
		-0.32	-2.68	-0.32	-3.35	
		-0.40	-3.35	-0.40	-4.02	
		-0.48	-4.02			
3		-1.98	-5.19	-1.98	-4.69	On Site Soil
		-1.48	-4.69	-1.48	-4.02	
		-1.40	-4.02	-1.40	-3.94	
		-32.80	-3.94	-32.80	-5.19	
4		-0.48	-4.69	-0.48	-4.02	Material of structure
		-1.40	-4.02	-1.48	-4.02	
		-1.48	-4.69	-1.98	-4.69	
		-1.98	-5.19	0.02	-5.19	
		0.02	-4.69			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		-32.80	-5.19	-32.80	-21.59	On Site Soil
		32.80	-21.59	32.80	2.47	
		15.57	2.47	3.92	0.62	
		3.92	-1.34	3.68	-3.35	
		3.52	-4.69	0.02	-4.69	
		0.02	-5.19	-1.98	-5.19	

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	-0.08	-1.34	3.92	-1.34	4.00	505.3	T_p = 109.4 lbf/ft^2	Fixed
2	-0.32	-3.35	3.68	-3.35	4.00	505.3	T_p = 273.4 lbf/ft^2	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.36	[ft]	Angles :	α_1 =	-35.67	[°]
	z =	2.08	[ft]		α_2 =	81.18	[°]
Radius :	R =	7.41	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.7

Slope stability verification (Bishop)

Sum of active forces : F_a = 1429.2 lbf/ft
Sum of passive forces : F_p = 3382.5 lbf/ft

Sliding moment : M_a = 10590.3 lbfft/ft
Resisting moment : M_p = 25064.2 lbfft/ft
Factor of safety = 2.37 > 1.30

Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 6' Max MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 10
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 2XT	Miragrid 2XT	————	2000.84	505.26	0.70	0.70
2	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.80	0.80

Reinforcement details

1. Miragrid 2XT

Short-term char. strength	T_{ult}	=	2000.84	lbf/ft
Long-term design strength	R_t	=	505.26	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.50

2. Miragrid 3XT

Short-term char. strength	T_{ult}	=	3152.00	lbf/ft
Long-term design strength	R_t	=	955.15	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 3.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 3XT	-0.56	3.44	1.34	4.00
6	Miragrid 2XT	-0.32	3.68	3.35	4.00
9	Miragrid 2XT	-0.08	3.92	5.36	4.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	γ_{sat}	=	125.0 pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	φ_{ef}	=	34.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Angle of friction struc.-soil :	δ	=	17.00 °
Saturated unit weight :	γ_{sat}	=	130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure $h = 1.25$ ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-3.49	3522.9	3.41	1.000
Active pressure	434.6	-1.55	142.8	5.19	1.000
Weight - wall	0.0	-3.35	593.6	0.86	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 13272.9$ lbfft/ft
Overturning moment $M_{ovr} = 333.0$ lbfft/ft

Safety factor = 39.85 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2486.18 lbf/ft
Active horizontal force H_{act} = -188.79 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-2.35	415.5	0.74	1.000
Active pressure	374.0	-1.56	114.3	1.15	1.000
Reinforcement	-505.3	-1.34	0.0	2.76	1.000
Reinforcement	-294.6	-3.35	0.0	3.96	1.000

Verification of construction joint above the block No.: 3

Check for overturning stability
Resisting moment M_{res} = 2102.9 lbfft/ft
Overturning moment M_{ovr} = 584.6 lbfft/ft

Safety factor = 3.60 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1328.31 lbf/ft
Active horizontal force H_{act} = 373.98 lbf/ft

Safety factor = 3.55 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-3836.0	1222.93	-1369.29	0.000	611.5

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-3836.0	1222.93	-1369.29

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force $e = 0.000$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom $\sigma = 611.5$ psf
Bearing capacity of foundation soil $R_d = 2000.0$ psf

Safety factor = 3.27 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 3)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-0.67	118.7	-0.38	1.000
Active pressure	0.4	-0.05	0.2	5.07	1.000
Weight - reinforced soil	0.0	-0.99	1100.4	2.83	1.000

Verification against slip along geotextile No.: 3

Inclination of slip surface = 45.00 °
Overall normal force acting on reinforcement = 1100.57 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.70
Resistance along geo-reinforcement = 519.64 lbf/ft
Wall resistance = 309.28 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force $H_{res} = 828.92$ lbf/ft
Active horiz. force $H_{act} = 0.40$ lbf/ft

Factor of safety = 2051.81 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength $R_t = 955.15$ lbf/ft
Force in reinforcement $F_x = 381.88$ lbf/ft

Safety factor = 2.50 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance $T_p = 2543.29$ lbf/ft
Force in reinforcement $F_x = 381.88$ lbf/ft

Safety factor = 6.66 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-2.04;-1.03) ft
Radius r = 8.45 ft
Angle α_1 = -34.31 °
α_2 = 89.89 °

Slope stability check (Bishop)
FS = 1.89 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

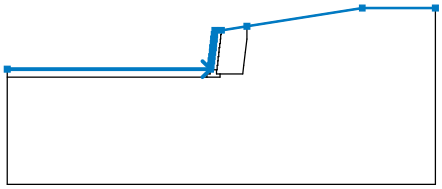
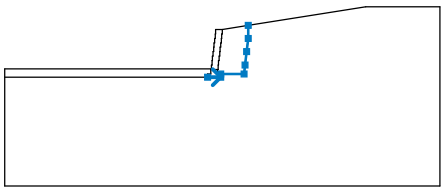
(input for current task)

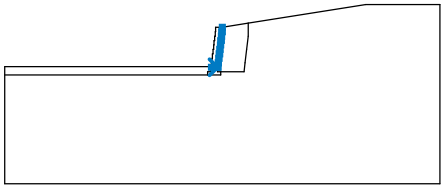
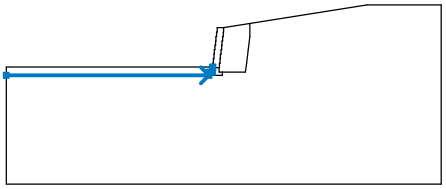
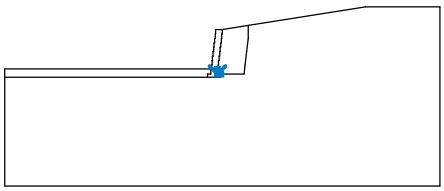
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-5.95	-1.64	-5.95	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	3.92	0.62
		21.60	3.42	32.80	3.42		
2		-2.22	-7.20	-0.22	-7.20	-0.22	-6.70
		3.28	-6.70	3.44	-5.36	3.68	-3.35
		3.92	-1.34	3.92	0.62		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
3		-1.64	-6.03	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		
4		-32.80	-7.20	-2.22	-7.20	-2.22	-6.70
		-1.72	-6.70	-1.72	-6.03	-1.64	-6.03
		-1.64	-5.95				
5		-0.72	-6.03	-0.72	-6.70	-0.22	-6.70

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : $\gamma = 120.0$ pcf
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 25.00$ °

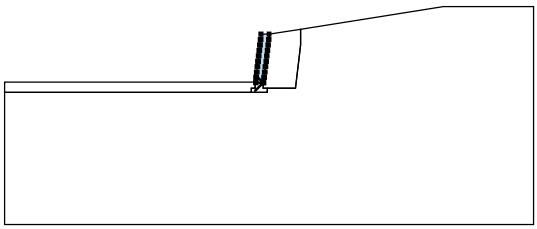
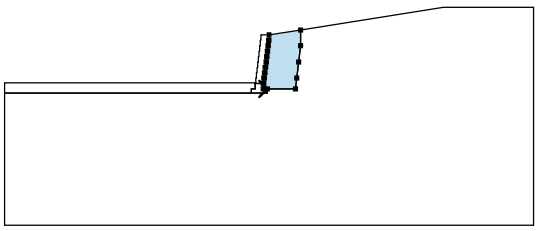
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

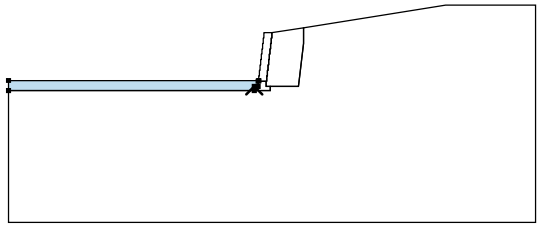
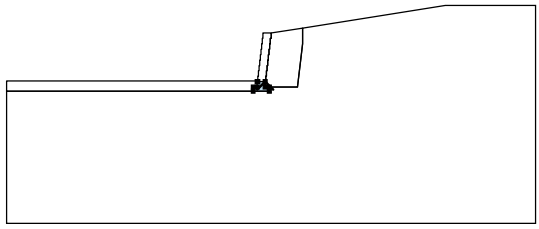
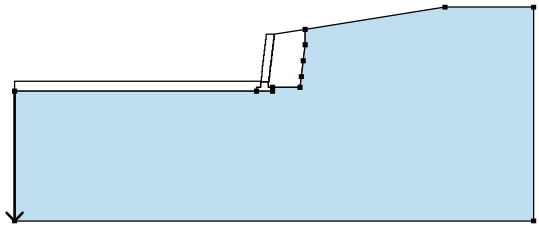
CDOT Class I strcutural fill
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-1.64	-6.03	-0.72	-6.03	Material of structure
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-5.95	
2		-0.72	-6.70	-0.22	-6.70	CDOT Class I strcutural fill
		3.28	-6.70	3.44	-5.36	
		3.68	-3.35	3.92	-1.34	
		3.92	0.62	0.00	0.00	
		0.00	-0.67	-0.08	-0.67	
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	
		-0.40	-4.02	-0.48	-4.02	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.48	-4.69	-0.56	-4.69	
		-0.56	-5.36	-0.64	-5.36	
		-0.64	-6.03	-0.72	-6.03	
3		-2.22	-7.20	-2.22	-6.70	On Site Soil
		-1.72	-6.70	-1.72	-6.03	
		-1.64	-6.03	-1.64	-5.95	
		-32.80	-5.95	-32.80	-7.20	
4		-0.72	-6.70	-0.72	-6.03	Material of structure
		-1.64	-6.03	-1.72	-6.03	
		-1.72	-6.70	-2.22	-6.70	
		-2.22	-7.20	-0.22	-7.20	
		-0.22	-6.70			
5		-32.80	-7.20	-32.80	-23.60	On Site Soil
		32.80	-23.60	32.80	3.42	
		21.60	3.42	3.92	0.62	
		3.92	-1.34	3.68	-3.35	
		3.44	-5.36	3.28	-6.70	
		-0.22	-6.70	-0.22	-7.20	
		-2.22	-7.20			

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.08	-1.34	3.92	-1.34	4.00	505.3	T_p = 109.4 lbf/ft^2	Fixed
2	-0.32	-3.35	3.68	-3.35	4.00	505.3	T_p = 273.4 lbf/ft^2	Fixed
3	-0.56	-5.36	3.44	-5.36	4.00	955.2	T_p = 500.0 lbf/ft^2	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.09	[ft]	Angles :	α_1 =	-33.98	[°]
	z =	1.14	[ft]		α_2 =	89.21	[°]
Radius :	R =	8.55	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 2467.5 lbf/ft
Sum of passive forces : F_p = 4654.4 lbf/ft

Sliding moment : M_a = 21097.0 lbfft/ft
Resisting moment : M_p = 39795.2 lbfft/ft
Factor of safety = 1.89 > 1.30
Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 8' Max MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 13
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.70	0.70

Reinforcement details

1. Miragrid 3XT

Short-term char. strength	T_{ult}	=	3152.00	lbf/ft
Long-term design strength	R_t	=	955.15	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 4.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 3XT	-0.80	5.20	1.34	6.00
6	Miragrid 3XT	-0.56	5.44	3.35	6.00
9	Miragrid 3XT	-0.32	5.68	5.36	6.00
12	Miragrid 3XT	-0.08	5.92	7.37	6.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0	pcf
Angle of internal friction :	φ_{ef}	=	25.00	°
Cohesion of soil :	c_{ef}	=	100.0	psf
Angle of friction struc.-soil :	δ	=	18.00	°
Saturated unit weight :	γ_{sat}	=	125.0	pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0	pcf
Angle of internal friction :	φ_{ef}	=	34.00	°
Cohesion of soil :	c_{ef}	=	0.0	psf
Angle of friction struc.-soil :	δ	=	17.00	°

Saturated unit weight : γ_{sat} = 130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-4.58	6911.0	4.56	1.000
Active pressure	977.7	-2.33	321.3	7.28	1.000
Weight - wall	0.0	-4.36	771.7	0.98	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 34636.6 lbfft/ft
Overturning moment M_{ovr} = 1935.0 lbfft/ft

Safety factor = 17.90 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 4432.32 lbf/ft
Active horizontal force H_{act} = 354.27 lbf/ft

Safety factor = 12.51 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-4.36	771.7	0.98	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	1289.8	-2.90	394.3	1.31	1.000
Reinforcement	-955.2	-1.34	0.0	1.80	1.000
Reinforcement	-955.2	-3.35	0.0	3.00	1.000
Reinforcement	-955.2	-5.36	0.0	4.20	1.000
Reinforcement	-551.9	-7.37	0.0	5.40	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability

Resisting moment M_{res} = 14938.9 lbfft/ft
Overturning moment M_{ovr} = 3635.7 lbfft/ft

Safety factor = 4.11 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 4288.88 lbf/ft
Active horizontal force H_{act} = 971.23 lbf/ft

Safety factor = 4.42 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-11701.5	1678.44	-2458.33	0.000	839.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-11701.5	1678.44	-2458.33

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 839.2 psf

Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 2.38 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 4)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-0.67	118.7	-0.38	1.000
Active pressure	5.8	-0.17	2.7	7.45	1.000
Weight - reinforced soil	0.0	-1.09	1729.7	4.09	1.000

Verification against slip along geotextile No.: 4

Inclination of slip surface	=	45.00	°
Overall normal force acting on reinforcement	=	1732.46	lbf/ft
Coefficient of reduction of slip along geo-textile	=	0.70	
Resistance along geo-reinforcement	=	817.99	lbf/ft
Wall resistance	=	309.28	lbf/ft
Overall bearing capacity of reinforcements	=	0.00	lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 1127.27 lbf/ft
Active horiz. force H_{act} = 5.83 lbf/ft

Factor of safety = 193.43 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 955.15 lbf/ft
Force in reinforcement F_x = 521.24 lbf/ft

Safety factor = 1.83 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 4900.78 lbf/ft
Force in reinforcement F_x = 521.24 lbf/ft

Safety factor = 9.40 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-2.26;-4.35) ft
Radius r = 13.91 ft
Angle α_1 = -27.75 °
α_2 = 79.48 °

Slope stability check (Bishop)

FS = 1.72 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

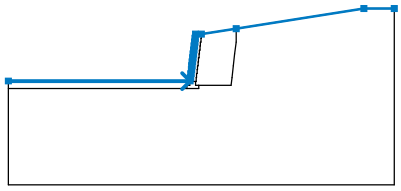
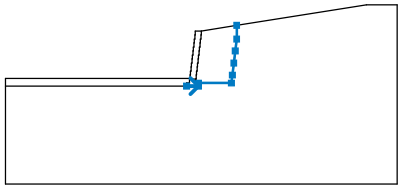
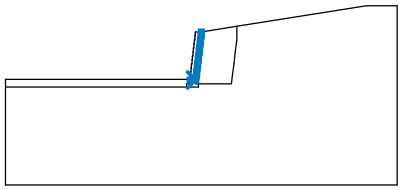
(input for current task)

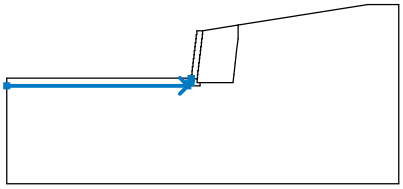
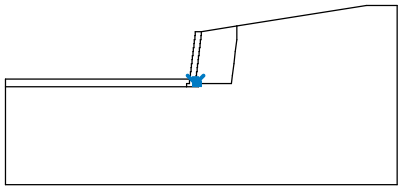
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-7.96	-1.88	-7.96	-1.88	-7.37
		-1.80	-7.37	-1.80	-6.70	-1.72	-6.70
		-1.72	-6.03	-1.64	-6.03	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	5.92	0.94
		27.63	4.38	32.80	4.38		
2		-2.46	-9.21	-0.46	-9.21	-0.46	-8.71
		5.04	-8.71	5.20	-7.37	5.44	-5.36
		5.68	-3.35	5.92	-1.34	5.92	0.94
3		-1.88	-8.04	-0.96	-8.04	-0.88	-8.04
		-0.88	-7.37	-0.80	-7.37	-0.80	-6.70
		-0.72	-6.70	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-32.80	-9.21	-2.46	-9.21	-2.46	-8.71
		-1.96	-8.71	-1.96	-8.04	-1.88	-8.04
		-1.88	-7.96				
5		-0.96	-8.04	-0.96	-8.71	-0.46	-8.71

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

CDOT Class I strcutural fill

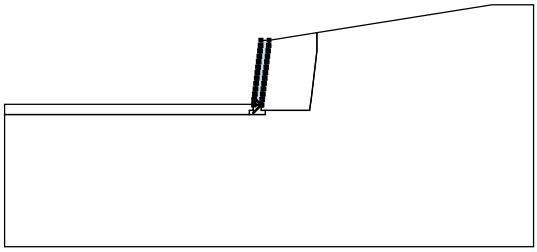
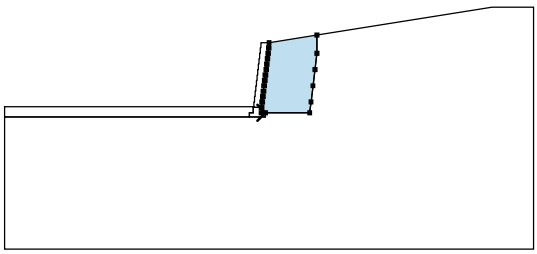
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °

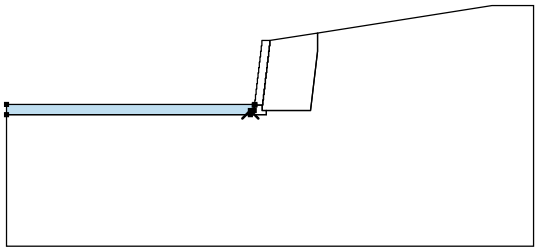
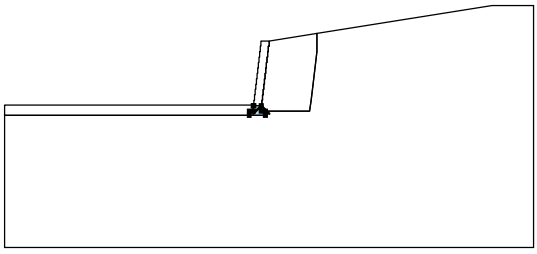
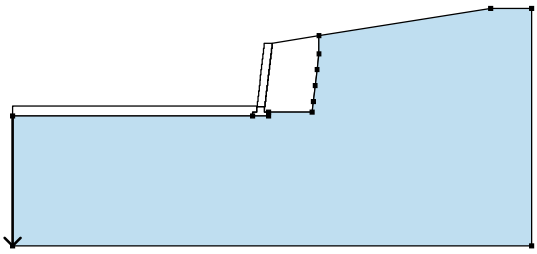
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-1.88	-8.04	-0.96	-8.04	Material of structure
		-0.88	-8.04	-0.88	-7.37	
		-0.80	-7.37	-0.80	-6.70	
		-0.72	-6.70	-0.72	-6.03	
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-6.03	
		-1.72	-6.03	-1.72	-6.70	
		-1.80	-6.70	-1.80	-7.37	
		-1.88	-7.37	-1.88	-7.96	
2		-0.96	-8.71	-0.46	-8.71	CDOT Class I strcutural fill
		5.04	-8.71	5.20	-7.37	
		5.44	-5.36	5.68	-3.35	
		5.92	-1.34	5.92	0.94	
		0.00	0.00	0.00	-0.67	
		-0.08	-0.67	-0.08	-1.34	
		-0.16	-1.34	-0.16	-2.01	
		-0.24	-2.01	-0.24	-2.68	
		-0.32	-2.68	-0.32	-3.35	
		-0.40	-3.35	-0.40	-4.02	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.48	-4.02	-0.48	-4.69	
		-0.56	-4.69	-0.56	-5.36	
		-0.64	-5.36	-0.64	-6.03	
		-0.72	-6.03	-0.72	-6.70	
		-0.80	-6.70	-0.80	-7.37	
		-0.88	-7.37	-0.88	-8.04	
		-0.96	-8.04			
3		-2.46	-9.21	-2.46	-8.71	On Site Soil
		-1.96	-8.71	-1.96	-8.04	
		-1.88	-8.04	-1.88	-7.96	
		-32.80	-7.96	-32.80	-9.21	
4		-0.96	-8.71	-0.96	-8.04	Material of structure
		-1.88	-8.04	-1.96	-8.04	
		-1.96	-8.71	-2.46	-8.71	
		-2.46	-9.21	-0.46	-9.21	
		-0.46	-8.71			
5		-32.80	-9.21	-32.80	-25.61	On Site Soil
		32.80	-25.61	32.80	4.38	
		27.63	4.38	5.92	0.94	
		5.92	-1.34	5.68	-3.35	
		5.44	-5.36	5.20	-7.37	
		5.04	-8.71	-0.46	-8.71	
		-0.46	-9.21	-2.46	-9.21	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.08	-1.34	5.92	-1.34	6.00	955.2	T_p = 109.4 lbf/ft^2	Fixed
2	-0.32	-3.35	5.68	-3.35	6.00	955.2	T_p = 273.4 lbf/ft^2	Fixed
3	-0.56	-5.36	5.44	-5.36	6.00	955.2	T_p = 437.5 lbf/ft^2	Fixed
4	-0.80	-7.37	5.20	-7.37	6.00	955.2	T_p = 601.5 lbf/ft^2	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.23	[ft]	Angles :	α_1 =	-28.18	[°]
	z =	4.09	[ft]		α_2 =	80.29	[°]
Radius :	R =	13.67	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 4885.9 lbf/ft
Sum of passive forces : F_p = 8391.8 lbf/ft

Sliding moment : M_a = 66789.9 lbfft/ft
Resisting moment : M_p = 114715.7 lbfft/ft
Factor of safety = 1.72 > 1.30
Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 10' Max MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 16
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70

Reinforcement details

1. Miragrid 5XT

Short-term char. strength	T_{ult}	=	4296.31	lbf/ft
Long-term design strength	R_t	=	1301.91	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 5.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 5XT	-1.04	6.96	1.34	8.00
6	Miragrid 5XT	-0.80	7.20	3.35	8.00
9	Miragrid 5XT	-0.56	7.44	5.36	8.00
12	Miragrid 5XT	-0.32	7.68	7.37	8.00
15	Miragrid 5XT	-0.08	7.92	9.38	8.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	$φ_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	$γ_{sat}$	=	125.0 pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	$φ_{ef}$	=	34.00 °

Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 17.00 °
Saturated unit weight : γ_{sat} = 130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-5.67	11383.5	5.72	1.000
Active pressure	1741.1	-3.12	572.6	9.37	1.000
Weight - wall	0.0	-5.36	949.8	1.10	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 71481.5 lbfft/ft
Overturning moment M_{ovr} = 5084.3 lbfft/ft

Safety factor = 14.06 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 6918.11 lbf/ft
Active horizontal force H_{act} = 1117.65 lbf/ft

Safety factor = 6.19 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-5.36	949.8	1.10	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	1953.8	-3.57	597.3	1.39	1.000
Reinforcement	-1301.9	-1.34	0.0	1.80	1.000
Reinforcement	-1301.9	-3.35	0.0	3.00	1.000
Reinforcement	-1301.9	-5.36	0.0	4.20	1.000
Reinforcement	-1301.9	-7.37	0.0	5.40	1.000
Reinforcement	-846.6	-9.38	0.0	6.60	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability

Resisting moment M_{res} = 32493.6 lbfft/ft
Overturning moment M_{ovr} = 6872.6 lbfft/ft

Safety factor = 4.73 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7128.83 lbf/ft
Active horizontal force H_{act} = 1635.23 lbf/ft

Safety factor = 4.36 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-26735.5	2175.95	-4384.24	0.000	1088.0

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-26735.5	2175.95	-4384.24

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1088.0 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 1.84 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.69	831.1	0.10	1.000
Active pressure	1355.5	-2.56	505.3	8.40	1.000
Weight - reinforced soil	0.0	-5.03	10110.7	4.68	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 83.00 °
Overall normal force acting on reinforcement = 10615.97 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.70
Resistance along geo-reinforcement = 5012.39 lbf/ft
Wall resistance = 688.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 5701.35 lbf/ft
Active horiz. force H_{act} = 1355.46 lbf/ft

Factor of safety = 4.21 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 1301.91 lbf/ft
Force in reinforcement F_x = 660.59 lbf/ft

Safety factor = 1.97 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 8582.25 lbf/ft
Force in reinforcement F_x = 660.59 lbf/ft

Safety factor = 12.99 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-2.79;-5.43) ft
Radius r = 17.74 ft
Angle α_1 = -29.76 °
α_2 = 79.91 °

Slope stability check (Bishop)
FS = 1.63 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

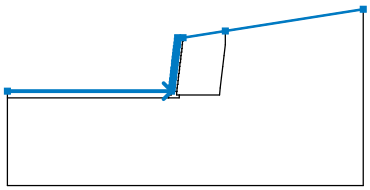
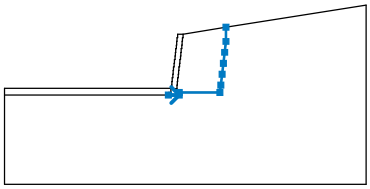
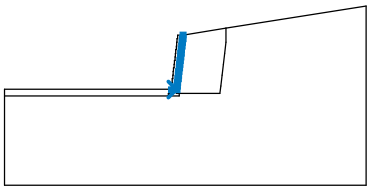
(input for current task)

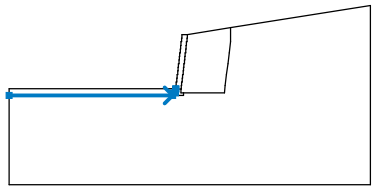
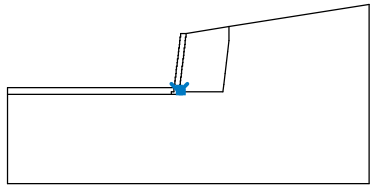
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-9.97	-2.12	-9.97	-2.12	-9.38
		-2.04	-9.38	-2.04	-8.71	-1.96	-8.71
		-1.96	-8.04	-1.88	-8.04	-1.88	-7.37
		-1.80	-7.37	-1.80	-6.70	-1.72	-6.70
		-1.72	-6.03	-1.64	-6.03	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	7.92	1.25
		33.66	5.33				
2		-2.70	-11.22	-0.70	-11.22	-0.70	-10.72
		6.80	-10.72	6.96	-9.38	7.20	-7.37
		7.44	-5.36	7.68	-3.35	7.92	-1.34
		7.92	1.25				
3		-2.12	-10.05	-1.20	-10.05	-1.12	-10.05
		-1.12	-9.38	-1.04	-9.38	-1.04	-8.71
		-0.96	-8.71	-0.96	-8.04	-0.88	-8.04
		-0.88	-7.37	-0.80	-7.37	-0.80	-6.70
		-0.72	-6.70	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		
4		-32.80	-11.22	-2.70	-11.22	-2.70	-10.72
		-2.20	-10.72	-2.20	-10.05	-2.12	-10.05
		-2.12	-9.97				
5		-1.20	-10.05	-1.20	-10.72	-0.70	-10.72

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

CDOT Class I strcutural fill

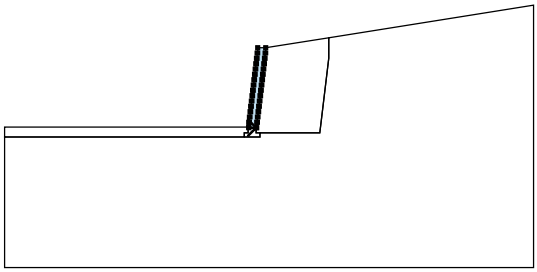
Unit weight : γ = 125.0 pcf

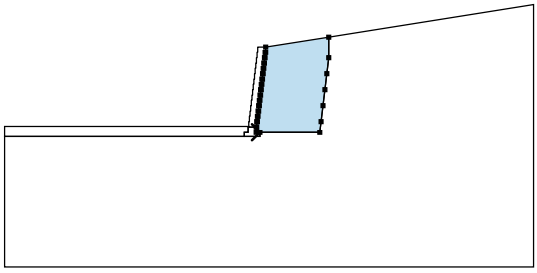
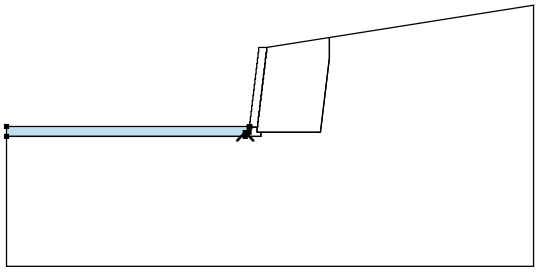
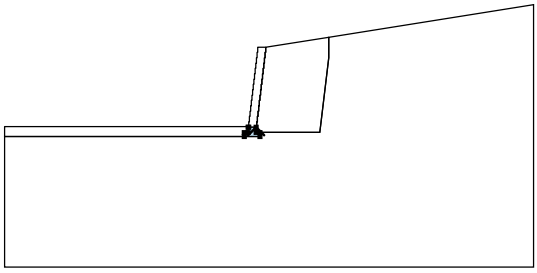
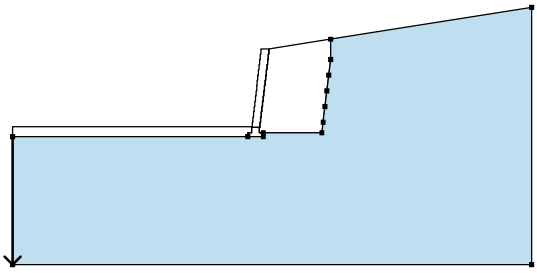
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-2.12	-10.05	-1.20	-10.05	Material of structure
		-1.12	-10.05	-1.12	-9.38	
		-1.04	-9.38	-1.04	-8.71	
		-0.96	-8.71	-0.96	-8.04	
		-0.88	-8.04	-0.88	-7.37	
		-0.80	-7.37	-0.80	-6.70	
		-0.72	-6.70	-0.72	-6.03	
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-6.03	
		-1.72	-6.03	-1.72	-6.70	
		-1.80	-6.70	-1.80	-7.37	
		-1.88	-7.37	-1.88	-8.04	
		-1.96	-8.04	-1.96	-8.71	
		-2.04	-8.71	-2.04	-9.38	
		-2.12	-9.38	-2.12	-9.97	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		-1.20	-10.72	-0.70	-10.72	CDOT Class I strcutural fill
		6.80	-10.72	6.96	-9.38	
		7.20	-7.37	7.44	-5.36	
		7.68	-3.35	7.92	-1.34	
		7.92	1.25	0.00	0.00	
		0.00	-0.67	-0.08	-0.67	
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	
		-0.40	-4.02	-0.48	-4.02	
		-0.48	-4.69	-0.56	-4.69	
		-0.56	-5.36	-0.64	-5.36	
		-0.64	-6.03	-0.72	-6.03	
		-0.72	-6.70	-0.80	-6.70	
		-0.80	-7.37	-0.88	-7.37	
		-0.88	-8.04	-0.96	-8.04	
		-0.96	-8.71	-1.04	-8.71	
		-1.04	-9.38	-1.12	-9.38	
		-1.12	-10.05	-1.20	-10.05	
3		-2.70	-11.22	-2.70	-10.72	On Site Soil
		-2.20	-10.72	-2.20	-10.05	
		-2.12	-10.05	-2.12	-9.97	
		-32.80	-9.97	-32.80	-11.22	
4		-1.20	-10.72	-1.20	-10.05	Material of structure
		-2.12	-10.05	-2.20	-10.05	
		-2.20	-10.72	-2.70	-10.72	
		-2.70	-11.22	-0.70	-11.22	
		-0.70	-10.72			
5		-32.80	-11.22	-32.80	-27.62	On Site Soil
		33.66	-27.62	33.66	5.33	
		7.92	1.25	7.92	-1.34	
		7.68	-3.35	7.44	-5.36	
		7.20	-7.37	6.96	-9.38	
		6.80	-10.72	-0.70	-10.72	
		-0.70	-11.22	-2.70	-11.22	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.08	-1.34	7.92	-1.34	8.00	1301.9	T_p = 109.4 lbf/ft^2	Fixed
2	-0.32	-3.35	7.68	-3.35	8.00	1301.9	T_p = 273.4 lbf/ft^2	Fixed
3	-0.56	-5.36	7.44	-5.36	8.00	1301.9	T_p = 437.5 lbf/ft^2	Fixed
4	-0.80	-7.37	7.20	-7.37	8.00	1301.9	T_p = 601.5 lbf/ft^2	Fixed
5	-1.04	-9.38	6.96	-9.38	8.00	1301.9	T_p = 765.6 lbf/ft^2	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.77	[ft]	Angles :	α_1 =	-29.82	[°]
	z =	5.36	[ft]		α_2 =	80.08	[°]
Radius :	R =	17.67	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.7

Slope stability verification (Bishop)

Sum of active forces : F_a = 8037.4 lbf/ft
Sum of passive forces : F_p = 13129.9 lbf/ft

Sliding moment : M_a = 142020.7 lbfft/ft
Resisting moment : M_p = 232005.2 lbfft/ft
Factor of safety = 1.63 > 1.30
Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 10' Max MSE Wall Height w/ Sidewalk Loading
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 16
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70

Reinforcement details

1. Miragrid 5XT

Short-term char. strength	T_{ult}	=	4296.31	lbf/ft
Long-term design strength	R_t	=	1301.91	lbf/ft
Overall coeff. of model uncertainty	FS_{UNC}	=	1.50	

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 5.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 5XT	-1.04	6.96	1.34	8.00
6	Miragrid 5XT	-0.80	7.20	3.35	8.00
9	Miragrid 5XT	-0.56	7.44	5.36	8.00
12	Miragrid 5XT	-0.32	7.68	7.37	8.00
15	Miragrid 5XT	-0.08	7.92	9.38	8.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	$φ_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	$γ_{sat}$	=	125.0 pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	$φ_{ef}$	=	34.00 °

Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 17.00 °
Saturated unit weight : γ_{sat} = 130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		2.00	7.00	on terrain

No.	Name
1	sidewalk

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-5.35	10762.4	5.61	1.000
Active pressure	1061.8	-2.60	348.9	9.31	1.000
sidewalk	0.0	-10.72	22.4	10.12	1.000
Weight - wall	0.0	-5.36	949.8	1.10	1.000
sidewalk	0.0	-10.72	592.0	7.16	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 69182.7 lbfft/ft
Overturning moment M_{ovr} = 2417.3 lbfft/ft

Safety factor = 28.62 > 2.00

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 6810.69 lbf/ft
Active horizontal force H_{act} = 438.38 lbf/ft

Safety factor = 15.54 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-5.36	949.8	1.10	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	1761.7	-3.57	538.6	1.39	1.000
sidewalk	210.1	-4.91	64.2	1.55	1.000
Reinforcement	-1301.9	-1.34	0.0	1.80	1.000
Reinforcement	-1301.9	-3.35	0.0	3.00	1.000
Reinforcement	-1301.9	-5.36	0.0	4.20	1.000
Reinforcement	-1301.9	-7.37	0.0	5.40	1.000
Reinforcement	-556.9	-9.38	0.0	6.60	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability
Resisting moment M_{res} = 29794.7 lbfft/ft
Overturning moment M_{ovr} = 7217.2 lbfft/ft

Safety factor = 4.13 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 6842.14 lbf/ft
Active horizontal force H_{act} = 1653.24 lbf/ft

Safety factor = 4.14 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-23618.9	2109.37	-4136.09	0.000	1054.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-23618.9	2109.37	-4136.09

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1054.7 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 1.90 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.69	831.1	0.10	1.000
Active pressure	937.9	-2.32	437.4	8.00	1.000
sidewalk	30.3	-6.91	43.2	8.00	1.000
Weight - reinforced soil	0.0	-4.57	8771.1	4.25	1.000
sidewalk	0.0	-9.38	496.0	5.60	1.000
Reinforcement	-170.1	0.00	0.0	7.92	1.000
Reinforcement	-334.1	-2.01	0.0	7.92	1.000
Reinforcement	-388.7	-4.02	0.0	7.92	1.000
Reinforcement	-334.1	-6.03	0.0	7.92	1.000
Reinforcement	-170.1	-8.04	0.0	7.92	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 9747.64 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.70
Resistance along geo-reinforcement = 4602.41 lbf/ft
Wall resistance = 688.96 lbf/ft
Overall bearing capacity of reinforcements = 1396.94 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 6688.31 lbf/ft
Active horiz. force H_{act} = 968.29 lbf/ft

Factor of safety = 6.91 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 1301.91 lbf/ft
Force in reinforcement F_x = 632.04 lbf/ft

Safety factor = 2.06 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 8130.69 lbf/ft
Force in reinforcement F_x = 632.04 lbf/ft

Safety factor = 12.86 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-2.21;-1.66) ft
Radius r = 14.33 ft
Angle α_1 = -35.75 °
α_2 = 83.35 °

Slope stability check (Bishop)
FS = 1.74 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

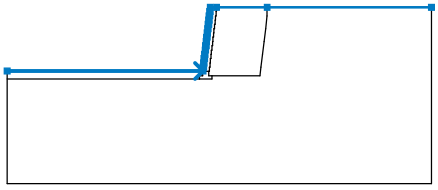
(input for current task)

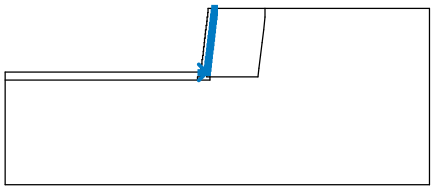
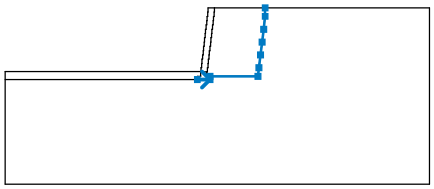
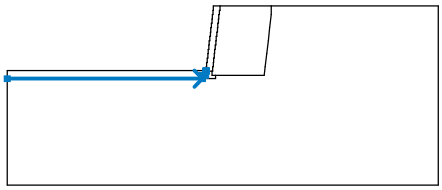
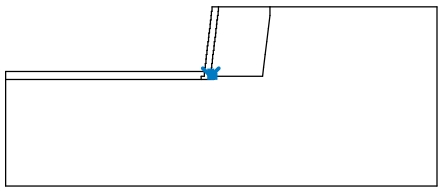
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-9.97	-2.12	-9.97	-2.12	-9.38
		-2.04	-9.38	-2.04	-8.71	-1.96	-8.71
		-1.96	-8.04	-1.88	-8.04	-1.88	-7.37
		-1.80	-7.37	-1.80	-6.70	-1.72	-6.70
		-1.72	-6.03	-1.64	-6.03	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
		-1.00	0.00	0.00	0.00	7.92	0.00
		33.66	0.00				
2		-2.12	-10.05	-1.20	-10.05	-1.12	-10.05
		-1.12	-9.38	-1.04	-9.38	-1.04	-8.71
		-0.96	-8.71	-0.96	-8.04	-0.88	-8.04
		-0.88	-7.37	-0.80	-7.37	-0.80	-6.70
		-0.72	-6.70	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		
3		-2.70	-11.22	-0.70	-11.22	-0.70	-10.72
		6.80	-10.72	6.96	-9.38	7.20	-7.37
		7.44	-5.36	7.68	-3.35	7.92	-1.34
		7.92	0.00				
4		-32.80	-11.22	-2.70	-11.22	-2.70	-10.72
		-2.20	-10.72	-2.20	-10.05	-2.12	-10.05
		-2.12	-9.97				
5		-1.20	-10.05	-1.20	-10.72	-0.70	-10.72

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

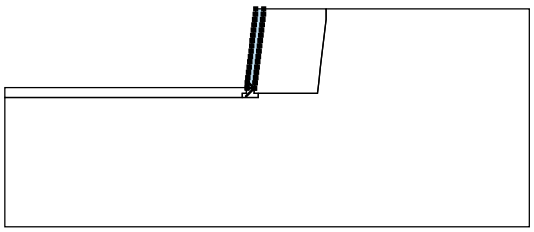
CDOT Class I strcutural fill

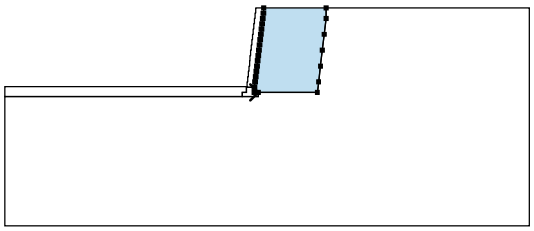
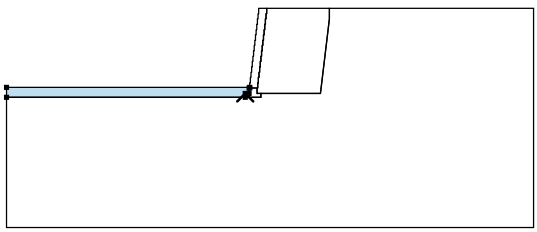
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

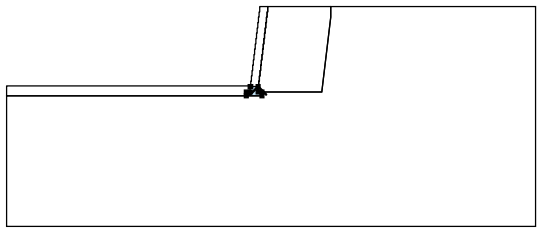
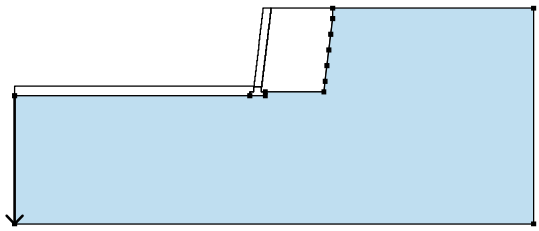
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-2.12	-10.05	-1.20	-10.05	Material of structure
		-1.12	-10.05	-1.12	-9.38	
		-1.04	-9.38	-1.04	-8.71	
		-0.96	-8.71	-0.96	-8.04	
		-0.88	-8.04	-0.88	-7.37	
		-0.80	-7.37	-0.80	-6.70	
		-0.72	-6.70	-0.72	-6.03	
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-6.03	
		-1.72	-6.03	-1.72	-6.70	
		-1.80	-6.70	-1.80	-7.37	
		-1.88	-7.37	-1.88	-8.04	
		-1.96	-8.04	-1.96	-8.71	
		-2.04	-8.71	-2.04	-9.38	
		-2.12	-9.38	-2.12	-9.97	
2		-1.20	-10.72	-0.70	-10.72	CDOT Class I strcutural fill
		6.80	-10.72	6.96	-9.38	
		7.20	-7.37	7.44	-5.36	
		7.68	-3.35	7.92	-1.34	
		7.92	0.00	0.00	0.00	
		0.00	-0.67	-0.08	-0.67	
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	
		-0.40	-4.02	-0.48	-4.02	
		-0.48	-4.69	-0.56	-4.69	
		-0.56	-5.36	-0.64	-5.36	
		-0.64	-6.03	-0.72	-6.03	
		-0.72	-6.70	-0.80	-6.70	
		-0.80	-7.37	-0.88	-7.37	
		-0.88	-8.04	-0.96	-8.04	
		-0.96	-8.71	-1.04	-8.71	
		-1.04	-9.38	-1.12	-9.38	
		-1.12	-10.05	-1.20	-10.05	
3		-2.70	-11.22	-2.70	-10.72	On Site Soil
		-2.20	-10.72	-2.20	-10.05	
		-2.12	-10.05	-2.12	-9.97	
		-32.80	-9.97	-32.80	-11.22	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
4		-1.20	-10.72	-1.20	-10.05	Material of structure
		-2.12	-10.05	-2.20	-10.05	
		-2.20	-10.72	-2.70	-10.72	
		-2.70	-11.22	-0.70	-11.22	
		-0.70	-10.72			
5		-32.80	-11.22	-32.80	-27.62	On Site Soil
		33.66	-27.62	33.66	0.00	
		7.92	0.00	7.92	-1.34	
		7.68	-3.35	7.44	-5.36	
		7.20	-7.37	6.96	-9.38	
		6.80	-10.72	-0.70	-10.72	
		-0.70	-11.22	-2.70	-11.22	

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	-0.08	-1.34	7.92	-1.34	8.00	1301.9	T_p = 109.4 lbf/ft^2	Fixed
2	-0.32	-3.35	7.68	-3.35	8.00	1301.9	T_p = 273.4 lbf/ft^2	Fixed
3	-0.56	-5.36	7.44	-5.36	8.00	1301.9	T_p = 437.5 lbf/ft^2	Fixed
4	-0.80	-7.37	7.20	-7.37	8.00	1301.9	T_p = 601.5 lbf/ft^2	Fixed
5	-1.04	-9.38	6.96	-9.38	8.00	1301.9	T_p = 765.6 lbf/ft^2	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 2.00	l = 7.00		0.00	100.0		lbf/ft^2

Surcharges

No.	Name
1	sidewalk

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.31	[ft]	Angles :	α_1 =	-34.72	[°]
	z =	2.26	[ft]		α_2 =	81.26	[°]
Radius :	R =	14.88	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	19.5

Slope stability verification (Bishop)

Sum of active forces : F_a = 6873.1 lbf/ft
Sum of passive forces : F_p = 11929.7 lbf/ft

Sliding moment : M_a = 102271.8 lbfft/ft
Resisting moment : M_p = 177514.0 lbfft/ft
Factor of safety = 1.74 > 1.30
Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 12' Max MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 20
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material
Unit weight γ = 88.60 pcf
Cohesion c = 50.0 psf
Friction f = 0.533
Shear bearing capacity of joint R_s = 200.00 lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70

Reinforcement details

1. Miragrid 5XT
Short-term char. strength T_{ult} = 4296.31 lbf/ft
Long-term design strength R_t = 1301.91 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 6.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 5XT	-1.36	8.64	1.34	10.00
6	Miragrid 5XT	-1.12	8.88	3.35	10.00
9	Miragrid 5XT	-0.88	9.12	5.36	10.00
12	Miragrid 5XT	-0.64	9.36	7.37	10.00
15	Miragrid 5XT	-0.40	9.60	9.38	10.00
18	Miragrid 5XT	-0.16	9.84	11.39	10.00

Soil parameters

On Site Soil
Unit weight : γ = 120.0 pcf
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

CDOT Class I strcutural fill
Unit weight : γ = 125.0 pcf

Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 17.00 °
Saturated unit weight : γ_{sat} = 130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-7.08	17749.0	6.89	1.000
Active pressure	3055.6	-4.16	1009.9	11.50	1.000
Weight - wall	0.0	-6.70	1187.2	1.26	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 135484.3 lbfft/ft
Overturning moment M_{ovr} = 12382.8 lbfft/ft

Safety factor = 10.94 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 10401.04 lbf/ft
Active horizontal force H_{act} = 2432.23 lbf/ft

Safety factor = 4.28 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-6.70	1187.2	1.26	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	3052.9	-4.47	933.4	1.49	1.000
Reinforcement	-1301.9	-1.34	0.0	1.80	1.000
Reinforcement	-1301.9	-3.35	0.0	3.00	1.000
Reinforcement	-1301.9	-5.36	0.0	4.20	1.000
Reinforcement	-1301.9	-7.37	0.0	5.40	1.000
Reinforcement	-1301.9	-9.38	0.0	6.60	1.000
Reinforcement	-1301.9	-11.39	0.0	7.80	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability

Resisting moment M_{res} = 52610.4 lbfft/ft
Overturning moment M_{ovr} = 13527.1 lbfft/ft

Safety factor = 3.89 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 9191.75 lbf/ft
Active horizontal force H_{act} = 2734.26 lbf/ft

Safety factor = 3.36 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-41158.2	2904.63	-5060.93	0.000	1452.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-41158.2	2904.63	-5060.93

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1452.3 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 1.38 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-6.03	1068.5	0.26	1.000
Active pressure	2537.5	-3.54	934.8	10.52	1.000
Weight - reinforced soil	0.0	-6.45	16202.0	5.87	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 83.00 °
Overall normal force acting on reinforcement = 17136.76 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.70
Resistance along geo-reinforcement = 8091.22 lbf/ft
Wall resistance = 815.52 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 8906.74 lbf/ft
Active horiz. force H_{act} = 2537.55 lbf/ft

Factor of safety = 3.51 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 1301.91 lbf/ft
Force in reinforcement F_x = 841.02 lbf/ft

Safety factor = 1.55 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 13994.79 lbf/ft
Force in reinforcement F_x = 841.02 lbf/ft

Safety factor = 16.64 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-3.12;-7.34) ft
Radius r = 22.70 ft
Angle α_1 = -28.28 °

α_2 = 79.07 °

Slope stability check (Bishop)
FS = 1.53 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

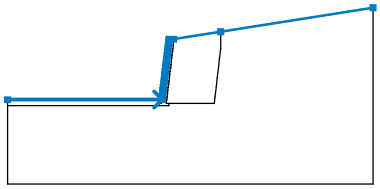
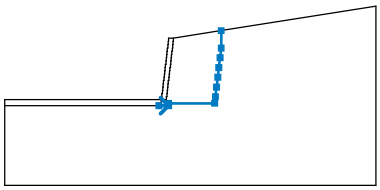
(input for current task)

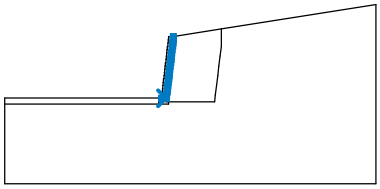
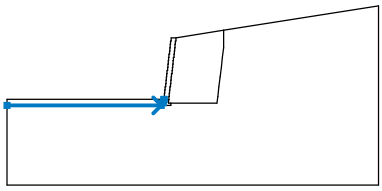
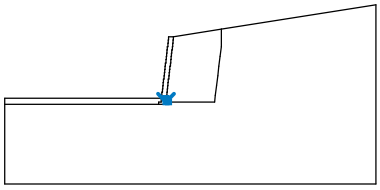
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-34.75	-12.65	-2.44	-12.65	-2.44	-12.06
		-2.36	-12.06	-2.36	-11.39	-2.28	-11.39
		-2.28	-10.72	-2.20	-10.72	-2.20	-10.05
		-2.12	-10.05	-2.12	-9.38	-2.04	-9.38
		-2.04	-8.71	-1.96	-8.71	-1.96	-8.04
		-1.88	-8.04	-1.88	-7.37	-1.80	-7.37
		-1.80	-6.70	-1.72	-6.70	-1.72	-6.03
		-1.64	-6.03	-1.64	-5.36	-1.56	-5.36
		-1.56	-4.69	-1.48	-4.69	-1.48	-4.02
		-1.40	-4.02	-1.40	-3.35	-1.32	-3.35
		-1.32	-2.68	-1.24	-2.68	-1.24	-2.01
		-1.16	-2.01	-1.16	-1.34	-1.08	-1.34
		-1.08	-0.67	-1.00	-0.67	-1.00	0.00
		0.00	0.00	9.84	1.56	41.70	6.60
2		-3.02	-13.90	-1.02	-13.90	-1.02	-13.40
		8.48	-13.40	8.64	-12.06	8.88	-10.05
		9.12	-8.04	9.36	-6.03	9.60	-4.02
		9.84	-2.01	9.84	1.56		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
3		-2.44	-12.73	-1.52	-12.73	-1.44	-12.73
		-1.44	-12.06	-1.36	-12.06	-1.36	-11.39
		-1.28	-11.39	-1.28	-10.72	-1.20	-10.72
		-1.20	-10.05	-1.12	-10.05	-1.12	-9.38
		-1.04	-9.38	-1.04	-8.71	-0.96	-8.71
		-0.96	-8.04	-0.88	-8.04	-0.88	-7.37
		-0.80	-7.37	-0.80	-6.70	-0.72	-6.70
		-0.72	-6.03	-0.64	-6.03	-0.64	-5.36
		-0.56	-5.36	-0.56	-4.69	-0.48	-4.69
		-0.48	-4.02	-0.40	-4.02	-0.40	-3.35
		-0.32	-3.35	-0.32	-2.68	-0.24	-2.68
		-0.24	-2.01	-0.16	-2.01	-0.16	-1.34
		-0.08	-1.34	-0.08	-0.67	0.00	-0.67
		0.00	0.00				
4		-34.75	-13.90	-3.02	-13.90	-3.02	-13.40
		-2.52	-13.40	-2.52	-12.73	-2.44	-12.73
		-2.44	-12.65				
5		-1.52	-12.73	-1.52	-13.40	-1.02	-13.40

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight :	γ =	120.0 pcf
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	25.00 °
Cohesion of soil :	c_{ef} =	100.0 psf
Saturated unit weight :	γ_{sat} =	125.0 pcf

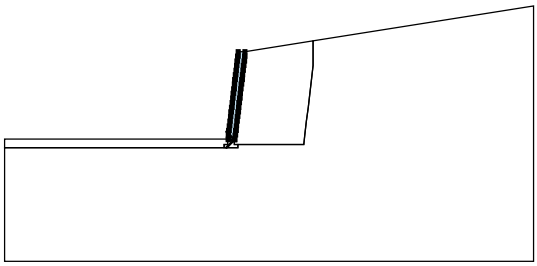
CDOT Class I strcutural fill

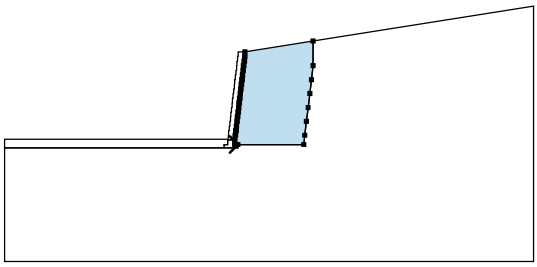
Unit weight :	γ =	125.0 pcf
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	34.00 °
Cohesion of soil :	c_{ef} =	0.0 psf
Saturated unit weight :	γ_{sat} =	130.0 pcf

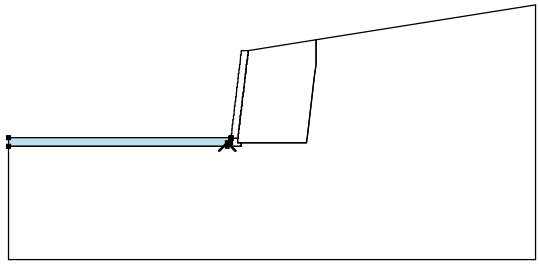
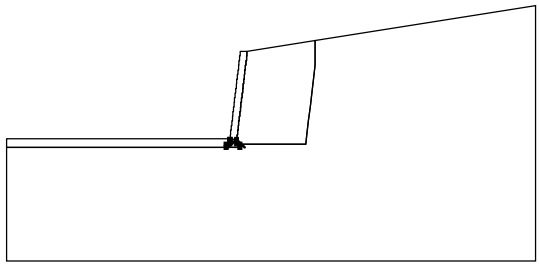
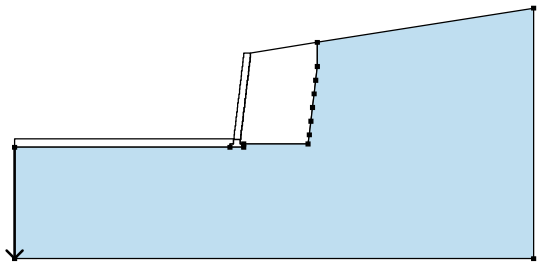
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-2.44	-12.73	-1.52	-12.73	Material of structure
		-1.44	-12.73	-1.44	-12.06	
		-1.36	-12.06	-1.36	-11.39	
		-1.28	-11.39	-1.28	-10.72	
		-1.20	-10.72	-1.20	-10.05	
		-1.12	-10.05	-1.12	-9.38	
		-1.04	-9.38	-1.04	-8.71	
		-0.96	-8.71	-0.96	-8.04	
		-0.88	-8.04	-0.88	-7.37	
		-0.80	-7.37	-0.80	-6.70	
		-0.72	-6.70	-0.72	-6.03	
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-6.03	
		-1.72	-6.03	-1.72	-6.70	
		-1.80	-6.70	-1.80	-7.37	
		-1.88	-7.37	-1.88	-8.04	
		-1.96	-8.04	-1.96	-8.71	
		-2.04	-8.71	-2.04	-9.38	
		-2.12	-9.38	-2.12	-10.05	
		-2.20	-10.05	-2.20	-10.72	
		-2.28	-10.72	-2.28	-11.39	
		-2.36	-11.39	-2.36	-12.06	
		-2.44	-12.06	-2.44	-12.65	
2		-1.52	-13.40	-1.02	-13.40	CDOT Class I strcutural fill
		8.48	-13.40	8.64	-12.06	
		8.88	-10.05	9.12	-8.04	
		9.36	-6.03	9.60	-4.02	
		9.84	-2.01	9.84	1.56	
		0.00	0.00	0.00	-0.67	
		-0.08	-0.67	-0.08	-1.34	
		-0.16	-1.34	-0.16	-2.01	
		-0.24	-2.01	-0.24	-2.68	
		-0.32	-2.68	-0.32	-3.35	
		-0.40	-3.35	-0.40	-4.02	
		-0.48	-4.02	-0.48	-4.69	
		-0.56	-4.69	-0.56	-5.36	
		-0.64	-5.36	-0.64	-6.03	
		-0.72	-6.03	-0.72	-6.70	
		-0.80	-6.70	-0.80	-7.37	
		-0.88	-7.37	-0.88	-8.04	
		-0.96	-8.04	-0.96	-8.71	
		-1.04	-8.71	-1.04	-9.38	
		-1.12	-9.38	-1.12	-10.05	
		-1.20	-10.05	-1.20	-10.72	
		-1.28	-10.72	-1.28	-11.39	
		-1.36	-11.39	-1.36	-12.06	
		-1.44	-12.06	-1.44	-12.73	
		-1.52	-12.73			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		-3.02	-13.90	-3.02	-13.40	On Site Soil
		-2.52	-13.40	-2.52	-12.73	
		-2.44	-12.73	-2.44	-12.65	
		-34.75	-12.65	-34.75	-13.90	
4		-1.52	-13.40	-1.52	-12.73	Material of structure
		-2.44	-12.73	-2.52	-12.73	
		-2.52	-13.40	-3.02	-13.40	
		-3.02	-13.90	-1.02	-13.90	
		-1.02	-13.40			
5		-34.75	-13.90	-34.75	-30.30	On Site Soil
		41.70	-30.30	41.70	6.60	
		9.84	1.56	9.84	-2.01	
		9.60	-4.02	9.36	-6.03	
		9.12	-8.04	8.88	-10.05	
		8.64	-12.06	8.48	-13.40	
		-1.02	-13.40	-1.02	-13.90	
		-3.02	-13.90			

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.16	-2.01	9.84	-2.01	10.00	1301.9	T_p = 164.1 lbf/ft^2	Fixed
2	-0.40	-4.02	9.60	-4.02	10.00	1301.9	T_p = 328.1 lbf/ft^2	Fixed
3	-0.64	-6.03	9.36	-6.03	10.00	1301.9	T_p = 492.2 lbf/ft^2	Fixed
4	-0.88	-8.04	9.12	-8.04	10.00	1301.9	T_p = 656.2 lbf/ft^2	Fixed
5	-1.12	-10.05	8.88	-10.05	10.00	1301.9	T_p = 820.3 lbf/ft^2	Fixed
6	-1.36	-12.06	8.64	-12.06	10.00	1301.9	T_p = 984.3 lbf/ft^2	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.08	[ft]	Angles :	α_1 =	-28.19	[°]
	z =	7.41	[ft]		α_2 =	78.96	[°]
Radius :	R =	22.76	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 12897.1 lbf/ft
Sum of passive forces : F_p = 19787.5 lbf/ft

Sliding moment : M_a = 293538.9 lbfft/ft
Resisting moment : M_p = 450362.5 lbfft/ft

Factor of safety = 1.53 > 1.30

Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 6' Max Lower Tier MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 10
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70
2	Miragrid 2XT	Miragrid 2XT	————	2000.84	505.26	0.80	0.80
3	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.80	0.80
4	Miragrid 7XT	Miragrid 7XT	————	5701.01	1727.58	0.80	0.80

Reinforcement details

1. Miragrid 5XT

Short-term char. strength T_{ult} = 4296.31 lbf/ft
Long-term design strength R_t = 1301.91 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

2. Miragrid 2XT

Short-term char. strength T_{ult} = 2000.84 lbf/ft
Long-term design strength R_t = 505.26 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.50

3. Miragrid 3XT

Short-term char. strength T_{ult} = 3152.00 lbf/ft
Long-term design strength R_t = 955.15 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0

Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

4. Miragrid 7XT
Short-term char. strength T_{ult} = 5701.01 lbf/ft
Long-term design strength R_t = 1727.58 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 4.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 7XT	-0.56	10.44	1.34	11.00
5	Miragrid 3XT	-0.40	10.60	2.68	11.00
7	Miragrid 2XT	-0.24	10.76	4.02	11.00
9	Miragrid 2XT	-0.08	10.92	5.36	11.00

Soil parameters

On Site Soil
Unit weight : γ = 120.0 pcf
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

CDOT Class I strcutural fill
Unit weight : γ = 125.0 pcf
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 17.00 °
Saturated unit weight : γ_{sat} = 130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).
Embankment height is 0.95 ft, embankment length is 6.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	882.00		6.00	2.00	on terrain
2	Yes		permanent	750.00		8.00	10.00	on terrain

No.	Name
1	Wall
2	Soil

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure $h = 1.25$ ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-3.69	10175.2	7.02	1.000
Active pressure	390.1	-1.57	128.2	12.19	1.000
Soil	1767.9	-3.57	693.2	12.44	1.000
Weight - wall	0.0	-3.35	593.6	0.86	1.000
Wall	0.0	-7.65	1764.0	8.72	1.000
Soil	0.0	-7.65	2190.0	11.18	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment $M_{res} = 122002.6$ lbfft/ft
Overturning moment $M_{ovr} = 6587.6$ lbfft/ft

Safety factor = 18.52 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force $H_{res} = 8448.39$ lbf/ft
Active horizontal force $H_{act} = 1534.57$ lbf/ft

Safety factor = 5.51 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-3.35	593.6	0.86	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	763.2	-2.23	233.3	1.23	1.000
Wall	407.8	-1.92	124.7	1.19	1.000
Soil	393.8	-1.14	120.4	1.10	1.000
Reinforcement	-1727.6	-1.34	0.0	1.80	1.000
Reinforcement	-955.2	-2.68	0.0	2.60	1.000
Reinforcement	-505.3	-4.02	0.0	3.40	1.000
Reinforcement	-505.3	-5.36	0.0	4.20	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability
Resisting moment M_{res} = 10691.9 lbfft/ft
Overturning moment M_{ovr} = 2826.5 lbfft/ft

Safety factor = 3.78 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 4514.64 lbf/ft
Active horizontal force H_{act} = 1246.17 lbf/ft

Safety factor = 3.62 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-9138.7	1640.24	-2581.95	0.000	820.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-9138.7	1640.24	-2581.95

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 820.1 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 2.44 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.68	474.9	-0.14	1.000
Active pressure	236.5	-1.08	96.7	11.21	1.000
Soil	1422.2	-2.95	566.2	11.41	1.000
Weight - reinforced soil	0.0	-3.03	8327.7	5.97	1.000
Wall	0.0	-6.31	1764.0	7.64	1.000
Soil	0.0	-6.31	2327.3	10.19	1.000
Reinforcement	-24.7	-1.34	0.0	11.20	1.000
Reinforcement	-27.0	-2.68	0.0	11.34	1.000
Reinforcement	-22.7	-4.02	0.0	11.48	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 84.00 °
Overall normal force acting on reinforcement = 13081.98 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.80
Resistance along geo-reinforcement = 7059.13 lbf/ft
Wall resistance = 499.12 lbf/ft
Overall bearing capacity of reinforcements = 74.41 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 7632.66 lbf/ft
Active horiz. force H_{act} = 1658.65 lbf/ft

Factor of safety = 4.60 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 4

Check for tensile strength
Tension strength R_t = 505.26 lbf/ft
Force in reinforcement F_x = 90.64 lbf/ft

Safety factor = 5.57 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 2585.51 lbf/ft
Force in reinforcement F_x = 90.64 lbf/ft

Safety factor = 28.52 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (0.12;-8.39) ft
Radius r = 17.21 ft
Angle α_1 = -33.57 °
α_2 = 64.39 °

Slope stability check (Bishop)
FS = 1.64 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

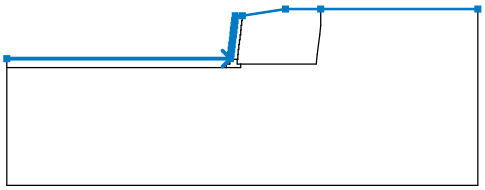
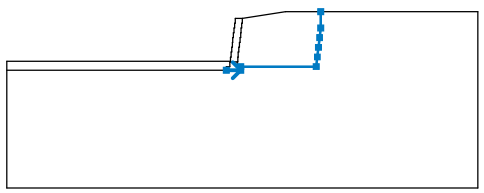
(input for current task)

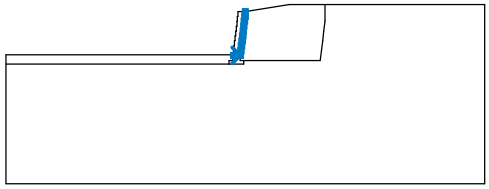
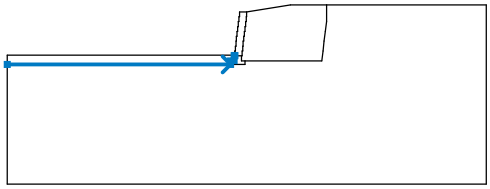
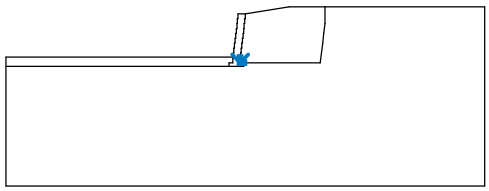
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-5.95	-1.64	-5.95	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	6.00	0.95
		10.92	0.95	32.80	0.95		
2		-2.22	-7.20	-0.22	-7.20	-0.22	-6.70
		10.28	-6.70	10.44	-5.36	10.60	-4.02
		10.76	-2.68	10.92	-1.34	10.92	0.95

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
3		-1.64	-6.03	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		
4		-32.80	-7.20	-2.22	-7.20	-2.22	-6.70
		-1.72	-6.70	-1.72	-6.03	-1.64	-6.03
		-1.64	-5.95				
5		-0.72	-6.03	-0.72	-6.70	-0.22	-6.70

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

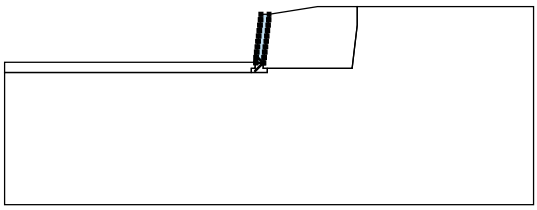
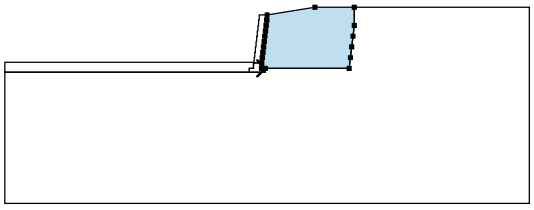
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

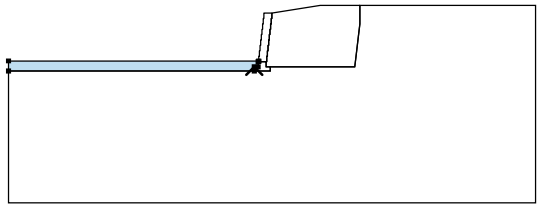
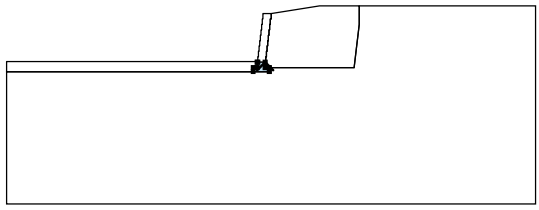
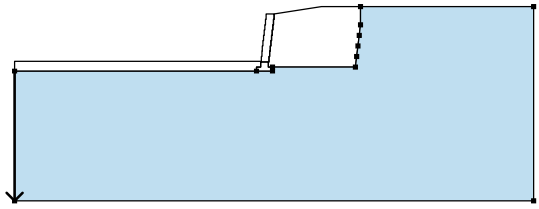
CDOT Class I strcutural fill
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-1.64	-6.03	-0.72	-6.03	Material of structure
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-5.95	
2		-0.72	-6.70	-0.22	-6.70	CDOT Class I strcutural fill
		10.28	-6.70	10.44	-5.36	
		10.60	-4.02	10.76	-2.68	
		10.92	-1.34	10.92	0.95	
		6.00	0.95	0.00	0.00	
		0.00	-0.67	-0.08	-0.67	
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.40	-4.02	-0.48	-4.02	
		-0.48	-4.69	-0.56	-4.69	
		-0.56	-5.36	-0.64	-5.36	
		-0.64	-6.03	-0.72	-6.03	
3		-2.22	-7.20	-2.22	-6.70	On Site Soil
		-1.72	-6.70	-1.72	-6.03	
		-1.64	-6.03	-1.64	-5.95	
		-32.80	-5.95	-32.80	-7.20	
4		-0.72	-6.70	-0.72	-6.03	Material of structure
		-1.64	-6.03	-1.72	-6.03	
		-1.72	-6.70	-2.22	-6.70	
		-2.22	-7.20	-0.22	-7.20	
		-0.22	-6.70			
5		-32.80	-7.20	-32.80	-23.60	On Site Soil
		32.80	-23.60	32.80	0.95	
		10.92	0.95	10.92	-1.34	
		10.76	-2.68	10.60	-4.02	
		10.44	-5.36	10.28	-6.70	
		-0.22	-6.70	-0.22	-7.20	
		-2.22	-7.20			

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.08	-1.34	10.92	-1.34	11.00	505.3	T_p = 125.0 lbf/ft^2	Fixed
2	-0.24	-2.68	10.76	-2.68	11.00	505.3	T_p = 250.0 lbf/ft^2	Fixed
3	-0.40	-4.02	10.60	-4.02	11.00	955.2	T_p = 375.0 lbf/ft^2	Fixed
4	-0.56	-5.36	10.44	-5.36	11.00	1727.6	T_p = 500.0 lbf/ft^2	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 6.00	l = 2.00		0.00	882.0		lbf/ft^2
2	strip	permanent	on terrain	x = 8.00	l = 10.00		0.00	750.0		lbf/ft^2

Surcharges

No.	Name
1	Wall

No.	Name
2	Soil

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	0.36	[ft]	Angles :	α_1 =	-33.81	[°]
	z =	7.91	[ft]		α_2 =	65.34	[°]
Radius :	R =	16.68	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 8694.0 lbf/ft
Sum of passive forces : F_p = 14294.0 lbf/ft

Sliding moment : M_a = 145016.4 lbfft/ft
Resisting moment : M_p = 238423.7 lbfft/ft

Factor of safety = 1.64 > 1.30

Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac Wall
Description : 8' Max Upper Tier MSE Wall Height
Customer : Integrated Walls
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

Number of blocks n = 13
Block height h = 0.67 ft
Block width b = 1.00 ft
Block offset o_1 = 0.08 ft

Structure foundation
Foundation width b_b = 2.00 ft

Foundation height l_b = 0.50 ft
Foundation offset a_b = 0.50 ft

Material

Block material

Unit weight	γ	=	88.60	pcf
Cohesion	c	=	50.0	psf
Friction	f	=	0.533	
Shear bearing capacity of joint	R_s	=	200.00	lbf/ft

Reinforced soil - CDOT Class I strcutural fill

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70
2	Miragrid 2XT	Miragrid 2XT	————	2000.84	505.26	0.80	0.80
3	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.80	0.80

Reinforcement details

1. Miragrid 5XT

Short-term char. strength T_{ult} = 4296.31 lbf/ft
Long-term design strength R_t = 1301.91 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

2. Miragrid 2XT

Short-term char. strength T_{ult} = 2000.84 lbf/ft
Long-term design strength R_t = 505.26 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.50

3. Miragrid 3XT

Short-term char. strength T_{ult} = 3152.00 lbf/ft
Long-term design strength R_t = 955.15 lbf/ft
Overall coeff. of model uncertainty FS_{UNC} = 1.50

Calculate reduction factors
Life time : 114 years
Creep red. factor RF_{CR} = 1.60
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1.10

Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor RF_{ID} = 1.25

Reinforcement

Total number of input reinforcements : 4.

Reinforcement details

Block No.	Type of reinforcement	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
3	Miragrid 3XT	-0.80	5.20	1.34	6.00
6	Miragrid 3XT	-0.56	5.44	3.35	6.00
9	Miragrid 2XT	-0.32	5.68	5.36	6.00
12	Miragrid 2XT	-0.08	5.92	7.37	6.00

Soil parameters

On Site Soil

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	γ_{sat}	=	125.0 pcf

CDOT Class I strcutural fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	φ_{ef}	=	34.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Angle of friction struc.-soil :	δ	=	17.00 °
Saturated unit weight :	γ_{sat}	=	130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	On Site Soil	

Terrain profile

Terrain behind construction has the slope 1: 6.31 (slope angle is 9.00 °).
Embankment height is 0.63 ft, embankment length is 4.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	200.00		4.00	50.00	on terrain

No.	Name
1	Road

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - On Site Soil
Soil thickness in front of structure h = 1.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Reduction of soil/soil friction angle : do not reduce
Design situation : permanent

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
FF resistance	-623.4	-0.55	0.0	0.00	1.000
Weight - reinforced soil	0.0	-4.56	6872.8	4.55	1.000
Active pressure	719.1	-2.14	236.3	7.26	1.000
Road	508.1	-3.80	220.3	7.55	1.000
Weight - wall	0.0	-4.36	771.7	0.98	1.000
Road	0.0	-9.34	384.0	6.92	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 38059.9 lbfft/ft
Overturning moment M_{ovr} = 3125.0 lbfft/ft

Safety factor = 12.18 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 4656.66 lbf/ft
Active horizontal force H_{act} = 603.82 lbf/ft

Safety factor = 7.71 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-4.36	771.7	0.98	1.000
FF resistance	-318.6	-0.34	0.0	0.00	1.000
Active pressure	1275.1	-2.92	389.8	1.31	1.000
Road	332.2	-3.33	101.6	1.36	1.000
Reinforcement	-955.2	-1.34	0.0	1.80	1.000
Reinforcement	-955.2	-3.35	0.0	3.00	1.000
Reinforcement	-505.3	-5.36	0.0	4.20	1.000
Reinforcement	-505.3	-7.37	0.0	5.40	1.000

Verification of construction joint above the block No.: 0

Check for overturning stability
Resisting moment M_{res} = 12316.6 lbfft/ft

Overturning moment M_{ovr} = 4725.0 lbfft/ft

Safety factor = 2.61 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 3844.06 lbf/ft
Active horizontal force H_{act} = 1288.66 lbf/ft

Safety factor = 2.98 > 1.50
Joint for slip is SATISFACTORY

Joint is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-8222.9	1765.72	-1749.99	0.000	882.9

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-8222.9	1765.72	-1749.99

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 882.9 psf
Bearing capacity of foundation soil R_d = 2000.0 psf

Safety factor = 2.27 > 1.30
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.68	653.0	-0.02	1.000
Active pressure	603.3	-1.86	281.3	6.08	1.000
Road	410.2	-3.22	237.5	6.08	1.000
Weight - reinforced soil	0.0	-3.78	5411.4	3.24	1.000
Road	0.0	-8.00	240.0	5.48	1.000
Reinforcement	-310.3	-2.01	0.0	5.92	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Reinforcement	-329.9	-4.02	0.0	5.92	1.000
Reinforcement	-224.5	-6.03	0.0	5.92	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 6170.18 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.80
Resistance along geo-reinforcement = 3329.47 lbf/ft
Wall resistance = 594.04 lbf/ft
Overall bearing capacity of reinforcements = 864.66 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 4788.17 lbf/ft
Active horiz. force H_{act} = 1013.50 lbf/ft

Factor of safety = 4.72 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 955.15 lbf/ft
Force in reinforcement F_x = 634.00 lbf/ft

Safety factor = 1.51 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 5599.27 lbf/ft
Force in reinforcement F_x = 634.00 lbf/ft

Safety factor = 8.83 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-1.94;-2.97) ft
Radius r = 12.58 ft
Angle α_1 = -29.68 °
α_2 = 79.28 °

Slope stability check (Bishop)
FS = 1.59 > 1.30
Slope stability is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

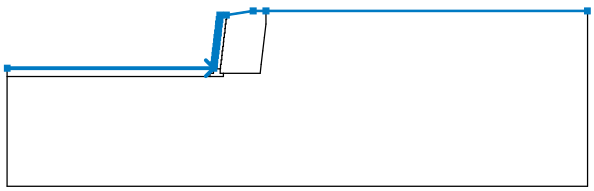
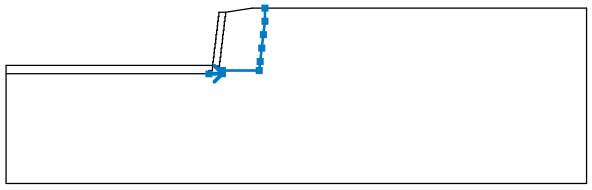
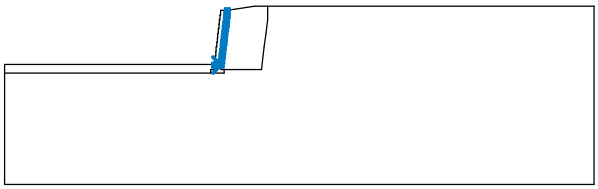
(input for current task)

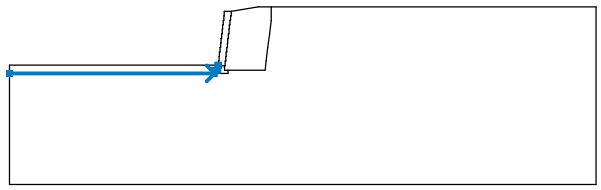
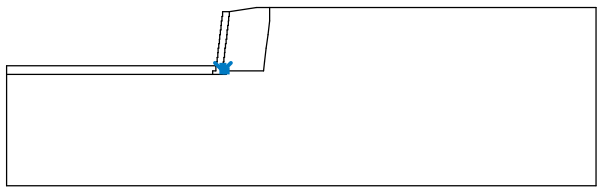
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-7.96	-1.88	-7.96	-1.88	-7.37
		-1.80	-7.37	-1.80	-6.70	-1.72	-6.70
		-1.72	-6.03	-1.64	-6.03	-1.64	-5.36
		-1.56	-5.36	-1.56	-4.69	-1.48	-4.69
		-1.48	-4.02	-1.40	-4.02	-1.40	-3.35
		-1.32	-3.35	-1.32	-2.68	-1.24	-2.68
		-1.24	-2.01	-1.16	-2.01	-1.16	-1.34
		-1.08	-1.34	-1.08	-0.67	-1.00	-0.67
		-1.00	0.00	0.00	0.00	4.00	0.63
		5.92	0.63	54.00	0.63		
2		-2.46	-9.21	-0.46	-9.21	-0.46	-8.71
		5.04	-8.71	5.20	-7.37	5.44	-5.36
		5.68	-3.35	5.92	-1.34	5.92	0.63
3		-1.88	-8.04	-0.96	-8.04	-0.88	-8.04
		-0.88	-7.37	-0.80	-7.37	-0.80	-6.70
		-0.72	-6.70	-0.72	-6.03	-0.64	-6.03
		-0.64	-5.36	-0.56	-5.36	-0.56	-4.69
		-0.48	-4.69	-0.48	-4.02	-0.40	-4.02
		-0.40	-3.35	-0.32	-3.35	-0.32	-2.68
		-0.24	-2.68	-0.24	-2.01	-0.16	-2.01
		-0.16	-1.34	-0.08	-1.34	-0.08	-0.67
		0.00	-0.67	0.00	0.00		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-32.80	-9.21	-2.46	-9.21	-2.46	-8.71
		-1.96	-8.71	-1.96	-8.04	-1.88	-8.04
		-1.88	-7.96				
5		-0.96	-8.04	-0.96	-8.71	-0.46	-8.71

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soil		25.00	100.0	120.0
2	CDOT Class I strcutural fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soil		125.0		
2	CDOT Class I strcutural fill		130.0		

Soil parameters

On Site Soil

Unit weight : $\gamma = 120.0$ pcf
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 25.00$ °
Cohesion of soil : $c_{ef} = 100.0$ psf
Saturated unit weight : $\gamma_{sat} = 125.0$ pcf

CDOT Class I strcutural fill

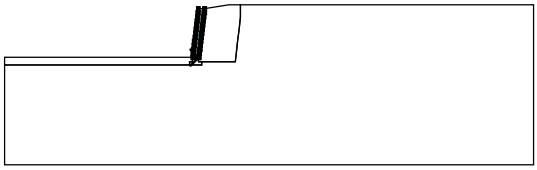
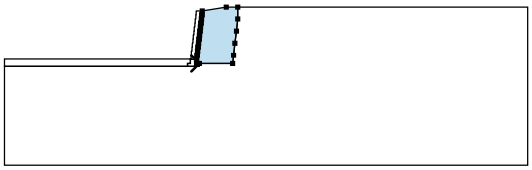
Unit weight : $\gamma = 125.0$ pcf
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 34.00$ °

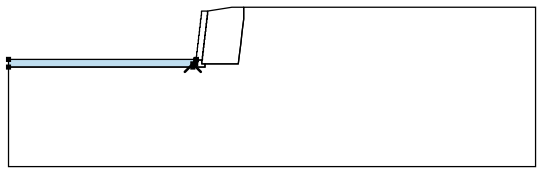
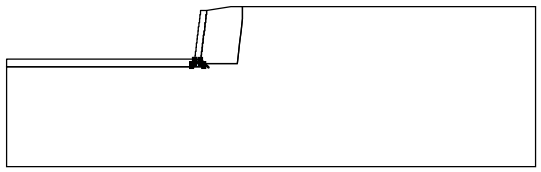
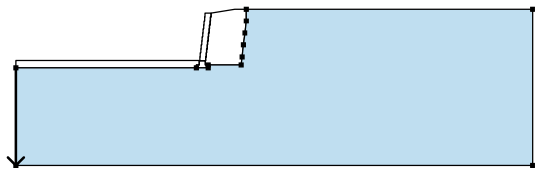
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		88.6

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-1.88	-8.04	-0.96	-8.04	Material of structure
		-0.88	-8.04	-0.88	-7.37	
		-0.80	-7.37	-0.80	-6.70	
		-0.72	-6.70	-0.72	-6.03	
		-0.64	-6.03	-0.64	-5.36	
		-0.56	-5.36	-0.56	-4.69	
		-0.48	-4.69	-0.48	-4.02	
		-0.40	-4.02	-0.40	-3.35	
		-0.32	-3.35	-0.32	-2.68	
		-0.24	-2.68	-0.24	-2.01	
		-0.16	-2.01	-0.16	-1.34	
		-0.08	-1.34	-0.08	-0.67	
		0.00	-0.67	0.00	0.00	
		-1.00	0.00	-1.00	-0.67	
		-1.08	-0.67	-1.08	-1.34	
		-1.16	-1.34	-1.16	-2.01	
		-1.24	-2.01	-1.24	-2.68	
		-1.32	-2.68	-1.32	-3.35	
		-1.40	-3.35	-1.40	-4.02	
		-1.48	-4.02	-1.48	-4.69	
		-1.56	-4.69	-1.56	-5.36	
		-1.64	-5.36	-1.64	-6.03	
		-1.72	-6.03	-1.72	-6.70	
		-1.80	-6.70	-1.80	-7.37	
		-1.88	-7.37	-1.88	-7.96	
2		-0.96	-8.71	-0.46	-8.71	CDOT Class I strcutural fill
		5.04	-8.71	5.20	-7.37	
		5.44	-5.36	5.68	-3.35	
		5.92	-1.34	5.92	0.63	
		4.00	0.63	0.00	0.00	
		0.00	-0.67	-0.08	-0.67	
		-0.08	-1.34	-0.16	-1.34	
		-0.16	-2.01	-0.24	-2.01	
		-0.24	-2.68	-0.32	-2.68	
		-0.32	-3.35	-0.40	-3.35	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
		-0.40	-4.02	-0.48	-4.02	
		-0.48	-4.69	-0.56	-4.69	
		-0.56	-5.36	-0.64	-5.36	
		-0.64	-6.03	-0.72	-6.03	
		-0.72	-6.70	-0.80	-6.70	
		-0.80	-7.37	-0.88	-7.37	
		-0.88	-8.04	-0.96	-8.04	
3		-2.46	-9.21	-2.46	-8.71	On Site Soil
		-1.96	-8.71	-1.96	-8.04	
		-1.88	-8.04	-1.88	-7.96	
		-32.80	-7.96	-32.80	-9.21	
4		-0.96	-8.71	-0.96	-8.04	Material of structure
		-1.88	-8.04	-1.96	-8.04	
		-1.96	-8.71	-2.46	-8.71	
		-2.46	-9.21	-0.46	-9.21	
		-0.46	-8.71			
5		-32.80	-9.21	-32.80	-25.61	On Site Soil
		54.00	-25.61	54.00	0.63	
		5.92	0.63	5.92	-1.34	
		5.68	-3.35	5.44	-5.36	
		5.20	-7.37	5.04	-8.71	
		-0.46	-8.71	-0.46	-9.21	
		-2.46	-9.21			

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.08	-1.34	5.92	-1.34	6.00	505.3	T_p = 125.0 lbf/ft^2	Fixed
2	-0.32	-3.35	5.68	-3.35	6.00	505.3	T_p = 312.5 lbf/ft^2	Fixed
3	-0.56	-5.36	5.44	-5.36	6.00	955.2	T_p = 500.0 lbf/ft^2	Fixed
4	-0.80	-7.37	5.20	-7.37	6.00	955.2	T_p = 687.5 lbf/ft^2	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 4.00	l = 50.00		0.00	200.0		lbf/ft^2

Surcharges

No.	Name
1	Road

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.10	[ft]	Angles :	α_1 =	-29.37	[°]
	z =	3.36	[ft]		α_2 =	77.87	[°]
Radius :	R =	12.99	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 5417.1 lbf/ft
Sum of passive forces : F_p = 8618.4 lbf/ft

Sliding moment : M_a = 70368.1 lbfft/ft
Resisting moment : M_p = 111953.1 lbfft/ft
Factor of safety = 1.59 > 1.30
Slope stability ACCEPTABLE

Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac
Description : 2 tier walls
Customer : Integrated Wall
Author : JNH
Date : 12/2/2022
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

No.	Embankment height h_n[ft]	Embankment length l_n[ft]	Terrace length l_t[ft]	With cover	Cover thickness t_c[ft]
1	6.00	1.50		Yes	1.00
2	8.00	1.50	6.00	Yes	1.00

Material

Cover material
Unit weight $\gamma = 82.00$ pcf
Shear resistance $R_s = 800.0$ psf

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70
2	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.80	0.80

Reinforcement details

1. Miragrid 5XT
Short-term char. strength $T_{ult} = 4296.31$ lbf/ft
Long-term design strength $R_t = 1301.91$ lbf/ft
Overall coeff. of model uncertainty $FS_{UNC} = 1.50$

Calculate reduction factors
Life time : 114 years
Creep red. factor $RF_{CR} = 1.60$
Chemistry : pH 4.0-9.0
Durability red. factor $RF_D = 1.10$
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor $RF_{ID} = 1.25$

2. Miragrid 3XT
Short-term char. strength $T_{ult} = 3152.00$ lbf/ft
Long-term design strength $R_t = 955.15$ lbf/ft
Overall coeff. of model uncertainty $FS_{UNC} = 1.50$

Calculate reduction factors
Life time : 114 years
Creep red. factor $RF_{CR} = 1.60$
Chemistry : pH 4.0-9.0
Durability red. factor $RF_D = 1.10$
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor $RF_{ID} = 1.25$

Reinforcement

No.	Number of reinforcements	Type of reinforcement	Spacing of reinforcements h_r[ft]	Height of first reinforcement y[ft]	Reinforcements geometry
1	4	Miragrid 5XT	1.33	1.00	identical length of reinforcements
2	4	Miragrid 3XT	2.00	1.33	identical length of reinforcements

Reinforcement details

Reinforcement No. 1
Reinforcement type : Miragrid 5XT
Number of reinforcements 4
Reinforcement geometry : identical length of reinforcements
Reinforcement length : 11.00 ft

No.	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
1	-8.75	2.25	1.00	11.00
2	-8.42	2.58	2.33	11.00
3	-8.09	2.91	3.66	11.00
4	-7.75	3.25	4.99	11.00

Reinforcement No. 2
Reinforcement type : Miragrid 3XT
Number of reinforcements 4
Reinforcement geometry : identical length of reinforcements
Reinforcement length : 4.00 ft

No.	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
1	-1.25	2.75	7.33	4.00
2	-0.88	3.12	9.33	4.00
3	-0.50	3.50	11.33	4.00
4	-0.13	3.87	13.33	4.00

Soil parameters

On Site Soils

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	γ_{sat}	=	125.0 pcf

CDOT Class 1 Fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	φ_{ef}	=	34.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Angle of friction struc.-soil :	δ	=	17.00 °
Saturated unit weight :	γ_{sat}	=	130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	10.00	0.00 .. 10.00	On Site Soils	
2	15.00	10.00 .. 25.00	On Site Soils	
3	-	25.00 .. ∞	On Site Soils	

Terrain profile

Terrain behind construction has the slope 1: 14.00 (slope angle is 4.09 °).
Embankment height is 0.29 ft, embankment length is 4.00 ft.

Water influence

Ground water table is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	200.00		4.00	50.00	on terrain

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Reduction of soil/soil friction angle : reduce to 2/3 φ (AASHTO)
Design situation : permanent

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-16673.7	13079.54	2980.50	0.000	1189.0

Service load acting at the center of footing bottom

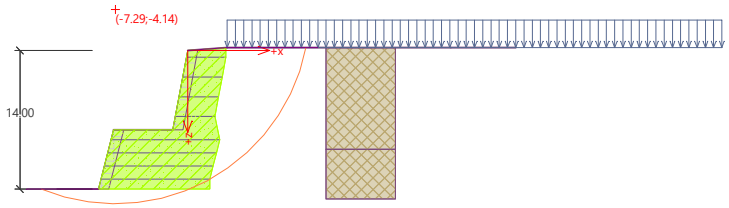
No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-16673.7	13079.54	2980.50

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-7.29;-4.14) ft
Radius r = 19.63 ft
Angle α_1 = -22.47 °
α_2 = 78.69 °

Slope stability check (Bishop)
FS = 1.34 > 1.30
Slope stability is SATISFACTORY

Name : Global stability	Stage - analysis : 1 - 1



Slope stability analysis

Input data

Project

Settings

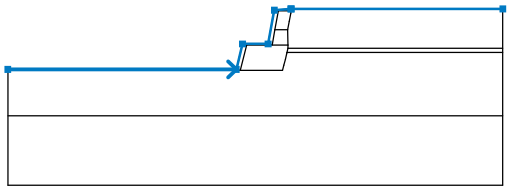
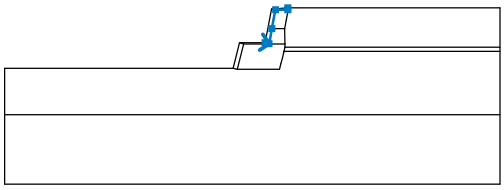
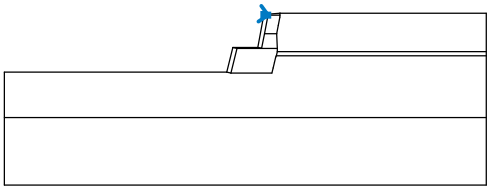
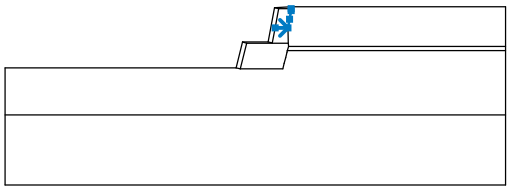
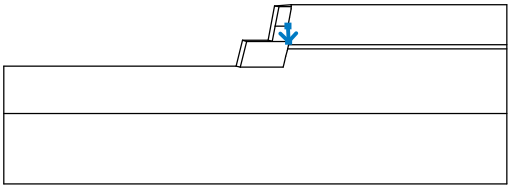
(input for current task)

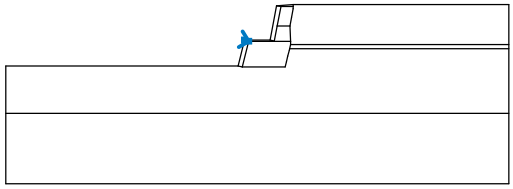
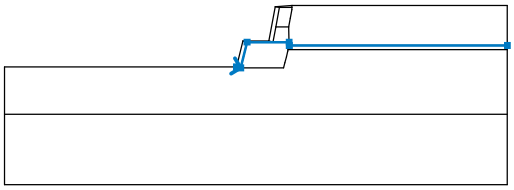
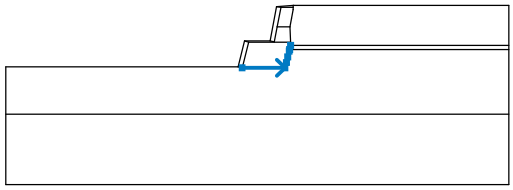
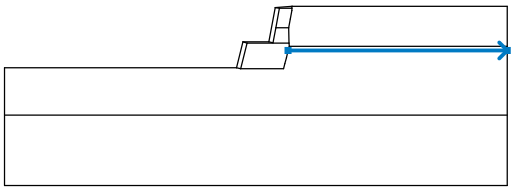
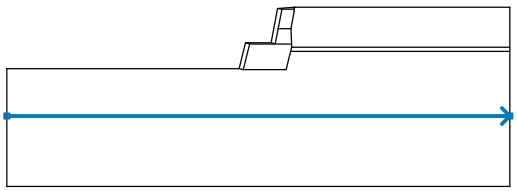
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-63.00	-14.00	-9.00	-14.00	-7.50	-8.00
		-1.50	-8.00	0.00	0.00	3.87	0.28
		4.00	0.29	54.00	0.29		
2		-1.50	-8.00	-0.52	-8.18	0.14	-4.67
		0.98	-0.18	3.87	-0.18	3.87	0.28
3		0.00	0.00	0.98	-0.18		
4		0.14	-4.67	3.12	-4.67	3.50	-2.67
		3.87	-0.67	3.87	-0.18		
5		3.12	-4.67	3.23	-8.24		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-7.50	-8.00	-6.53	-8.24		
7		-9.00	-14.00	-8.03	-14.24	-6.53	-8.24
		3.23	-8.24	3.25	-9.01	54.00	-9.01
8		-8.03	-14.24	1.94	-14.24	2.25	-13.00
		2.58	-11.67	2.91	-10.34	3.00	-10.00
		3.25	-9.01				
9		3.00	-10.00	54.00	-10.00		
10		-63.00	-25.00	54.00	-25.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soils		25.00	100.0	120.0
2	CDOT Class 1 Fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soils		125.0		
2	CDOT Class 1 Fill		130.0		

Soil parameters

On Site Soils

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

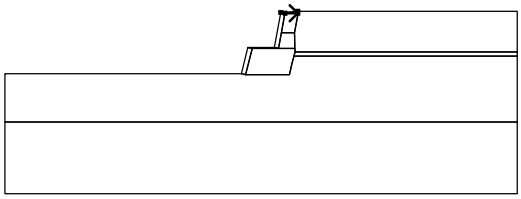
CDOT Class 1 Fill

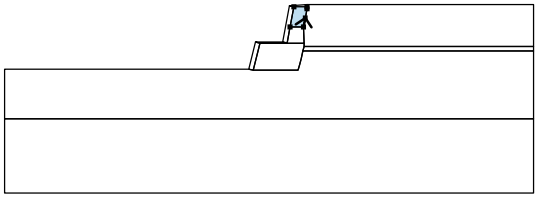
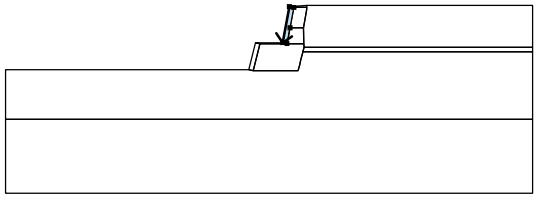
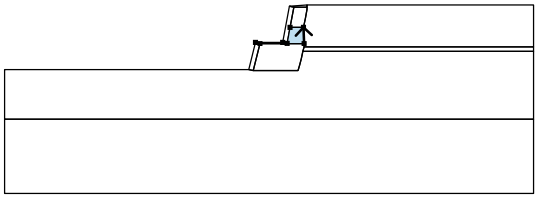
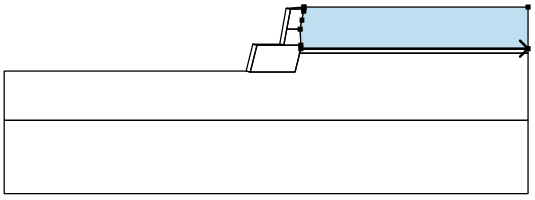
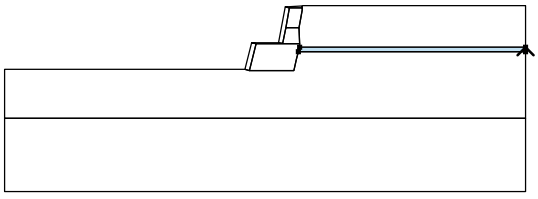
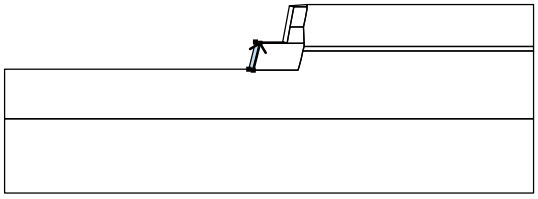
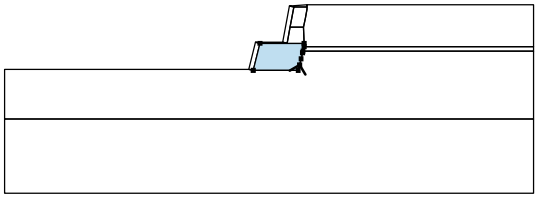
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

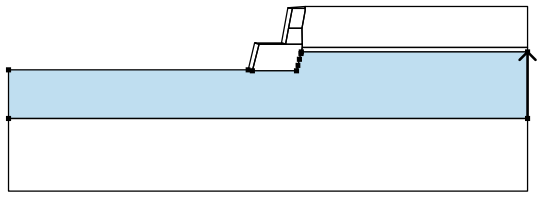
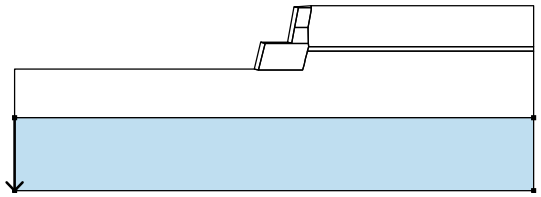
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Cover		82.0
2	Material of cover		82.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		0.98	-0.18	3.87	-0.18	CDOT Class 1 Fill
		3.87	0.28	0.00	0.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		3.12	-4.67	3.50	-2.67	CDOT Class 1 Fill
		3.87	-0.67	3.87	-0.18	
		0.98	-0.18	0.14	-4.67	
3		0.00	0.00	-1.50	-8.00	Cover
		-0.52	-8.18	0.14	-4.67	
		0.98	-0.18			
4		3.23	-8.24	3.12	-4.67	CDOT Class 1 Fill
		0.14	-4.67	-0.52	-8.18	
		-1.50	-8.00	-7.50	-8.00	
		-6.53	-8.24			
5		3.25	-9.01	54.00	-9.01	On Site Soils
		54.00	0.29	4.00	0.29	
		3.87	0.28	3.87	-0.18	
		3.87	-0.67	3.50	-2.67	
		3.12	-4.67	3.23	-8.24	
6		54.00	-10.00	54.00	-9.01	On Site Soils
		3.25	-9.01	3.00	-10.00	
7		-8.03	-14.24	-6.53	-8.24	Cover
		-7.50	-8.00	-9.00	-14.00	
8		1.94	-14.24	2.25	-13.00	CDOT Class 1 Fill
		2.58	-11.67	2.91	-10.34	
		3.00	-10.00	3.25	-9.01	
		3.23	-8.24	-6.53	-8.24	
		-8.03	-14.24			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
9		54.00	-25.00	54.00	-10.00	On Site Soils
		3.00	-10.00	2.91	-10.34	
		2.58	-11.67	2.25	-13.00	
		1.94	-14.24	-8.03	-14.24	
		-9.00	-14.00	-63.00	-14.00	
		-63.00	-25.00			
10		-63.00	-25.00	-63.00	-41.40	On Site Soils
		54.00	-41.40	54.00	-25.00	

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	-0.13	-0.67	3.87	-0.67	4.00	955.2	T_p = 62.5 lbf/ft^2	Fixed
2	-0.50	-2.67	3.50	-2.67	4.00	955.2	T_p = 249.0 lbf/ft^2	Fixed
3	-0.88	-4.67	3.12	-4.67	4.00	955.2	T_p = 435.5 lbf/ft^2	Fixed
4	-1.25	-6.67	2.75	-6.67	4.00	955.2	T_p = 622.1 lbf/ft^2	Fixed
5	-7.75	-9.01	3.25	-9.01	11.00	1301.9	T_p = 735.3 lbf/ft^2	Fixed
6	-8.09	-10.34	2.91	-10.34	11.00	1301.9	T_p = 843.8 lbf/ft^2	Fixed
7	-8.42	-11.67	2.58	-11.67	11.00	1301.9	T_p = 952.3 lbf/ft^2	Fixed
8	-8.75	-13.00	2.25	-13.00	11.00	1301.9	T_p = 1060.8 lbf/ft^2	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 4.00	l = 50.00		0.00	200.0		lbf/ft^2

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-7.39	[ft]	Angles :	α_1 =	-21.67	[°]
	z =	4.94	[ft]		α_2 =	76.81	[°]
Radius :	R =	20.38	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

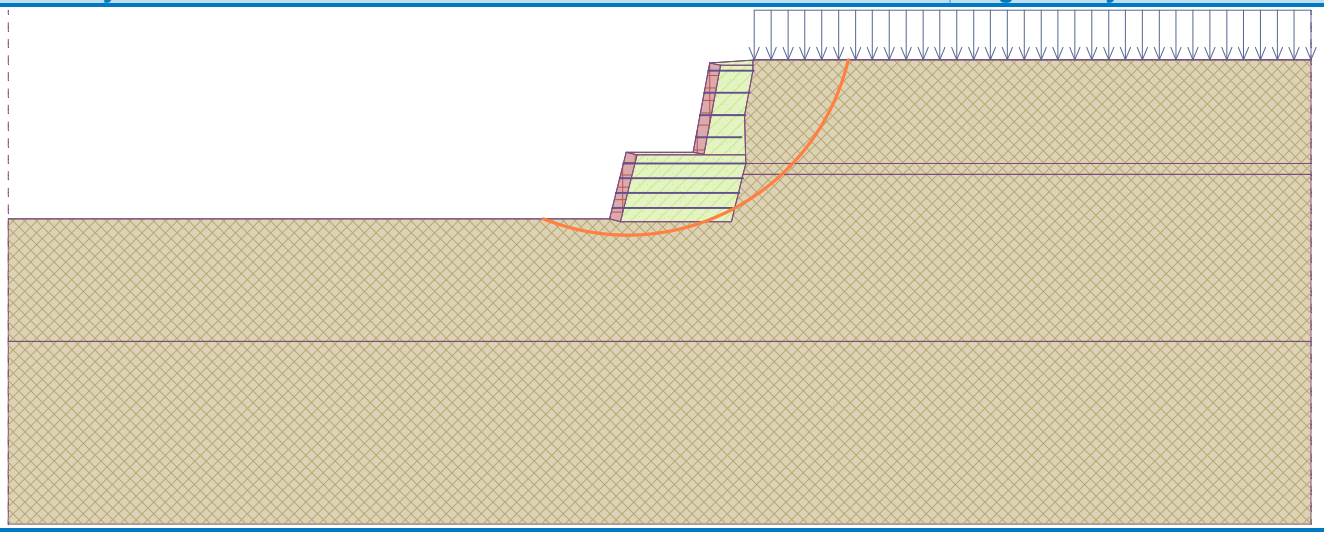
Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	1.4

Slope stability verification (Bishop)

Sum of active forces : F_a = 11034.9 lbf/ft
Sum of passive forces : F_p = 14829.6 lbf/ft

Sliding moment : M_a = 224891.6 lbfft/ft
Resisting moment : M_p = 302227.5 lbfft/ft
Factor of safety = 1.34 > 1.30
Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of reinforced slopes

Input data

Project

Task : Compark Village South
Part : Keystone Compac
Description : 2 tier walls
Customer : Integrated Wall
Author : JNH
Date : 1/3/2023
Project number : 22A252

Settings

(input for current task)

Materials and standards

Concrete structures : ACI 318-19

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	1.30	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Stability analysis

Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Geometry of structure

No.	Embankment height h_n[ft]	Embankment length l_n[ft]	Terrace length l_t[ft]	With cover	Cover thickness t_c[ft]
1	8.00	1.50		Yes	1.00
2	8.00	1.50	6.00	Yes	1.00

Material

Cover material
Unit weight $\gamma = 82.00$ pcf
Shear resistance $R_s = 800.0$ psf

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[lbf/ft]	R_t[lbf/ft]	C_{ds}[–]	C_i[–]
1	Miragrid 5XT	Miragrid 5XT	————	4296.31	1301.91	0.70	0.70
2	Miragrid 3XT	Miragrid 3XT	————	3152.00	955.15	0.80	0.80
3	SG-80 (user)	user-defined	————	5482.00	3146.00	0.60	0.70

Reinforcement details

1. Miragrid 5XT
Short-term char. strength $T_{ult} = 4296.31$ lbf/ft
Long-term design strength $R_t = 1301.91$ lbf/ft
Overall coeff. of model uncertainty $FS_{UNC} = 1.50$

Calculate reduction factors
Life time : 114 years
Creep red. factor $RF_{CR} = 1.60$
Chemistry : pH 4.0-9.0
Durability red. factor $RF_D = 1.10$
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor $RF_{ID} = 1.25$

2. Miragrid 3XT
Short-term char. strength $T_{ult} = 3152.00$ lbf/ft
Long-term design strength $R_t = 955.15$ lbf/ft
Overall coeff. of model uncertainty $FS_{UNC} = 1.50$

Calculate reduction factors
Life time : 114 years
Creep red. factor $RF_{CR} = 1.60$
Chemistry : pH 4.0-9.0
Durability red. factor $RF_D = 1.10$
Partical size : $D_{50} \leq 22$ mm
Installation damage red. factor $RF_{ID} = 1.25$

3. SG-80 (user)
Short-term char. strength $T_{ult} = 5482.00$ lbf/ft
Long-term design strength $R_t = 3146.00$ lbf/ft

Reinforcement

No.	Number of reinforcements	Type of reinforcement	Spacing of reinforcements h_r[ft]	Height of first reinforcement y[ft]	Reinforcements geometry
1	6	SG-80 (user)	1.33	0.66	identical length of reinforcements
2	4	Miragrid 3XT	2.00	1.33	identical length of reinforcements

Reinforcement details

Reinforcement No. 1
Reinforcement type : SG-80 (user)
Number of reinforcements 6

Reinforcement geometry : identical length of reinforcements
Reinforcement length : 11.00 ft

No.	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
1	-8.88	2.12	0.66	11.00
2	-8.63	2.37	1.99	11.00
3	-8.38	2.62	3.32	11.00
4	-8.13	2.87	4.65	11.00
5	-7.88	3.12	5.98	11.00
6	-7.63	3.37	7.31	11.00

Reinforcement No. 2
Reinforcement type : Miragrid 3XT
Number of reinforcements 4
Reinforcement geometry : identical length of reinforcements
Reinforcement length : 6.00 ft

No.	Origin l_1[ft]	End l_2[ft]	Height from bottom y[ft]	Length l[ft]
1	-1.25	4.75	9.33	6.00
2	-0.88	5.12	11.33	6.00
3	-0.50	5.50	13.33	6.00
4	-0.13	5.87	15.33	6.00

Soil parameters

On Site Soils

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Angle of friction struc.-soil :	δ	=	18.00 °
Saturated unit weight :	γ_{sat}	=	125.0 pcf

CDOT Class 1 Fill

Unit weight :	γ	=	125.0 pcf
Angle of internal friction :	φ_{ef}	=	34.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Angle of friction struc.-soil :	δ	=	17.00 °
Saturated unit weight :	γ_{sat}	=	130.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	10.00	0.00 .. 10.00	On Site Soils	
2	15.00	10.00 .. 25.00	On Site Soils	
3	-	25.00 .. ∞	On Site Soils	

Terrain profile

Terrain behind construction has the slope 1: 14.00 (slope angle is 4.09 °).

Embankment height is 0.29 ft, embankment length is 4.00 ft.

Water influence

Ground water table is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		4.00	50.00	on terrain

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Reduction of soil/soil friction angle : reduce to 2/3 φ (AASHTO)
Design situation : permanent

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-35616.2	17742.59	2817.78	0.000	1624.2

Service load acting at the center of footing bottom

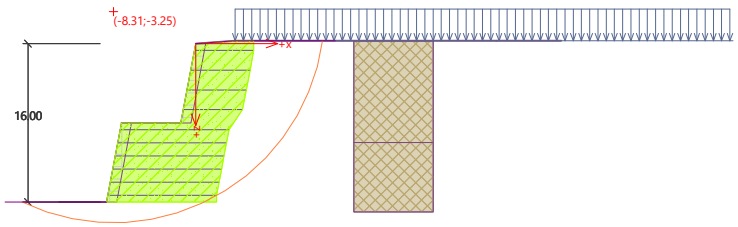
No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-35616.2	17742.59	2817.78

Global stability analysis No. 1

Slip surface parameters
(slip surface after optimization)
Center S = (-8.31;-3.25) ft
Radius r = 21.34 ft
Angle α_1 = -25.57 °
α_2 = 82.03 °

Slope stability check (Bishop)
FS = 1.33 > 1.30
Slope stability is SATISFACTORY

Name : Global stability	Stage - analysis : 1 - 1



Slope stability analysis

Input data

Project

Settings

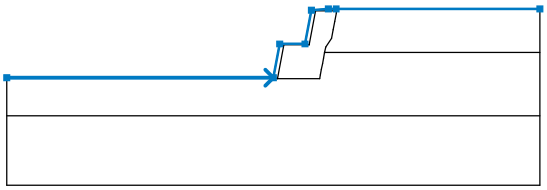
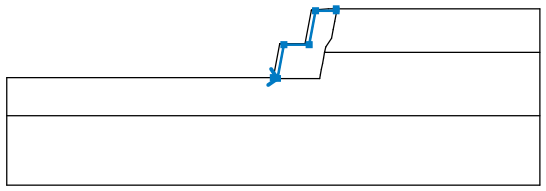
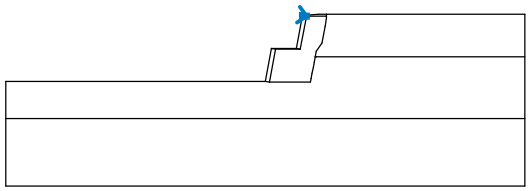
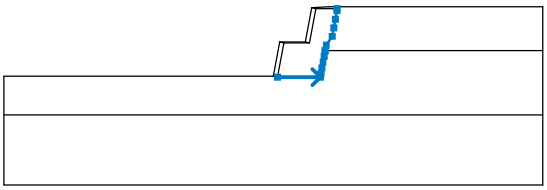
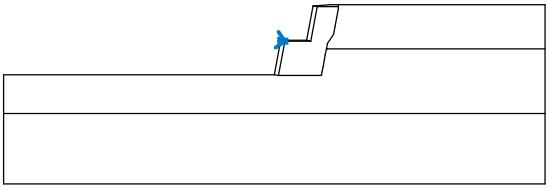
(input for current task)

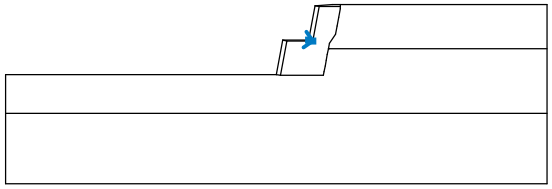
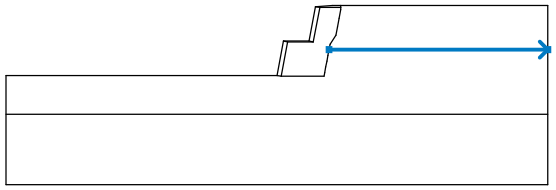
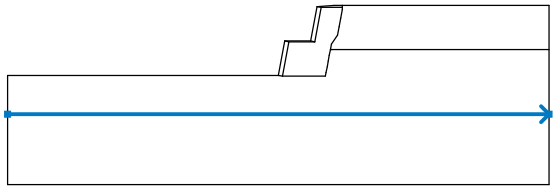
Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-72.00	-16.00	-9.00	-16.00	-7.50	-8.00
		-1.50	-8.00	0.00	0.00	4.00	0.29
		5.87	0.29	54.00	0.29		
2		-9.00	-16.00	-8.02	-16.18	-6.52	-8.18
		-0.52	-8.18	0.98	-0.18	5.87	-0.18
		5.87	0.29				
3		0.00	0.00	0.98	-0.18		
4		-8.02	-16.18	1.97	-16.18	2.12	-15.34
		2.37	-14.01	2.62	-12.68	2.87	-11.35
		3.12	-10.02	3.12	-10.00	3.37	-8.69
		4.75	-6.67	5.12	-4.67	5.50	-2.67
		5.87	-0.67	5.87	-0.18		
5		-7.50	-8.00	-6.52	-8.18		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-1.50	-8.00	-0.52	-8.18		
7		3.12	-10.00	54.00	-10.00		
8		-72.00	-25.00	54.00	-25.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	On Site Soils		25.00	100.0	120.0
2	CDOT Class 1 Fill		34.00	0.0	125.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	On Site Soils		125.0		
2	CDOT Class 1 Fill		130.0		

Soil parameters

On Site Soils

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 100.0 psf

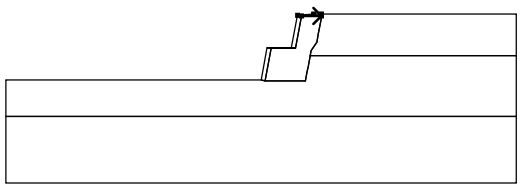
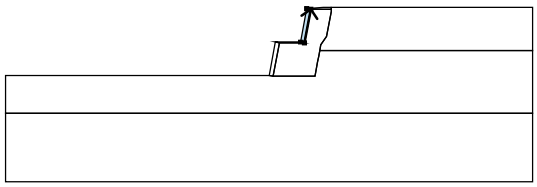
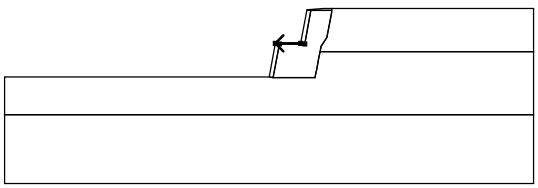
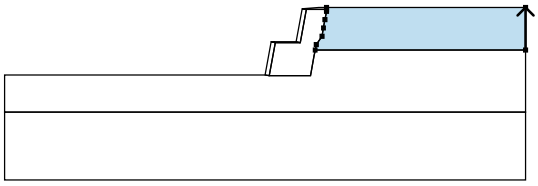
Saturated unit weight : γ_{sat} = 125.0 pcf

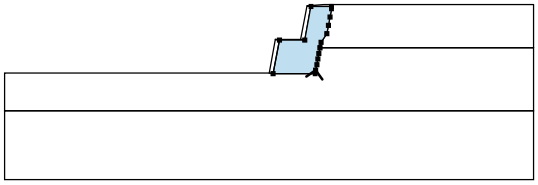
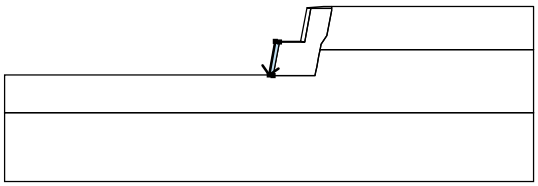
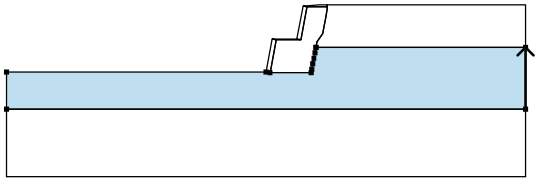
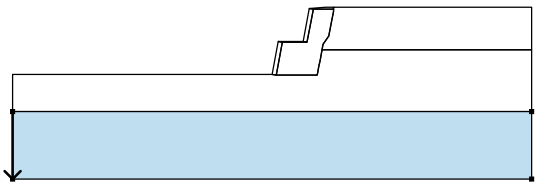
CDOT Class 1 Fill
Unit weight : γ = 125.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 34.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 130.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Cover		82.0
2	Material of cover		82.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		0.98	-0.18	5.87	-0.18	CDOT Class 1 Fill
		5.87	0.29	4.00	0.29	
		0.00	0.00			
2		-0.52	-8.18	0.98	-0.18	Cover
		0.00	0.00	-1.50	-8.00	
3		-1.50	-8.00	-7.50	-8.00	CDOT Class 1 Fill
		-6.52	-8.18	-0.52	-8.18	
4		54.00	-10.00	54.00	0.29	On Site Soils
		5.87	0.29	5.87	-0.18	
		5.87	-0.67	5.50	-2.67	
		5.12	-4.67	4.75	-6.67	
		3.37	-8.69	3.12	-10.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		1.97	-16.18	2.12	-15.34	CDOT Class 1 Fill
		2.37	-14.01	2.62	-12.68	
		2.87	-11.35	3.12	-10.02	
		3.12	-10.00	3.37	-8.69	
		4.75	-6.67	5.12	-4.67	
		5.50	-2.67	5.87	-0.67	
		5.87	-0.18	0.98	-0.18	
		-0.52	-8.18	-6.52	-8.18	
		-8.02	-16.18			
6		-7.50	-8.00	-9.00	-16.00	Cover
		-8.02	-16.18	-6.52	-8.18	
7		54.00	-25.00	54.00	-10.00	On Site Soils
		3.12	-10.00	3.12	-10.02	
		2.87	-11.35	2.62	-12.68	
		2.37	-14.01	2.12	-15.34	
		1.97	-16.18	-8.02	-16.18	
		-9.00	-16.00	-72.00	-16.00	
		-72.00	-25.00			
8		-72.00	-25.00	-72.00	-41.40	On Site Soils
		54.00	-41.40	54.00	-25.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	-0.13	-0.67	5.87	-0.67	6.00	955.2	T_p = 62.5 lbf/ft^2	Fixed
2	-0.50	-2.67	5.50	-2.67	6.00	955.2	T_p = 249.0 lbf/ft^2	Fixed
3	-0.88	-4.67	5.12	-4.67	6.00	955.2	T_p = 435.5 lbf/ft^2	Fixed
4	-1.25	-6.67	4.75	-6.67	6.00	955.2	T_p = 622.1 lbf/ft^2	Fixed
5	-7.63	-8.69	3.37	-8.69	11.00	3146.0	T_p = 709.1 lbf/ft^2	Fixed
6	-7.88	-10.02	3.12	-10.02	11.00	3146.0	T_p = 817.7 lbf/ft^2	Fixed
7	-8.13	-11.35	2.87	-11.35	11.00	3146.0	T_p = 926.2 lbf/ft^2	Fixed
8	-8.38	-12.68	2.62	-12.68	11.00	3146.0	T_p = 1034.7 lbf/ft^2	Fixed
9	-8.63	-14.01	2.37	-14.01	11.00	3146.0	T_p = 1143.3 lbf/ft^2	Fixed
10	-8.88	-15.34	2.12	-15.34	11.00	3146.0	T_p = 1251.8 lbf/ft^2	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 4.00	l = 50.00		0.00	100.0		lbf/ft^2

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-8.04	[ft]	Angles :	α_1 =	-25.46	[°]
	z =	2.69	[ft]		α_2 =	83.34	[°]
Radius :	R =	20.70	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 13256.0 lbf/ft
Sum of passive forces : F_p = 17605.1 lbf/ft

Sliding moment : M_a = 274399.6 lbfft/ft
Resisting moment : M_p = 364425.7 lbfft/ft

Factor of safety = 1.33 > 1.30

Slope stability ACCEPTABLE

Name : Analysis | **Stage - analysis : 1 - 1**