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Calc. Title	Port Property Development - Dock Wall Design				

Summary

This submission provides the 90% design demands to be used in the design of the structural components for the Brown County Port Property Development dock wall for the support of a multi-use port facility by handling a range of dry cargoes and provide a berthing face to be used by large cargo ships, located in Green Bay, Wisconsin.

The major components of the dock wall design include:

- Dock Wall: 54" x 11/16" pipe & NZ-26 (ASTM A572, Gr. 60) Pipe-Combined Wall System , king piles spaced 9.3-ft O.C., I = 4,607 in4/ft, S.x = 170.6 in3/ft, All. Moment = 510.8 k-ft/ft
- Deadman Sheets: NZ-19 (ASTM A572, Gr. 60), I = 283.1 in4/ft, S.x = 35.08 in3/ft, All. Moment = 105.2 k-ft/ft
- Deadman Tierod: No. 28 (ASTM A615, Gr. 75/80), tierods spacing: 9.3-ft O.C.

Signature Block & Record of Revisions

Rev.	Description	Code	Pages/Sections	Signature	Date
0	90% Design	P	All	E. Burton/A. Gradeski	10/22/25
		C	All	C. Englert	08/25/25
		A	All	A. Pepin	

Codes: P = Prepared; C = Checked; A = Approved

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Purpose

The purpose of this project is to analyze and design an anchored bulkhead wall to support operations at a bulk material handling marine terminal facility. Figures 1 - 4 provide the existing and proposed site conditions of the property. The proposed dock wall will retain fill and material stockpiles on the site and provide a berthing face for bulk carrier ships. At the time of this report, the extent of the stockpile area on the landside of the dock wall is unknown, therefore the material stockpile was conservatively considered at each analysis section. A generalized section of the waterside dock wall system is provided as Figure 5. The dock wall will be a combined wall system consisting of steel pipe king piles and steel sheet piling. The proposed berth depth will be consistent with the Fox River navigation channel, with a minimum draft of 26 feet relative to low water datum (LWD). Including a 2-foot over-dredge results in a maximum dredge depth of 28 feet relative to LWD (El. -550 NAVD88). Proposed site grades along the proposed dock wall will be no greater than +591.0 NAVD88 and pitch down moving away from the wall. To support this exposed wall height, a tie rod and anchor wall system was designed to restrain the proposed wall.

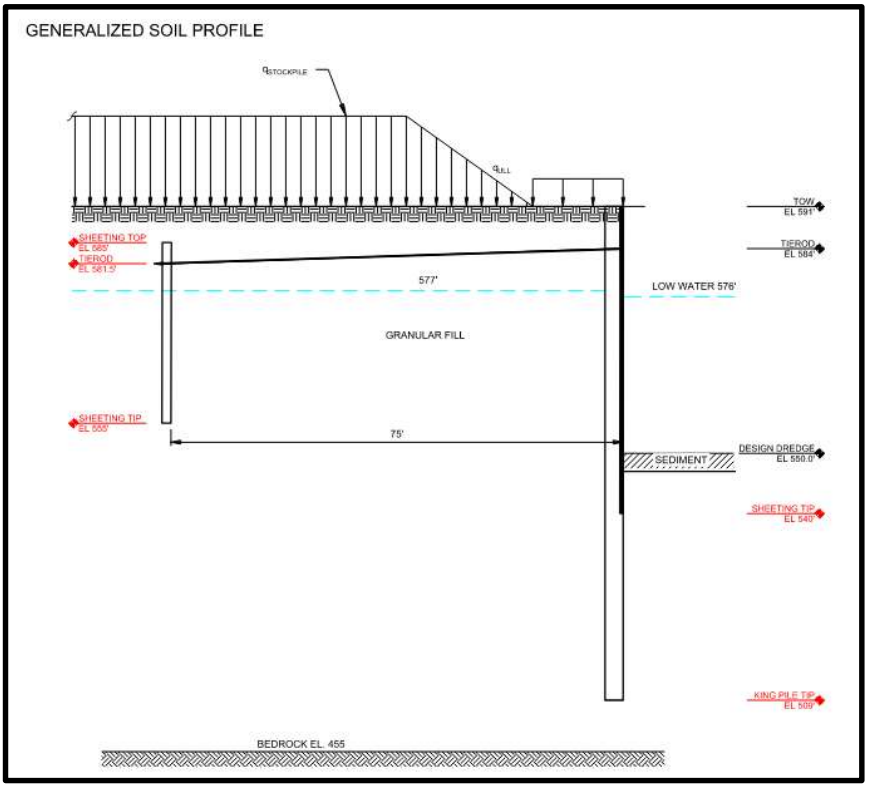

Figure 1: Generalized Dock Wall Cross-Section

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Vertical Datum

Unless otherwise stated, all datums refer to the North American Vertical Datum of 1988 (NAVD88) which is approximately 0.44-feet below the low water datum IGLD85 (i.e. IGLD85 + 0.44' = NAVD88).

Soil Properties

We selected soil properties developed in GEI's Geotechnical Data Report, dated March 2023, to analyze the various sections of the dock wall. Thicknesses of each considered soil layer were informed by soil borings nearest the considered sections and borings selected for design have been included in Appendix B. A summary of the soil properties used for analysis can be seen in Table 1.

TABLE 1. SOIL PROPERTIES

Name	Total Unit Weight (pcf)	Undrained Strength Parameters		Effective Stress Strength Parameters (drained)		†Undrained Elastic Modulus (psf)	Coefficient of Consolidation, C_c (-)	Initial Void Ratio, e_0 (-)	†Drained Elastic Modulus (psf)	Rankine Earth Pressures Coefficient, Drained		
		Su (psf)	ϕ (deg)	c' (psf)	ϕ' (deg)					Ko	Ka	Kp
Marine Stone Fill[8] (AASHTO No. 67)	120				36				3,000,000	0.41	0.26	3.85
Granular Fill (Above Water)	130	-	–	-	32	-	-	-	(42,000)	0.47	0.31	3.25
Granular Fill (Below Water)	125	-	-	-	30	-	-	-	(15,000)	0.50	0.33	3.00
Sediment - CA-94 and CB-60	80	60	-	-	24	-	-	-	(36,000)	0.59	0.42	2.37
(Existing) Fill: Sand/Clay	130	2000	-	-	30	1,200,000	0.33	2.0	28,527	0.50	0.33	3.00
CLAY I	130	2000	-	-	28	1,200,000	0.33	0.9	43,889	0.53	0.36	2.77
CLAY IIA	130	1000	-	-	26	600,000	0.44	1.0	47,151	0.56	0.39	2.56
CLAY III	130	2500	-	-	26	1,500,000	0.47	1.2	68,650	0.56	0.39	2.56
Coal (Stockpile)	60	0	36	-	36	-	-	-	-	0.41	0.26	3.85
Limestone (Stockpile)	100		45		45	-	-	-	-	0.29	0.17	5.83
Sand and Gravel (sediment capping materials)	125	0	35	-	35	-	-	-	-	0.43	0.27	3.69

Notes:

1. Clay I corresponds to Clay - Very Stiff from Geotechnical Data Report (GDR) dated March 2023, Clay IIA to Clay - Soft, Clay IIB to Clay - Soft (NE Corner) and Clay III to Clay - Stiff
2. Soils below the continuous wall (depth at which sheeting concludes and king piles continue to max embedment depth) are considered using Ka and Kp values for design in WALLAP based on guidance from AASTHO 2012, Section 3.11.5.6. Ka and Kp values are modified to develop and equivalent continous wall lateral earth pressure coefficient for consideration in WALLAP.
3. 54" Pipe at 112" on-center
4. Fill considered granular
5. For long-term, drained conditions, Kpc and Kac = 0
6. Undrained Elastic Modulus is based on Duncan and Buchignani (1987) conservatively considering E = 600*Su for clays and dE/dy (psf/ft) for granular soils varies based on soil density and N-value.
7. Drained Elastic Modulus is based on consolidation parameters presented in Section 4.7 of the GDR dated March 2023
8. Marine Stone Fill produces an angle of internal friction of 40 degrees, however we've assumed that the stone fill will be placed through the water column which reduces the friction angle to approximately 36 deg based on USACE EM 1110-2-2503, Table 4-2

†: Moduli that vary with depth (dE/dy) are shown in parantheses

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Because we are considering a combi-wall system with the king piles extending beyond the sheet piles, we used the methodology described in AASHTO (2012) Section 3.11.5.6 to model equivalent, continuous active and passive lateral earth pressures along the embedded length of the king piles. Continuous, equivalent lateral earth pressure coefficients can be seen in Table 2.

Name	Equivalent Continuous Wall LEP Coefficients (based on AASHTO 2012) (Short-Term, Undrained phi=0)				Equivalent Continuous Wall LEP Coefficients (based on AASHTO 2012) (Long-Term, Drained Su=0)			
	Equiv. Ka	Equiv. Kac	Equiv. Kp	Equiv. Kpc	Equiv. Ka	Equiv. Kac	Equiv. Kp	Equiv. Kpc
Granular Fill (Above Water)	-	-	-	-	-	-	-	-
Granular Fill (Below Water)	-	-	-	-	-	-	-	-
Sediment - CA-94 and CB-60	0.484	0.968	-	2.00	0.204	0	2.371	-
(Existing) Fill: Sand/Clay	0.484	0.968	-	2.00	0.161	0	3.000	-
CLAY I	0.484	0.968	-	2.00	0.175	0	2.770	-
CLAY IIA	0.484	0.968	-	2.00	0.189	0	2.561	-
CLAY III	0.484	0.968	-	2.00	0.189	0	2.561	-

Table 2: Equivalent, Continuous Lateral Earth Pressure Coefficients

General Dock Wall Design Criteria

- Top of Wall Elevation: 591.0
- Maximum Berth Elevation: 552.0
- Minimum Berth Elevation: 550.0 which includes a 2-foot over-dredge tolerance
- Maximum Deflection: 6-inches (<1 degree out of plumb)
- Design Life: 50 years

Structural Material Properties

- King Piles: Grade 60 ksi
- Steel Sheet Piles: Grade 60 ksi
- Tiebacks: Grade 75/80 ksi
- Rolled Shapes and miscellaneous metals: 50 ksi
- Welding Consumables: E70XX Electrodes
- Bolts: ASTM F1325 (Grade A325)

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Analysis & Design Methodology

We analyzed the dock wall using the program WALLAP which uses a conventional limit equilibrium analysis to calculate the safety factor for overall stability considering the CP-2 method. The CP-2 method applies the safety factor to the passive resistance of the toe embedment – for undrained cohesive soils, the CP-2 method applies the safety factor to the total passive resistance.

We evaluated the minimum required toe embedment of the king piles by applying an additional Factor of Safety of 1.5 to the passive lateral earth pressure coefficient for the cohesive layers and analyzing the dock wall with WALLAP. Once a toe embedment was developed based on moment equilibrium about the tierod location, a separate WALLAP analysis was conducted with full, unaltered passive resistance and the previously evaluated toe embedment to determine the maximum moment, shear and deflection demands as well as the required minimum tierod load for the tierod and deadman system.

We also performed a global stability analysis which considered various material stockpile setbacks from the land-side face of the dock wall. This analysis provided a minimum allowable setback of the considered material stockpiles for design of the dock wall. The global stability analysis can be seen in Appendix D.

The maximum required tierod load calculated from the WALLAP analyses was used in a WALLAP analysis of the deadman sheeting. The deadman was modeled as a cantilevered wall with a concentrated load, equal to the dock wall tierod load, applied at the connection elevation. The tierods were sloped at 15 degrees from horizontal to reduce the moment demand on the deadman sheeting. Soil above the anchor wall was assumed to provide no passive resistance however the weight of the soil was still included into the passive resistance in the WALLAP analyses. This was achieved by modeling a null layer which does not contain any shear strength (Kp = 0), but is modeled with a dry and saturated unit weight.

The distance of the deadman sheeting from the dock wall was selected such that full passive wedge of the deadman anchor wall did not intersect the active wedge of the dock wall. We've also assumed that the tierods will be pre-stressed to mitigate deflections at the dock wall due to anchor elongation as load is applied behind the dock wall. The tierods were designed in accordance with the USS Steel Sheet Piling Manual and FHWA GEC No. 7 in which a 30% increase in tierod load, above what was estimated from the WALLAP analyses, as well as an allowable yield strength of 0.56Fy were considered for sizing the tierods.

We also computed an estimate of settlement for the clay layers beneath the tierod and anchor wall system. These computed settlements were used to estimate the degree of rotation that may be expected at the tierod connection points between the dock wall and anchor wall. Settlement estimates are included in Appendix E. Due to the estimated amount of settlement, we've assumed a 12" diameter PVC pipe will be installed encasing the tierods, with tierods resting on the bottom of the PVC casing, to mitigate the rotation at the tierod connection points.

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Loading Conditions

Uniform Live Loads:

Where stockpile loads were not present, a 500 psf uniform surcharge load was modeled.

Bulk Material Stockpiling Loads:

The dock wall analysis includes trapezoidal stockpile loads to model 60-foot-high coal and 40-foot-high limestone piles. Maximum stockpile heights and minimum setbacks from the dock wall are based on the global slope stability analysis performed by GEI under a separate cover. A summary of the modeled stockpiles is provided as Table 3. Although the top of the stockpiles will extend several hundred feet inland of the wall, we only modeled the lateral extent of stockpile that would intersect the retained height of wall of 41-ft at an angle of 45 degrees from design dredge elevation (El. 550-ft). For the dock wall analysis, we assumed that the effect of the stockpile surcharge beyond the retained height of the wall would have a negligible effect on dock wall, therefore a limited portion of the stockpile was modeled.

Stockpile Material Considered for Design	Bulk Unit Weight	Maximum Angle of Repose	Minimum Wall Setback	Maximum Stockpile Height
	(pcf)	(degrees)	(ft)	(ft)
Coal	60	36	15	60 (3,600 psf)
Limestone	100	45	50	40 (4,000 psf)

Table 3: Stockpile Material Properties

Fender Loads:

Fender loads from ship berthing would counteract the driving earth pressure loads therefore no fender loads were considered for the dock wall analysis.

Mooring Loads:

Mooring fixtures will be supported on an independent foundation system, however we considered a 100-ton horizontal load on the dock wall as well as a 10psf/ft of dead load in our WALLAP analyses.

Groundwater:

Water levels at the site are influenced by variations in lake level and storm surges. Water level data was obtained from the U.S. Department of Commerce, NOAA, and the National Ocean Services (NOS) Tides and Currents website. Green Bay East gauge (Station ID 9087077) data shows current water levels but historic

data only extends back to 2020 and no extreme water levels are provided. Menominee gauge (Station ID 9087088) provides maximum and minimum water levels as follows:

Water Elevations NOAA STA ID 9087088 Menominee (ft - NAVD88)	
Water Level Max	583.24
Water Level Min	574.84
Water Elevations NOAA STA ID 9087077 Green Bay East (ft - NAVD88)	
Water Level Max (8/2/2020)	583.20
Water Level Min (12/23/2022)	578.09
Design Low Water Datum	577.94
Current Water Level (6/21/2024)	580.11

Table 4: NOAA Station Data

According to NOAA, the average daily water elevation is about 580.2-ft NAVD88. However, this elevation fluctuates daily - typically fluctuations in elevation range from 1 to 2 feet around the lake's average elevation. Though not as predictable as tidal cycles, the time between local minima and maxima was found to vary between 2 to 8 hours.

Water levels assumed on the riverside were assumed to be near the low water level and were modeled at El. 576.0. Water levels in front and behind the wall are anticipated to closely correlate with each other however we included a differential head of 1-foot between the river water and groundwater elevation (i.e. groundwater is 1-foot above the river elevation).

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Earthquake:

The following parameters were used to develop seismic loading for the dock wall. Unmodified ground motion parameters are from the ASCE Hazard Mapping tool and based on the values published in ASCE7-10.

Risk Category: II
Site Class: E
Peak Ground Acceleration: 0.024g
Peak Ground Acceleration modified for Site Class: 0.061g
Design Peak Ground Acceleration: 0.041g

We estimated seismic loads for the retained fill and reductions in waterside earth pressures using the methods developed by Mononobe-Okabe and Westergaard, respectively. Seismic activity at the site is minimal therefore we compared the seismic load to the driving load resulting from the 500 psf live load. Since the uniform live load is a transient load, it is considered to not be present during the design earthquake. Comparing the total seismic load to the driving load due to the 500 psf live load, it was determined that the live load imparted a significantly larger load on the wall and bounds the seismic effects. Similarly, by inspection, the coal and limestone stockpile loads will impart a significantly larger load on the wall. Therefore, seismic loads were not considered further for the wall analysis.

Load Cases

Three (3) load cases were analyzed for each wall section as described below.

LC1. Coal surcharge (3600 psf) with a 15-ft wide, 500 psf uniform live load behind the dock wall. (See Figure 5)

LC2. Limestone surcharge (4000 psf) with a 50-ft wide, 500 psf uniform live load behind the dock wall. (See Figure 6)

LC3. Limestone surcharge (4,000 psf) setback 75-feet inland from the wall (toe of material stockpile is at the anchor wall) with a 50-ft wide, 500 psf uniform live load on the landside of the dock wall. A 25-foot width on the waterside of the anchor wall was left unloaded since this would apply additional passive resistance to the anchor wall. This condition is considered a short-term condition but will likely occur on a regular basis based on offloading operations (fill is anticipated to offloaded via a ship-mounted stacker working inland towards dock wall). (See Figure 7)

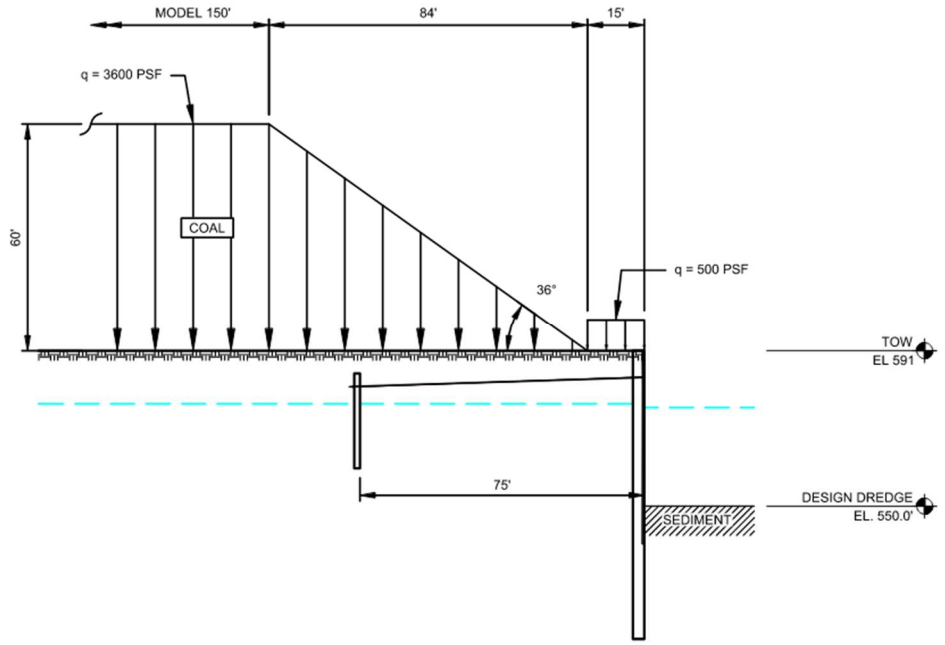

Figure 5: Load Case 1 Loading Diagram

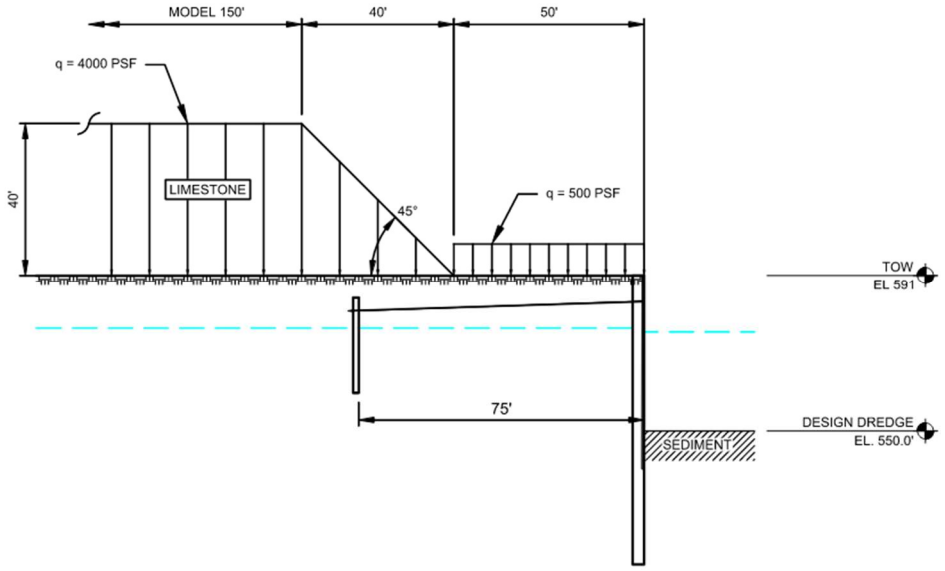

Figure 6: Load Case 2 Loading Diagram

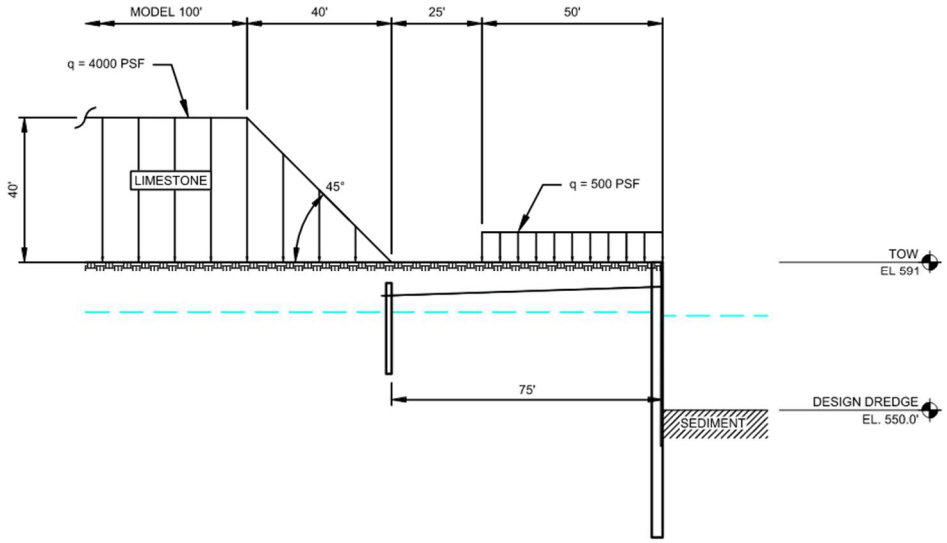

Figure 7: Load Case 3 Loading Diagram

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Corrosion

The dock wall is located along a freshwater inland river and the piles will be installed into undisturbed natural soils (clays). Where fill is required, non-aggressive fill will be used. Based on Tables 4-4 and 4-5 from ASCE Manuals and Reports on Engineering Practice No. 130, Waterfront Facilities Inspection and Assessment, we estimated corrosion rates for a 50-year design life of uncoated steel located in the following conditions to be as follows:

- Undisturbed natural soils (sand, silt, clay, schist, etc): 0.0005 inches per year (ipy)
- Non-compact and non-aggressive fills: 0.0009 ipy
- Common fresh water (river, ship, canal, etc): 0.0006 ipy

The king piles will be filled with concrete or undisturbed natural soils. Areas of concrete can be assumed to have a corrosion rate of 0 while areas filled with undisturbed natural soils will have significantly less access to oxygen and, thus, will corrode less than the exterior of the king piles. We've assumed a corrosion rate of ½ that of the estimated corrosion rate due to undisturbed natural soils. Since the king piles and sheet piles are exposed on both faces, the total corrosion rates at different elevations are as follows:

- King Pile Exterior
    - River water frontside: (0.0006 ipy) * 50 years = 0.03 inches
    - Embedded portion of piles: (0.0005 ipy) * 50 years = 0.025 inches
- King Pile Interior
    - Concrete fill: 0 ipy
    - Undisturbed natural soils: ½ * (0.0005 ipy) * 50 years = 0.0125 inches

Since the maximum moment occurs within the water column, the larger thickness loss shall be used.

Approximate bending capacity reduction for a 54" diameter pipe with 11/16" walls as follows:

Uncorroded Elastic Section Modulus = 1516.5 in^3

Corroded Elastic Section Modulus = 1422.94 in^3

Percent remaining section modulus after 50 years = 94%

Therefore, the structural utilization for king piles will be limited to 94%.

Similarly, the deadman sheeting structural utilization will be limited to 85% (see deadman sheeting calculations appended) considering corrosion due to the presence of undisturbed natural soils. For the tierods, we've assumed that the tierods will be double corrosion protected.

Dock Wall Analysis Sections

We considered four (4) sections for analysis along the dock wall alignment. General locations for each section considered can be seen in Figure 8. Cross-sections, general descriptions, and anticipated construction sequence are described on the following pages. Final construction sequencing will be determined by the Contractor.

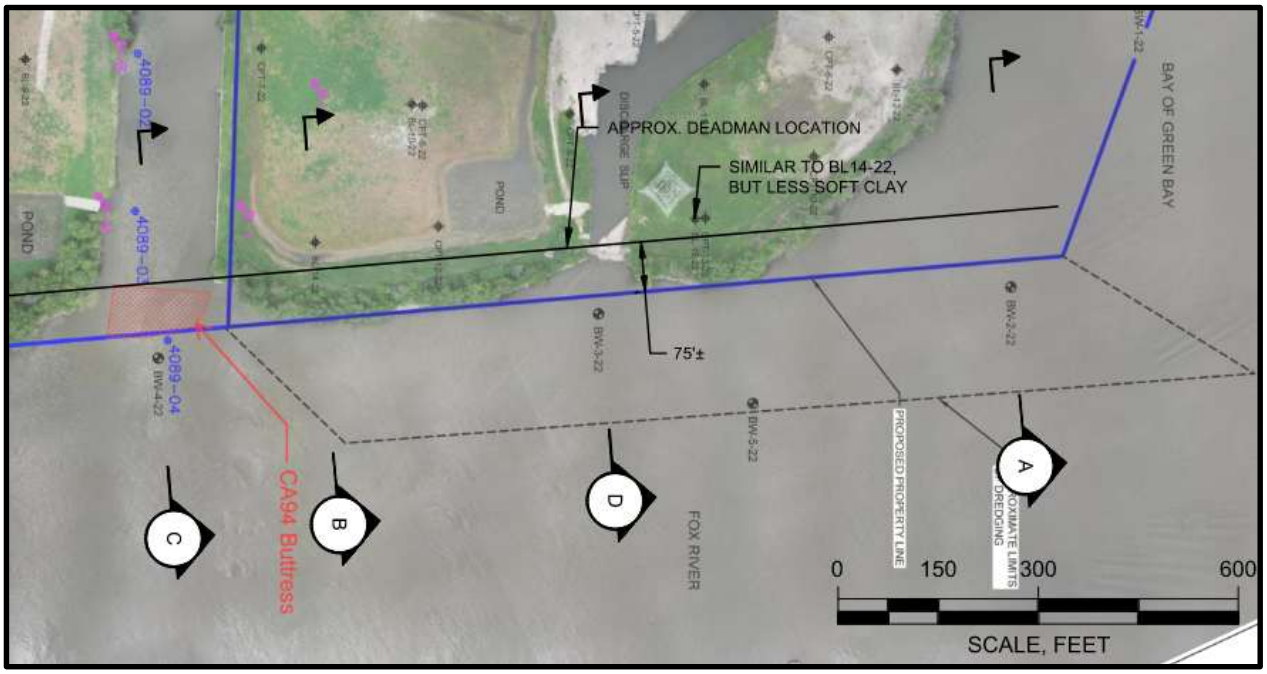

Figure 8: Sections Considered for Analysis

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Section A

Section A is located near the northern return of dock wall in an area that is currently water. Based on the boring in this area, there are considerable deposits of soft sediments which will need to be removed and replaced with granular fill. The sediments cannot remain in place due to excessive settlements which would occur to fill the area to final grade and considerable stresses it would impart on the dock wall system. Ground improvement was not considered for this analysis.

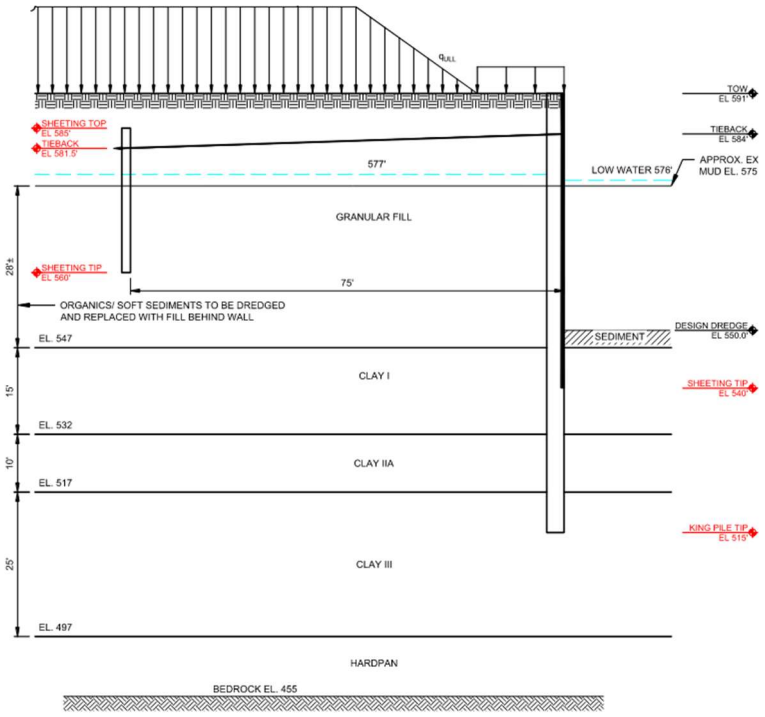

Figure 9: Section A cross-section

Anticipated Construction Sequence:

1. Pre-dredge as required to minimize cantilevered height as required for stability during sediment removal.
2. Drive king piles and sheets to respective required embedment depth.
3. Excavate Sediment layer to top of Clay 1 in area of driveline.
4. Place first lift of Granular Fill to El. 580 to facilitate installation of tierods and anchor wall.
5. Drive anchor wall sheets and install tierods/wales.
6. Place second lift of Granular Fill to El. 591 (Top of Wall).
7. Dredge to Elevation 552.0 (no deeper than 550).

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Section B

Section B is located just north of the former boat slip along the existing shoreline. The dock wall is located just outboard of the existing shoreline.

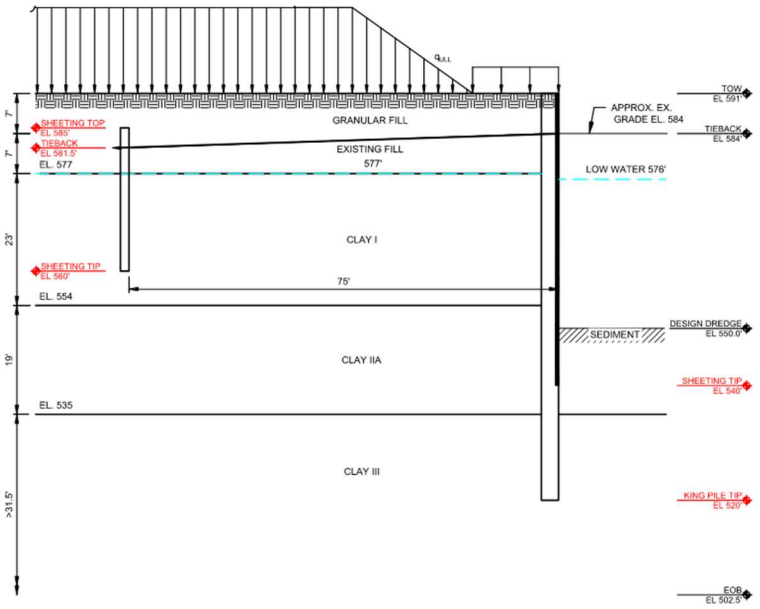

Figure 10: Section B cross-section

Anticipated Construction Sequence:

1. Clear and grub shoreline. Prepare subgrade for receival of granular fill.
2. Drive king piles and sheets to respective required embedment depth.
3. Drive anchor sheets and install tiebacks. Temporarily support tiebacks where unsupported over the shoreline (by contractor). Trenching will be required to install tiebacks at the anchor wall as existing grades are approximately El. 584.
4. Place lift of Granular Fill to Top of Wall at El. 591.
5. Dredge to Elevation 552.0 (no deeper than 550).

Section C

Section C is located at the historic boat slip. Mudline in this area is deep and is approximately 1-foot above the required dredge elevation. A temporary work platform will be required to facilitate construction of the tieback system.

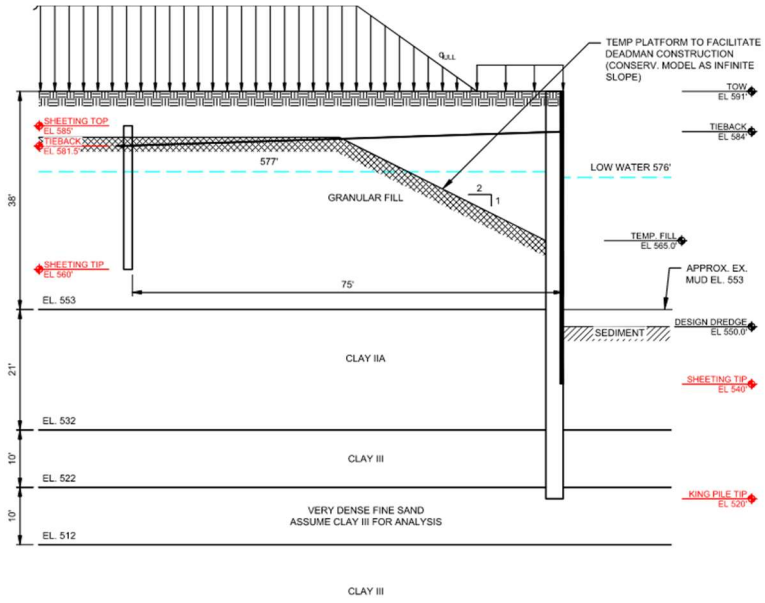

Figure 11: Section C cross-section

Anticipated Construction Sequence:

1. Drive king piles and sheets to respective required embedment depth.
2. Place Granular Fill on the landside to construct temporary construction platform. For the purposes of this analysis, we assumed the first lift of Granular Fill would go up to El. 565 at the dock wall and slope up at a 2H:1V. We conservatively assumed an infinite slope condition rather than modeling a berm to convince ourselves this approach would be viable. Fill operations during construction will ultimately be determined by the Contractor based on his means and methods. The Contractor will need to minimize the deflection at the top of the wall prior to installation of the tieback system.
3. Once the construction platform is built, install anchor wall sheets and tiebacks. Temporary supports may be required for tiebacks prior to final backfilling.
4. Place second lift of Granular Fill to Top of Wall at El. 591.
5. Dredge to Elevation 552.0 (no deeper than 550).

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Section D

Section D is located at the historic discharge slip. The existing mudline is approximately El. 570 with an approximately 4-foot-thick layer of sediment.

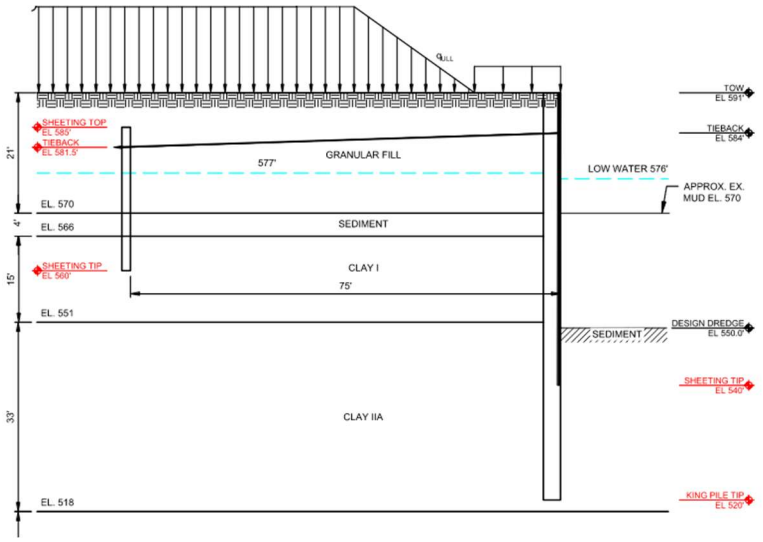

Figure 12: Section D cross-section

Anticipated Construction Sequence:

1. Drive king piles and sheets to respective required embedment depth
2. Place lift of Granular Fill to El. 580. Note, wall is cantilevered 10’ in temporary condition.
3. Remove sediments from influence zones of anchor wall.
4. Drive anchor wall sheets and install tiebacks.
5. Place lift of Granular Fill to Top of Wall at El. 591.
6. Dredge to Elevation 552.0 (no deeper than 550).

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Deadman Analysis Sections

We considered two (2) sections for analysis along the dock wall alignment. The general locations selected for analysis were determind based on the requirement to place backfill material to reach final ground surface elevation from the river channel or through an existing boat / discharge slip – areas in which backfill placement is required include design sections A, D and C. The second section for analysis is based on design section B in which Boring BL-14-22 was used to develop the design stratigraphy. The backfill assumed for design include a granular fill as well as a marine stone fill. Cross-sections, general descriptions, and anticipated construction sequence are described on the following pages. Final construction sequencing will be determined by the Contractor.

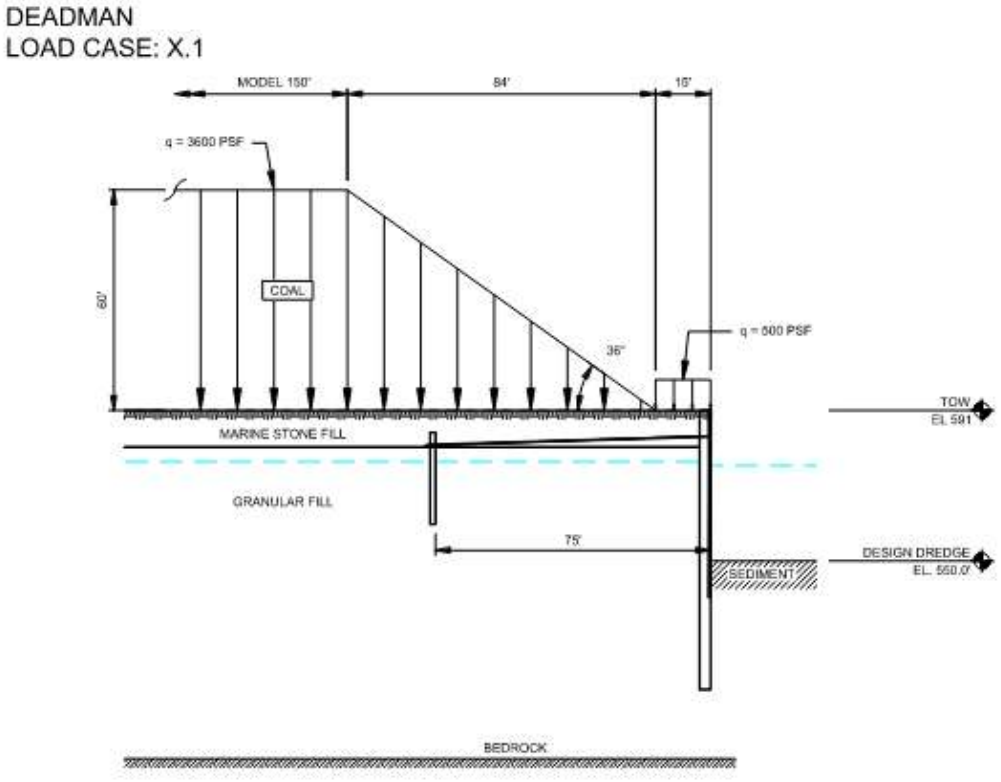

Figure 13: Deadman Load Case X.1 cross-section

DEADMAN
LOAD CASE: X.3

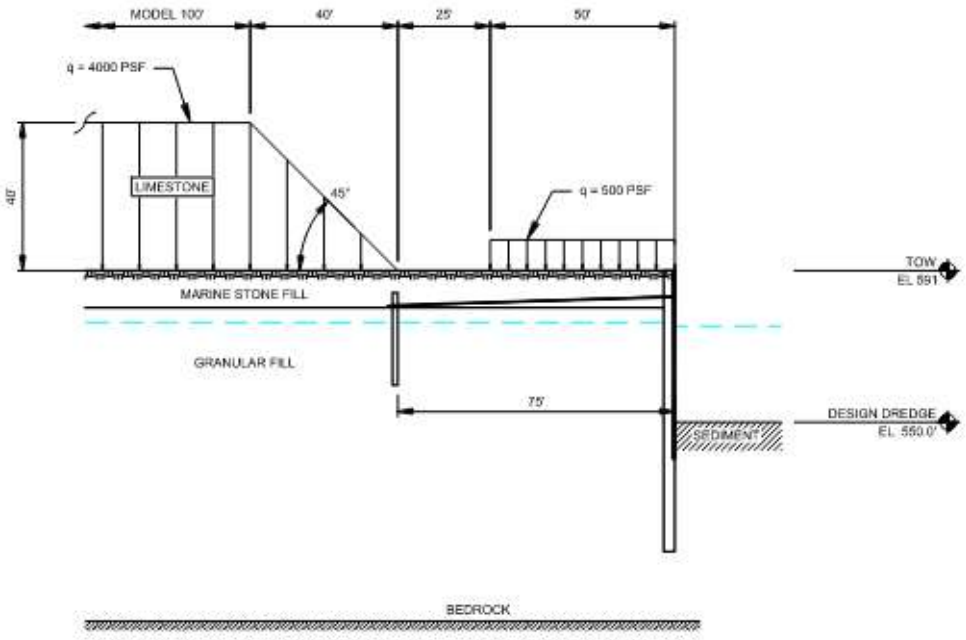

Figure 13: Deadman Load Case X.3 cross-section

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Summary of Results

Initially, a wide-flange, beam-combined system was selected for the design of the dock wall. Four wall cross sections were analyzed; each section was analyzed for the three load cases referenced herein. For this assessment, in which we have selected a pipe-combined wall system, we have only evaluated the critical live load condition for each wall cross section. Please note that the critical live load condition was the same for each wall cross section: LC1. For the deadman analyses, the loading conditions of LC1 and LC3 were considered, however only the maximum tierod load was used.

Results of the previous, wide-flanged, beam-combined dock wall WALLAP analyses are summarized in Table 5.

Analysis Section	Dockwall Construction Details					Load Case ID	Dockwall Loads				
	Top of Wall Elevation (ft)	Beam-Combined Wall System (-)	Tip of Sheets Elevation (ft)	Tip of King Piles Elevation (ft)	Tierod Elevation at Wall Face (ft)		Tieback Load (kip/ft of wall)	Moment Demand (kip-ft/ft of wall)	Shear Demand (kip/ft of wall)	Deflection (ft)	Critical Toe FS (-)
A	591	W40x199 & NZ-14	540	515	584	A.1	27.8	344	24	0.386	2.16
						A.1-W	24.9	316.4	24.1	0.52	2.3
						A.2	27.6	339	23.8	0.381	2.19
						A.3	27	327.3	23.3	0.371	2.25
B	591	W44x230 & NZ-14	540	520	584	B.1	29.1	402.1	26.8	0.253	1.54
						B.1-W	24.6	342.7	23.3	0.221	1.74
						B.2	28.9	395.3	26.5	0.248	1.56
						B.3	28.2	379	25.9	0.237	1.61
C	591	W44x230 & NZ-14	540	520	584	C.1	26.8	354.8	24.1	0.233	1.66
						C.1-W	24.9	348.9	23.7	0.23	1.73
						C.2	26.6	350	23.9	0.229	1.69
						C.3	26	333.9	23.2	0.219	1.74
D	591	W44x230 & NZ-14	540	520	584	D.1	28.1	375.8	25.4	0.248	1.63
						D.1-W	24.9	350.2	23.6	0.259	1.74
						D.2	28.1	372.2	25.3	0.247	1.65
						D.3	27.4	358.7	24.7	0.238	1.7

Notes:
1. The low water datum (LWD) for the Fox River is +577.5 (IGLD85) or 577.9 (NAVD88). The authorized dredge depth for the Port is 26.0 feet; El. +551.9 (NAVD88). Considering a 2-ft overdredge allowance, design dredge = El. +550.0 (NAVD88).
2. The coal stockpile assumes an angle of repose of 36 degrees, a unit weight of 60 pcf, a maximum allowable stockpile height of 60 ft (3600 psf) and a minimum setback of 15 ft from the face of the wall.
3. The limestone stockpile assumes an angle of repose of 45 degrees, a unit weight of 100 pcf, a maximum allowable stockpile height of 40 ft (4000 psf) and a minimum setback of 50 ft from the face of the wall.
4. An undrained shear strength for Clay IIA in= 1,500 psf was assumed for this analysis only based on the average undrained strength measured at BW-3-22 about equal to 1,550 psf.

Table 5: Dock Wall WALLAP Results

Similar soil properties were used, however for this analysis we considered drained as well as undrained elastic moduli values based on laboratory test results provided in the Geotechnical Data Report (Appendix C) and the active and passive pressure coefficients for the embedded length of the king piles were updated for the new effective pile width.

The previous dock wall analysis used the approach produced by Brom's (1965) for the king piles in which the active pressure on the embedded length of the king piles is considered negligible and can be neglected. However, while the approach produced by Brom's could be valid, we've conservatively selected the methodologies described in AASHTO (2012) Section 3.11.5.6 for the development of equivalent,

continuous lateral earth pressure coefficients - which no longer neglects active pressures on the embedded length of the king piles. In keeping with the assumptions of the previous analysis, wall friction has been neglected.

Results of the critical load case for each wall cross section of the pipe-combined dock wall WALLAP analyses are summarized in Table 6.

Analysis Section	Dockwall Construction Details					Load Case ID	Dockwall Loads				
	Top of Wall Elevation (ft)	Beam-Combined Wall System (-)	Tip of Sheets Elevation (ft)	Tip of King Piles Elevation (ft)	Tierod Elevation at Wall Face (ft)		Tierod Load (kip/ft of wall)	Moment Demand (kip-ft/ft of wall)	Shear Demand (kip/ft of wall)	Deflection (ft)	Critical Toe FS[5] (-)
A	591	P54"x11/16" &NZ26	540	509	584	A.1	27.4	303.3	25.7	0.242	2.2
B	591	P54"x11/16" &NZ26	540	509	584	B.1	34.5	470.4	30.0	0.303	2.3
C	591	P54"x11/16" &NZ26	540	509	584	C.1	31.2	393.4	26.2	0.293	2.4
D	591	P54"x11/16" &NZ26	540	509	584	D.1	28.7	331.4	24.4	0.204	2.4

Notes:

1. The low water datum (LWD) for the Fox River is +577.5 (IGLD85) or 577.9 (NAVD88). The authorized dredge depth for the Port is 26.0 feet; El. +551.9 (NAVD88). Considering a 2-ft overdredge allowance, design dredge = El. +550.0 (NAVD88).
2. The coal stockpile assumes an angle of repose of 36 degrees, a unit weight of 60 pcf, a maximum allowable stockpile height of 60 ft (3600 psf) and a minimum setback of 15 ft from the face of the wall.
3. The limestone stockpile assumes an angle of repose of 45 degrees, a unit weight of 100 pcf, a maximum allowable stockpile height of 40 ft (4000 psf) and a minimum setback of 50 ft from the face of the wall.
4. An undrained shear strength for Clay IIA in= 1,500 psf was assumed for this analysis only based on the average undrained strength measured at BW-3-22 about equal to 1,550 psf.
5. Critical Toe FS is 1.5 when considering FS = 1.5 applied to Passive term in Wallap analyses. This run in Wallap pproduces required minimum toe embedment for FS = 1.5. A subsequent wallap run without FS applied to passive Kp produces max moment, max deflection, shear and deflection. Therefore, the FS presented is misleading despite correpsonding to the FS of the wall in the second Wallap run.

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Results of the deadman WALLAP analyses are also provided in Appendix A and summarized below in Table 7.

TABLE 7. DEADMAN WALLAP ANALYSIS RESULTS

Analysis Section	Deadman Construction Details					Surface Live Loads					Deadman Loads				
									Stockpile[1]						
	Top of Deadman Elevation (ft)	Beam-Combined Wall System (-)	Tip of Sheets Elevation (ft)	Sheet Pile Length (ft)	Tierod Elevation at Deadman (ft)	Load Case ID	Parent Dockwall Analysis Section(s)	Water Elevation (ft)	Type (-)	Location (P or A)	Tieback Load (kip/ft of wall)	Moment Demand (kip-ft/ft of wall)	Shear Demand (kip/ft of wall)	Deflection (ft)	Critical Toe FS (-)
BL-14-22	585	NZ-14	555	30	581.5	X.1	B.1/D.1	577	Coal	P&A	31.8	53.9	25.8	0.21	2.12
						X.3	B.3/D.3	577	Limestone	A	31.8	58.6	23.8	0.23	1.65
Fill	585	NZ-19	555	30	581.5	X.1	A.1/C.1/D.1	577	Coal	P&A	31.8	62.9	20	0.31	1.70
						X.3	A.3/C.3/D.3	577	Limestone	A	31.8	65.0	20.5	0.46	1.58

Notes:

1. P = Passive Side; A = Active Side
2. A high groundwater condition equal to the extreme high lake levels was assumed. Groundwater is anticipated to closely correlate with the lake levels however precipitation may result in a greater differential. Conservatively, the tieback loads for the low lake level condition were used for the analysis.
3. Considering the relatively high deflections noted, we've assumed that the tierods will be post-tensioned to mitigate deflections at deadman sheeting which will translate to movement at the dockwall.

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Conclusion

The controlling tierod load from the pipe-combined wall was used for design of the tierod and deadman system, however a 30% increase in tierod load (1.30 x 34.5 k-ft/ft of wall = 44.9 k-ft/ft) was used to specify the required size of tierod as well as evaluated in the associated structural connections. We conservatively assumed this increase in tierod load for evaluation and sizing due to the uncertainty in the loading conditions of the anchored bulkhead wall over its design life. Additionally, due to the deflections estimated in our deadman system analysis, which assumes a passive anchorage system, we've conservatively assumed that the tierods will be pre-stressed. Pre-stressing the tierods will mitigate deflections at the dockwall face in keeping with the maximum allowable deflection of 6-inches. We have also assumed that the tierods will be protected against corrosion with double corrosion protection and, to mitigate the negative effects of settlement beneath the tierods, a 12" diameter PVC conduit will be installed around the tierods such that when the ground around the tierod settles, the PVC may settle, but the tierods will remain unaffected.

The allowable capacity of the pipe system at the end of its service life is 0.94 * 510.8 kip*ft/ft = 480 kip*ft/ft which is greater than the maximum moment demand of 470 kip*ft/ft.

Use 54"x11/16" king piles with NZ26 intermediate sheet piles. Minimum king pile tip elevation is El. 509 and intermediate sheeting tip elevation is El. 540.

For the deadman wall, use NZ19 sheet piles. Minimum sheet pile tip elevation is El. 555. The allowable capacity of the deadman sheeting at the end of its service life is 0.85 * 91.2 kip*ft/ft = 77.5 kip*ft/ft which is greater than the maximum moment demand of 65 kip*ft/ft.

Considering a 30% increase in tierod load, use #28, 3.5" diameter tierods with double corrosion protection and a 12" diameter PVC pipe for mitigation of additional tensile stresses due to settlement beneath the tierods.

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APPENDIX A: DOCK WALL CALCULATIONS

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DOCK WALL WALLAP ANALYSIS

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WALLAP ANALYSIS: A.1 – EMBEDMENT CHECK

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side		Soil types Right side	
1	575.00	12	Sediment	12	Sediment
2	547.00	3	Clay I	3	Clay I
3	540.00	17	KP - Clay I	17	KP - Clay I
4	532.00	7	KP - Clay IIA	7	KP - Clay IIA
5	517.00	8	KP - Clay III	8	KP - Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing Fill	130.0	1200000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (1.330)	2000d
4	Clay I - L. Term	130.0	43889	0.531	OC (0.490)	0.361 (0.000)	1.847 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1000d
6	Clay IIA - L.Term	130.0	600000	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	KP - Clay IIA	130.0	600000	0.560	NC (0.490)	0.484 (0.968)	0.000 (1.330)	1000d
8	KP - Clay III	130.0	1500000	0.560	NC (0.490)	0.484 (0.968)	0.000 (1.330)	2500d
9	KP-ClayIIA. L.Term	130.0	47151	0.560	NC (0.330)	0.189 (0.000)	1.707 (0.000)	0.0d
10	KP-Clay III. LTerm	130.0	68650	0.560	NC (0.330)	0.189 (0.000)	1.707 (0.000)	0.0d
11	Exist. Fill - L.Term	130.0	1200000	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Sediment	80.00	36000	0.500	NC (0.490)	1.000 (2.000)	1.000 (1.330)	60.00d
13	Sediment - L.Term	80.00	(36000)	0.500	NC (0.490)	0.422 (0.000)	1.581 (0.000)	
14	Granular Fill - AW	130.0	(42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
15	Granular Fill - BW	125.0	(15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
16	Exist. Fill - Broms	130.0	1200000	0.500	NC (0.490)	0.000 (0.000)	0.000 (1.650)	2000d
17	KP - Clay I	130.0	1200000	0.531	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2000d
18	KP - Clay I L.Term	130.0	1200000	0.531	NC (0.490)	0.175 (0.000)	2.770 (0.000)	0.0d
19	E. Fill - Broms L.Te	130.0	(1.20E+6)	0.500	NC (0.490)	0.000 (0.000)	1.650 (0.000)	

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
------- Soil type -------		Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	-0.507	0.00
4	Clay I - L.Term	28.00	0.000	0.00	17.31	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
7	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP-ClayIIA.L.Term	43.01	0.000	0.00	15.14	0.000	0.00
10	KP-Clay III.LTerm	43.01	0.000	0.00	15.14	0.000	0.00
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Sediment	0.00	0.000	0.00	0.00	-0.507	0.00
13	Sediment - L.Term	24.00	0.000	0.00	13.01	0.000	0.00
14	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
15	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
16	Exist. Fill - Broms	0.00	0.000	0.00	0.00	0.000	0.00
17	KP - Clay I	28.06	-0.627	0.00	Incompatible values		
18	KP - Clay I L.Term	44.60	0.000	0.00	Incompatible values		
19	E. Fill - Broms L.Te	0.00	0.000	0.00	14.20	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 480.00
Maximum finite element length = 6.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge ----- lb/ft2 ----- Near edge	Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 480.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Excavate to elevation 547.00 on LEFT side
3	Fill to elevation 576.00 on LEFT side with soil type 15
4	Fill to elevation 581.00 on LEFT side with soil type 14
5	Install strut or anchor no.1 at elevation 584.00
6	Fill to elevation 591.00 on LEFT side with soil type 14
7	Excavate to elevation 550.00 on RIGHT side
8	Apply water pressure profile no.1
9	Apply surcharge no.1 at elevation 591.00
10	Apply surcharge no.4 at elevation 591.00
11	Apply load no.1 at elevation 593.00
12	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
13	Apply surcharge no.3 at elevation 591.00
14	Change properties of soil type 12 to soil type 13 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 17 to soil type 18 No analysis at this stage Ko pressures will not be reset
17	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
18	Change properties of soil type 8 to soil type 10 Ko pressures will be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Excav. to elev. 547.00 on LEFT side	No	No	No
3	Fill to elev. 576.00 on LEFT side	No	No	No
4	Fill to elev. 581.00 on LEFT side	No	No	No
5	Install prop no.1 at elev. 584.00	No	No	No
6	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
7	Excav. to elev. 550.00 on RIGHT side	No	No	No
8	Apply water pressure profile no.1	No	No	No
9	Apply surcharge no.1 at elev. 591.00	No	No	No
10	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
11	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
12	Apply surcharge no.2 at elev. 591.00	No	No	No
13	Apply surcharge no.3 at elev. 591.00	No	No	No
14	Change soil type 12 to soil type 13	No	No	No
15	Change soil type 3 to soil type 4	No	No	No
16	Change soil type 17 to soil type 18	No	No	No
17	Change soil type 7 to soil type 9	No	No	No
18	Change soil type 8 to soil type 10	No	No	No
*	Summary output	Yes	-	Yes

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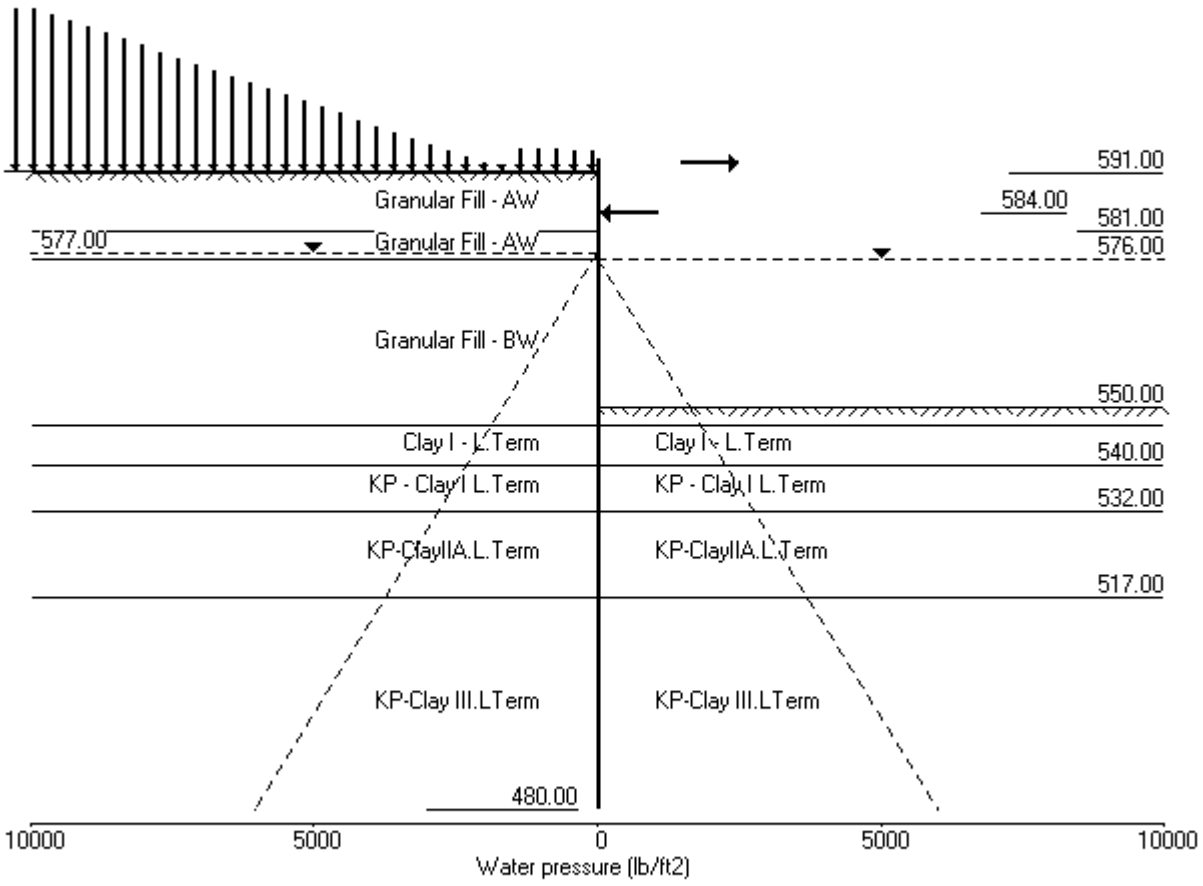
Units: lb,ft

Stage No.18 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 480.00 Factor of Safety	FoS for toe elev. = 480.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
18	591.00	550.00	584.00	2.678	n/a	510.20	39.80	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

*** Convergence failure - Out of balance shear force at elevation 480.00
is 67.415% of the maximum shear force. see Note.

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	0.116	-1.12E-02	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.138	-1.12E-02	2000.0	4000.0		9.18E+08
		488.53	0.138	-1.12E-02	2000.0	4000.0		
3	587.50	786.46	0.178	-1.12E-02	4231.2	14430.9		9.18E+08
4	584.00	432.36	0.217	-1.13E-02	6364.2	34444.4	-31309.2	9.18E+08
		432.36	0.217	-1.13E-02	-24945.0	34444.4		
5	581.00	551.32	0.251	-1.13E-02	-23469.5	-38172.5		9.18E+08
6	577.00	711.58	0.296	-1.10E-02	-20943.7	-127242.2		9.18E+08
7	576.00	795.39	0.307	-1.08E-02	-20190.3	-147812.9		9.18E+08
		857.60	0.307	-1.08E-02	-20190.3	-147812.9		
8	575.00	879.42	0.318	-1.06E-02	-19321.7	-167563.3		9.18E+08
9	569.50	1004.25	0.373	-9.40E-03	-14141.6	-258951.1		9.18E+08
10	564.00	1136.31	0.420	-7.66E-03	-8255.1	-320079.3		9.18E+08
11	558.00	1286.24	0.460	-5.48E-03	-987.4	-348553.0		9.18E+08
12	554.00	1388.39	0.479	-3.98E-03	4361.8	-341496.4		9.18E+08
13	550.00	1491.61	0.492	-2.55E-03	10121.8	-312709.3		9.18E+08
14	547.00	1485.97	0.498	-1.60E-03	14588.2	-274608.4		9.18E+08
		1597.17	0.498	-1.60E-03	14588.2	-274608.4		
15	543.50	1265.10	0.502	-6.78E-04	19597.2	-209827.4		9.18E+08
16	540.00	933.12	0.503	-2.27E-05	23444.0	-134208.9		8.07E+08
		-501.65	0.503	-2.27E-05	23444.0	-134208.9		
17	536.00	-1192.55	0.502	4.28E-04	20055.6	-48179.6		8.07E+08
18	532.00	-1883.60	0.500	5.05E-04	13903.3	17161.7		8.07E+08
		-439.60	0.500	5.05E-04	13903.3	17161.7		
19	528.25	-340.02	0.499	3.14E-04	12441.6	65151.5		8.07E+08
20	524.50	-95.51	0.498	-6.74E-05	11624.9	99399.2		8.07E+08
21	520.75	125.88	0.499	-5.65E-04	11681.9	115286.1		8.07E+08
22	517.00	311.39	0.502	-1.09E-03	12501.8	110873.4		8.07E+08
		-17.56	0.502	-1.09E-03	12501.8	110873.4		

(continued)

Stage No.18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
23	513.50	50.14	0.507	-1.53E-03	12558.8	95696.5		8.07E+08
24	510.00	73.43	0.513	-1.92E-03	12775.0	81195.6		8.07E+08
25	504.00	75.15	0.526	-2.44E-03	13220.8	58766.9		8.07E+08
26	498.00	79.40	0.542	-2.80E-03	13684.4	38806.8		8.07E+08
27	492.00	98.66	0.560	-3.02E-03	14218.6	21454.9		8.07E+08
28	486.00	192.00	0.578	-3.13E-03	15090.6	6745.6		8.07E+08
29	480.00	383.32	0.597	-3.15E-03	16816.6	0.0		---

At elev. 584.00 Prop force = 31309.2 lb/ft run

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	488.53	488.53	4370
3	587.50	0.00	954.67	293.33	3107.07	786.46	786.46	26221
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	6785
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	9693
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	13571
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	14540
		62.40	2385.59	795.20	7156.77	795.20	857.60a	5193
8	575.00	124.80	2451.06	817.02	7353.17	817.02	941.82a	5539
9	569.50	468.00	2825.56	941.85	8476.68	941.85	1409.85a	7443
10	564.00	811.20	3221.74	1073.91	9665.22	1073.91	1885.11a	9347
11	558.00	1185.60	3671.52	1223.84	11014.55	1223.84	2409.44a	11424
12	554.00	1435.20	3977.96	1325.99	11933.89	1325.99	2761.19a	12809
13	550.00	1684.80	4287.63	1429.21	12862.88	1429.21	3114.01a	14194
14	547.00	1872.00	4521.15	1507.05	13563.46	1507.05	3379.05a	15232
		1872.00	4521.15	1632.29	8350.57	1632.29	3504.29a	1456
15	543.50	2090.40	4811.81	1737.23	8887.42	1737.23	3827.63a	1456
16	540.00	2308.80	5102.68	1842.24	9424.65	1842.24	4151.04a	1456
		2308.80	5102.68	892.97	14134.42	892.97	3201.77a	39814
17	536.00	2558.40	5434.74	951.08	15054.24	951.08	3509.48a	39814
18	532.00	2808.00	5765.91	1009.03	15971.58	1009.03	3817.03a	39814
		2808.00	5765.91	1089.76	9842.42	1319.03	4127.03	1088
19	528.25	3042.00	6075.20	1148.21	10370.36	1462.22	4504.22	1088
20	524.50	3276.00	6383.05	1206.40	10895.87	1605.90	4881.90	1088
21	520.75	3510.00	6689.29	1264.28	11418.62	1748.99	5258.99	1088
22	517.00	3744.00	6993.75	1321.82	11938.33	1890.69	5634.69	1088
		3744.00	6993.75	1321.82	11938.33	3150.25	6894.25	1584
23	513.50	3962.40	7276.22	1375.21	12420.51	3299.48	7261.88	1584
24	510.00	4180.80	7556.99	1428.27	12899.78	3446.25	7627.05	1584
25	504.00	4555.20	8034.24	1518.47	13714.44	3691.89	8247.09	1584
26	498.00	4929.60	8506.29	1607.69	14520.23	3930.36	8859.96	1584
27	492.00	5304.00	8973.15	1695.93	15317.17	4162.75	9466.75	1584
28	486.00	5678.40	9434.92	1783.20	16105.41	4390.48	10068.88	1584
29	480.00	6052.80	9891.74	1869.54	16885.19	4614.81	10667.61	1584

(continued)

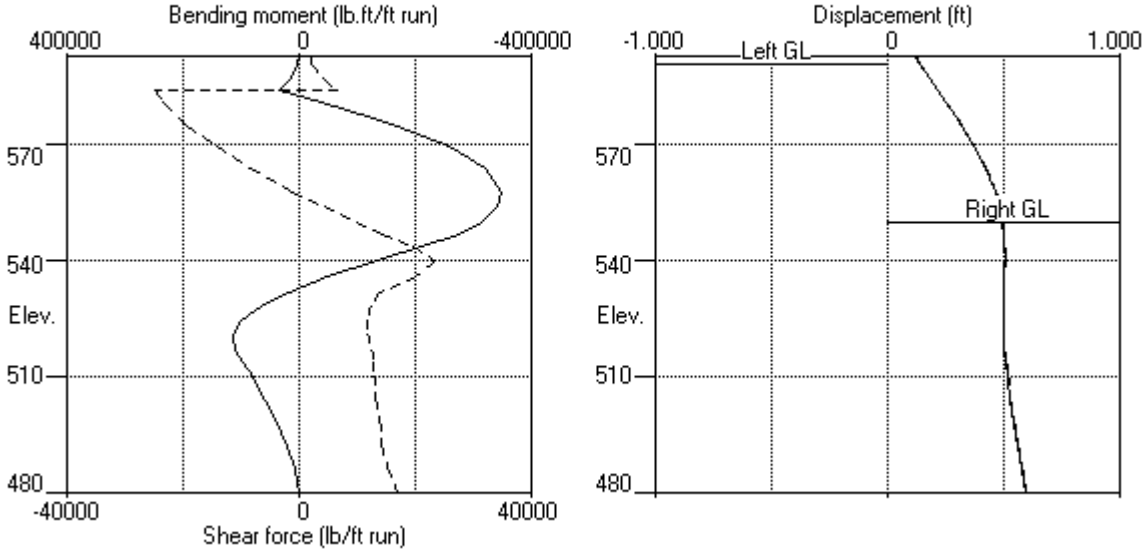
Stage No.18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
9	569.50	405.60	0.00	0.00	0.00	0.00	405.60	0.0
10	564.00	748.80	-0.00	0.00	0.00	0.00	748.80	0.0
11	558.00	1123.20	-0.00	0.00	0.00	0.00	1123.20	0.0
12	554.00	1372.80	-0.00	0.00	0.00	0.00	1372.80	0.0
13	550.00	1622.40	-0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	-0.00	0.00	-0.00	-0.00	1622.40	617
14	547.00	1809.60	52.80	22.27	83.48	83.48	1893.08p	3703
		1809.60	52.80	19.06	97.52	97.52	1907.12p	1505
15	543.50	2028.00	289.40	104.48	534.52	534.52	2562.52p	1505
16	540.00	2246.40	526.00	189.90	971.52	971.52	3217.92p	1505
		2246.40	526.00	92.05	1457.02	1457.02	3703.42p	41141
17	536.00	2496.00	796.40	139.37	2206.03	2206.03	4702.03p	41141
18	532.00	2745.60	1066.80	186.69	2955.04	2955.04	5700.64p	41141
		2745.60	1066.80	201.63	1821.03	1821.03	4566.63p	1140
19	528.25	2979.60	1320.30	249.54	2253.76	1864.64	4844.24	1140
20	524.50	3213.60	1573.80	297.45	2686.48	1763.81	4977.41	1140
21	520.75	3447.60	1827.30	345.36	3119.21	1685.51	5133.11	1140
22	517.00	3681.60	2080.81	393.27	3551.94	1641.70	5323.30	1140
		3681.60	2080.81	393.27	3551.94	3230.21	6911.81	1660
23	513.50	3900.00	2317.41	437.99	3955.82	3311.74	7211.74	1660
24	510.00	4118.40	2554.01	482.71	4359.70	3435.22	7553.62	1660
25	504.00	4492.80	2959.62	559.37	5052.07	3679.14	8171.94	1660
26	498.00	4867.20	3365.23	636.03	5744.44	3913.36	8780.56	1660
27	492.00	5241.60	3770.84	712.69	6436.82	4126.49	9368.09	1660
28	486.00	5616.00	4176.45	789.35	7129.20	4260.88	9876.88	1660
29	480.00	5990.40	4582.06	866.01	7821.58	4293.89	10284.29	1660

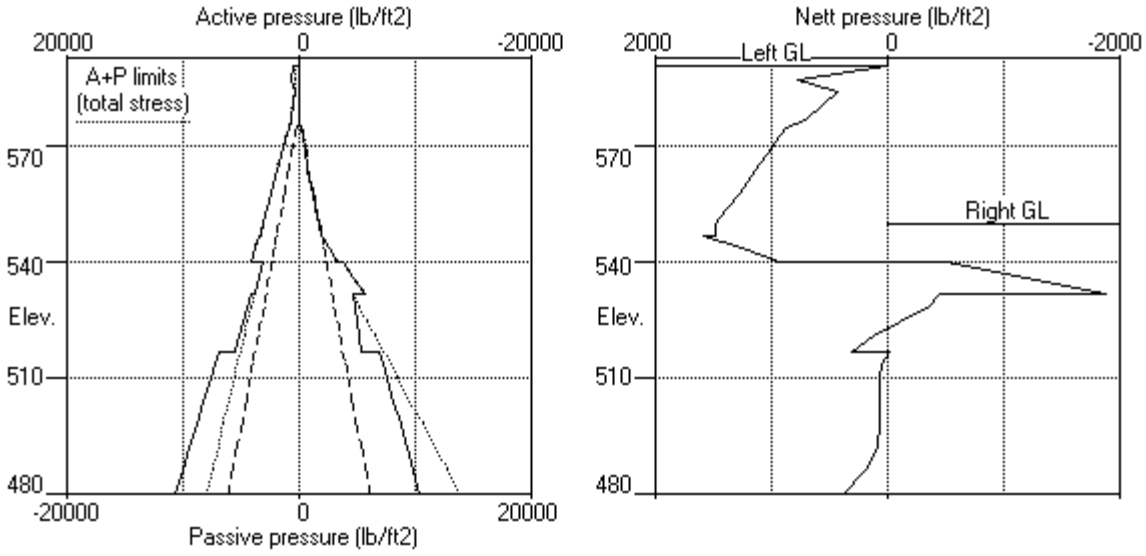
Note: 3817.03a Soil pressure at active limit
4566.63p Soil pressure at passive limit

Units: lb,ft

Stage No.18 Change soil type 8 to soil type 10



Stage No.18 Change soil type 8 to soil type 10



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 480.00 Factor of Safety	FoS for toe elev. = 480.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
1	575.00	575.00	Cant.	15.734	499.45	***	***	L to R
2	575.00	547.00	Cant.	12.829	499.63	533.51	13.49	R to L
3	576.00	575.00	Cant.	5.334	495.97	537.83	37.17	L to R
4	581.00	575.00	Cant.	3.045	496.02	510.01	64.99	L to R
5	581.00	575.00		No analysis at this stage				
6	591.00	575.00	584.00	2.632	n/a	541.13	33.87	L to R
7	591.00	550.00	584.00	2.568	n/a	538.83	11.17	L to R
8	591.00	550.00	584.00	2.485	n/a	538.45	11.55	L to R
9	591.00	550.00	584.00	2.348	n/a	516.14	33.86	L to R
10	591.00	550.00	584.00	2.344	n/a	516.09	33.91	L to R
11	591.00	550.00	584.00	2.351	n/a	516.25	33.75	L to R
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00	584.00	1.568	n/a	502.45	47.55	L to R
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00		No analysis at this stage				
17	591.00	550.00		No analysis at this stage				
18	591.00	550.00	584.00	2.678	n/a	510.20	39.80	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.203	-0.047	0.0	-0.0	2000.0	0.0
2	591.00	0.199	-0.046	4000.0	-0.0	2000.0	0.0
3	587.50	0.195	-0.043	14430.9	-0.0	4231.2	0.0
4	584.00	0.217	-0.040	34444.4	-0.0	6364.2	-24945.0
5	581.00	0.251	-0.037	0.0	-38172.5	0.0	-23469.5
6	577.00	0.296	-0.034	426.1	-127242.2	319.5	-20943.7
7	576.00	0.307	-0.033	832.2	-147812.9	499.3	-20190.3
8	575.00	0.318	-0.032	1443.3	-167563.3	726.4	-19321.7
9	569.50	0.373	-0.027	8428.0	-258951.1	1643.3	-14141.6
10	564.00	0.420	-0.023	20125.0	-320079.3	3318.6	-8255.1
11	558.00	0.460	-0.018	40377.5	-348553.0	9208.2	-987.4
12	554.00	0.479	-0.014	58491.1	-341496.4	13962.0	-1818.4
13	550.00	0.492	-0.011	81438.2	-312709.3	19222.7	-2957.6
14	547.00	0.498	-0.009	103330.7	-274608.4	23702.0	-3996.8
15	543.50	0.502	-0.007	142646.7	-209827.4	19597.2	-1040.0
16	540.00	0.503	-0.005	172392.5	-134208.9	23444.0	-4021.4
17	536.00	0.502	-0.004	165205.4	-48179.6	20055.6	-5738.6
18	532.00	0.500	-0.003	145854.4	-18585.2	13903.3	-9215.8
19	528.25	0.499	-0.003	125337.7	-8978.5	12441.6	-8295.9
20	524.50	0.498	-0.003	106922.5	-2467.3	11624.9	-6792.9
21	520.75	0.499	-0.003	115286.1	-0.0	11681.9	-4743.8
22	517.00	0.502	-0.003	110873.4	-0.0	12501.8	-3785.7
23	513.50	0.507	-0.002	95696.5	-2363.9	12558.8	-2335.7
24	510.00	0.513	-0.002	81195.6	-8316.1	12775.0	-1268.4
25	504.00	0.526	-0.002	58766.9	-18097.5	16058.4	-270.9
26	498.00	0.542	-0.002	38806.8	-16409.6	17796.3	0.0
27	492.00	0.560	-0.002	21454.9	-8993.1	18291.4	0.0
28	486.00	0.578	-0.002	6745.6	-2329.2	17847.6	0.0
29	480.00	0.597	-0.002	0.0	-0.0	16816.6	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	486.00	-0.0	498.00	0.0	540.00	0.0	593.00
2	758.7	520.75	-37105.5	540.00	2921.7	532.00	-3996.8	547.00
3	30183.9	543.50	-3757.8	504.00	2794.7	547.00	-1607.8	536.00
4	118683.5	543.50	-11313.8	504.00	7511.3	547.00	-5463.1	536.00
5	No calculation at this stage							
6	141061.5	540.00	-68735.1	569.50	15700.3	547.00	-8450.2	584.00
7	158206.8	540.00	-104179.5	564.00	20212.7	547.00	-10807.9	584.00
8	159102.1	540.00	-112698.8	564.00	20785.3	547.00	-11344.1	584.00
9	172392.5	540.00	-136411.1	564.00	22726.2	547.00	-15190.0	584.00
10	169405.5	540.00	-138480.3	564.00	22666.1	547.00	-15291.9	584.00
11	165578.6	540.00	-131106.2	564.00	22179.7	547.00	-15249.2	584.00
12	No calculation at this stage							
13	165205.4	536.00	-163774.1	564.00	23702.0	547.00	-17049.5	584.00
14	No calculation at this stage							
15	No calculation at this stage							
16	No calculation at this stage							
17	No calculation at this stage							
18	115286.1	520.75	-348553.0	558.00	23444.0	540.00	-24945.0	584.00

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	480.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.000	593.00	-0.047	593.00	Excav. to elev. 547.00 on LEFT side
3	0.037	593.00	0.000	593.00	Fill to elev. 576.00 on LEFT side
4	0.169	593.00	0.000	593.00	Fill to elev. 581.00 on LEFT side
5	No calculation at this stage				Install prop no.1 at elev. 584.00
6	0.182	593.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
7	0.181	593.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
8	0.182	593.00	0.000	593.00	Apply water pressure profile no.1
9	0.195	593.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
10	0.195	593.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
11	0.203	593.00	0.000	593.00	Apply load no.1 at elev. 593.00
12	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
13	0.200	593.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
14	No calculation at this stage				Change soil type 12 to soil type 13
15	No calculation at this stage				Change soil type 3 to soil type 4
16	No calculation at this stage				Change soil type 17 to soil type 18
17	No calculation at this stage				Change soil type 7 to soil type 9
18	0.597	480.00	0.000	593.00	Change soil type 8 to soil type 10

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
6	9428.84	87688.23
7	11786.54	109614.79
8	12322.69	114600.99
9	17885.12	166331.63
10	17984.82	167258.82
11	19570.40	182004.70
13	21346.74	198524.70
18	31309.20	291175.60

*** Convergence errors have occurred in at least one Construction Stage.
The errors are cumulative, and the results of all stages must be inspected for significant out of balance moment or shear at the toe of the wall.

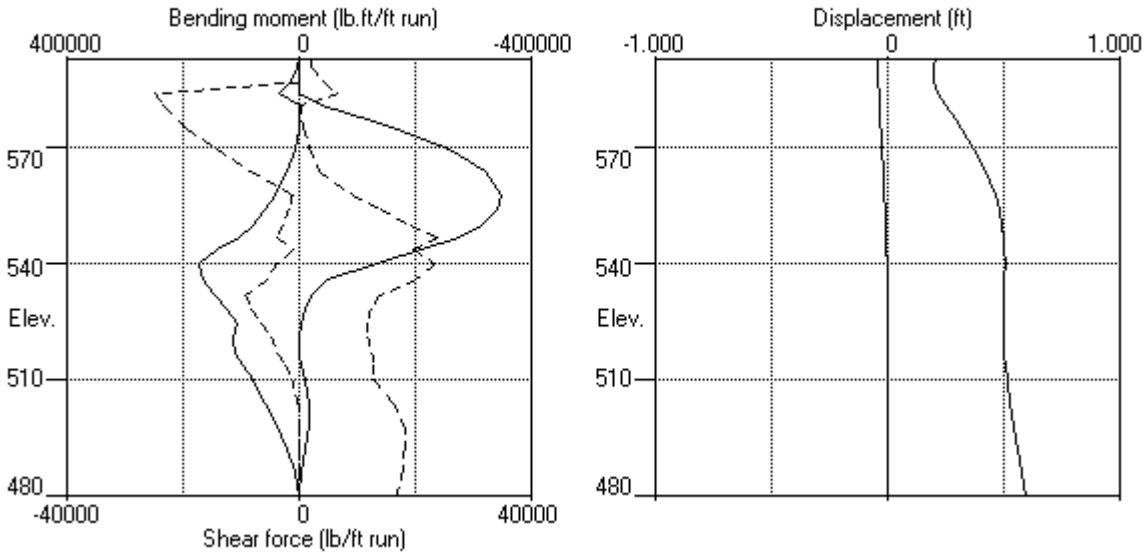
Failure of the iterative procedure to converge to an equilibrium solution may be due to a very high ratio of soil stiffness to wall stiffness. The data should be reviewed to see if realistic values have been specified

Out of balance shear forces.

Percentage Error	Interpretation
< 2%	Generally acceptable
2% to 4%	Use with caution
> 4%	Should not be used

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: A.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side		Soil types Right side	
1	575.00	12	Sediment	12	Sediment
2	547.00	3	Clay I	3	Clay I
3	540.00	17	KP - Clay I	17	KP - Clay I
4	532.00	7	KP - Clay IIA	7	KP - Clay IIA
5	517.00	8	KP - Clay III	8	KP - Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing Fill	130.0	1200000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I - L. Term	130.0	1200000	0.531	OC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1000d
6	Clay IIA - L.Term	130.0	600000	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	KP - Clay IIA	130.0	600000	0.560	NC (0.490)	0.484 (0.968)	0.000 (2.000)	1000d
8	KP - Clay III	130.0	1500000	0.560	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2500d
9	KP-ClayIIA. L.Term	130.0	600000	0.560	NC (0.490)	0.189 (0.000)	2.561 (0.000)	0.0d
10	KP-Clay III. LTerm	130.0	1500000	0.560	NC (0.490)	0.189 (0.000)	2.561 (0.000)	0.0d
11	Exist. Fill - L.Term	130.0	1200000	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Sediment	80.00	36000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	60.00d
13	Sediment - L.Term	80.00	0 (36000)	0.500	NC (0.490)	0.422 (0.000)	2.371 (0.000)	
14	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
15	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
16	Exist. Fill - Broms	130.0	1200000	0.500	NC (0.490)	0.000 (0.000)	0.000 (1.650)	2000d
17	KP - Clay I	130.0	1200000	0.531	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2000d
18	KP - Clay I L.Term	130.0	1200000	0.531	NC (0.490)	0.175 (0.000)	2.770 (0.000)	0.0d
19	E. Fill - Broms L.Te	130.0	0 (1.20E+6)	0.500	NC (0.490)	0.000 (0.000)	1.650 (0.000)	

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
------- Soil type -------		Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I - L.Term	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
7	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP-ClayIIA.L.Term	43.01	0.000	0.00	26.00	0.000	0.00
10	KP-Clay III.LTerm	43.01	0.000	0.00	26.00	0.000	0.00
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Sediment	0.00	0.000	0.00	0.00	0.000	0.00
13	Sediment - L.Term	24.00	0.000	0.00	24.00	0.000	0.00
14	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
15	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
16	Exist. Fill - Broms	0.00	0.000	0.00	0.00	0.000	0.00
17	KP - Clay I	28.06	-0.627	0.00	Incompatible values		
18	KP - Clay I L.Term	44.60	0.000	0.00	Incompatible values		
19	E. Fill - Broms L.Te	0.00	0.000	0.00	14.20	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 509.00
Maximum finite element length = 5.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge Near edge (lb/ft2)	Surcharge Far edge (lb/ft2)	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 509.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Excavate to elevation 547.00 on LEFT side
3	Fill to elevation 576.00 on LEFT side with soil type 15
4	Fill to elevation 581.00 on LEFT side with soil type 14
5	Install strut or anchor no.1 at elevation 584.00
6	Fill to elevation 591.00 on LEFT side with soil type 14
7	Excavate to elevation 550.00 on RIGHT side
8	Apply water pressure profile no.1
9	Apply surcharge no.1 at elevation 591.00
10	Apply surcharge no.4 at elevation 591.00
11	Apply load no.1 at elevation 593.00
12	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
13	Apply surcharge no.3 at elevation 591.00
14	Change properties of soil type 12 to soil type 13 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 17 to soil type 18 No analysis at this stage Ko pressures will not be reset
17	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
18	Change properties of soil type 8 to soil type 10 Ko pressures will be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Excav. to elev. 547.00 on LEFT side	No	No	No
3	Fill to elev. 576.00 on LEFT side	No	No	No
4	Fill to elev. 581.00 on LEFT side	No	No	No
5	Install prop no.1 at elev. 584.00	No	No	No
6	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
7	Excav. to elev. 550.00 on RIGHT side	No	No	No
8	Apply water pressure profile no.1	No	No	No
9	Apply surcharge no.1 at elev. 591.00	No	No	No
10	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
11	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
12	Apply surcharge no.2 at elev. 591.00	No	No	No
13	Apply surcharge no.3 at elev. 591.00	No	No	No
14	Change soil type 12 to soil type 13	No	No	No
15	Change soil type 3 to soil type 4	No	No	No
16	Change soil type 17 to soil type 18	No	No	No
17	Change soil type 7 to soil type 9	No	No	No
18	Change soil type 8 to soil type 10	No	No	No
*	Summary output	Yes	-	Yes

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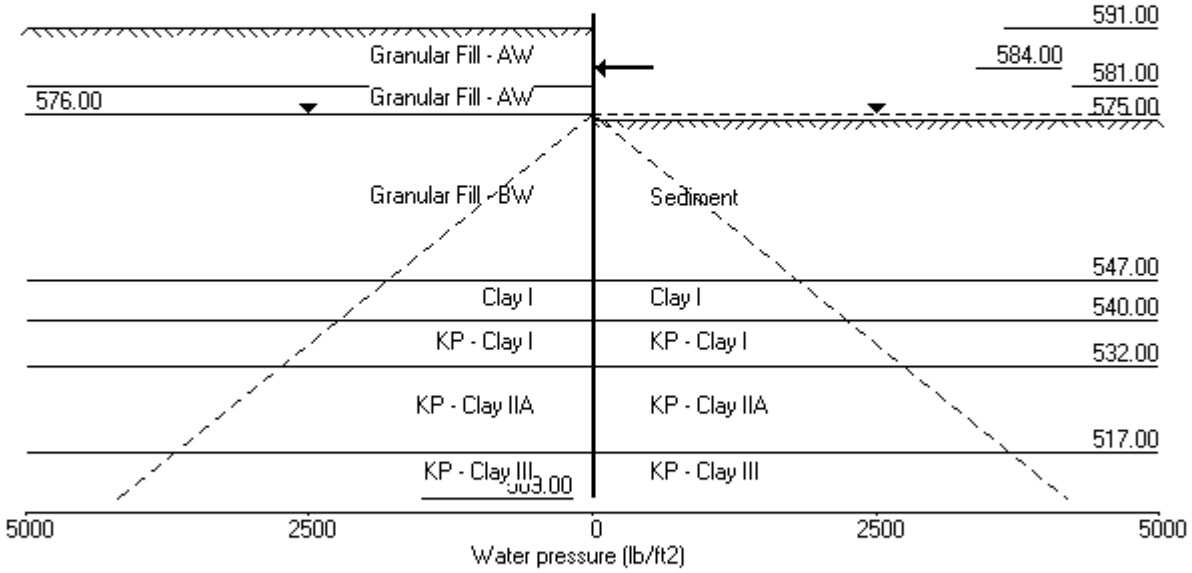
Units: lb,ft

Stage No.6 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No. 6 Fill to elevation 591.00 on LEFT side with soil type 14

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 509.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
6	591.00	575.00	584.00	3.091	n/a	542.86	32.14	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.162	1.80E-03	0.0	-0.0		9.18E+08
2	591.00	0.00	0.159	1.80E-03	0.0	0.0		9.18E+08
3	587.50	139.80	0.153	1.80E-03	244.7	285.4		9.18E+08
4	584.00	279.61	0.146	1.79E-03	978.6	2283.4	-9381.5	9.18E+08
		279.61	0.146	1.79E-03	-8402.9	2283.4		
5	581.00	399.44	0.141	1.82E-03	-7384.3	-21487.2		9.18E+08
6	577.00	559.21	0.133	1.97E-03	-5467.0	-47402.8		9.18E+08
7	576.00	599.15	0.131	2.03E-03	-4887.8	-52583.5		9.18E+08
		776.52	0.131	2.03E-03	-4887.8	-52583.5		
8	575.00	789.02	0.129	2.09E-03	-4105.1	-57077.9		9.18E+08
		669.02	0.129	2.09E-03	-4105.1	-57077.9		
9	570.00	642.10	0.118	2.43E-03	-827.3	-69013.4		9.18E+08
10	565.00	623.83	0.105	2.79E-03	2337.5	-64397.0		9.18E+08
11	560.00	652.41	0.090	3.09E-03	5528.1	-44456.9		9.18E+08
12	555.00	732.68	0.074	3.23E-03	8990.8	-8375.8		9.18E+08
13	550.00	849.83	0.058	3.13E-03	12947.1	46022.4		9.18E+08
14	547.00	934.90	0.049	2.91E-03	15624.2	89768.4		9.18E+08
		-3538.33	0.049	2.91E-03	15624.2	89768.4		
15	543.50	-2549.18	0.039	2.50E-03	4971.1	126798.3		9.18E+08
16	540.00	-1369.32	0.031	2.01E-03	-1886.3	128154.4		8.07E+08
17	536.00	-459.57	0.025	1.42E-03	-5544.1	110016.6		8.07E+08
18	532.00	7.95	0.020	9.47E-04	-6447.3	84031.4		8.07E+08
		291.29	0.020	9.47E-04	-6447.3	84031.4		
19	528.50	284.68	0.017	6.28E-04	-5439.4	62938.5		8.07E+08
20	525.00	235.38	0.015	3.94E-04	-4529.3	45355.6		8.07E+08
21	521.00	139.97	0.014	2.10E-04	-3778.6	28707.4		8.07E+08
22	517.00	16.52	0.014	1.04E-04	-3465.6	14305.2		8.07E+08
		403.08	0.014	1.04E-04	-3465.6	14305.2		
23	513.00	436.18	0.013	5.98E-05	-1787.1	3662.5		8.07E+08
24	509.00	457.36	0.013	5.07E-05	-0.0	-0.0		---

At elev. 584.00 Prop force = 9381.5 lb/ft run

(continued)

Stage No.6 Fill to elevation 591.00 on LEFT side with soil type 14

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	683
3	587.50	0.00	455.00	139.80	1480.84	139.80	139.80a	4101
4	584.00	0.00	910.00	279.61	2961.68	279.61	279.61a	8201
5	581.00	0.00	1300.00	399.44	4230.96	399.44	399.44a	11716
6	577.00	0.00	1820.00	559.21	5923.35	559.21	559.21a	16403
7	576.00	0.00	1950.00	599.15	6346.45	599.15	599.15a	17575
		0.00	1950.00	650.00	5850.00	776.52	776.52	6277
8	575.00	62.40	2012.60	670.87	6037.80	789.02	851.42	6695
9	570.00	374.40	2325.60	775.20	6976.80	850.10	1224.50	8787
10	565.00	686.40	2638.60	879.53	7915.80	919.83	1606.23	10880
11	560.00	998.40	2951.60	983.87	8854.80	1012.43	2010.83	12972
12	555.00	1310.40	3264.60	1088.20	9793.80	1138.61	2449.01	15064
13	550.00	1622.40	3577.60	1192.53	10732.80	1302.81	2925.21	17156
14	547.00	1809.60	3765.40	1255.13	11296.20	1418.02	3227.62	18411
		1809.60	3765.40	0.00	7765.40	138.94	1948.54	46003
15	543.50	2028.00	4002.00	2.00	8002.00	354.98	2382.98	46003
16	540.00	2246.40	4238.60	238.60	8238.60	1059.69	3306.09	46003
		2246.40	4238.60	115.48	4000.00	1059.69	3306.09	46003
17	536.00	2496.00	4509.00	246.36	4000.00	1681.98	4177.98	46003
18	532.00	2745.60	4779.40	377.23	4000.00	2006.92	4752.52	46003
		2745.60	4779.40	1345.23	2000.00	1734.53	4480.13	23002
19	528.50	2964.00	5016.00	1459.74	2000.00	1780.25	4744.25	23002
20	525.00	3182.40	5252.60	1574.26	2000.00	1813.13	4995.53	23002
21	521.00	3432.00	5523.00	1705.13	2000.00	1836.36	5268.36	23002
22	517.00	3681.60	5793.40	1836.01	2000.00	1847.80	5529.40	23002
		3681.60	5793.40	384.01	5000.00	2863.80	6545.40	57504
23	513.00	3931.20	6063.80	514.88	5000.00	3027.25	6958.45	57504
24	509.00	4180.80	6334.20	645.75	5000.00	3185.26	7366.06	57504

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
		62.40	0.00	0.00	120.00	120.00	182.40p	1569
9	570.00	374.40	88.00	0.00	208.00	208.00	582.40p	1569
10	565.00	686.40	176.00	56.00	296.00	296.00	982.40p	1569
11	560.00	998.40	264.00	144.00	384.00	360.02	1358.42	1569
12	555.00	1310.40	352.00	232.00	472.00	405.93	1716.33	1569
13	550.00	1622.40	440.00	320.00	560.00	452.98	2075.38	1569
14	547.00	1809.60	492.80	372.80	612.80	483.12	2292.72	1569
		1809.60	492.80	0.00	4492.80	3677.27	5486.87	52304
15	543.50	2028.00	729.40	0.00	4729.40	2904.16	4932.16	52304
16	540.00	2246.40	966.00	0.00	4966.00	2429.01	4675.41	52304
		2246.40	966.00	0.00	4000.00	2429.01	4675.41	52304

(continued)

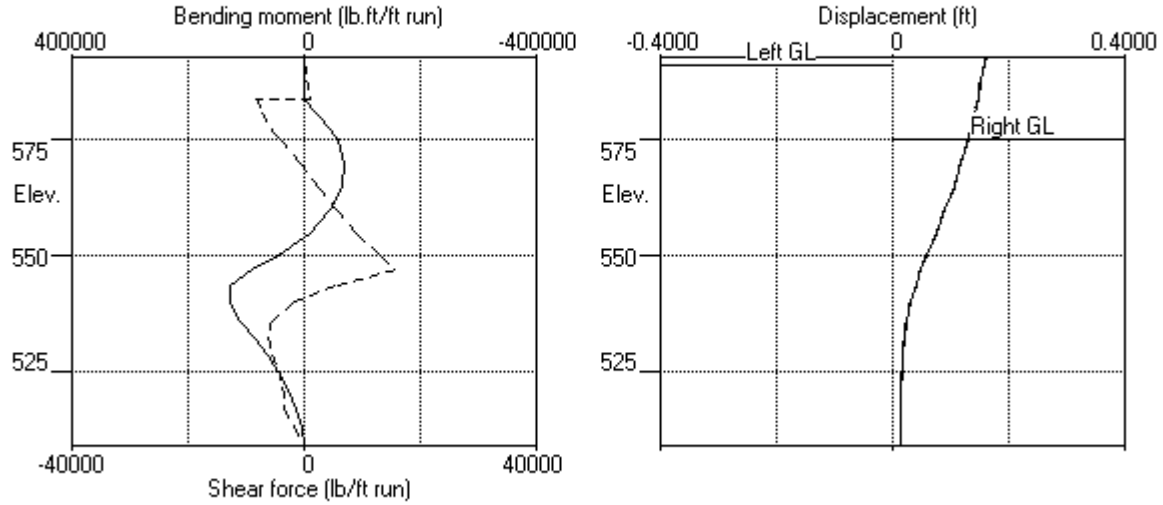
Stage No.6 Fill to elevation 591.00 on LEFT side with soil type 14

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	536.00	2496.00	1236.40	0.00	4000.00	2141.55	4637.55	52304
18	532.00	2745.60	1506.80	0.00	4000.00	1998.97	4744.57	52304
		2745.60	1506.80	0.00	2000.00	1443.24	4188.84	26152
19	528.50	2964.00	1743.40	0.00	2000.00	1495.57	4459.57	26152
20	525.00	3182.40	1980.00	0.00	2000.00	1577.75	4760.15	26152
21	521.00	3432.00	2250.40	121.19	2000.00	1696.39	5128.39	26152
22	517.00	3681.60	2520.80	252.07	2000.00	1831.28	5512.88	26152
		3681.60	2520.80	0.00	5000.00	2460.72	6142.32	65380
23	513.00	3931.20	2791.20	0.00	5000.00	2591.06	6522.26	65380
24	509.00	4180.80	3061.60	0.00	5000.00	2727.91	6908.71	65380

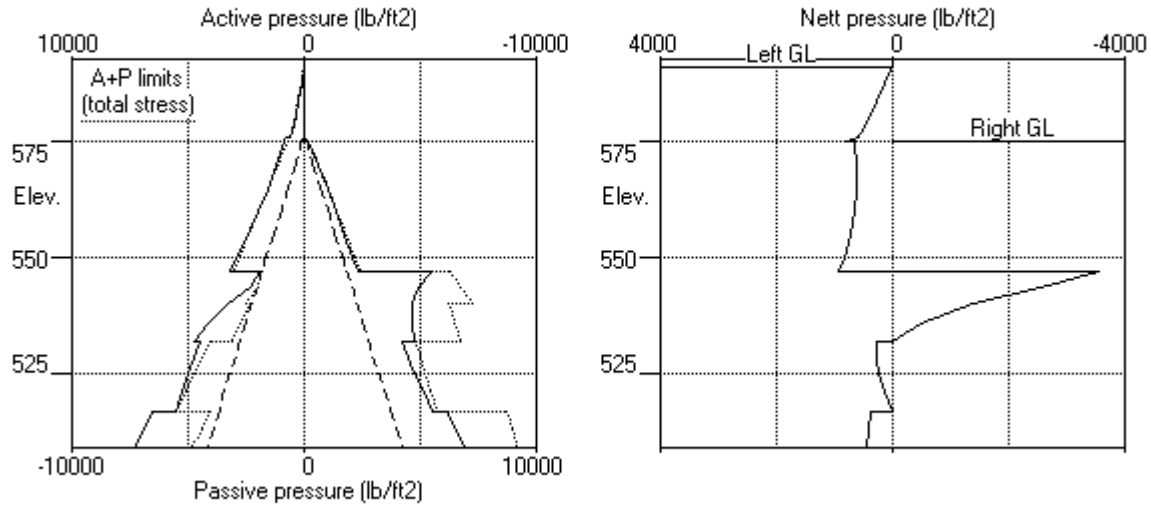
Note: 599.15a Soil pressure at active limit
982.40p Soil pressure at passive limit

Units: lb,ft

Stage No.6 Fill to elev. 591.00 on LEFT side

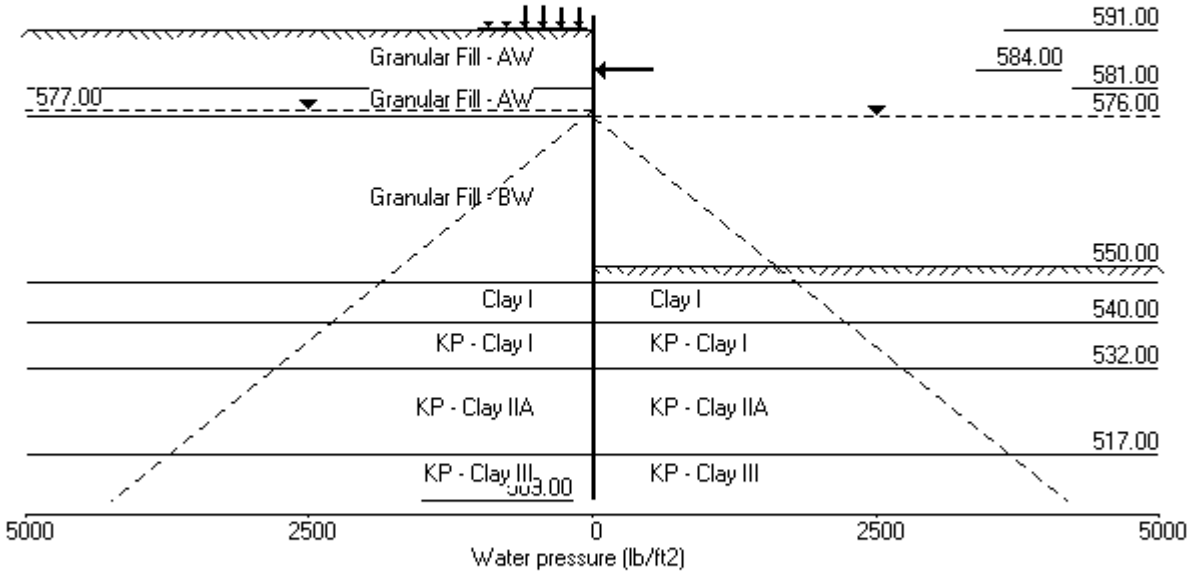


Stage No.6 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No.10 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No. 10 Apply surcharge no.4 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 509.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
10	591.00	550.00	584.00	2.612	n/a	539.95	10.05	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.176	1.09E-03	0.0	0.0		9.18E+08
2	591.00	0.00	0.174	1.09E-03	0.0	0.0		9.18E+08
		225.26	0.174	1.09E-03	0.0	-0.0		
3	587.50	389.04	0.170	1.09E-03	1075.0	1815.1		9.18E+08
4	584.00	536.77	0.167	1.07E-03	2695.2	8386.6	-17576.1	9.18E+08
		536.77	0.167	1.07E-03	-14880.9	8386.6		
5	581.00	656.20	0.163	1.11E-03	-13091.4	-33580.1		9.18E+08
6	577.00	735.53	0.159	1.35E-03	-10308.0	-80288.8		9.18E+08
7	576.00	790.12	0.157	1.45E-03	-9545.1	-90216.8		9.18E+08
		1048.94	0.157	1.45E-03	-9545.1	-90216.8		
8	575.00	1035.48	0.156	1.55E-03	-8502.9	-99234.1		9.18E+08
9	570.00	1039.23	0.146	2.17E-03	-3316.2	-128692.2		9.18E+08
10	565.00	1078.99	0.134	2.88E-03	1979.4	-131227.6		9.18E+08
11	560.00	1138.10	0.118	3.53E-03	7522.1	-107224.6		9.18E+08
12	555.00	1217.53	0.099	3.97E-03	13411.2	-55126.6		9.18E+08
13	550.00	1315.37	0.079	4.04E-03	19743.4	27277.9		9.18E+08
		1230.32	0.079	4.04E-03	19743.4	27277.9		
14	547.00	1273.62	0.067	3.85E-03	23499.3	93027.0		9.18E+08
		-3990.40	0.067	3.85E-03	23499.3	93027.0		
15	543.50	-3559.82	0.054	3.38E-03	10286.4	154737.4		9.18E+08
16	540.00	-2337.57	0.043	2.76E-03	-34.0	169209.0		8.07E+08
17	536.00	-1077.99	0.034	1.97E-03	-6865.1	150702.7		8.07E+08
18	532.00	-367.98	0.027	1.31E-03	-9757.1	114458.0		8.07E+08
		395.00	0.027	1.31E-03	-9757.1	114458.0		
19	528.50	455.78	0.023	8.89E-04	-8268.2	82399.5		8.07E+08
20	525.00	453.10	0.021	5.89E-04	-6677.7	55948.6		8.07E+08
21	521.00	397.54	0.019	3.70E-04	-4976.4	32428.1		8.07E+08
22	517.00	410.09	0.018	2.52E-04	-3361.1	15324.8		8.07E+08
		301.67	0.018	2.52E-04	-3361.1	15324.8		
23	513.00	423.61	0.017	2.03E-04	-1910.6	4272.2		8.07E+08
24	509.00	531.67	0.016	1.93E-04	-0.0	-0.0		---

At elev. 584.00 Prop force = 17576.1 lb/ft run

(continued)

Stage No.10 Apply surcharge no.4 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	225.26	225.26	701
3	587.50	0.00	953.04	292.83	3101.75	389.04	389.04	4203
4	584.00	0.00	1395.20	428.69	4540.80	536.77	536.77	8407
5	581.00	0.00	1763.13	541.74	5738.28	656.20	656.20	12009
6	577.00	0.00	2244.06	689.51	7303.48	735.53	735.53	16813
7	576.00	62.40	2301.20	707.06	7489.45	727.72	790.12	18014
		62.40	2301.20	767.07	6903.59	986.54	1048.94	6434
8	575.00	124.80	2353.30	784.43	7059.91	973.08	1097.88	6862
9	570.00	436.80	2615.91	871.97	7847.73	976.83	1413.63	9007
10	565.00	748.80	2885.14	961.71	8655.42	1016.59	1765.39	11152
11	560.00	1060.80	3161.79	1053.93	9485.37	1075.70	2136.50	13296
12	555.00	1372.80	3444.92	1148.31	10334.76	1155.13	2527.93	15441
13	550.00	1684.80	3733.30	1244.43	11199.91	1252.97	2937.77	17585
14	547.00	1872.00	3908.39	1302.80	11725.16	1318.63	3190.63	18872
		1872.00	3908.39	0.00	7908.39	0.00	1872.00a	46957
15	543.50	2090.40	4131.77	131.77	8131.77	131.77	2222.17a	46957
16	540.00	2308.80	4356.65	356.65	8356.65	616.09	2924.89	46957
		2308.80	4356.65	172.62	4000.00	616.09	2924.89	46957
17	536.00	2558.40	4615.21	297.76	4000.00	1351.25	3909.65	46957
18	532.00	2808.00	4875.15	423.57	4000.00	1753.10	4561.10	46957
		2808.00	4875.15	1391.57	2000.00	1656.72	4464.72	23478
19	528.50	3026.40	5103.57	1502.13	2000.00	1720.48	4746.88	23478
20	525.00	3244.80	5332.76	1613.05	2000.00	1764.91	5009.71	23478
21	521.00	3494.40	5595.51	1740.23	2000.00	1797.87	5292.27	23478
22	517.00	3744.00	5859.02	1867.76	2000.00	1919.89	5663.89	23478
		3744.00	5859.02	415.76	5000.00	2686.41	6430.41	58696
23	513.00	3993.60	6123.17	543.62	5000.00	2879.29	6872.89	58696
24	509.00	4243.20	6387.90	671.74	5000.00	3066.36	7309.56	58696

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	555.00	1310.40	0.00	0.00	0.00	0.00	1310.40	0.0
13	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	120.00	85.04	1707.44	2820
14	547.00	1809.60	52.80	0.00	172.80	107.42	1917.02	2820
		1809.60	52.80	0.00	4052.80	4052.80	5862.40p	93997
15	543.50	2028.00	289.40	0.00	4289.40	3753.99	5781.99	93997
16	540.00	2246.40	526.00	0.00	4526.00	3016.07	5262.47	93997
		2246.40	526.00	0.00	4000.00	3016.07	5262.47	93997

(continued)

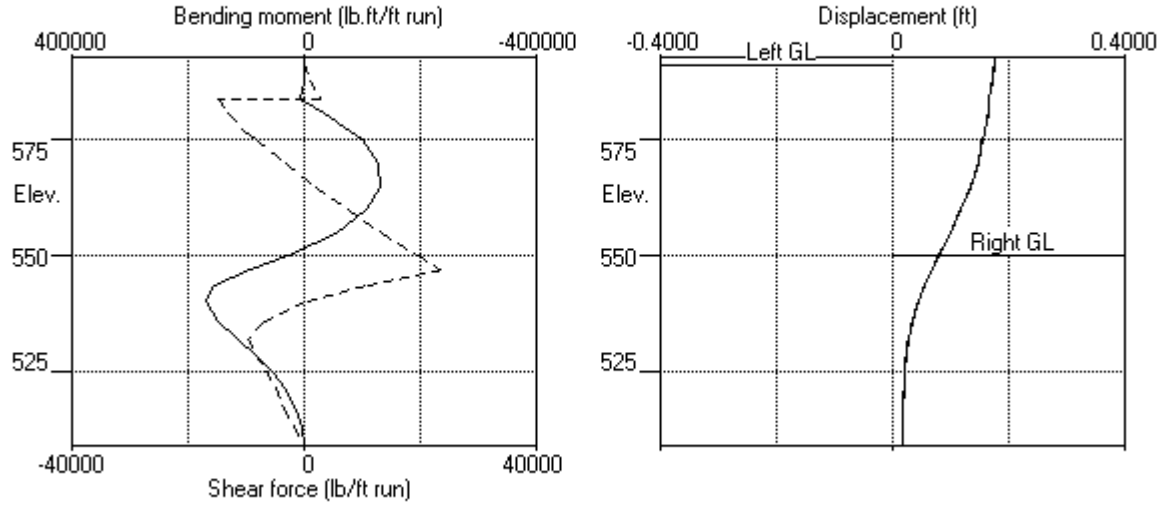
Stage No.10 Apply surcharge no.4 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	536.00	2496.00	796.40	0.00	4000.00	2491.65	4987.65	93997
18	532.00	2745.60	1066.80	0.00	4000.00	2183.48	4929.08	93997
		2745.60	1066.80	0.00	2000.00	1324.12	4069.72	46999
19	528.50	2964.00	1303.40	0.00	2000.00	1327.10	4291.10	46999
20	525.00	3182.40	1540.00	0.00	2000.00	1374.21	4556.61	46999
21	521.00	3432.00	1810.40	0.00	2000.00	1462.72	4894.72	46999
22	517.00	3681.60	2080.81	39.11	2000.00	1572.20	5253.80	46999
		3681.60	2080.81	0.00	5000.00	2447.14	6128.74	117496
23	513.00	3931.20	2351.21	0.00	5000.00	2518.08	6449.28	117496
24	509.00	4180.80	2621.61	0.00	5000.00	2597.09	6777.89	117496

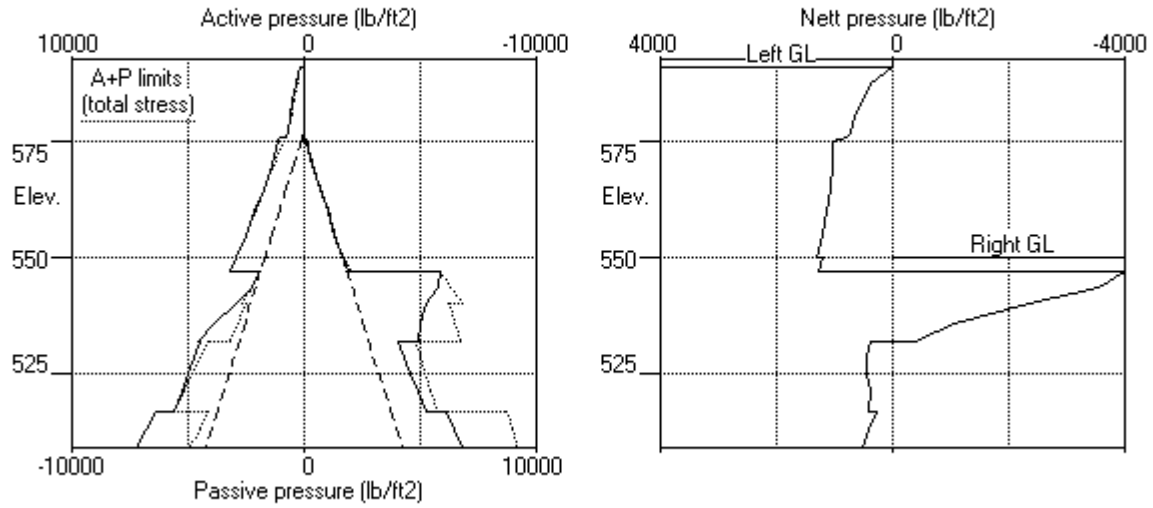
Note: 2222.17a Soil pressure at active limit
5862.40p Soil pressure at passive limit

Units: lb,ft

Stage No.10 Apply surcharge no.4 at elev. 591.00

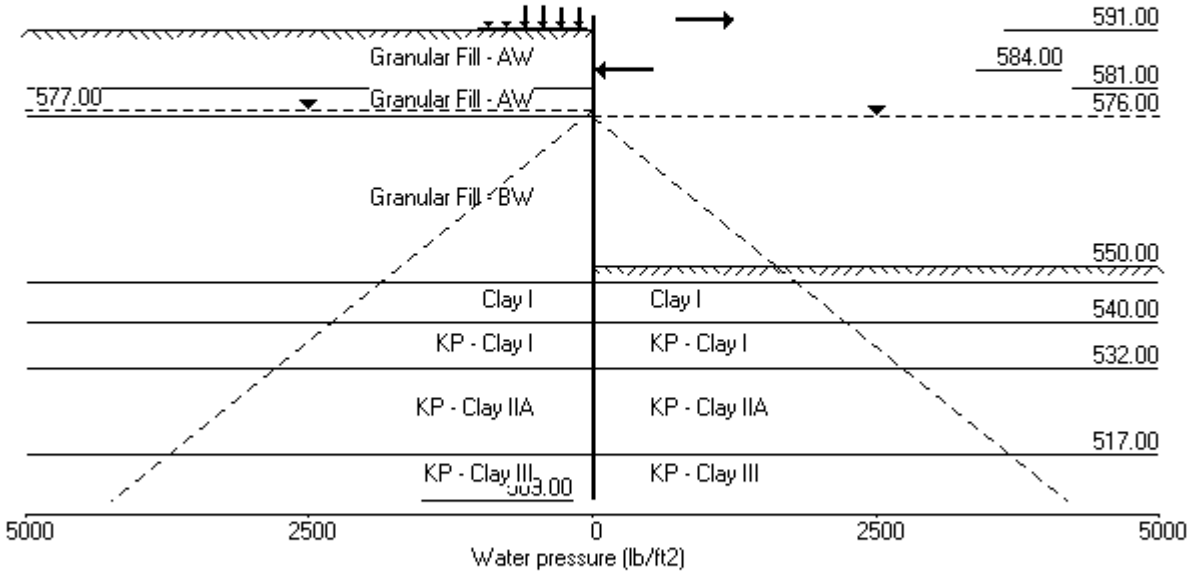


Stage No.10 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No.11 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No. 11 Apply load no.1 at elevation 593.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 509.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
11	591.00	550.00	584.00	2.629	n/a	540.11	9.89	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.184	1.54E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.181	1.54E-03	2000.0	4000.0		9.18E+08
		212.95	0.181	1.54E-03	2000.0	4000.0		
3	587.50	332.05	0.176	1.51E-03	2953.8	12739.7		9.18E+08
4	584.00	453.37	0.170	1.43E-03	4328.2	25537.7	-19090.2	9.18E+08
		453.37	0.170	1.43E-03	-14762.0	25537.7		
5	581.00	569.12	0.166	1.42E-03	-13228.3	-16447.8		9.18E+08
6	577.00	689.51	0.160	1.60E-03	-10711.0	-64523.1		9.18E+08
7	576.00	769.46	0.159	1.67E-03	-9981.5	-74873.0		9.18E+08
		1024.78	0.159	1.67E-03	-9981.5	-74873.0		
8	575.00	1013.57	0.157	1.76E-03	-8962.4	-84338.7		9.18E+08
9	570.00	1030.36	0.147	2.30E-03	-3852.5	-116367.8		9.18E+08
10	565.00	1081.16	0.134	2.95E-03	1426.3	-121696.0		9.18E+08
11	560.00	1145.57	0.117	3.56E-03	6993.1	-100431.4		9.18E+08
12	555.00	1227.63	0.098	3.97E-03	12926.1	-50885.1		9.18E+08
13	550.00	1325.47	0.078	4.03E-03	19308.8	29220.0		9.18E+08
		1241.69	0.078	4.03E-03	19308.8	29220.0		
14	547.00	1283.81	0.066	3.83E-03	23097.1	93716.5		9.18E+08
		-3933.15	0.066	3.83E-03	23097.1	93716.5		
15	543.50	-3516.64	0.054	3.35E-03	10059.9	154369.6		9.18E+08
16	540.00	-2307.82	0.043	2.74E-03	-132.9	168312.7		8.07E+08
17	536.00	-1060.99	0.034	1.95E-03	-6870.5	149648.8		8.07E+08
18	532.00	-360.23	0.027	1.30E-03	-9712.9	113518.6		8.07E+08
		398.87	0.027	1.30E-03	-9712.9	113518.6		
19	528.50	456.92	0.023	8.81E-04	-8215.3	81638.2		8.07E+08
20	525.00	452.53	0.021	5.85E-04	-6623.8	55379.5		8.07E+08
21	521.00	395.95	0.019	3.68E-04	-4926.8	32070.2		8.07E+08
22	517.00	408.07	0.018	2.51E-04	-3318.8	15152.5		8.07E+08
		296.62	0.018	2.51E-04	-3318.8	15152.5		
23	513.00	418.25	0.017	2.03E-04	-1889.0	4228.9		8.07E+08
24	509.00	526.26	0.016	1.93E-04	-0.0	-0.0		---

At elev. 584.00 Prop force = 19090.2 lb/ft run

(continued)

Stage No.11 Apply load no.1 at elevation 593.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	212.95	212.95	1836
3	587.50	0.00	953.04	292.83	3101.75	332.05	332.05	11017
4	584.00	0.00	1395.20	428.69	4540.80	453.37	453.37	22034
5	581.00	0.00	1763.13	541.74	5738.28	569.12	569.12	31477
6	577.00	0.00	2244.06	689.51	7303.48	689.51	689.51a	44068
7	576.00	62.40	2301.20	707.06	7489.45	707.06	769.46a	47215
		62.40	2301.20	767.07	6903.59	962.38	1024.78	16863
8	575.00	124.80	2353.30	784.43	7059.91	951.17	1075.97	17987
9	570.00	436.80	2615.91	871.97	7847.73	967.96	1404.76	23608
10	565.00	748.80	2885.14	961.71	8655.42	1018.76	1767.56	16430
11	560.00	1060.80	3161.79	1053.93	9485.37	1083.17	2143.97	19590
12	555.00	1372.80	3444.92	1148.31	10334.76	1165.23	2538.03	22750
13	550.00	1684.80	3733.30	1244.43	11199.91	1263.07	2947.87	25909
14	547.00	1872.00	3908.39	1302.80	11725.16	1327.76	3199.76	27805
		1872.00	3908.39	0.00	7908.39	21.74	1893.74	66240
15	543.50	2090.40	4131.77	131.77	8131.77	148.17	2238.57	66240
16	540.00	2308.80	4356.65	356.65	8356.65	627.39	2936.19	66240
		2308.80	4356.65	172.62	4000.00	627.39	2936.19	66240
17	536.00	2558.40	4615.21	297.76	4000.00	1357.71	3916.11	66240
18	532.00	2808.00	4875.15	423.57	4000.00	1756.04	4564.04	66240
		2808.00	4875.15	1391.57	2000.00	1658.19	4466.19	33120
19	528.50	3026.40	5103.57	1502.13	2000.00	1720.91	4747.31	33120
20	525.00	3244.80	5332.76	1613.05	2000.00	1764.62	5009.42	42267
21	521.00	3494.40	5595.51	1740.23	2000.00	1797.07	5291.47	42267
22	517.00	3744.00	5859.02	1867.76	2000.00	1918.88	5662.88	42267
		3744.00	5859.02	415.76	5000.00	2683.88	6427.88	105668
23	513.00	3993.60	6123.17	543.62	5000.00	2876.61	6870.21	105668
24	509.00	4243.20	6387.90	671.74	5000.00	3063.66	7306.86	105668

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	555.00	1310.40	0.00	0.00	0.00	0.00	1310.40	0.0
13	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	120.00	83.78	1706.18	3245
14	547.00	1809.60	52.80	0.00	172.80	106.35	1915.95	3245
		1809.60	52.80	0.00	4052.80	4017.30	5826.90	108156
15	543.50	2028.00	289.40	0.00	4289.40	3727.22	5755.22	108156
16	540.00	2246.40	526.00	0.00	4526.00	2997.62	5244.02	108156
		2246.40	526.00	0.00	4000.00	2997.62	5244.02	108156

(continued)

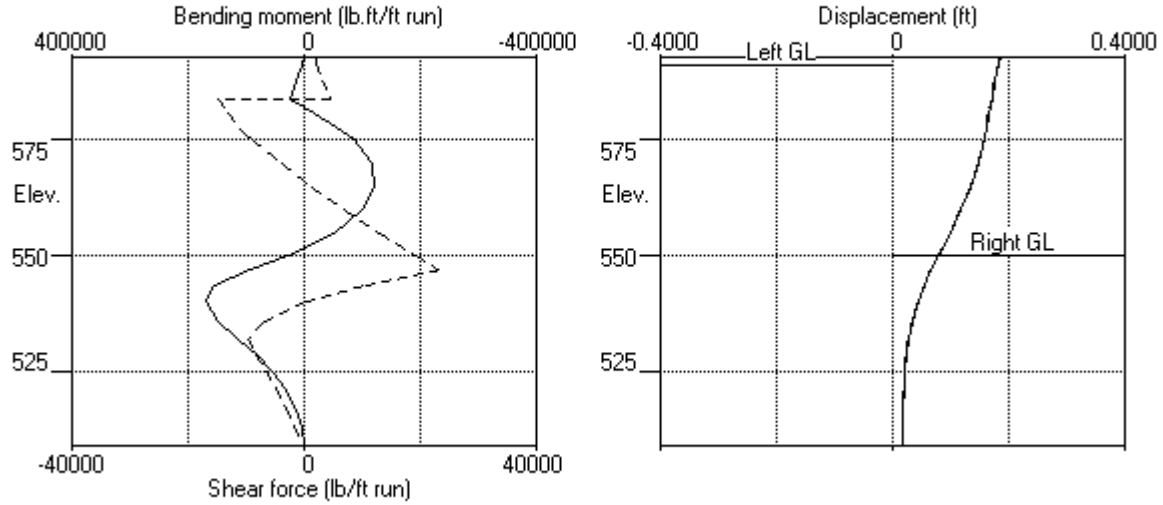
Stage No.11 Apply load no.1 at elevation 593.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	536.00	2496.00	796.40	0.00	4000.00	2481.10	4977.10	108156
18	532.00	2745.60	1066.80	0.00	4000.00	2178.67	4924.27	108156
		2745.60	1066.80	0.00	2000.00	1321.72	4067.32	54078
19	528.50	2964.00	1303.40	0.00	2000.00	1326.39	4290.39	54078
20	525.00	3182.40	1540.00	0.00	2000.00	1374.49	4556.89	42267
21	521.00	3432.00	1810.40	0.00	2000.00	1463.52	4895.52	42267
22	517.00	3681.60	2080.81	39.11	2000.00	1573.21	5254.81	42267
		3681.60	2080.81	0.00	5000.00	2449.66	6131.26	105668
23	513.00	3931.20	2351.21	0.00	5000.00	2520.76	6451.96	105668
24	509.00	4180.80	2621.61	0.00	5000.00	2599.80	6780.60	105668

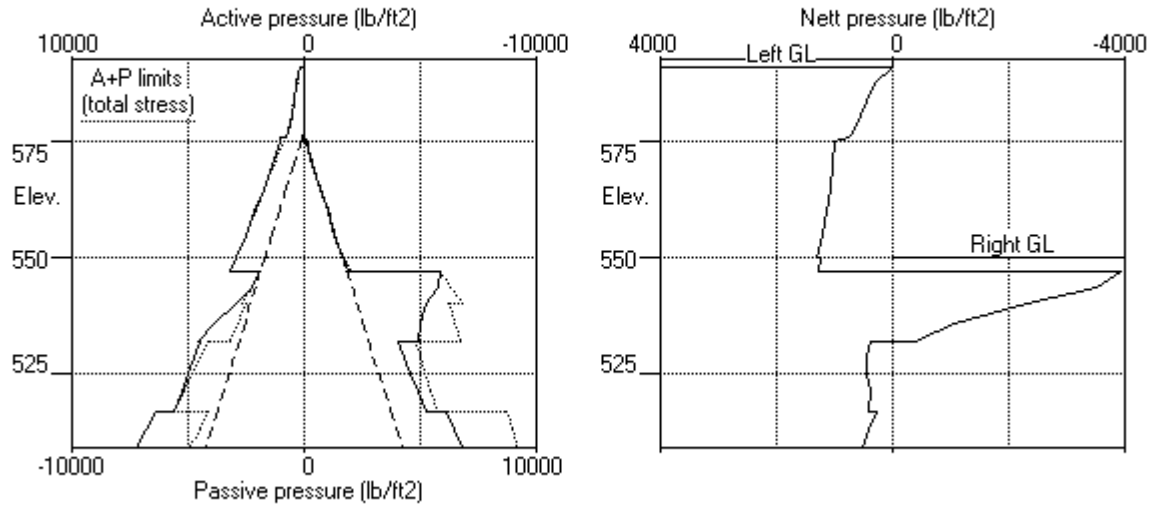
Note: 769.46a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.11 Apply load no.1 at elev. 593.00

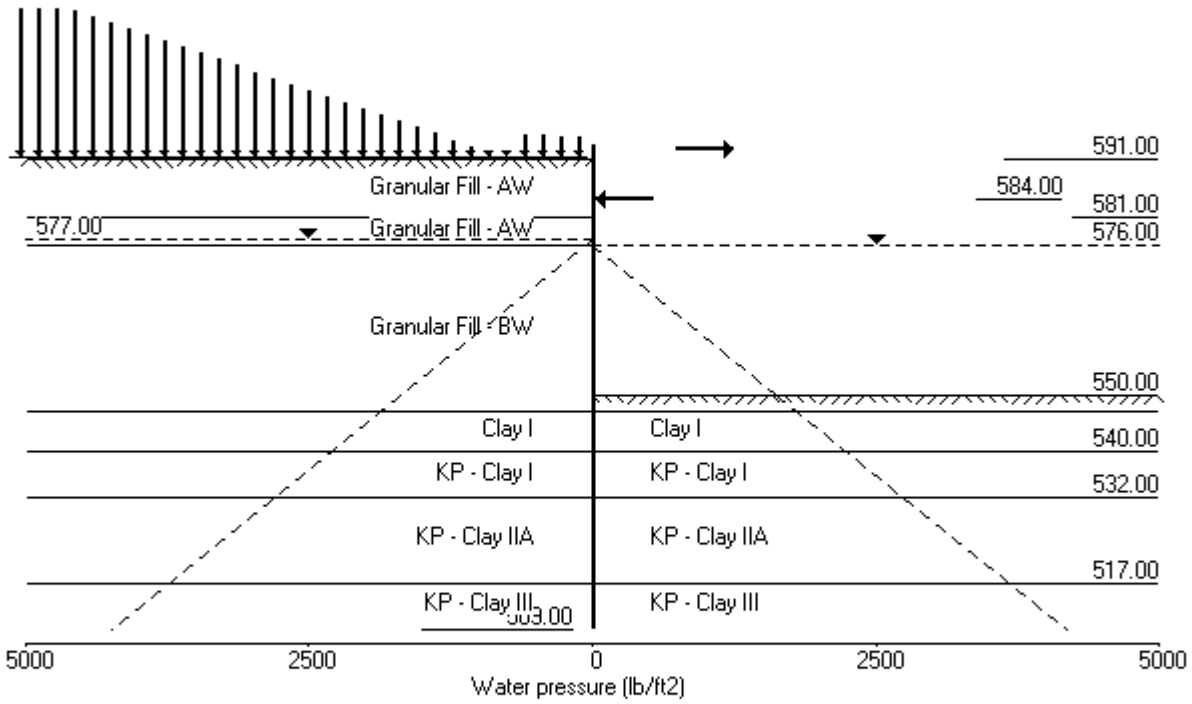


Stage No.11 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No.13 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No. 13 Apply surcharge no.3 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 509.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
13	591.00	550.00	584.00	1.845	n/a	514.97	35.03	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	0.182	8.10E-04	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.180	8.05E-04	2000.0	4000.0		9.18E+08
		224.98	0.180	8.05E-04	2000.0	4000.0		
3	587.50	327.17	0.177	7.73E-04	2966.3	12816.7		9.18E+08
4	584.00	433.77	0.175	7.00E-04	4297.9	25649.7	-20850.2	9.18E+08
		433.77	0.175	7.00E-04	-16552.3	25649.7		
5	581.00	551.32	0.173	6.94E-04	-15074.7	-21839.6		9.18E+08
6	577.00	711.58	0.170	9.10E-04	-12548.9	-77336.8		9.18E+08
7	576.00	795.39	0.169	1.00E-03	-11795.4	-89512.9		9.18E+08
		1053.56	0.169	1.00E-03	-11795.4	-89512.9		
8	575.00	1048.10	0.168	1.10E-03	-10744.6	-100775.8		9.18E+08
9	570.00	1098.76	0.161	1.76E-03	-5377.4	-140964.0		9.18E+08
10	565.00	1190.35	0.150	2.56E-03	345.3	-152692.5		9.18E+08
11	560.00	1302.72	0.135	3.34E-03	6578.0	-135071.9		9.18E+08
12	555.00	1442.14	0.117	3.94E-03	13440.1	-85229.0		9.18E+08
13	550.00	1609.16	0.096	4.17E-03	21068.4	537.2		9.18E+08
		1498.92	0.096	4.17E-03	21068.4	537.2		
14	547.00	1589.48	0.084	4.05E-03	25701.0	71557.6		9.18E+08
		-3469.25	0.084	4.05E-03	25701.0	71557.6		
15	543.50	-3415.19	0.070	3.64E-03	13653.2	143425.9		9.18E+08
16	540.00	-2591.29	0.058	3.04E-03	3141.9	171330.2		8.07E+08
		-2963.01	0.058	3.04E-03	3141.9	171330.2		
17	536.00	-1537.99	0.048	2.22E-03	-5860.1	160720.0		8.07E+08
18	532.00	-678.85	0.041	1.51E-03	-10293.8	125005.4		8.07E+08
		235.94	0.041	1.51E-03	-10293.8	125005.4		
19	528.50	387.30	0.036	1.05E-03	-9203.1	90251.3		8.07E+08
20	525.00	491.49	0.033	7.25E-04	-7665.3	60303.6		8.07E+08
21	521.00	573.46	0.031	4.93E-04	-5535.4	33475.2		8.07E+08
22	517.00	632.91	0.029	3.71E-04	-3122.6	15637.7		8.07E+08
		169.80	0.029	3.71E-04	-3122.6	15637.7		
23	513.00	403.63	0.028	3.21E-04	-1975.8	4640.2		8.07E+08
24	509.00	584.25	0.026	3.10E-04	-0.0	0.0		---

At elev. 584.00 Prop force = 20850.2 lb/ft run

(continued)

Stage No.13 Apply surcharge no.3 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	224.98	224.98	15747
3	587.50	0.00	954.67	293.33	3107.07	327.17	327.17	3584
4	584.00	0.00	1407.14	432.36	4579.66	433.77	433.77	7168
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	10240
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	14336
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	15360
		62.40	2385.59	795.20	7156.77	991.16	1053.56	5486
8	575.00	124.80	2451.06	817.02	7353.17	985.70	1110.50	5851
9	570.00	436.80	2790.54	930.18	8371.61	1036.36	1473.16	7680
10	565.00	748.80	3148.36	1049.45	9445.08	1127.95	1876.75	9508
11	560.00	1060.80	3520.02	1173.34	10560.06	1240.32	2301.12	11337
12	555.00	1372.80	3900.99	1300.33	11702.97	1379.74	2752.54	13165
13	550.00	1684.80	4287.63	1429.21	12862.88	1546.76	3231.56	14994
14	547.00	1872.00	4521.15	1507.05	13563.46	1659.08	3531.08	16091
		1872.00	4521.15	521.15	8521.15	521.15	2393.15a	41383
15	543.50	2090.40	4811.81	811.81	8811.81	811.81	2902.21a	41383
16	540.00	2308.80	5102.68	1102.68	9102.68	1102.68	3411.48a	41383
		2308.80	5102.68	533.70	4000.00	730.97	3039.77	41383
17	536.00	2558.40	5434.74	694.42	4000.00	1582.79	4141.19	41383
18	532.00	2808.00	5765.91	854.70	4000.00	2092.30	4900.30	41383
		2808.00	5765.91	1822.70	2000.00	1822.70	4630.70a	20691
19	528.50	3026.40	6054.62	1962.44	2000.00	1962.44	4988.84a	20691
20	525.00	3244.80	6342.10	2101.57	2000.00	2101.57	5346.37a	20691
21	521.00	3494.40	6668.93	2259.76	2000.00	2259.76	5754.16a	20691
22	517.00	3744.00	6993.75	2416.98	2000.00	2416.98	6160.98a	20691
		3744.00	6993.75	964.98	5000.00	3240.20	6984.20	51729
23	513.00	3993.60	7316.43	1121.15	5000.00	3516.06	7509.66	51729
24	509.00	4243.20	7636.89	1276.25	5000.00	3747.09	7990.29	51729

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	555.00	1310.40	0.00	0.00	0.00	0.00	1310.40	0.0
13	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	120.00	110.24	1732.64	1466
14	547.00	1809.60	52.80	0.00	172.80	132.00	1941.60	1466
		1809.60	52.80	0.00	4052.80	4052.80	5862.40p	48875
15	543.50	2028.00	289.40	0.00	4289.40	4289.40	6317.40p	48875
16	540.00	2246.40	526.00	0.00	4526.00	3756.37	6002.77	48875
		2246.40	526.00	0.00	4000.00	3756.37	6002.77	48875

(continued)

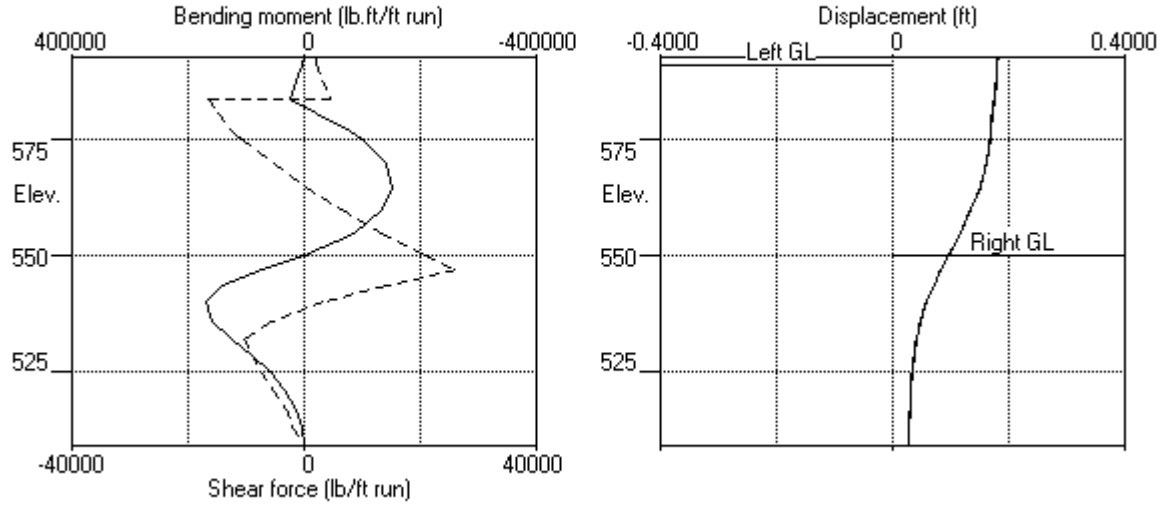
Stage No.13 Apply surcharge no.3 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	536.00	2496.00	796.40	0.00	4000.00	3183.18	5679.18	48875
18	532.00	2745.60	1066.80	0.00	4000.00	2833.55	5579.15	48875
		2745.60	1066.80	0.00	2000.00	1649.16	4394.76	24437
19	528.50	2964.00	1303.40	0.00	2000.00	1637.54	4601.54	24437
20	525.00	3182.40	1540.00	0.00	2000.00	1672.49	4854.89	24437
21	521.00	3432.00	1810.40	0.00	2000.00	1748.70	5180.70	24437
22	517.00	3681.60	2080.81	39.11	2000.00	1846.46	5528.06	24437
		3681.60	2080.81	0.00	5000.00	3132.80	6814.40	61093
23	513.00	3931.20	2351.21	0.00	5000.00	3174.83	7106.03	61093
24	509.00	4180.80	2621.61	0.00	5000.00	3225.24	7406.04	61093

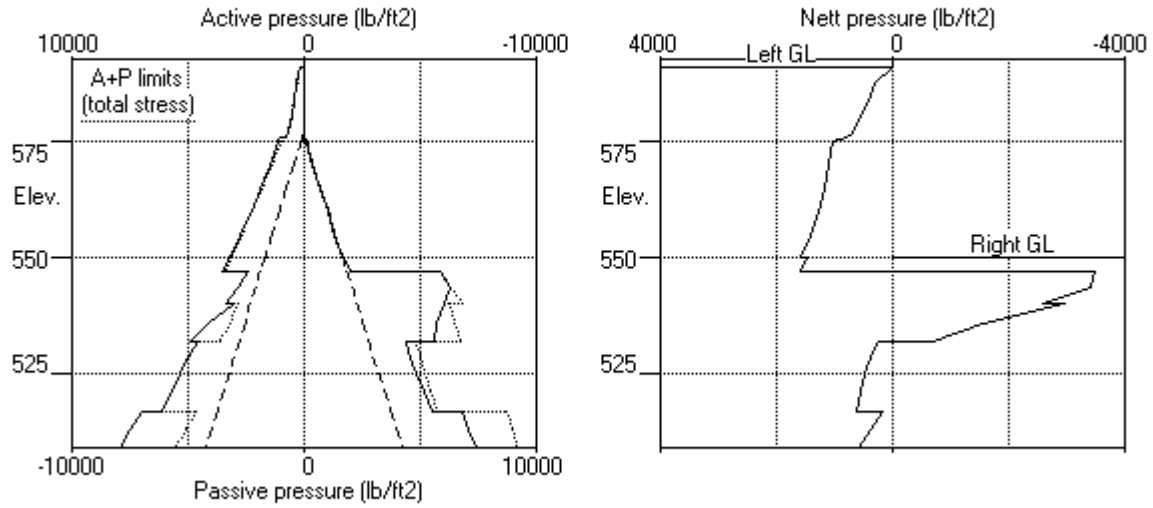
Note: 6160.98a Soil pressure at active limit
6317.40p Soil pressure at passive limit

Units: lb,ft

Stage No.13 Apply surcharge no.3 at elev. 591.00

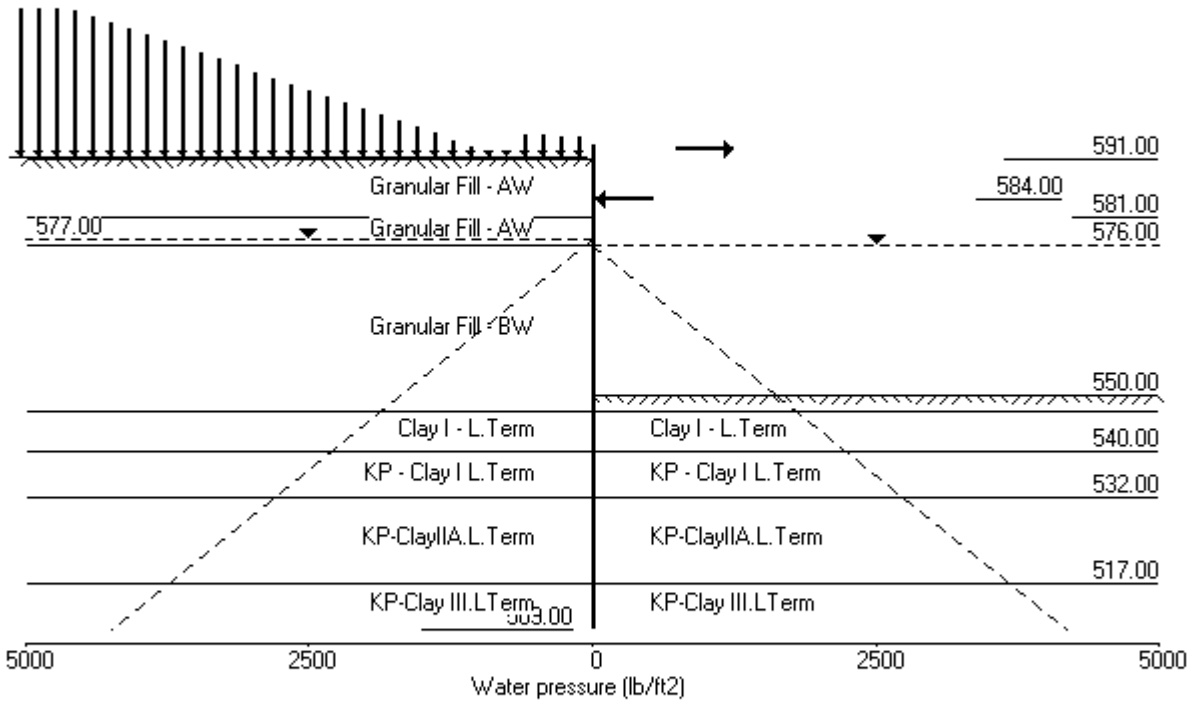


Stage No.13 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No.18 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
18	591.00	550.00	584.00	2.213	n/a	519.14	30.86	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.158	-3.61E-03	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.166	-3.61E-03	2000.0	4000.0		9.18E+08
		312.01	0.166	-3.61E-03	2000.0	4000.0		
3	587.50	323.73	0.178	-3.64E-03	3112.5	13349.8		9.18E+08
4	584.00	432.36	0.191	-3.72E-03	4435.7	26670.7	-27373.1	9.18E+08
		432.36	0.191	-3.72E-03	-22937.4	26670.7		
5	581.00	551.32	0.202	-3.70E-03	-21461.9	-39978.2		9.18E+08
6	577.00	711.58	0.217	-3.35E-03	-18936.1	-121024.3		9.18E+08
7	576.00	795.39	0.220	-3.21E-03	-18182.7	-139587.7		9.18E+08
		857.60	0.220	-3.21E-03	-18182.7	-139587.7		
8	575.00	879.42	0.223	-3.05E-03	-17314.1	-157331.3		9.18E+08
9	570.00	992.58	0.236	-1.99E-03	-12634.2	-232215.4		9.18E+08
10	565.00	1111.85	0.242	-5.92E-04	-7373.1	-281439.4		9.18E+08
11	560.00	1235.74	0.241	9.98E-04	-1504.1	-303344.0		9.18E+08
12	555.00	1362.73	0.232	2.62E-03	4992.1	-294800.6		9.18E+08
13	550.00	1491.61	0.215	4.11E-03	12127.9	-252426.1		9.18E+08
14	547.00	1444.25	0.202	4.86E-03	16531.7	-208466.8		9.18E+08
		1548.44	0.202	4.86E-03	16531.7	-208466.8		
15	543.50	998.04	0.184	5.53E-03	20988.1	-139191.7		9.18E+08
16	540.00	447.71	0.163	5.91E-03	23518.1	-61390.1		8.07E+08
		-501.65	0.163	5.91E-03	23518.1	-61390.1		
17	536.00	-1192.55	0.140	6.00E-03	20129.7	23553.0		8.07E+08
18	532.00	-1883.60	0.116	5.72E-03	13977.4	90427.3		8.07E+08
		-1579.92	0.116	5.72E-03	13977.4	90427.3		
19	528.50	-2131.29	0.097	5.25E-03	7482.8	128065.6		8.07E+08
20	525.00	-1916.17	0.079	4.66E-03	399.7	144390.9		8.07E+08
21	521.00	-1186.64	0.062	3.97E-03	-5805.9	132969.0		8.07E+08
22	517.00	-400.72	0.047	3.39E-03	-8980.6	99968.5		8.07E+08
		-1737.98	0.047	3.39E-03	-8980.6	99968.5		
23	513.00	-5.80	0.035	3.02E-03	-12468.2	50022.9		8.07E+08
24	509.00	6239.90	0.023	2.90E-03	-0.0	-0.0		---

At elev. 584.00 Prop force = 27373.1 lb/ft run

(continued)

Stage No.18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	312.01	312.01	5937
3	587.50	0.00	954.67	293.33	3107.07	323.73	323.73	4199
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	8398
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	11997
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	16796
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	17995
		62.40	2385.59	795.20	7156.77	795.20	857.60a	6427
8	575.00	124.80	2451.06	817.02	7353.17	817.02	941.82a	6855
9	570.00	436.80	2790.54	930.18	8371.61	930.18	1366.98a	8998
10	565.00	748.80	3148.36	1049.45	9445.08	1049.45	1798.25a	11140
11	560.00	1060.80	3520.02	1173.34	10560.06	1173.34	2234.14a	13282
12	555.00	1372.80	3900.99	1300.33	11702.97	1300.33	2673.13a	15425
13	550.00	1684.80	4287.63	1429.21	12862.88	1429.21	3114.01a	17567
14	547.00	1872.00	4521.15	1507.05	13563.46	1507.05	3379.05a	18852
		1872.00	4521.15	1632.29	12522.81	1632.29	3504.29a	46916
15	543.50	2090.40	4811.81	1737.23	13327.89	1737.23	3827.63a	46916
16	540.00	2308.80	5102.68	1842.24	14133.53	1842.24	4151.04a	46916
		2308.80	5102.68	892.97	14134.42	892.97	3201.77a	46916
17	536.00	2558.40	5434.74	951.08	15054.24	951.08	3509.48a	46916
18	532.00	2808.00	5765.91	1009.03	15971.58	1009.03	3817.03a	46916
		2808.00	5765.91	1089.76	14766.51	1089.76	3897.76a	23458
19	528.50	3026.40	6054.62	1144.32	15505.88	1144.32	4170.72a	23458
20	525.00	3244.80	6342.10	1198.66	16242.11	1198.66	4443.46a	23458
21	521.00	3494.40	6668.93	1260.43	17079.12	1521.77	5016.17	23458
22	517.00	3744.00	6993.75	1321.82	17911.00	1983.59	5727.59	23458
		3744.00	6993.75	1321.82	17911.00	2833.03	6577.03	58645
23	513.00	3993.60	7316.43	1382.81	18737.39	3681.87	7675.47	58645
24	509.00	4243.20	7636.89	1443.37	19558.07	6839.70	11082.90	746608

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	575.00	62.40	0.00	0.00	0.00	0.00	62.40	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	555.00	1310.40	0.00	0.00	0.00	0.00	1310.40	0.0
13	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	975
14	547.00	1809.60	52.80	22.27	125.20	125.20	1934.80p	5848
		1809.60	52.80	19.06	146.25	146.25	1955.85p	64979
15	543.50	2028.00	289.40	104.48	801.59	801.59	2829.59p	64979

(continued)

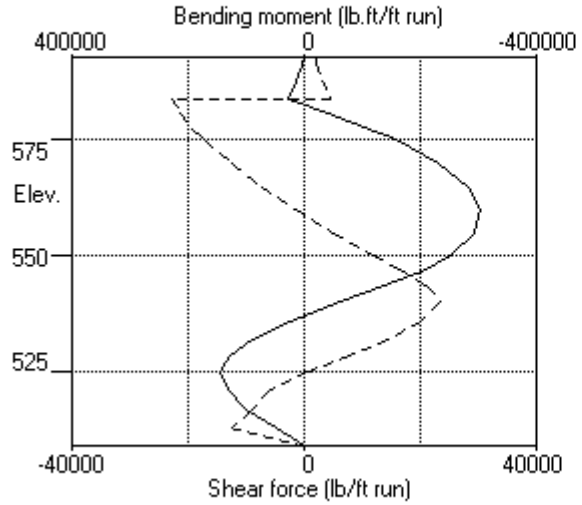
Stage No.18 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

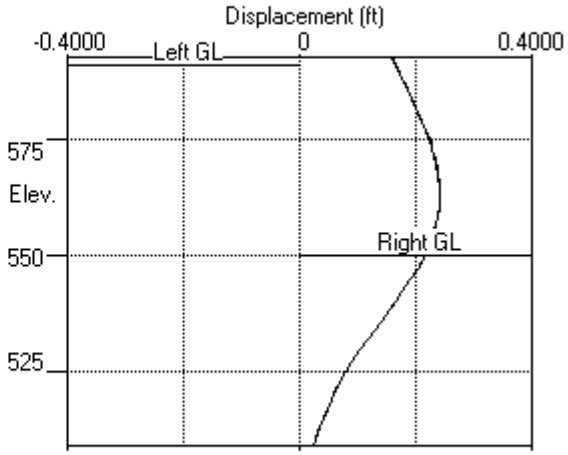
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
16	540.00	2246.40	526.00	189.90	1456.93	1456.93	3703.33p	64979
		2246.40	526.00	92.05	1457.02	1457.02	3703.42p	64979
17	536.00	2496.00	796.40	139.37	2206.03	2206.03	4702.03p	64979
18	532.00	2745.60	1066.80	186.69	2955.04	2955.04	5700.64p	64979
		2745.60	1066.80	201.63	2732.08	2732.08	5477.68p	32490
19	528.50	2964.00	1303.40	246.34	3338.01	3338.01	6302.01p	32490
20	525.00	3182.40	1540.00	291.06	3943.95	3177.23	6359.63	32490
21	521.00	3432.00	1810.40	342.17	4636.45	2770.82	6202.82	32490
22	517.00	3681.60	2080.81	393.27	5328.95	2446.71	6128.31	32490
		3681.60	2080.81	393.27	5328.95	4633.41	8315.01	81224
23	513.00	3931.20	2351.21	444.38	6021.45	3750.07	7681.27	81224
24	509.00	4180.80	2621.61	495.48	6713.95	662.20	4843.00	746608

Note: 4443.46a Soil pressure at active limit
6302.01p Soil pressure at passive limit

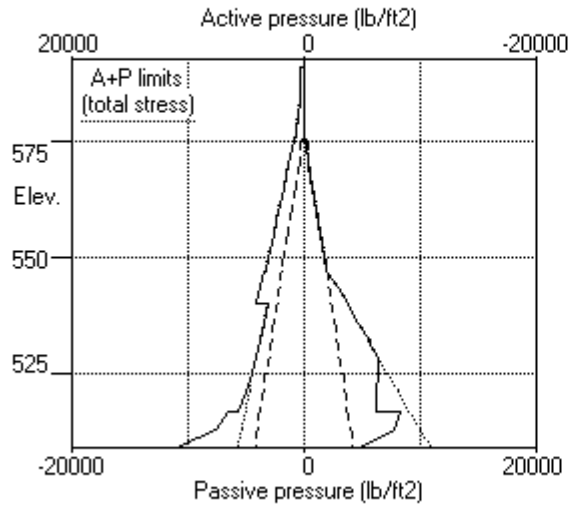
Units: lb,ft

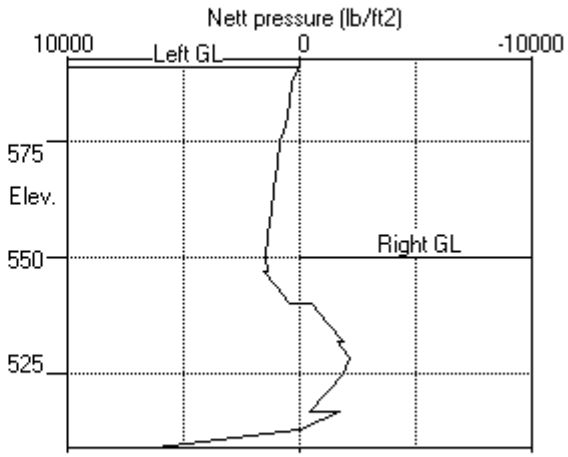
Stage No.18 Change soil type 8 to soil type 10





Stage No.18 Change soil type 8 to soil type 10





Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	575.00	575.00	Cant.	14.193	516.43	***	***	L to R
2	575.00	547.00	Cant.	10.729	516.80	535.96	11.04	R to L
3	576.00	575.00	Cant.	5.303	513.72	***	***	L to R
4	581.00	575.00	Cant.	2.888	514.84	518.91	56.09	L to R
5	581.00	575.00		No analysis at this stage				
6	591.00	575.00	584.00	3.091	n/a	542.86	32.14	L to R
7	591.00	550.00	584.00	2.941	n/a	541.05	8.95	L to R
8	591.00	550.00	584.00	2.829	n/a	540.72	9.28	L to R
9	591.00	550.00	584.00	2.616	n/a	539.97	10.03	L to R
10	591.00	550.00	584.00	2.612	n/a	539.95	10.05	L to R
11	591.00	550.00	584.00	2.629	n/a	540.11	9.89	L to R
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00	584.00	1.845	n/a	514.97	35.03	L to R
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00		No analysis at this stage				
17	591.00	550.00		No analysis at this stage				
18	591.00	550.00	584.00	2.213	n/a	519.14	30.86	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.184	-0.047	0.0	-0.0	2000.0	0.0
2	591.00	0.181	-0.046	4000.0	-0.0	2000.0	0.0
3	587.50	0.178	-0.043	13349.8	-0.0	3112.5	0.0
4	584.00	0.191	-0.040	26670.7	-0.0	4435.7	-22937.4
5	581.00	0.202	-0.037	0.0	-39978.2	0.0	-21461.9
6	577.00	0.217	-0.034	426.1	-121024.3	319.5	-18936.1
7	576.00	0.220	-0.033	832.2	-139587.7	499.3	-18182.7
8	575.00	0.223	-0.032	1443.3	-157331.3	726.4	-17314.1
9	570.00	0.236	-0.028	6554.1	-232215.4	1354.9	-12634.2
10	565.00	0.242	-0.023	15680.3	-281439.4	2337.5	-7373.1
11	560.00	0.241	-0.019	28966.3	-303344.0	7522.1	-1504.1
12	555.00	0.232	-0.015	48416.5	-294800.6	13440.1	-1580.0
13	550.00	0.215	-0.011	75375.7	-252426.1	21068.4	-2960.0
14	547.00	0.202	-0.009	96788.1	-208466.8	25701.0	-3999.2
15	543.50	0.184	-0.007	154737.4	-139191.7	20988.1	-1044.7
16	540.00	0.163	-0.005	171330.2	-61390.1	23518.1	-4364.3
17	536.00	0.140	-0.004	160720.0	-29647.3	20129.7	-6870.5
18	532.00	0.116	-0.003	125005.4	-18603.8	13977.4	-10293.8
19	528.50	0.097	-0.003	128065.6	-9440.8	7482.8	-9203.1
20	525.00	0.079	-0.003	144390.9	-7973.3	1461.7	-7665.3
21	521.00	0.062	-0.003	132969.0	-8898.9	526.5	-5805.9
22	517.00	0.047	-0.003	99968.5	-4964.4	1468.3	-8980.6
23	513.00	0.035	-0.002	50022.9	-1003.8	607.8	-12468.2
24	509.00	0.026	-0.002	0.0	-0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	540.00	-0.0	513.00	0.0	540.00	-0.0	570.00
2	1289.8	517.00	-37212.2	540.00	2949.7	532.00	-3999.2	547.00
3	30293.6	543.50	-8898.9	521.00	2866.9	547.00	-3161.7	532.00
4	112213.8	543.50	-0.0	581.00	7384.6	547.00	-7569.3	532.00
5	No calculation at this stage							
6	128154.4	540.00	-69013.4	570.00	15624.2	547.00	-8402.9	584.00
7	146427.8	540.00	-102544.1	565.00	20456.5	547.00	-10638.6	584.00
8	149872.1	540.00	-109240.1	565.00	21132.2	547.00	-11094.9	584.00
9	168976.7	540.00	-130805.8	565.00	23460.2	547.00	-14837.0	584.00
10	169209.0	540.00	-131227.6	565.00	23499.3	547.00	-14880.9	584.00
11	168312.7	540.00	-121696.0	565.00	23097.1	547.00	-14762.0	584.00
12	No calculation at this stage							
13	171330.2	540.00	-152692.5	565.00	25701.0	547.00	-16552.3	584.00
14	No calculation at this stage							
15	No calculation at this stage							
16	No calculation at this stage							
17	No calculation at this stage							
18	144390.9	525.00	-303344.0	560.00	23518.1	540.00	-22937.4	584.00

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	593.00	-0.000	536.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.000	593.00	-0.047	593.00	Excav. to elev. 547.00 on LEFT side
3	0.029	593.00	0.000	593.00	Fill to elev. 576.00 on LEFT side
4	0.149	593.00	0.000	593.00	Fill to elev. 581.00 on LEFT side
5	No calculation at this stage				Install prop no.1 at elev. 584.00
6	0.162	593.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
7	0.163	593.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
8	0.163	593.00	0.000	593.00	Apply water pressure profile no.1
9	0.176	593.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
10	0.176	593.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
11	0.184	593.00	0.000	593.00	Apply load no.1 at elev. 593.00
12	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
13	0.182	593.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
14	No calculation at this stage				Change soil type 12 to soil type 13
15	No calculation at this stage				Change soil type 3 to soil type 4
16	No calculation at this stage				Change soil type 17 to soil type 18
17	No calculation at this stage				Change soil type 7 to soil type 9
18	0.242	565.00	0.000	593.00	Change soil type 8 to soil type 10

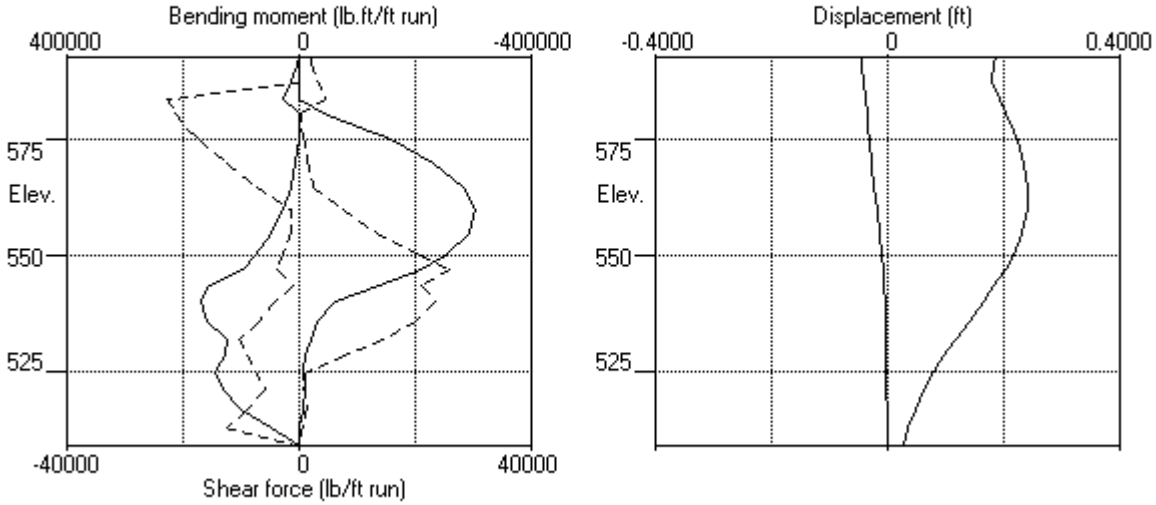
Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
6	9381.48	87247.73
7	11617.26	108040.49
8	12073.50	112283.57
9	17529.57	163025.04
10	17576.08	163457.54
11	19090.24	177539.23
13	20850.24	193907.23
18	27373.14	254570.23

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: B.1 – EMBEDMENT CHECK

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	584.00	2 Existing Fill	2 Existing Fill
2	577.00	3 Clay I	3 Clay I
3	554.00	5 Clay IIA	5 Clay IIA
4	540.00	7 KP - Clay IIA	7 KP - Clay IIA
5	535.00	8 KP-Clay III	8 KP-Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing .. (584.00)	130.0	1200000 (15000)	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I - L. Term	130.0	0 (43889)	0.531	NC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (1.330)	1000d
6	Clay IIA - L.Term	130.0	47151	0.561	OC (0.490)	0.390 (0.000)	1.707 (0.000)	
7	KP - Clay IIA	130.0	600000	0.561	NC (0.490)	0.484 (0.968)	0.000 (1.330)	1000d
8	KP-Clay III	130.0	1500000	0.561	NC (0.490)	0.484 (0.968)	0.000 (1.330)	2500d
9	KP-ClayIIA. L.Term	130.0	47151	0.561	OC (0.490)	0.189 (0.000)	1.707 (0.000)	
10	KP-Clay III. LTerm	130.0	68650	0.561	OC (0.490)	0.189 (0.000)	1.707 (0.000)	
11	Exist. Fi.. (584.00)	130.0	1200000 (15000)	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
13	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I - L.Term	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	-0.507	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	15.14	0.000	0.00
7	KP - Clay IIA	28.20	-0.622	0.00	Incompatible values		
8	KP-Clay III	28.20	-0.622	0.00	Incompatible values		
9	KP-ClayIIA.L.Term	43.01	0.000	0.00	15.14	0.000	0.00
10	KP-Clay III.LTerm	42.90	0.000	0.00	23.35	-0.384	0.00
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
13	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 490.00
Maximum finite element length = 6.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 490.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Install strut or anchor no.1 at elevation 584.00
3	Fill to elevation 591.00 on LEFT side with soil type 13
4	Excavate to elevation 550.00 on RIGHT side
5	Apply water pressure profile no.1
6	Apply surcharge no.4 at elevation 591.00
7	Apply surcharge no.1 at elevation 591.00
8	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
9	Apply surcharge no.3 at elevation 591.00
10	Apply load no.1 at elevation 593.00
11	Change properties of soil type 2 to soil type 11 No analysis at this stage Ko pressures will not be reset
12	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
13	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
14	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 8 to soil type 10 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - CP2
 Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
 Minimum equivalent fluid density = 0.00 lb/ft3
 Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
 Method - Subgrade reaction model using Influence Coefficients
 Open Tension Crack analysis? - No
 Non-linear Modulus Parameter (L) = 69.00 ft

Boundary conditions:
 Length of wall (normal to plane of analysis) = 1000.00 ft

 Width of excavation on Left side of wall = 1000.00 ft
 Width of excavation on Right side of wall = 1000.00 ft

 Distance to rigid boundary on Left side = 500.00 ft
 Distance to rigid boundary on Right side = 500.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Install prop no.1 at elev. 584.00	No	No	No
3	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
4	Excav. to elev. 550.00 on RIGHT side	No	No	No
5	Apply water pressure profile no.1	No	No	No
6	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
7	Apply surcharge no.1 at elev. 591.00	No	No	No
8	Apply surcharge no.2 at elev. 591.00	No	No	No
9	Apply surcharge no.3 at elev. 591.00	No	No	No
10	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
11	Change soil type 2 to soil type 11	No	No	No
12	Change soil type 3 to soil type 4	No	No	No
13	Change soil type 5 to soil type 6	No	No	No
14	Change soil type 7 to soil type 9	No	No	No
15	Change soil type 8 to soil type 10	No	No	No
*	Summary output	Yes	-	Yes

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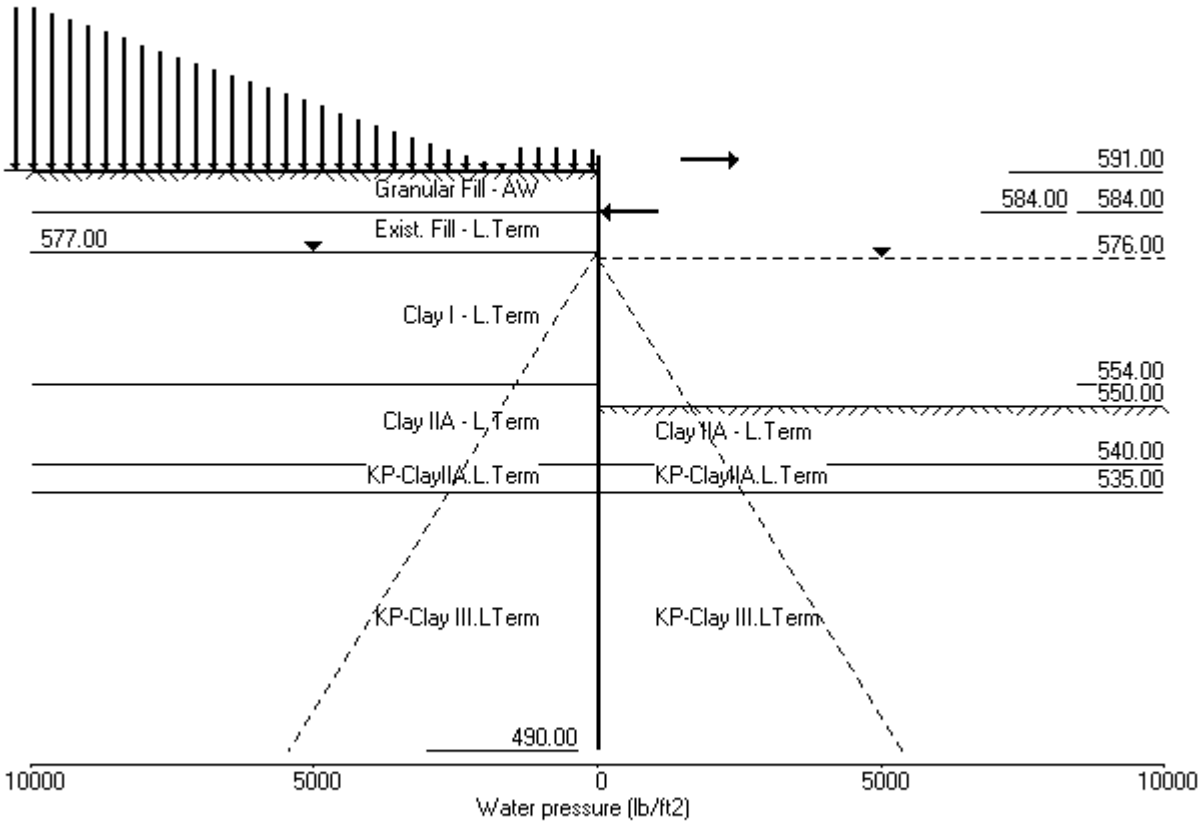
Units: lb,ft

Stage No.15 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 490.00 Factor of Safety	FoS for toe elev. = 490.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
15	591.00	550.00	584.00	2.314	n/a	509.14	40.86	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

*** Convergence failure - Out of balance shear force at elevation 490.00
is 5.363% of the maximum shear force. see Note.

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	-0.025	-1.28E-02	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.000	-1.28E-02	2000.0	4000.0		9.18E+08
		403.44	0.000	-1.28E-02	2000.0	4000.0		
3	587.50	293.08	0.046	-1.29E-02	3218.9	13783.8		9.18E+08
4	584.00	431.99	0.091	-1.30E-02	4487.8	27524.4	-36399.8	9.18E+08
		469.05	0.091	-1.30E-02	-31912.0	27524.4		
5	580.50	619.68	0.136	-1.29E-02	-30006.7	-80416.6		9.18E+08
6	577.00	771.97	0.181	-1.24E-02	-27571.3	-180692.5		9.18E+08
		836.12	0.181	-1.24E-02	-27571.3	-180692.5		
7	576.00	923.68	0.193	-1.21E-02	-26691.4	-207831.3		9.18E+08
8	570.00	1080.71	0.261	-1.03E-02	-20678.3	-350411.8		9.18E+08
9	564.00	1247.22	0.316	-7.74E-03	-13694.5	-456046.3		9.18E+08
10	559.00	1391.22	0.348	-5.11E-03	-7098.4	-508347.1		9.18E+08
11	554.00	1538.29	0.367	-2.30E-03	225.4	-525798.3		9.18E+08
		1685.28	0.367	-2.30E-03	225.4	-525798.3		
12	550.00	2008.03	0.372	-4.59E-05	7612.0	-510521.4		9.18E+08
13	545.00	1849.06	0.365	2.54E-03	17254.8	-441574.7		9.18E+08
14	540.00	1703.00	0.347	4.64E-03	26134.9	-331866.1		8.07E+08
		0.39	0.347	4.64E-03	26134.9	-331866.1		
15	535.00	-346.30	0.319	6.32E-03	25270.1	-207878.1		8.07E+08
		-598.27	0.319	6.32E-03	25270.1	-207878.1		
16	531.50	-947.42	0.296	7.05E-03	22565.2	-129544.9		8.07E+08
17	528.00	-1296.77	0.270	7.46E-03	18637.8	-62572.5		8.07E+08
18	522.00	-1442.55	0.225	7.64E-03	10419.9	14997.7		8.07E+08
19	516.00	-628.07	0.179	7.43E-03	4208.0	41505.7		8.07E+08
20	510.00	-315.87	0.136	7.11E-03	1376.2	44176.3		8.07E+08
21	504.00	-204.15	0.094	6.82E-03	-183.8	34739.7		8.07E+08
22	498.00	-33.29	0.054	6.62E-03	-896.2	19528.8		8.07E+08

(continued)

Stage No.15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
23	494.00	117.41	0.027	6.55E-03	-727.9	8813.9		8.07E+08
24	490.00	1102.29	0.001	6.52E-03	1711.5	0.0		---

At elev. 584.00 Prop force = 36399.8 lb/ft run

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.50	1627.50	403.44	403.44	14089
3	587.50	0.00	954.67	293.08	3107.46	293.08	293.08a	3824
4	584.00	0.00	1407.14	431.99	4580.24	431.99	431.99a	7647
		0.00	1407.14	469.05	4221.42	469.05	469.05a	43783
5	580.50	0.00	1859.04	619.68	5577.11	619.68	619.68a	45699
6	577.00	0.00	2315.91	771.97	6947.73	771.97	771.97a	47615
		0.00	2315.91	836.12	6414.67	836.12	836.12a	22419
7	576.00	62.40	2385.59	861.28	6607.67	861.28	923.68a	24020
8	570.00	436.80	2820.54	1018.31	7812.40	1018.31	1455.11a	33628
9	564.00	811.20	3281.74	1184.82	9089.85	1184.82	1996.02a	43236
10	559.00	1123.20	3680.60	1328.82	10194.62	1328.82	2452.02a	51243
11	554.00	1435.20	4087.96	1475.89	11322.95	1475.89	2911.09a	59250
		1435.20	4087.96	1596.19	6978.15	1622.88	3058.08	1720
12	550.00	1684.80	4417.63	1724.91	7540.89	1945.63	3630.43	1720
13	545.00	1996.80	4832.19	1886.78	8248.55	2363.63	4360.43	1720
14	540.00	2308.80	5247.68	2049.02	8957.79	2794.53	5103.33	1720
		2308.80	5247.68	991.81	8957.79	1091.92	3400.72	1720
15	535.00	2620.80	5662.64	1070.24	9666.13	1322.20	3943.00	1720
		2620.80	5662.64	1070.24	9666.13	1070.24	3691.04a	2505
16	531.50	2839.20	5952.23	1124.97	10160.45	1124.97	3964.17a	2505
17	528.00	3057.60	6240.77	1179.50	10652.99	1179.50	4237.10a	2505
18	522.00	3432.00	6732.40	1272.42	11492.21	1723.82	5155.82	2505
19	516.00	3806.40	7219.63	1364.51	12323.90	2330.64	6137.04	2505
20	510.00	4180.80	7701.99	1455.68	13147.29	2607.15	6787.95	2505
21	504.00	4555.20	8179.24	1545.88	13961.96	2702.69	7257.89	2505
22	498.00	4929.60	8651.29	1635.09	14767.75	2790.79	7720.39	2505
23	494.00	5179.20	8963.10	1694.03	15300.02	2871.25	8050.45	16782
24	490.00	5428.80	9272.63	1752.53	15828.39	3300.03	8728.83	16782

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
9	564.00	748.80	0.00	0.00	0.00	0.00	748.80	0.0
10	559.00	1060.80	0.00	0.00	0.00	0.00	1060.80	0.0

(continued)

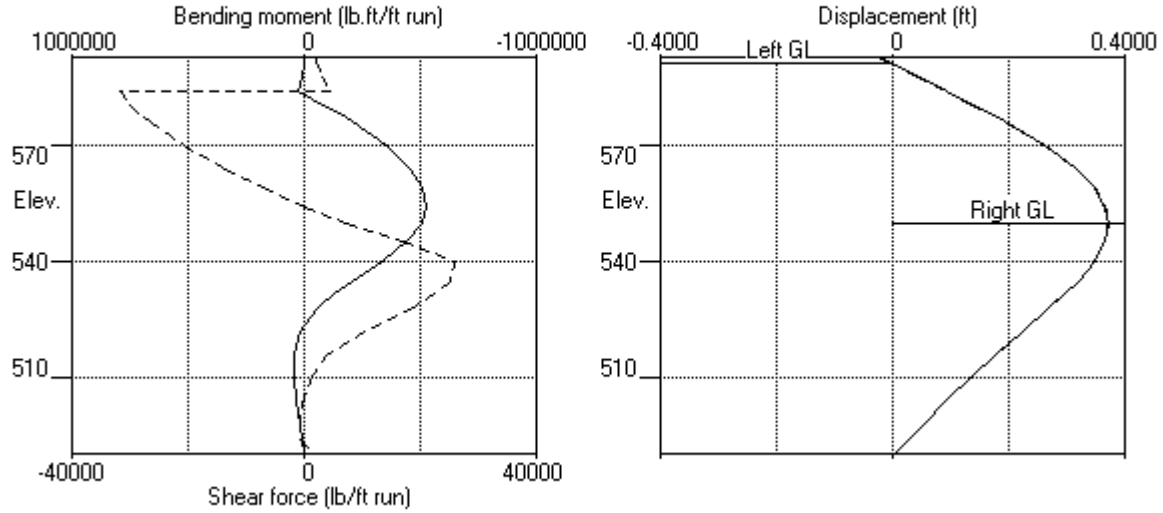
Stage No.15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
11	554.00	1372.80	0.00	0.00	0.00	0.00	1372.80	0.0
12	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	2101
13	545.00	1934.40	338.00	131.98	576.97	576.97	2511.37p	2101
14	540.00	2246.40	676.00	263.95	1153.93	1153.93	3400.33p	2101
		2246.40	676.00	127.76	1153.93	1153.93	3400.33p	2101
15	535.00	2558.40	1014.00	191.65	1730.90	1730.90	4289.30p	2101
		2558.40	1014.00	191.65	1730.90	1730.90	4289.30p	3058
16	531.50	2776.80	1250.61	236.36	2134.79	2134.79	4911.59p	3058
17	528.00	2995.20	1487.21	281.08	2538.67	2538.67	5533.87p	3058
18	522.00	3369.60	1892.83	357.74	3231.05	3228.78	6598.38	3058
19	516.00	3744.00	2298.45	434.41	3923.45	3021.10	6765.10	3058
20	510.00	4118.40	2704.08	511.07	4615.86	2985.43	7103.83	3058
21	504.00	4492.80	3109.72	587.74	5308.28	2969.24	7462.04	3058
22	498.00	4867.20	3515.37	664.40	6000.73	2886.47	7753.67	3058
23	494.00	5116.80	3785.81	715.52	6462.37	2816.23	7933.03	16782
24	490.00	5366.40	4056.26	766.63	6924.03	2260.15	7626.55	16782

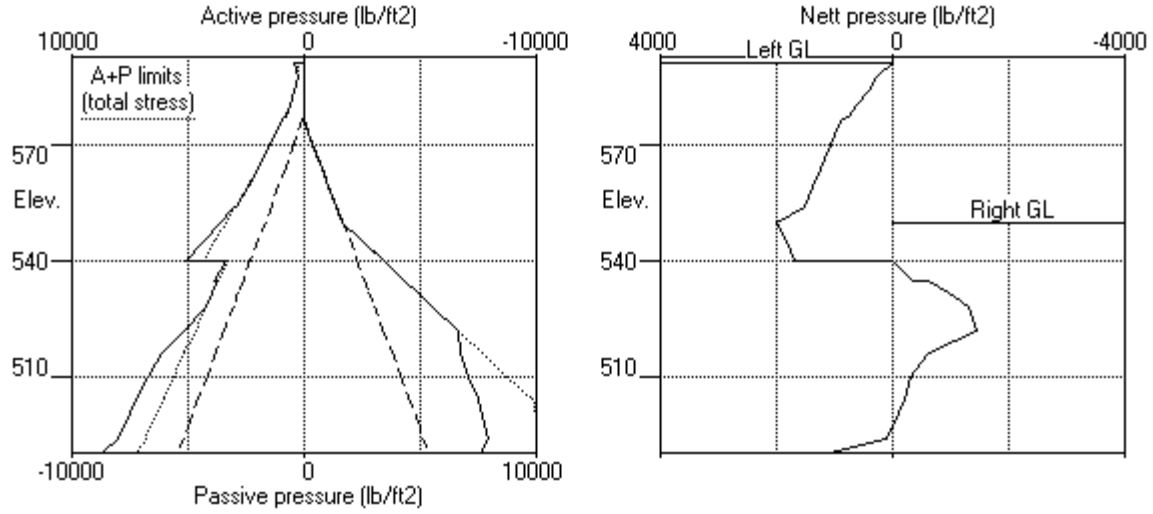
Note: 4237.10a Soil pressure at active limit
5533.87p Soil pressure at passive limit

Units: lb,ft

Stage No.15 Change soil type 8 to soil type 10



Stage No.15 Change soil type 8 to soil type 10



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 490.00 Factor of Safety	Moment equilib. at elev.	Toe Elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	584.00	584.00	---	Conditions not suitable for FoS calc.				
2	584.00	584.00		No analysis at this stage				
3	591.00	584.00	584.00	Conditions not suitable for FoS calc.				
4	591.00	550.00	584.00	3.343	n/a	529.34	20.66	L to R
5	591.00	550.00	584.00	3.209	n/a	528.90	21.10	L to R
6	591.00	550.00	584.00	3.204	n/a	528.89	21.11	L to R
7	591.00	550.00	584.00	2.969	n/a	***	***	L to R
8	591.00	550.00		No analysis at this stage				
9	591.00	550.00	584.00	1.870	n/a	520.67	29.33	L to R
10	591.00	550.00	584.00	1.876	n/a	520.93	29.07	L to R
11	591.00	550.00		No analysis at this stage				
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00		No analysis at this stage				
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00	584.00	2.314	n/a	509.14	40.86	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.008	-0.025	0.0	-0.0	2000.0	0.0
2	591.00	0.012	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.046	-0.000	13783.8	0.0	3218.9	0.0
4	584.00	0.091	-0.000	27524.4	0.0	4639.0	-31912.0
5	580.50	0.136	0.000	2470.6	-80416.6	0.0	-30006.7
6	577.00	0.181	0.000	1224.0	-180692.5	777.7	-27571.3
7	576.00	0.193	0.000	1959.1	-207831.3	692.8	-26691.4
8	570.00	0.261	0.000	4594.0	-350411.8	183.1	-20678.3
9	564.00	0.316	0.000	4156.0	-456046.3	0.0	-13694.5
10	559.00	0.348	0.000	1051.8	-508347.1	0.0	-7098.4
11	554.00	0.367	0.000	0.0	-525798.3	225.4	-5173.4
12	550.00	0.372	0.000	0.0	-510521.4	7612.0	-806.6
13	545.00	0.365	0.000	0.0	-441574.7	17254.8	0.0
14	540.00	0.347	0.000	0.0	-331866.1	26134.9	0.0
15	535.00	0.319	0.000	26087.7	-207878.1	25270.1	0.0
16	531.50	0.296	0.000	71794.0	-129544.9	22565.2	0.0
17	528.00	0.270	0.000	91464.5	-62572.5	18637.8	0.0
18	522.00	0.225	0.000	78436.5	-1274.0	10419.9	-3554.6
19	516.00	0.179	0.000	49549.4	-1052.6	4208.0	-4316.6
20	510.00	0.136	0.000	44176.3	0.0	1376.2	-2965.7
21	504.00	0.094	0.000	34739.7	0.0	192.4	-1666.0
22	498.00	0.054	0.000	19528.8	0.0	906.6	-896.2
23	494.00	0.029	0.000	8813.9	0.0	1239.1	-727.9
24	490.00	0.029	-0.000	0.0	-0.0	1711.5	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	504.00	-0.0	545.00	0.0	580.50	-0.0	490.00
2	No calculation at this stage							
3	4594.0	570.00	-11473.0	545.00	1356.4	540.00	-1584.7	554.00
4	47282.3	528.00	-106962.1	550.00	11393.7	535.00	-4651.9	584.00
5	50664.6	528.00	-110012.5	554.00	11606.7	535.00	-5013.3	584.00
6	50789.7	528.00	-110207.4	554.00	11625.4	535.00	-5028.0	584.00
7	59839.2	528.00	-120203.0	554.00	12618.7	535.00	-6285.9	584.00
8	No calculation at this stage							
9	91464.5	528.00	-174929.5	550.00	18701.3	535.00	-7062.4	584.00
10	90231.2	528.00	-171950.8	550.00	19320.7	535.00	-7102.4	584.00
11	No calculation at this stage							
12	No calculation at this stage							
13	No calculation at this stage							
14	No calculation at this stage							
15	44176.3	510.00	-525798.3	554.00	26134.9	540.00	-31912.0	584.00

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	490.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	No calculation at this stage				Install prop no.1 at elev. 584.00
3	0.008	550.00	-0.000	490.00	Fill to elev. 591.00 on LEFT side
4	0.054	554.00	-0.002	593.00	Excav. to elev. 550.00 on RIGHT side
5	0.056	554.00	-0.002	593.00	Apply water pressure profile no.1
6	0.056	554.00	-0.002	593.00	Apply surcharge no.4 at elev. 591.00
7	0.062	554.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
8	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
9	0.085	554.00	-0.000	593.00	Apply surcharge no.3 at elev. 591.00
10	0.084	554.00	0.000	593.00	Apply load no.1 at elev. 593.00
11	No calculation at this stage				Change soil type 2 to soil type 11
12	No calculation at this stage				Change soil type 3 to soil type 4
13	No calculation at this stage				Change soil type 5 to soil type 6
14	No calculation at this stage				Change soil type 7 to soil type 9
15	0.372	550.00	-0.025	593.00	Change soil type 8 to soil type 10

Prop forces at each stage (horizontal components)

Stage	-- Anchor no. 1 --- at elev. 584.00	
no.	lb/ft run	lb/prop
3	2738.58	25468.80
4	5849.97	54404.69
5	6190.18	57568.65
6	6209.52	57748.53
7	9187.20	85440.95
9	10085.02	93790.73
10	11741.38	109194.87
15	36399.77	338517.87

*** Convergence errors have occurred in at least one Construction Stage.
The errors are cumulative, and the results of all stages must be inspected for significant out of balance moment or shear at the toe of the wall.

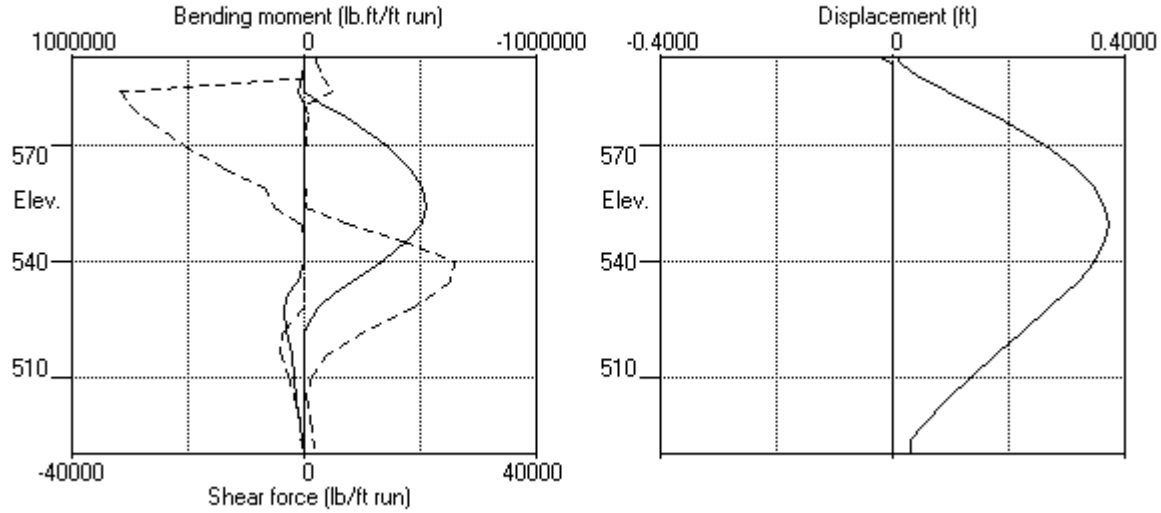
Failure of the iterative procedure to converge to an equilibrium solution may be due to a very high ratio of soil stiffness to wall stiffness. The data should be reviewed to see if realistic values have been specified

Out of balance shear forces.

Percentage Error	Interpretation
< 2%	Generally acceptable
2% to 4%	Use with caution
> 4%	Should not be used

Units: lb,ft

Bending moment, shear force, displacement envelopes



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	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: B.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	584.00	2 Existing Fill	2 Existing Fill
2	577.00	3 Clay I	3 Clay I
3	554.00	5 Clay IIA	5 Clay IIA
4	540.00	7 KP - Clay IIA	7 KP - Clay IIA
5	535.00	8 KP-Clay III	8 KP-Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing .. (584.00)	130.0	1200000 (15000)	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I - L. Term	130.0	0 (43889)	0.531	NC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1000d
6	Clay IIA - L.Term	130.0	47151	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	KP - Clay IIA	130.0	600000	0.561	NC (0.490)	0.484 (0.968)	0.000 (2.000)	1000d
8	KP-Clay III	130.0	1500000	0.561	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2500d
9	KP-ClayIIA. L.Term	130.0	47151	0.561	OC (0.490)	0.189 (0.000)	2.561 (0.000)	
10	KP-Clay III. LTerm	130.0	68650	0.561	OC (0.490)	0.189 (0.000)	2.561 (0.000)	
11	Exist. Fi.. (584.00)	130.0	1200000 (15000)	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
13	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I - L.Term	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	25.99	0.000	0.00
7	KP - Clay IIA	28.20	-0.622	0.00	Incompatible values		
8	KP-Clay III	28.20	-0.622	0.00	Incompatible values		
9	KP-ClayIIA.L.Term	43.01	0.000	0.00	25.99	0.000	0.00
10	KP-Clay III.LTerm	42.90	0.000	0.00	Incompatible values		
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
13	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 509.00
Maximum finite element length = 5.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 509.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Install strut or anchor no.1 at elevation 584.00
3	Fill to elevation 591.00 on LEFT side with soil type 13
4	Excavate to elevation 550.00 on RIGHT side
5	Apply water pressure profile no.1
6	Apply surcharge no.4 at elevation 591.00
7	Apply load no.1 at elevation 593.00
8	Apply surcharge no.1 at elevation 591.00
9	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
10	Apply surcharge no.3 at elevation 591.00
11	Change properties of soil type 2 to soil type 11 No analysis at this stage Ko pressures will not be reset
12	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
13	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
14	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 8 to soil type 10 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - CP2
 Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
 Minimum equivalent fluid density = 0.00 lb/ft3
 Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
 Method - Subgrade reaction model using Influence Coefficients
 Open Tension Crack analysis? - No
 Non-linear Modulus Parameter (L) = 69.00 ft

Boundary conditions:
 Length of wall (normal to plane of analysis) = 1000.00 ft

 Width of excavation on Left side of wall = 1000.00 ft
 Width of excavation on Right side of wall = 1000.00 ft

 Distance to rigid boundary on Left side = 500.00 ft
 Distance to rigid boundary on Right side = 500.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Install prop no.1 at elev. 584.00	No	No	No
3	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
4	Excav. to elev. 550.00 on RIGHT side	No	No	No
5	Apply water pressure profile no.1	No	No	No
6	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
7	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
8	Apply surcharge no.1 at elev. 591.00	No	No	No
9	Apply surcharge no.2 at elev. 591.00	No	No	No
10	Apply surcharge no.3 at elev. 591.00	Yes	Yes	Yes
11	Change soil type 2 to soil type 11	No	No	No
12	Change soil type 3 to soil type 4	No	No	No
13	Change soil type 5 to soil type 6	No	No	No
14	Change soil type 7 to soil type 9	No	No	No
15	Change soil type 8 to soil type 10	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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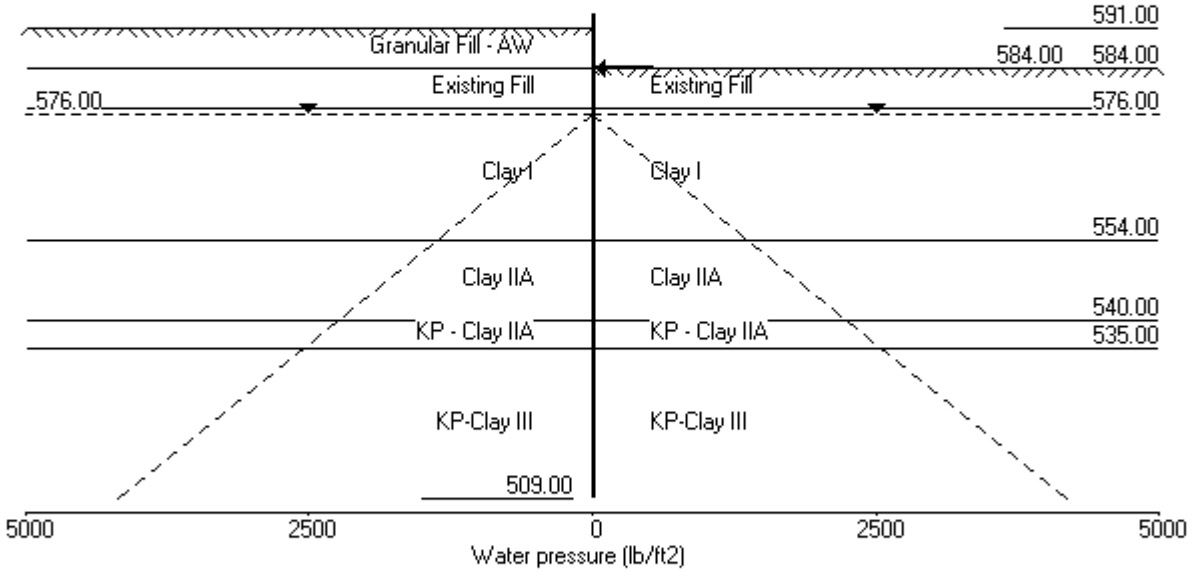
Units: lb,ft

Stage No.3 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No. 3 Fill to elevation 591.00 on LEFT side with soil type 13

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
3	591.00	584.00	584.00	Conditions not suitable for FoS calc.				

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.007	2.66E-05	0.0	0.0		9.18E+08
2	591.00	0.00	0.007	2.66E-05	0.0	-0.0		9.18E+08
3	587.50	189.48	0.007	2.57E-05	331.6	436.6		9.18E+08
4	584.00	379.51	0.007	1.88E-05	1327.3	3194.3	-2799.3	9.18E+08
		335.99	0.007	1.88E-05	-1472.0	3194.3		
5	580.50	315.30	0.007	1.25E-05	-332.2	100.3		9.18E+08
6	577.00	294.09	0.007	1.07E-05	734.2	868.8		9.18E+08
		-83.14	0.007	1.07E-05	734.2	868.8		
7	576.00	-82.31	0.007	9.42E-06	651.5	1561.4		9.18E+08
8	573.00	-80.83	0.007	1.74E-06	406.8	3145.5		9.18E+08
9	570.00	-81.78	0.007	-9.92E-06	162.9	4002.1		9.18E+08
10	565.00	-90.24	0.007	-3.11E-05	-267.2	3794.1		9.18E+08
11	560.00	-106.33	0.007	-4.50E-05	-758.6	1330.3		9.18E+08
12	557.00	-117.59	0.007	-4.49E-05	-1094.5	-1424.0		9.18E+08
13	554.00	-127.56	0.007	-3.40E-05	-1462.2	-5236.5		9.18E+08
		205.13	0.007	-3.40E-05	-1462.2	-5236.5		
14	550.00	201.91	0.008	-2.09E-06	-648.1	-9444.2		9.18E+08
15	545.00	206.88	0.007	5.12E-05	373.9	-10160.9		9.18E+08
16	540.00	289.44	0.007	9.52E-05	1614.7	-6020.5		8.07E+08
		-142.75	0.007	9.52E-05	1614.7	-6020.5		
17	535.00	-131.84	0.006	1.13E-04	928.2	268.5		8.07E+08
		-154.96	0.006	1.13E-04	928.2	268.5		
18	530.00	-98.85	0.006	1.03E-04	293.7	2972.5		8.07E+08
19	525.00	-50.86	0.005	8.39E-05	-80.6	3205.3		8.07E+08
20	520.00	-12.36	0.005	6.73E-05	-238.6	2166.7		8.07E+08
21	515.00	19.42	0.005	5.80E-05	-221.0	819.0		8.07E+08
22	512.00	36.92	0.005	5.60E-05	-136.5	243.4		8.07E+08
23	509.00	54.08	0.004	5.56E-05	-0.0	-0.0		---

At elev. 584.00 Prop force = 2799.3 lb/ft run

(continued)

Stage No.3 Fill to elevation 591.00 on LEFT side with soil type 13

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	574
3	587.50	0.00	455.00	139.68	1481.03	189.48	189.48	3443
4	584.00	0.00	910.00	279.37	2962.05	379.51	379.51	6886
		Total>	910.00	0.00	4910.00	625.70	625.70	40625
5	580.50	Total>	1365.00	0.00	5365.00	842.95	842.95	42402
6	577.00	Total>	1820.00	0.00	5820.00	1059.94	1059.94	44180
		0.00	1820.00	0.00	5820.00	685.91	685.91	40625
7	576.00	0.00	1950.00	0.00	5950.00	755.35	755.35	40625
8	573.00	187.20	2152.80	0.00	6152.80	863.77	1050.97	40625
9	570.00	374.40	2355.60	0.00	6355.60	970.99	1345.39	40625
10	565.00	686.40	2693.60	0.00	6693.60	1146.28	1832.68	40625
11	560.00	998.40	3031.60	0.00	7031.60	1317.79	2316.19	40625
12	557.00	1185.60	3234.40	0.00	7234.40	1419.90	2605.50	40625
13	554.00	1372.80	3437.20	0.00	7437.20	1522.64	2895.44	40625
		1372.80	3437.20	1437.20	5437.20	1777.01	3149.81	20313
14	550.00	1622.40	3707.60	1707.60	5707.60	1927.12	3549.52	20313
15	545.00	1934.40	4045.60	2045.60	6045.60	2119.20	4053.60	20313
16	540.00	2246.40	4383.60	2383.60	6383.60	2383.60	4630.00a	20313
		2246.40	4383.60	1153.66	2000.00	1857.25	4103.65	20313
17	535.00	2558.40	4721.60	1317.25	2000.00	1868.16	4426.56	20313
		2558.40	4721.60	0.00	5000.00	2319.21	4877.61	50781
18	530.00	2870.40	5059.60	28.85	5000.00	2536.63	5407.03	50781
19	525.00	3182.40	5397.60	192.44	5000.00	2750.01	5932.41	50781
20	520.00	3494.40	5735.60	356.03	5000.00	2958.70	6453.10	50781
21	515.00	3806.40	6073.60	519.62	5000.00	3164.05	6970.45	50781
22	512.00	3993.60	6276.40	617.78	5000.00	3286.49	7280.09	50781
23	509.00	4180.80	6479.20	715.93	5000.00	3408.76	7589.56	50781

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		Total>	0.00	0.00	4000.00	289.71	289.71	41397
5	580.50	Total>	455.00	0.00	4455.00	527.65	527.65	43208
6	577.00	Total>	910.00	0.00	4910.00	765.85	765.85	45020
		0.00	910.00	0.00	4910.00	769.05	769.05	41397
7	576.00	0.00	1040.00	0.00	5040.00	837.66	837.66	41397
8	573.00	187.20	1242.80	0.00	5242.80	944.60	1131.80	41397
9	570.00	374.40	1445.60	0.00	5445.60	1052.77	1427.17	41397
10	565.00	686.40	1783.60	0.00	5783.60	1236.52	1922.92	41397
11	560.00	998.40	2121.60	0.00	6121.60	1424.11	2422.51	41397
12	557.00	1185.60	2324.40	0.00	6324.40	1537.48	2723.08	41397
13	554.00	1372.80	2527.20	0.00	6527.20	1650.20	3023.00	41397
		1372.80	2527.20	527.20	4527.20	1571.89	2944.69	20699
14	550.00	1622.40	2797.60	797.60	4797.60	1725.21	3347.61	20699
15	545.00	1934.40	3135.60	1135.60	5135.60	1912.31	3846.71	20699
16	540.00	2246.40	3473.60	1473.60	5473.60	2094.16	4340.56	20699
		2246.40	3473.60	713.22	2000.00	2000.00	4246.40p	20699

(continued)

Stage No.3 Fill to elevation 591.00 on LEFT side with soil type 13

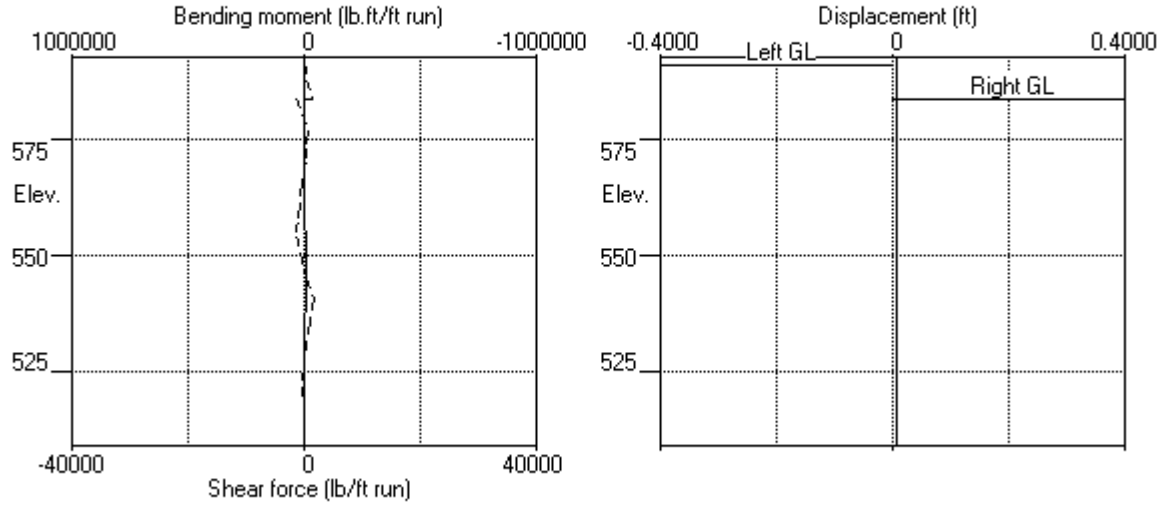
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	535.00	2558.40	3811.60	876.81	2000.00	2000.00	4558.40p	20699
		2558.40	3811.60	0.00	5000.00	2474.18	5032.58	51747
18	530.00	2870.40	4149.60	0.00	5000.00	2635.47	5505.87	51747
19	525.00	3182.40	4487.60	0.00	5000.00	2800.87	5983.27	51747
20	520.00	3494.40	4825.60	0.00	5000.00	2971.06	6465.46	51747
21	515.00	3806.40	5163.60	79.18	5000.00	3144.64	6951.04	51747
22	512.00	3993.60	5366.40	177.34	5000.00	3249.58	7243.18	51747
23	509.00	4180.80	5569.20	275.49	5000.00	3354.69	7535.49	51747

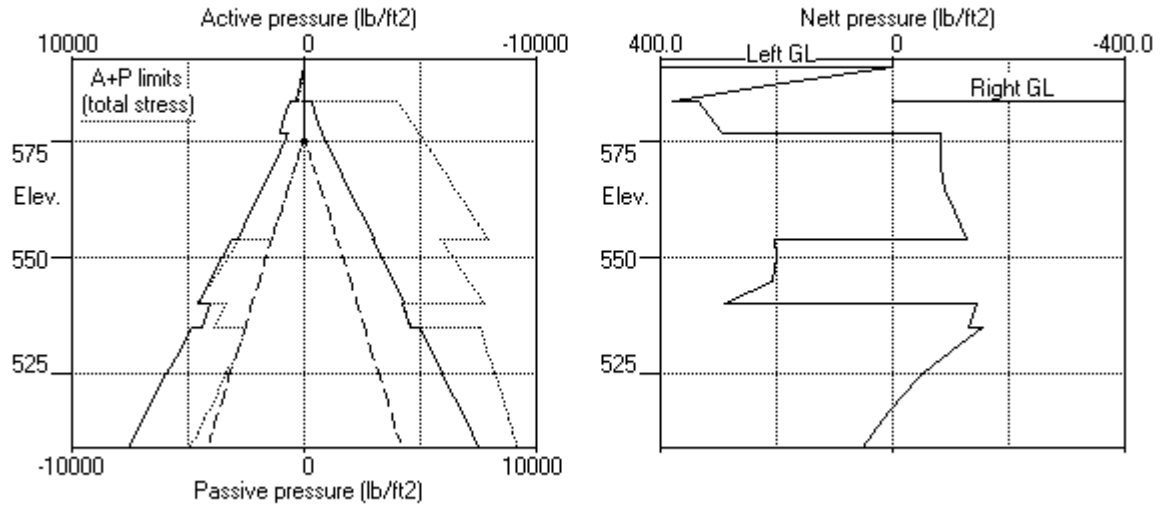
Note: 4630.00a Soil pressure at active limit
4558.40p Soil pressure at passive limit

Units: lb,ft

Stage No.3 Fill to elev. 591.00 on LEFT side

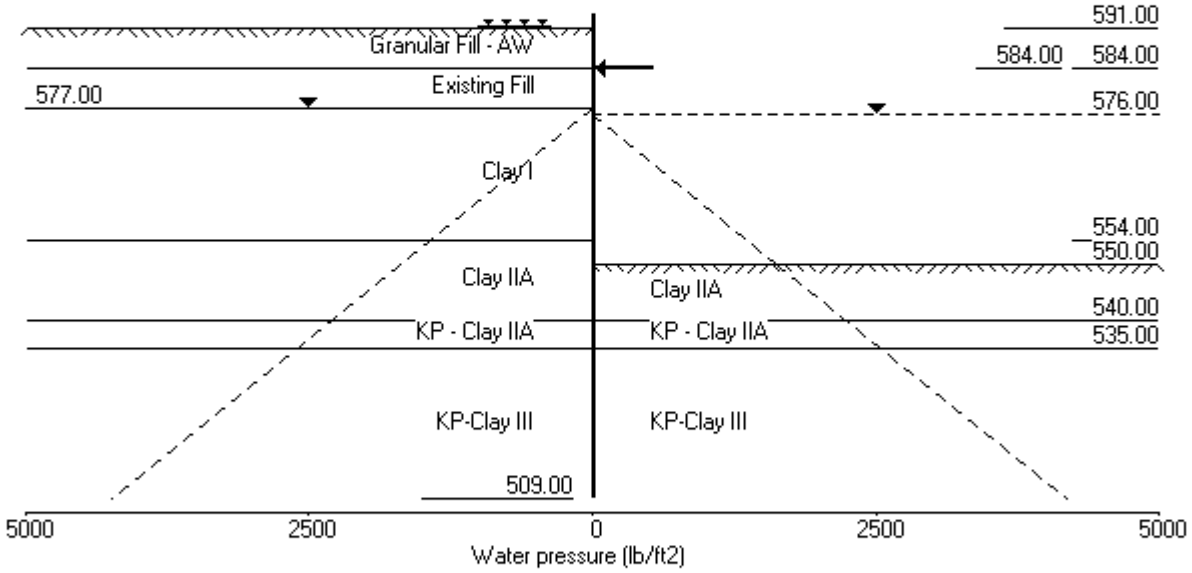


Stage No.3 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No.6 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No. 6 Apply surcharge no.4 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr -ation	Direction of failure
6	591.00	550.00	584.00	4.926	n/a	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	-0.002	-1.93E-03	0.0	-0.0		9.18E+08
2	591.00	0.00	0.002	-1.93E-03	0.0	-0.0		9.18E+08
3	587.50	183.61	0.009	-1.93E-03	321.3	437.8		9.18E+08
4	584.00	312.96	0.015	-1.94E-03	1190.3	3127.0	-6153.9	9.18E+08
		239.81	0.015	-1.94E-03	-4963.6	3127.0		
5	580.50	113.14	0.022	-1.92E-03	-4345.9	-12288.2		9.18E+08
6	577.00	0.92	0.029	-1.85E-03	-4146.3	-26420.5		9.18E+08
		1.20	0.029	-1.85E-03	-4146.3	-26420.5		
7	576.00	63.45	0.031	-1.81E-03	-4114.0	-30555.9		9.18E+08
8	573.00	63.38	0.036	-1.70E-03	-3923.8	-42614.3		9.18E+08
9	570.00	63.20	0.041	-1.54E-03	-3733.9	-54098.8		9.18E+08
10	565.00	62.83	0.048	-1.19E-03	-3418.8	-71943.5		9.18E+08
11	560.00	62.52	0.053	-7.63E-04	-3105.4	-88186.1		9.18E+08
12	557.00	62.41	0.054	-4.61E-04	-2918.0	-97204.5		9.18E+08
13	554.00	62.40	0.055	-1.29E-04	-2730.8	-105668.8		9.18E+08
		1441.19	0.055	-1.29E-04	-2730.8	-105668.8		
14	550.00	1709.41	0.055	3.27E-04	3570.4	-104334.0		9.18E+08
		267.01	0.055	3.27E-04	3570.4	-104334.0		
15	545.00	700.50	0.052	8.33E-04	5989.2	-81757.4		9.18E+08
16	540.00	1187.50	0.047	1.17E-03	10709.2	-42307.1		8.07E+08
		-11.63	0.047	1.17E-03	10709.2	-42307.1		
17	535.00	328.35	0.041	1.26E-03	11501.0	11728.7		8.07E+08
		-2187.21	0.041	1.26E-03	11501.0	11728.7		
18	530.00	-1241.21	0.035	1.09E-03	2929.9	42564.7		8.07E+08
19	525.00	-559.42	0.030	8.36E-04	-1571.7	41916.7		8.07E+08
20	520.00	-90.69	0.026	6.22E-04	-3197.0	27065.0		8.07E+08
21	515.00	269.09	0.023	5.08E-04	-2751.0	9945.9		8.07E+08
22	512.00	459.83	0.022	4.84E-04	-1657.6	2903.7		8.07E+08
23	509.00	645.24	0.021	4.79E-04	-0.0	-0.0		---

At elev. 584.00 Prop force = 6153.9 lb/ft run

(continued)

Stage No.6 Apply surcharge no.4 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	683
3	587.50	0.00	455.57	139.86	1482.89	183.61	183.61	4099
4	584.00	0.00	912.20	280.05	2969.23	312.96	312.96	8199
		Total>	912.20	0.00	4912.20	239.81	239.81	46258
5	580.50	Total>	1368.55	0.00	5368.55	113.14	113.14	48282
6	577.00	Total>	1824.31	0.00	5824.31	0.92	0.92	50306
		0.00	1824.31	0.00	5824.31	1.20	1.20	46258
7	576.00	62.40	1892.04	0.00	5892.04	1.05	63.45	46258
8	573.00	249.60	2095.08	0.00	6095.08	0.98	250.58	46258
9	570.00	436.80	2297.93	0.00	6297.93	0.80	437.60	46258
10	565.00	748.80	2635.80	0.00	6635.80	0.43	749.23	46258
11	560.00	1060.80	2973.54	0.00	6973.54	0.12	1060.92	46258
12	557.00	1248.00	3176.17	0.00	7176.17	0.01	1248.01	46258
13	554.00	1435.20	3378.79	0.00	7378.79	0.00	1435.20a	46258
		1435.20	3378.79	1378.79	5378.79	1378.79	2813.99a	23129
14	550.00	1684.80	3646.97	1646.97	5646.97	1647.01	3331.81	23129
15	545.00	1996.80	3986.69	1986.69	5986.69	1986.69	3983.49a	23129
16	540.00	2308.80	4324.44	2324.44	6324.44	2324.44	4633.24a	23129
		2308.80	4324.44	1125.03	2000.00	1125.31	3434.11	23129
17	535.00	2620.80	4662.22	1288.52	2000.00	1288.99	3909.79	23129
		2620.80	4662.22	0.00	5000.00	308.00	2928.80	57822
18	530.00	2932.80	4999.57	0.00	5000.00	837.58	3770.38	57822
19	525.00	3244.80	5337.85	163.52	5000.00	1301.03	4545.83	57822
20	520.00	3556.80	5675.69	327.03	5000.00	1696.42	5253.22	57822
21	515.00	3868.80	6013.55	490.56	5000.00	2044.78	5913.58	57822
22	512.00	4056.00	6216.27	588.68	5000.00	2242.66	6298.66	57822
23	509.00	4243.20	6419.00	686.79	5000.00	2438.19	6681.39	57822

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	557.00	1185.60	0.00	0.00	0.00	0.00	1185.60	0.0
13	554.00	1372.80	-0.00	0.00	0.00	0.00	1372.80	0.0
14	550.00	1622.40	-0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	-0.00	0.00	2000.00	1442.40	3064.80	38540
15	545.00	1934.40	338.00	0.00	2338.00	1348.59	3282.99	38540
16	540.00	2246.40	676.00	0.00	2676.00	1199.34	3445.74	38540
		2246.40	676.00	0.00	2000.00	1199.34	3445.74	38540
17	535.00	2558.40	1014.00	0.00	2000.00	1023.04	3581.44	38540
		2558.40	1014.00	0.00	5000.00	2557.61	5116.01	96349

(continued)

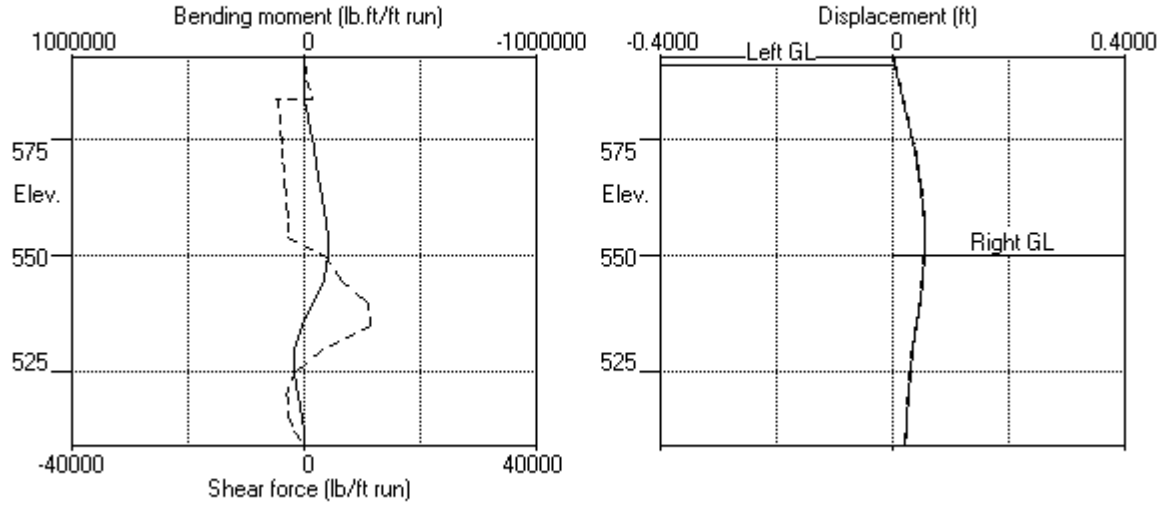
Stage No.6 Apply surcharge no.4 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	530.00	2870.40	1352.01	0.00	5000.00	2141.20	5011.60	96349
19	525.00	3182.40	1690.02	0.00	5000.00	1922.85	5105.25	96349
20	520.00	3494.40	2028.03	0.00	5000.00	1849.52	5343.92	96349
21	515.00	3806.40	2366.05	0.00	5000.00	1838.10	5644.50	96349
22	512.00	3993.60	2568.87	0.00	5000.00	1845.24	5838.84	96349
23	509.00	4180.80	2771.68	0.00	5000.00	1855.35	6036.15	96349

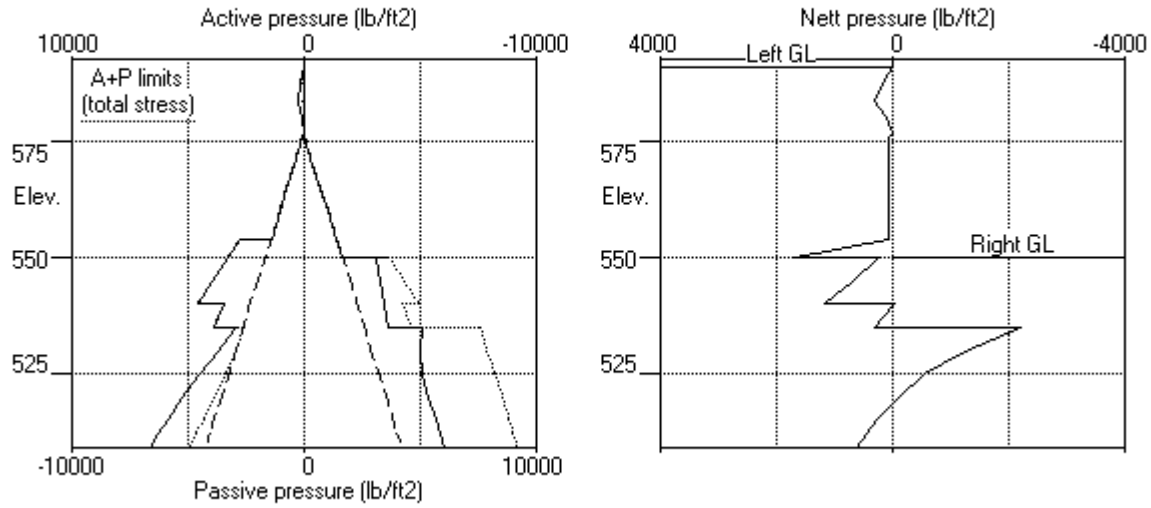
Note: 4633.24a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.6 Apply surcharge no.4 at elev. 591.00

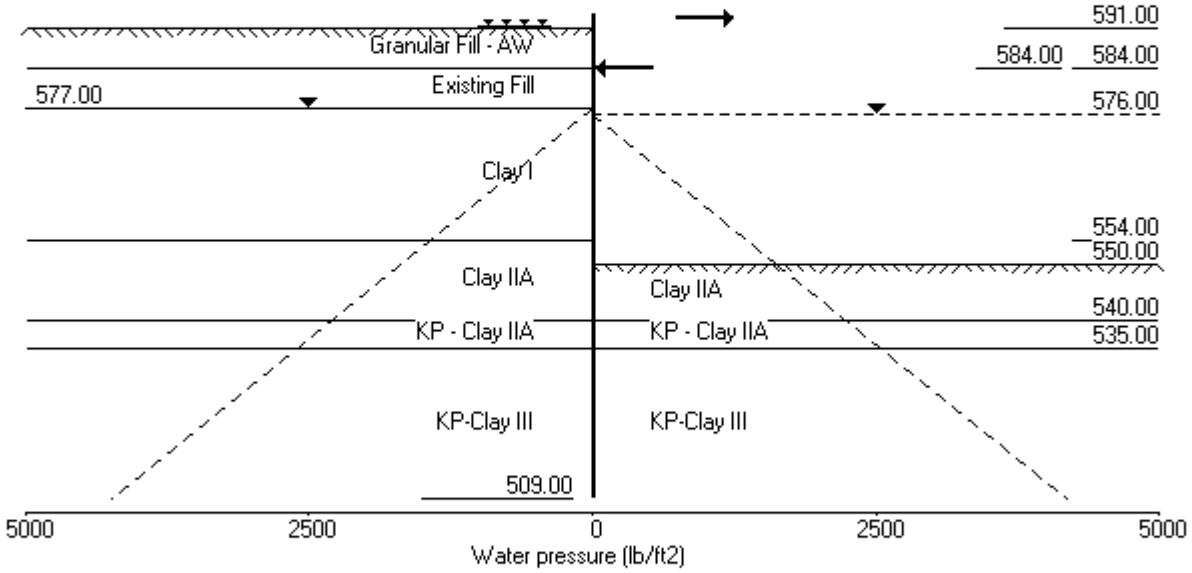


Stage No.6 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No.7 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No. 7 Apply load no.1 at elevation 593.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
7	591.00	550.00	584.00	4.972	n/a	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.006	-1.48E-03	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.008	-1.49E-03	2000.0	4000.0		9.18E+08
3	587.50	139.86	0.014	-1.52E-03	2244.8	11348.4		9.18E+08
4	584.00	280.05	0.019	-1.58E-03	2979.6	20523.8	-7672.3	9.18E+08
		0.00	0.019	-1.58E-03	-4692.7	20523.8		
5	580.50	0.00	0.025	-1.63E-03	-4692.7	4846.6		9.18E+08
6	577.00	0.00	0.031	-1.61E-03	-4692.7	-10963.2		9.18E+08
7	576.00	62.40	0.032	-1.60E-03	-4661.5	-15645.6		9.18E+08
8	573.00	62.40	0.037	-1.53E-03	-4474.3	-29351.1		9.18E+08
9	570.00	62.40	0.041	-1.41E-03	-4287.1	-42491.4		9.18E+08
10	565.00	63.15	0.048	-1.12E-03	-3973.2	-63108.8		9.18E+08
11	560.00	79.63	0.052	-7.31E-04	-3616.3	-82119.6		9.18E+08
12	557.00	84.07	0.054	-4.46E-04	-3370.7	-92593.5		9.18E+08
13	554.00	85.65	0.055	-1.27E-04	-3116.1	-102318.3		9.18E+08
		1452.81	0.055	-1.27E-04	-3116.1	-102318.3		
14	550.00	1720.47	0.055	3.17E-04	3230.4	-102431.8		9.18E+08
		294.32	0.055	3.17E-04	3230.4	-102431.8		
15	545.00	722.36	0.052	8.17E-04	5772.1	-81213.6		9.18E+08
16	540.00	1202.52	0.047	1.15E-03	10584.3	-42575.1		8.07E+08
		3.39	0.047	1.15E-03	10584.3	-42575.1		
17	535.00	337.04	0.041	1.25E-03	11435.4	11024.2		8.07E+08
		-2165.49	0.041	1.25E-03	11435.4	11024.2		
18	530.00	-1231.31	0.035	1.08E-03	2943.4	41803.8		8.07E+08
19	525.00	-556.84	0.030	8.31E-04	-1527.0	41346.9		8.07E+08
20	520.00	-92.45	0.026	6.20E-04	-3150.2	26750.7		8.07E+08
21	515.00	264.76	0.023	5.07E-04	-2719.5	9843.2		8.07E+08
22	512.00	454.55	0.022	4.83E-04	-1640.5	2876.1		8.07E+08
23	509.00	639.11	0.021	4.78E-04	-0.0	-0.0		---

At elev. 584.00 Prop force = 7672.3 lb/ft run

(continued)

Stage No.7 Apply load no.1 at elevation 593.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	1831
3	587.50	0.00	455.57	139.86	1482.89	139.86	139.86a	10988
4	584.00	0.00	912.20	280.05	2969.23	280.05	280.05a	21976
		Total>	912.20	0.00	4912.20	0.00	0.00a	114139
5	580.50	Total>	1368.55	0.00	5368.55	0.00	0.00a	119133
6	577.00	Total>	1824.31	0.00	5824.31	0.00	0.00a	124126
		0.00	1824.31	0.00	5824.31	0.00	0.00a	114139
7	576.00	62.40	1892.04	0.00	5892.04	0.00	62.40a	114139
8	573.00	249.60	2095.08	0.00	6095.08	0.00	249.60a	114139
9	570.00	436.80	2297.93	0.00	6297.93	0.00	436.80a	114139
10	565.00	748.80	2635.80	0.00	6635.80	0.75	749.55	65414
11	560.00	1060.80	2973.54	0.00	6973.54	17.23	1078.03	65414
12	557.00	1248.00	3176.17	0.00	7176.17	21.67	1269.67	65414
13	554.00	1435.20	3378.79	0.00	7378.79	23.25	1458.45	65414
		1435.20	3378.79	1378.79	5378.79	1390.41	2825.61	32707
14	550.00	1684.80	3646.97	1646.97	5646.97	1658.07	3342.87	32707
15	545.00	1996.80	3986.69	1986.69	5986.69	1995.54	3992.34	32707
16	540.00	2308.80	4324.44	2324.44	6324.44	2330.52	4639.32	32707
		2308.80	4324.44	1125.03	2000.00	1131.39	3440.19	32707
17	535.00	2620.80	4662.22	1288.52	2000.00	1292.51	3913.31	32707
		2620.80	4662.22	0.00	5000.00	316.79	2937.59	81768
18	530.00	2932.80	4999.57	0.00	5000.00	841.59	3774.39	81768
19	525.00	3244.80	5337.85	163.52	5000.00	1302.07	4546.87	81768
20	520.00	3556.80	5675.69	327.03	5000.00	1695.54	5252.34	143253
21	515.00	3868.80	6013.55	490.56	5000.00	2042.62	5911.42	143253
22	512.00	4056.00	6216.27	588.68	5000.00	2240.02	6296.02	143253
23	509.00	4243.20	6419.00	686.79	5000.00	2435.12	6678.32	143253

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	557.00	1185.60	0.00	0.00	0.00	0.00	1185.60	0.0
13	554.00	1372.80	-0.00	0.00	0.00	0.00	1372.80	0.0
14	550.00	1622.40	-0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	-0.00	0.00	2000.00	1426.15	3048.55	48097
15	545.00	1934.40	338.00	0.00	2338.00	1335.57	3269.97	48097
16	540.00	2246.40	676.00	0.00	2676.00	1190.40	3436.80	48097
		2246.40	676.00	0.00	2000.00	1190.40	3436.80	48097
17	535.00	2558.40	1014.00	0.00	2000.00	1017.87	3576.27	48097
		2558.40	1014.00	0.00	5000.00	2544.68	5103.08	120242

(continued)

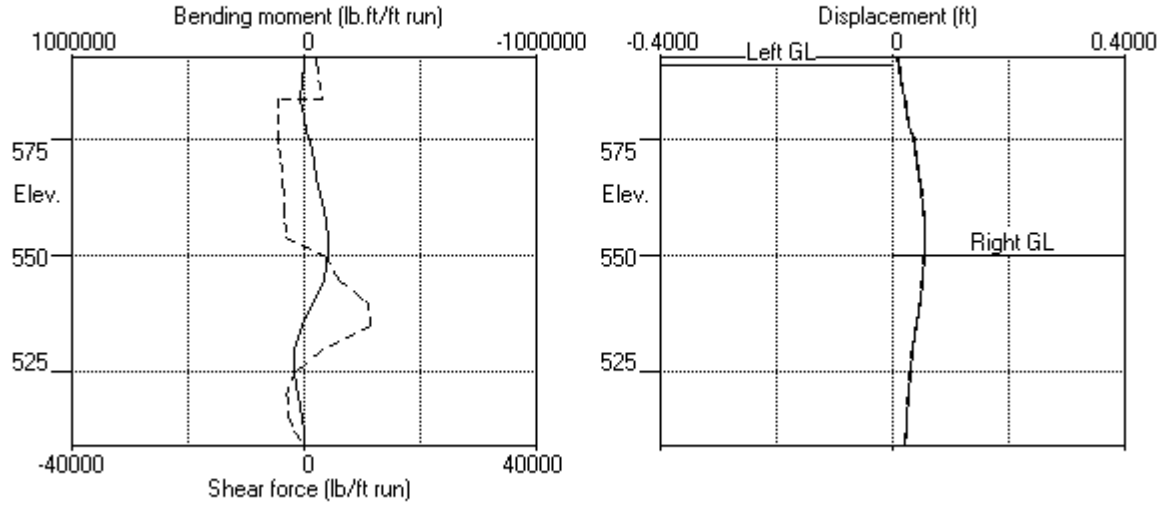
Stage No.7 Apply load no.1 at elevation 593.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	530.00	2870.40	1352.01	0.00	5000.00	2135.31	5005.71	120242
19	525.00	3182.40	1690.02	0.00	5000.00	1921.31	5103.71	120242
20	520.00	3494.40	2028.03	0.00	5000.00	1850.39	5344.79	143253
21	515.00	3806.40	2366.05	0.00	5000.00	1840.26	5646.66	143253
22	512.00	3993.60	2568.87	0.00	5000.00	1847.88	5841.48	143253
23	509.00	4180.80	2771.68	0.00	5000.00	1858.41	6039.21	143253

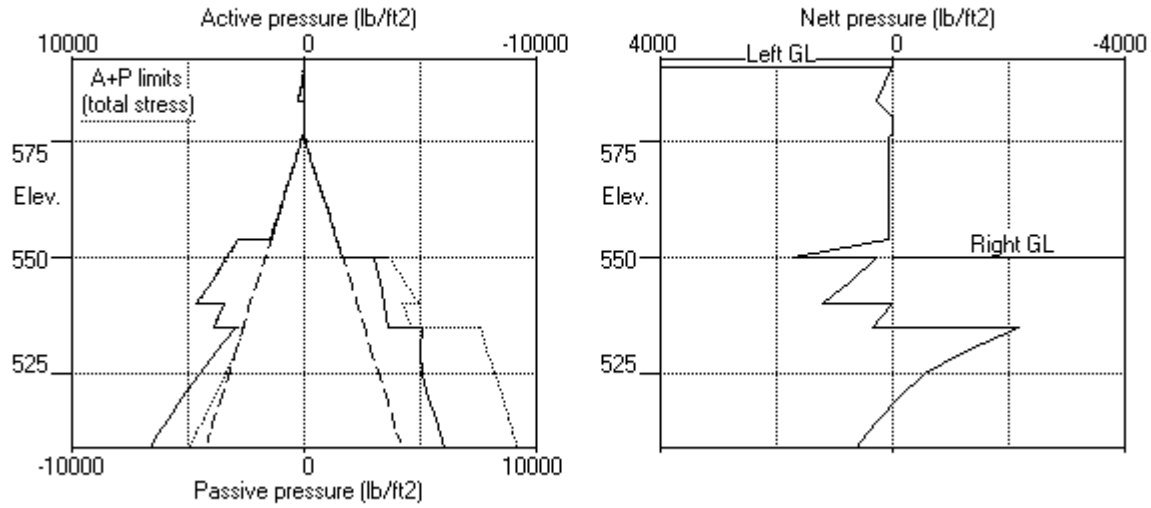
Note: 436.80a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.7 Apply load no.1 at elev. 593.00

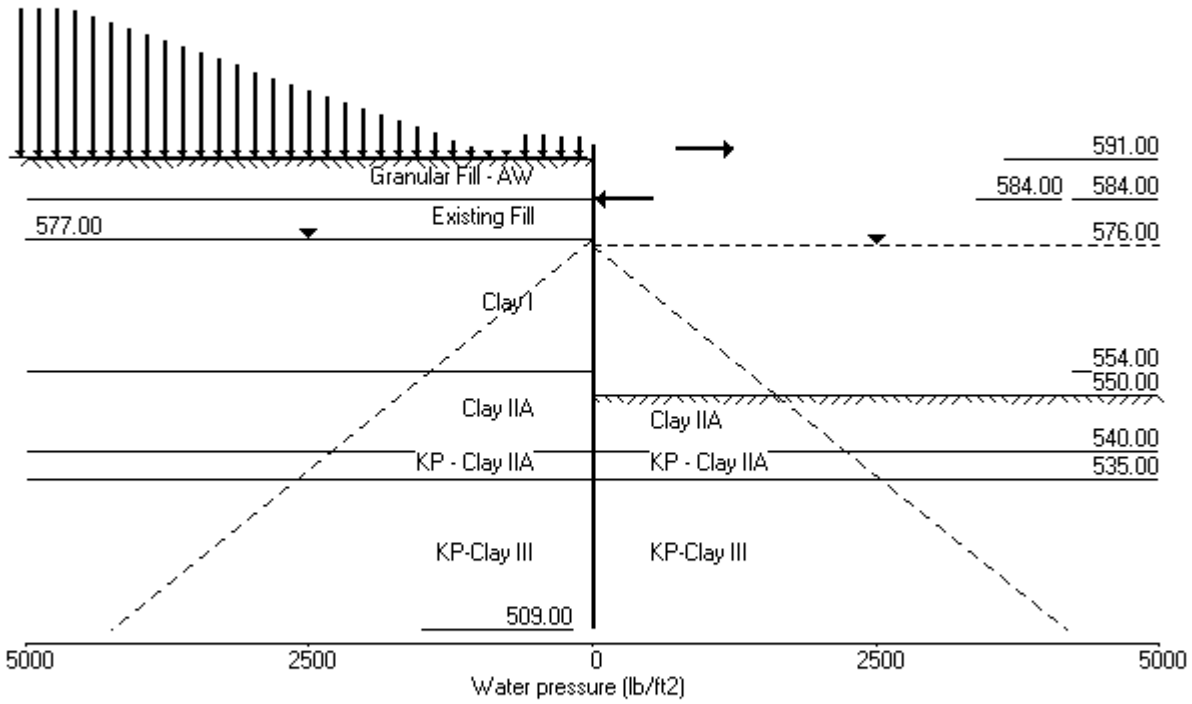


Stage No.7 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No.10 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No. 10 Apply surcharge no.3 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
10	591.00	550.00	584.00	2.819	n/a	528.66	21.34	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.010	-2.01E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.014	-2.02E-03	2000.0	4000.0		9.18E+08
		242.61	0.014	-2.02E-03	2000.0	4000.0		
3	587.50	436.15	0.021	-2.05E-03	3187.8	12986.9		9.18E+08
4	584.00	591.33	0.028	-2.13E-03	4985.9	27436.9	-11288.2	9.18E+08
		66.23	0.028	-2.13E-03	-6302.2	27436.9		
5	580.50	0.00	0.036	-2.19E-03	-6186.3	6274.7		9.18E+08
6	577.00	0.00	0.043	-2.17E-03	-6186.3	-14754.2		9.18E+08
7	576.00	62.40	0.046	-2.16E-03	-6155.1	-20930.8		9.18E+08
8	573.00	62.40	0.052	-2.06E-03	-5967.9	-39129.6		9.18E+08
9	570.00	62.40	0.058	-1.90E-03	-5780.7	-56763.8		9.18E+08
10	565.00	62.40	0.067	-1.51E-03	-5468.7	-86200.2		9.18E+08
11	560.00	62.40	0.073	-9.75E-04	-5156.7	-112766.6		9.18E+08
12	557.00	62.40	0.075	-5.83E-04	-4969.5	-127539.2		9.18E+08
13	554.00	150.36	0.076	-1.42E-04	-4650.4	-142054.4		9.18E+08
		2150.36	0.076	-1.42E-04	-4650.4	-142054.4		
14	550.00	2480.03	0.076	4.76E-04	4610.4	-142559.1		9.18E+08
		480.03	0.076	4.76E-04	4610.4	-142559.1		
15	545.00	1002.18	0.072	1.16E-03	8315.9	-110221.3		9.18E+08
16	540.00	1628.24	0.064	1.61E-03	14891.9	-55030.8		8.07E+08
		46.29	0.064	1.61E-03	14891.9	-55030.8		
17	535.00	398.74	0.056	1.72E-03	16004.5	19021.0		8.07E+08
		-3049.94	0.056	1.72E-03	16004.5	19021.0		
18	530.00	-1754.95	0.048	1.47E-03	3992.3	61905.5		8.07E+08
19	525.00	-795.34	0.041	1.09E-03	-2383.5	60452.8		8.07E+08
20	520.00	-121.26	0.037	7.88E-04	-4675.0	38886.4		8.07E+08
21	515.00	394.71	0.033	6.24E-04	-3991.3	14275.1		8.07E+08
22	512.00	667.40	0.031	5.90E-04	-2398.2	4135.2		8.07E+08
23	509.00	931.37	0.030	5.82E-04	-0.0	0.0		---

At elev. 584.00 Prop force = 11288.2 lb/ft run

(continued)

Stage No.10 Apply surcharge no.3 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.50	1627.50	242.61	242.61	4562
3	587.50	0.00	954.67	293.08	3107.46	436.15	436.15	27370
4	584.00	0.00	1407.14	431.99	4580.24	591.33	591.33	7471
		Total>	1407.14	0.00	5407.14	66.23	66.23	43016
5	580.50	Total>	1859.04	0.00	5859.04	0.00	0.00a	44898
6	577.00	Total>	2315.91	0.00	6315.91	0.00	0.00a	46780
		0.00	2315.91	0.00	6315.91	0.00	0.00a	43016
7	576.00	62.40	2385.59	0.00	6385.59	0.00	62.40a	43016
8	573.00	249.60	2599.43	0.00	6599.43	0.00	249.60a	43016
9	570.00	436.80	2820.54	0.00	6820.54	0.00	436.80a	43016
10	565.00	748.80	3203.36	0.00	7203.36	0.00	748.80a	43016
11	560.00	1060.80	3600.02	0.00	7600.02	0.00	1060.80a	43016
12	557.00	1248.00	3842.74	0.00	7842.74	0.00	1248.00a	43016
13	554.00	1435.20	4087.96	87.96	8087.96	87.96	1523.16a	43016
		1435.20	4087.96	2087.96	6087.96	2087.96	3523.16a	21508
14	550.00	1684.80	4417.63	2417.63	6417.63	2417.63	4102.43a	21508
15	545.00	1996.80	4832.19	2832.19	6832.19	2832.19	4828.99a	21508
16	540.00	2308.80	5247.68	3247.68	7247.68	3247.68	5556.48a	21508
		2308.80	5247.68	1571.88	2000.00	1665.73	3974.53	21508
17	535.00	2620.80	5662.64	1772.72	2000.00	1772.72	4393.52a	21508
		2620.80	5662.64	320.72	5000.00	478.61	3099.41	53770
18	530.00	2932.80	6076.03	520.80	5000.00	1200.69	4133.49	53770
19	525.00	3244.80	6487.10	719.75	5000.00	1825.06	5069.86	53770
20	520.00	3556.80	6895.33	917.34	5000.00	2348.39	5905.19	53770
21	515.00	3868.80	7300.37	1113.38	5000.00	2801.50	6670.30	53770
22	512.00	4056.00	7541.76	1230.21	5000.00	3056.24	7112.24	53770
23	509.00	4243.20	7781.89	1346.43	5000.00	3306.44	7549.64	53770

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	557.00	1185.60	0.00	0.00	0.00	0.00	1185.60	0.0
13	554.00	1372.80	-0.00	0.00	0.00	0.00	1372.80	0.0
14	550.00	1622.40	-0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	-0.00	0.00	2000.00	2000.00	3622.40p	24893
15	545.00	1934.40	338.00	0.00	2338.00	1892.41	3826.81	24893
16	540.00	2246.40	676.00	0.00	2676.00	1681.84	3928.24	24893
		2246.40	676.00	0.00	2000.00	1681.84	3928.24	24893
17	535.00	2558.40	1014.00	0.00	2000.00	1436.38	3994.78	24893
		2558.40	1014.00	0.00	5000.00	3590.96	6149.36	62231

(continued)

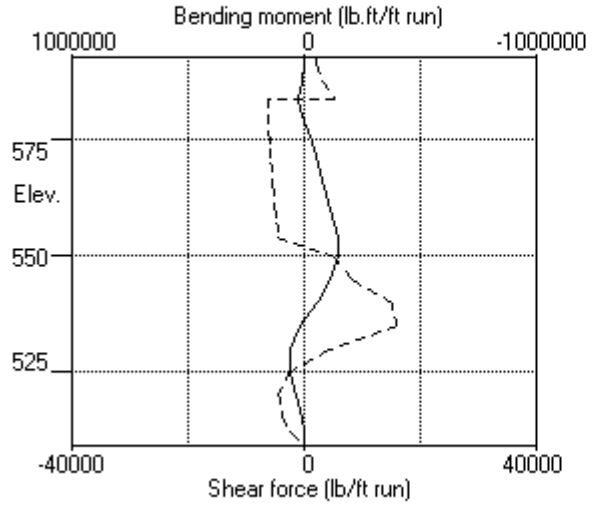
Stage No.10 Apply surcharge no.3 at elevation 591.00

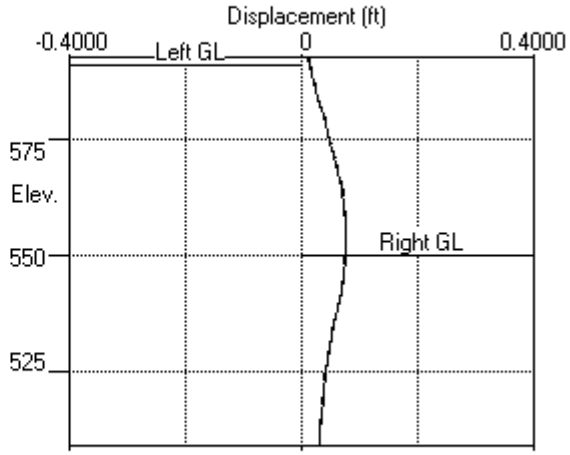
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	530.00	2870.40	1352.01	0.00	5000.00	3018.05	5888.45	62231
19	525.00	3182.40	1690.02	0.00	5000.00	2682.80	5865.20	62231
20	520.00	3494.40	2028.03	0.00	5000.00	2532.05	6026.45	62231
21	515.00	3806.40	2366.05	0.00	5000.00	2469.19	6275.59	62231
22	512.00	3993.60	2568.87	0.00	5000.00	2451.24	6444.84	62231
23	509.00	4180.80	2771.68	0.00	5000.00	2437.47	6618.27	62231

Note: 4393.52a Soil pressure at active limit
3622.40p Soil pressure at passive limit

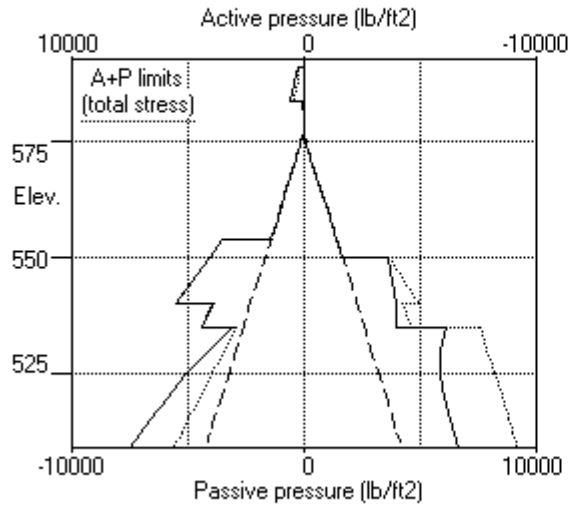
Units: lb,ft

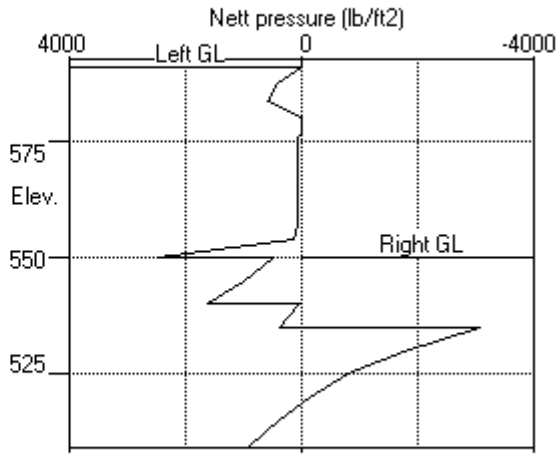
Stage No.10 Apply surcharge no.3 at elev. 591.00





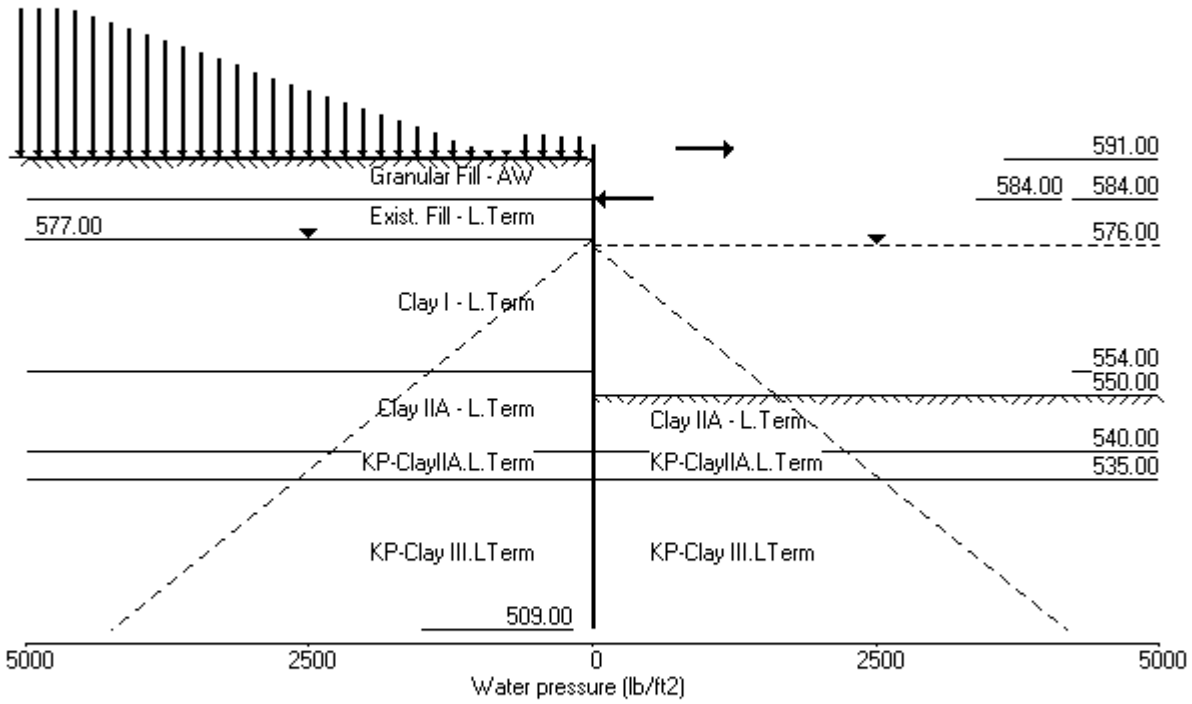
Stage No.10 Apply surcharge no.3 at elev. 591.00





Units: lb,ft

Stage No.15 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetr-ation	Direction of failure
15	591.00	550.00	584.00	2.262	n/a	519.76	30.24	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	-0.010	-1.06E-02	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.011	-1.06E-02	2000.0	4000.0		9.18E+08
		285.68	0.011	-1.06E-02	2000.0	4000.0		
3	587.50	326.84	0.049	-1.06E-02	3071.9	13250.8		9.18E+08
4	584.00	431.99	0.086	-1.07E-02	4399.9	26300.3	-34456.4	9.18E+08
		469.05	0.086	-1.07E-02	-30056.5	26300.3		
5	580.50	619.68	0.124	-1.06E-02	-28151.2	-75091.7		9.18E+08
6	577.00	771.97	0.160	-1.01E-02	-25715.8	-168891.3		9.18E+08
		836.12	0.160	-1.01E-02	-25715.8	-168891.3		
7	576.00	923.68	0.170	-9.99E-03	-24835.9	-194175.0		9.18E+08
8	573.00	1000.88	0.199	-9.25E-03	-21949.1	-264424.7		9.18E+08
9	570.00	1080.71	0.226	-8.28E-03	-18826.7	-325659.4		9.18E+08
10	565.00	1218.92	0.262	-6.29E-03	-13077.6	-407020.8		9.18E+08
11	560.00	1362.13	0.288	-3.94E-03	-6625.0	-456578.5		9.18E+08
12	557.00	1449.76	0.298	-2.43E-03	-2407.2	-469775.7		9.18E+08
13	554.00	1538.29	0.303	-8.95E-04	2074.9	-470359.9		9.18E+08
		1751.85	0.303	-8.95E-04	2074.9	-470359.9		
14	550.00	2081.12	0.302	1.10E-03	9740.8	-447151.5		9.18E+08
15	545.00	1642.54	0.291	3.33E-03	19050.0	-373202.8		9.18E+08
16	540.00	1217.35	0.270	5.05E-03	26199.7	-260821.6		8.07E+08
		-364.59	0.270	5.05E-03	26199.7	-260821.6		
17	535.00	-351.19	0.241	6.28E-03	24410.2	-135161.3		8.07E+08
		-1464.23	0.241	6.28E-03	24410.2	-135161.3		
18	530.00	-2251.73	0.208	6.82E-03	15120.4	-39103.8		8.07E+08
19	525.00	-1574.88	0.174	6.91E-03	5553.8	10944.1		8.07E+08
20	520.00	-725.70	0.139	6.81E-03	-197.6	19319.8		8.07E+08
21	515.00	-30.60	0.105	6.72E-03	-2088.4	9539.8		8.07E+08
22	512.00	350.22	0.085	6.70E-03	-1608.9	3194.8		8.07E+08
23	509.00	722.40	0.065	6.69E-03	0.0	0.0		---

At elev. 584.00 Prop force = 34456.4 lb/ft run

(continued)

Stage No.15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.50	1627.50	285.68	285.68	17605
3	587.50	0.00	954.67	293.08	3107.46	326.84	326.84	3941
4	584.00	0.00	1407.14	431.99	4580.24	431.99	431.99a	7882
		0.00	1407.14	469.05	4221.42	469.05	469.05a	44822
5	580.50	0.00	1859.04	619.68	5577.11	619.68	619.68a	46783
6	577.00	0.00	2315.91	771.97	6947.73	771.97	771.97a	48744
		0.00	2315.91	836.12	6414.67	836.12	836.12a	22951
7	576.00	62.40	2385.59	861.28	6607.67	861.28	923.68a	24590
8	573.00	249.60	2599.43	938.48	7199.98	938.48	1188.08a	29508
9	570.00	436.80	2820.54	1018.31	7812.40	1018.31	1455.11a	34426
10	565.00	748.80	3203.36	1156.52	8872.75	1156.52	1905.32a	42623
11	560.00	1060.80	3600.02	1299.73	9971.43	1299.73	2360.53a	50819
12	557.00	1248.00	3842.74	1387.36	10643.72	1387.36	2635.36a	55737
13	554.00	1435.20	4087.96	1475.89	11322.95	1475.89	2911.09a	60655
		1435.20	4087.96	1596.19	10469.27	1689.45	3124.65	1761
14	550.00	1684.80	4417.63	1724.91	11313.54	2018.72	3703.52	1761
15	545.00	1996.80	4832.19	1886.78	12375.24	2445.75	4442.55	1761
16	540.00	2308.80	5247.68	2049.02	13439.30	2886.19	5194.99	1761
		2308.80	5247.68	991.81	13439.30	1304.24	3613.04	1761
17	535.00	2620.80	5662.64	1070.24	14502.02	1446.71	4067.51	1761
		2620.80	5662.64	1070.24	14502.02	1070.24	3691.04a	2564
18	530.00	2932.80	6076.03	1148.37	15560.71	1148.37	4081.17a	2564
19	525.00	3244.80	6487.10	1226.06	16613.46	1486.18	4730.98	2564
20	520.00	3556.80	6895.33	1303.22	17658.94	2085.62	5642.42	2564
21	515.00	3868.80	7300.37	1379.77	18696.24	2616.61	6485.41	2564
22	512.00	4056.00	7541.76	1425.39	19314.45	2918.35	6974.35	2564
23	509.00	4243.20	7781.89	1470.78	19929.41	3215.60	7458.80	2564

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	557.00	1185.60	0.00	0.00	0.00	0.00	1185.60	0.0
13	554.00	1372.80	-0.00	0.00	0.00	0.00	1372.80	0.0
14	550.00	1622.40	-0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	-0.00	0.00	-0.00	-0.00	1622.40	2290
15	545.00	1934.40	338.00	131.98	865.62	865.62	2800.02p	2290
16	540.00	2246.40	676.00	263.95	1731.24	1731.24	3977.64p	2290
		2246.40	676.00	127.76	1731.24	1731.24	3977.64p	2290

(continued)

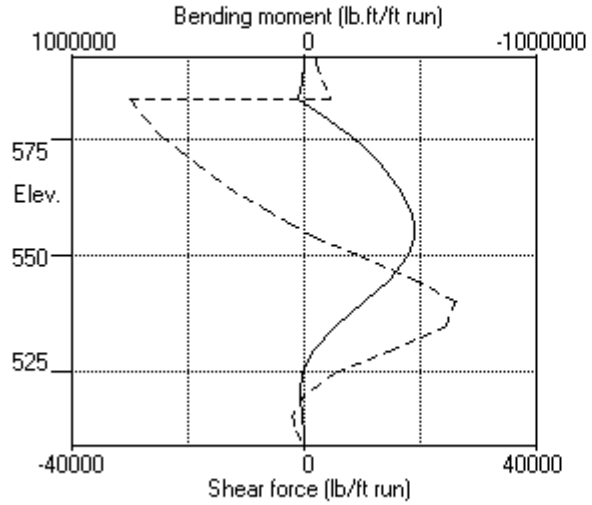
Stage No.15 Change properties of soil type 8 to soil type 10
Ko pressures will not be reset

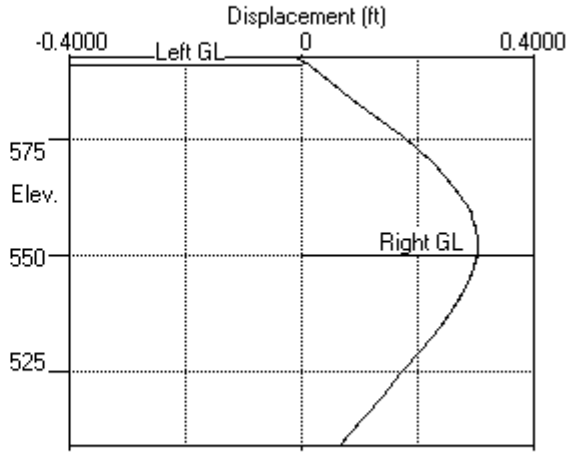
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	535.00	2558.40	1014.00	191.65	2596.86	1860.29	4418.69	2290
		2558.40	1014.00	191.65	2596.86	2596.86	5155.26p	3334
18	530.00	2870.40	1352.01	255.53	3462.50	3462.50	6332.90p	3334
19	525.00	3182.40	1690.02	319.41	4328.14	3123.46	6305.86	3334
20	520.00	3494.40	2028.03	383.30	5193.79	2873.72	6368.12	3334
21	515.00	3806.40	2366.05	447.18	6059.46	2709.60	6516.00	3334
22	512.00	3993.60	2568.87	485.52	6578.86	2630.53	6624.13	3334
23	509.00	4180.80	2771.68	523.85	7098.28	2555.59	6736.39	3334

Note: 4081.17a Soil pressure at active limit
6332.90p Soil pressure at passive limit

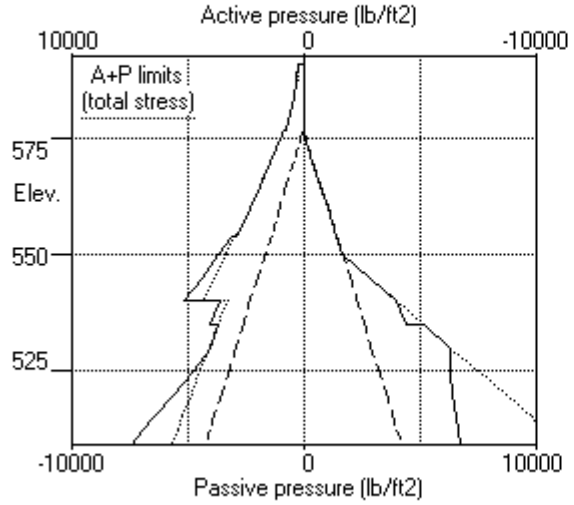
Units: lb,ft

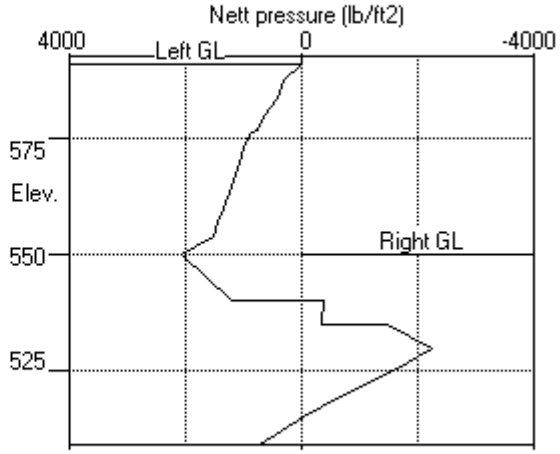
Stage No.15 Change soil type 8 to soil type 10





Stage No.15 Change soil type 8 to soil type 10





Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	584.00	584.00	---	Conditions not suitable for FoS calc.				
2	584.00	584.00		No analysis at this stage				
3	591.00	584.00	584.00	Conditions not suitable for FoS calc.				
4	591.00	550.00	584.00	5.177	n/a	***	***	L to R
5	591.00	550.00	584.00	4.934	n/a	***	***	L to R
6	591.00	550.00	584.00	4.926	n/a	***	***	L to R
7	591.00	550.00	584.00	4.972	n/a	***	***	L to R
8	591.00	550.00	584.00	4.467	n/a	531.94	18.06	L to R
9	591.00	550.00		No analysis at this stage				
10	591.00	550.00	584.00	2.819	n/a	528.66	21.34	L to R
11	591.00	550.00		No analysis at this stage				
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00		No analysis at this stage				
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00	584.00	2.262	n/a	519.76	30.24	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 500.00 from wall
Right side 500.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.014	-0.010	0.0	-0.0	2000.0	0.0
2	591.00	0.017	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.049	-0.000	13250.8	0.0	3187.8	0.0
4	584.00	0.086	-0.000	27436.9	0.0	4985.9	-30056.5
5	580.50	0.124	-0.000	7999.0	-75091.7	0.0	-28151.2
6	577.00	0.160	0.000	868.8	-168891.3	734.2	-25715.8
7	576.00	0.170	0.000	1561.4	-194175.0	651.5	-24835.9
8	573.00	0.199	0.000	3145.5	-264424.7	406.8	-21949.1
9	570.00	0.226	0.000	4002.1	-325659.4	162.9	-18826.7
10	565.00	0.262	0.000	3794.1	-407020.8	0.0	-13077.6
11	560.00	0.288	0.000	1330.3	-456578.5	0.0	-6625.0
12	557.00	0.298	0.000	0.0	-469775.7	0.0	-4969.5
13	554.00	0.303	0.000	0.0	-470359.9	2074.9	-4650.4
14	550.00	0.302	0.000	0.0	-447151.5	9740.8	-648.1
15	545.00	0.291	0.000	0.0	-373202.8	19050.0	-0.0
16	540.00	0.270	0.000	0.0	-260821.6	26199.7	-0.0
17	535.00	0.241	0.000	19021.0	-135161.3	24410.2	-0.0
18	530.00	0.208	0.000	61905.5	-39103.8	15120.4	-0.0
19	525.00	0.174	0.000	60452.8	-0.0	5553.8	-2383.5
20	520.00	0.139	0.000	38886.4	-0.0	0.0	-4675.0
21	515.00	0.105	0.000	14275.1	0.0	0.0	-3991.3
22	512.00	0.085	0.000	4135.2	0.0	0.0	-2398.2
23	509.00	0.065	0.000	0.0	-0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum lb.ft/ft	elev.	minimum lb.ft/ft	elev.	Shear force maximum lb/ft	elev.	minimum lb/ft	elev.
1	0.0	573.00	-0.0	535.00	0.0	580.50	-0.0	525.00
2	No calculation at this stage							
3	4002.1	570.00	-10160.9	545.00	1614.7	540.00	-1472.0	584.00
4	39740.6	525.00	-103037.3	550.00	11331.3	535.00	-4622.5	584.00
5	42468.5	530.00	-105510.4	554.00	11484.6	535.00	-4948.4	584.00
6	42564.7	530.00	-105668.8	554.00	11501.0	535.00	-4963.6	584.00
7	41803.8	530.00	-102431.8	550.00	11435.4	535.00	-4692.7	584.00
8	48278.7	530.00	-107706.4	554.00	12229.6	535.00	-5823.0	584.00
9	No calculation at this stage							
10	61905.5	530.00	-142559.1	550.00	16004.5	535.00	-6302.2	584.00
11	No calculation at this stage							
12	No calculation at this stage							
13	No calculation at this stage							
14	No calculation at this stage							
15	26300.3	584.00	-470359.9	554.00	26199.7	540.00	-30056.5	584.00

Maximum and minimum displacement at each stage

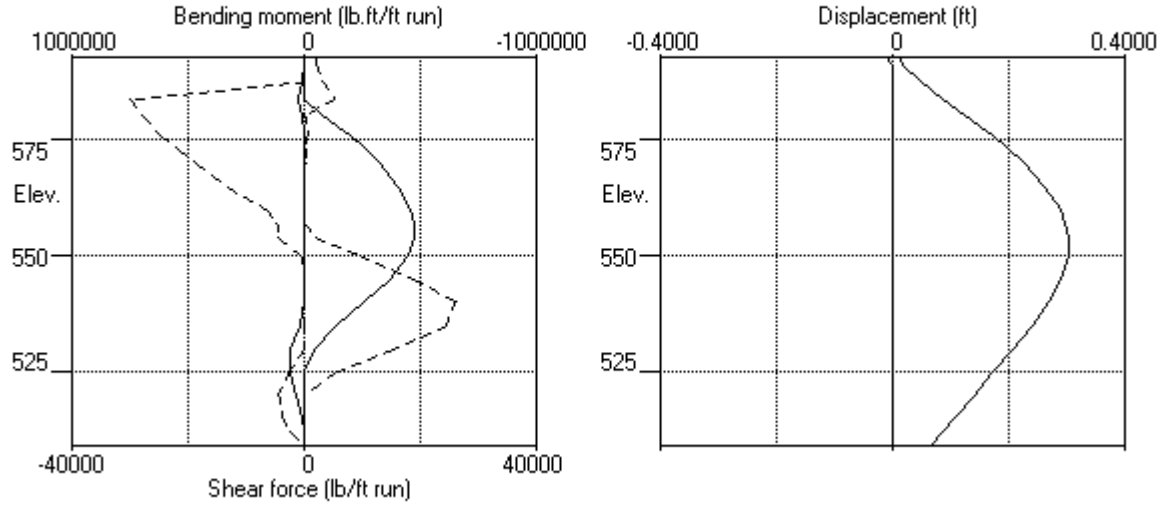
Stage no.	Displacement maximum ft	elev.	minimum ft	elev.	Stage description
1	0.000	535.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	No calculation at this stage				Install prop no.1 at elev. 584.00
3	0.008	550.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
4	0.054	554.00	-0.002	593.00	Excav. to elev. 550.00 on RIGHT side
5	0.055	554.00	-0.002	593.00	Apply water pressure profile no.1
6	0.055	554.00	-0.002	593.00	Apply surcharge no.4 at elev. 591.00
7	0.055	554.00	0.000	593.00	Apply load no.1 at elev. 593.00
8	0.060	554.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
9	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
10	0.076	554.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
11	No calculation at this stage				Change soil type 2 to soil type 11
12	No calculation at this stage				Change soil type 3 to soil type 4
13	No calculation at this stage				Change soil type 5 to soil type 6
14	No calculation at this stage				Change soil type 7 to soil type 9
15	0.303	554.00	-0.010	593.00	Change soil type 8 to soil type 10

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
3	2799.28	26033.27
4	5827.62	54196.91
5	6134.10	57047.14
6	6153.91	57231.35
7	7672.28	71352.24
8	10705.08	99557.26
10	11288.16	104979.93
15	34456.36	320444.16

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: C.1 – EMBEDMENT CHECK

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	553.00	3 Clay IIA	3 Clay IIA
2	540.00	5 KP - Clay IIA	5 KP - Clay IIA
3	532.00	8 KP - Clay III	8 KP - Clay III

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
2	Granular Fill - BW	120.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
3	Clay IIA	130.0	1200000	0.561	NC (0.490)	1.000 (2.000)	1.000 (1.330)	1000d
4	Clay IIA - L.Term	130.0	47151	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
5	KP - Clay IIA	130.0	600000	0.561	NC (0.490)	0.484 (0.968)	0.000 (1.330)	1000d
6	KP - ClayI-IA.L.Term	130.0	47151	0.561	OC (0.330)	0.189 (0.000)	1.707 (0.000)	
7	Clay III	130.0	1500000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2500d
8	KP - Clay III	130.0	1500000	0.561	NC (0.490)	0.484 (0.968)	0.000 (1.330)	2500d
9	KP - Clay III.LTerm	130.0	68650	0.561	OC (0.330)	0.189 (0.000)	1.707 (0.000)	
10	Granular Fill - Temp	120.0	0 (15000)	0.727	NC (0.330)	0.595 (0.000)	3.000 (0.000)	
11	Clay III - L.Term	130.0	68650	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	

Additional soil parameters associated with Ka and Kp

No.	Soil type Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
2	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
3	Clay IIA	0.00	0.000	0.00	0.00	-0.507	0.00
4	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
5	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
6	KP - ClayIIA.L.Term	43.01	0.000	0.00	15.14	0.000	0.00
7	Clay III	0.00	0.000	0.00	Incompatible values		
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP - Clay III.LTerm	43.01	0.000	0.00	23.35	-0.384	0.00
10	Granular Fill - Temp	30.00	0.000	27.00	30.00	0.000	0.00
11	Clay III - L.Term	26.00	0.000	0.00	26.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 480.00
Maximum finite element length = 6.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 480.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Fill to elevation 565.00 on LEFT side with soil type 10
3	Install strut or anchor no.1 at elevation 584.00
4	Change properties of soil type 10 to soil type 2 No analysis at this stage Ko pressures will not be reset
5	Fill to elevation 576.00 on LEFT side with soil type 2
6	Fill to elevation 591.00 on LEFT side with soil type 1
7	Excavate to elevation 550.00 on RIGHT side
8	Apply water pressure profile no.1
9	Apply surcharge no.1 at elevation 591.00
10	Apply load no.1 at elevation 593.00
11	Apply surcharge no.4 at elevation 591.00
12	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
13	Apply surcharge no.3 at elevation 591.00
14	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 8 to soil type 9 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
 Method of analysis - CP2
 Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
 Minimum equivalent fluid density = 0.00 lb/ft3
 Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
 Method - Subgrade reaction model using Influence Coefficients
 Open Tension Crack analysis? - No
 Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
 Length of wall (normal to plane of analysis) = 1000.00 ft

 Width of excavation on Left side of wall = 1000.00 ft
 Width of excavation on Right side of wall = 1000.00 ft

 Distance to rigid boundary on Left side = 1000.00 ft
 Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Fill to elev. 565.00 on LEFT side	Yes	Yes	Yes
3	Install prop no.1 at elev. 584.00	No	No	No
4	Change soil type 10 to soil type 2	No	No	No
5	Fill to elev. 576.00 on LEFT side	No	No	No
6	Fill to elev. 591.00 on LEFT side	No	No	No
7	Excav. to elev. 550.00 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
9	Apply surcharge no.1 at elev. 591.00	Yes	Yes	Yes
10	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
11	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
12	Apply surcharge no.2 at elev. 591.00	No	No	No
13	Apply surcharge no.3 at elev. 591.00	Yes	Yes	Yes
14	Change soil type 3 to soil type 4	No	No	No
15	Change soil type 5 to soil type 6	No	No	No
16	Change soil type 8 to soil type 9	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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Units: lb,ft

Stage No. 16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 480.00 Factor of Safety	FoS for toe elev. = 480.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
16	591.00	550.00	584.00	2.793	n/a	511.47	38.53	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	0.005	-1.06E-02	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.026	-1.06E-02	2000.0	4000.0		9.18E+08
		361.42	0.026	-1.06E-02	2000.0	4000.0		
3	587.50	470.97	0.063	-1.07E-02	3456.7	13652.4		9.18E+08
4	584.00	432.36	0.101	-1.07E-02	5037.5	29015.3	-33321.5	9.18E+08
		432.36	0.101	-1.07E-02	-28284.0	29015.3		
5	580.50	571.20	0.139	-1.07E-02	-26527.8	-66863.1		9.18E+08
6	577.00	711.58	0.176	-1.02E-02	-24282.9	-156519.8		9.18E+08
7	576.00	795.39	0.186	-1.01E-02	-23529.4	-180432.9		9.18E+08
		856.80	0.186	-1.01E-02	-23529.4	-180432.9		
8	570.50	970.89	0.238	-8.67E-03	-18503.2	-298420.1		9.18E+08
9	565.00	1092.49	0.280	-6.62E-03	-12829.0	-385768.2		9.18E+08
10	559.00	1231.43	0.312	-3.92E-03	-5857.2	-441896.2		9.18E+08
11	553.00	1374.47	0.327	-9.98E-04	1960.5	-453815.8		9.18E+08
		1768.75	0.327	-9.98E-04	1960.5	-453815.8		
12	550.00	2003.76	0.328	4.59E-04	7619.2	-439196.7		9.18E+08
13	545.00	1537.07	0.320	2.68E-03	16471.3	-379163.5		9.18E+08
14	540.00	1078.24	0.301	4.48E-03	23009.6	-280382.6		8.07E+08
		176.91	0.301	4.48E-03	23009.6	-280382.6		
15	536.00	-61.25	0.281	5.63E-03	23240.9	-187145.9		8.07E+08
16	532.00	104.49	0.257	6.33E-03	23327.4	-94430.1		8.07E+08
		-940.99	0.257	6.33E-03	23327.4	-94430.1		
17	527.00	-1440.07	0.224	6.59E-03	17374.8	10371.8		8.07E+08
18	522.00	-1638.99	0.192	6.30E-03	9677.1	82509.9		8.07E+08
19	516.00	-1142.04	0.156	5.61E-03	1334.0	104562.0		8.07E+08
20	510.00	-421.33	0.125	4.88E-03	-3356.1	92690.8		8.07E+08
21	504.00	92.65	0.097	4.30E-03	-4342.2	62838.0		8.07E+08
22	498.00	238.27	0.072	3.93E-03	-3349.4	36644.0		8.07E+08
23	492.00	196.44	0.050	3.72E-03	-2045.3	19091.4		8.07E+08
24	486.00	77.84	0.028	3.62E-03	-1222.4	8596.9		8.07E+08
25	480.00	342.32	0.006	3.59E-03	38.1	0.0		---

At elev. 584.00 Prop force = 33321.5 lb/ft run

(continued)

Stage No.16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	361.42	361.42	4711
3	587.50	0.00	954.67	293.33	3107.07	470.97	470.97	28265
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	7292
5	580.50	0.00	1859.04	571.20	6050.40	571.20	571.20a	10938
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	14583
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	15625
		62.40	2385.59	794.40	7156.77	794.40	856.80a	5580
8	570.50	405.60	2728.20	908.49	8184.60	908.49	1314.09a	7627
9	565.00	748.80	3093.36	1030.09	9280.08	1030.09	1778.89a	9673
10	559.00	1123.20	3510.60	1169.03	10531.80	1169.03	2292.23a	11905
11	553.00	1497.60	3940.14	1312.07	11820.41	1312.07	2809.67a	14137
		1497.60	3940.14	1538.47	10090.97	1706.35	3203.95	1647
12	550.00	1684.80	4187.63	1635.11	10724.80	1941.36	3626.16	1647
13	545.00	1996.80	4602.19	1796.98	11786.53	2340.31	4337.11	1647
14	540.00	2308.80	5017.68	1959.21	12850.63	2747.13	5055.93	1647
		2308.80	5017.68	948.34	8565.18	1268.44	3577.24	1169
15	536.00	2558.40	5349.74	1011.10	9132.01	1428.06	3986.46	1169
16	532.00	2808.00	5680.91	1073.69	9697.32	1590.88	4398.88	1169
		2808.00	5680.91	1073.69	9697.32	1073.69	3881.69a	1703
17	527.00	3120.00	6092.98	1151.57	10400.73	1151.57	4271.57a	1703
18	522.00	3432.00	6502.40	1228.95	11099.60	1529.62	4961.62	1703
19	516.00	3806.40	6989.63	1321.04	11931.29	2366.86	6173.26	1703
20	510.00	4180.80	7471.99	1412.21	12754.68	2783.08	6963.88	1703
21	504.00	4555.20	7949.24	1502.41	13569.35	3040.89	7596.09	1703
22	498.00	4929.60	8421.29	1591.62	14375.14	3178.10	8107.70	1703
23	492.00	5304.00	8888.15	1679.86	15172.08	3243.35	8547.35	1703
24	486.00	5678.40	9349.92	1767.13	15960.31	3275.25	8953.65	1703
25	480.00	6052.80	9806.74	1853.47	16740.10	3447.36	9500.16	38588

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	570.50	343.20	0.00	0.00	0.00	0.00	343.20	0.0
9	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
10	559.00	1060.80	0.00	0.00	0.00	0.00	1060.80	0.0
11	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
12	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	1838
13	545.00	1934.40	338.00	131.98	865.64	865.64	2800.04p	1838
14	540.00	2246.40	676.00	263.95	1731.28	1731.28	3977.68p	1838
		2246.40	676.00	127.76	1153.93	1153.93	3400.33p	1342
15	536.00	2496.00	946.40	178.87	1615.51	1551.71	4047.71	1342

(continued)

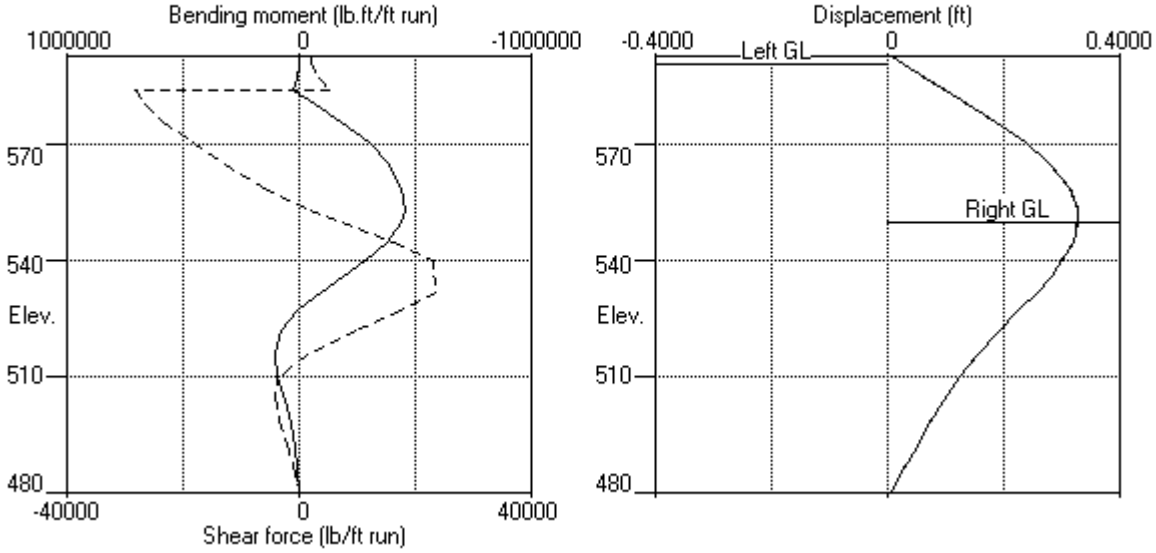
Stage No.16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
16	532.00	2745.60	1216.80	229.98	2077.08	1548.79	4294.39	1342
		2745.60	1216.80	229.98	2077.08	2077.08	4822.68p	1954
17	527.00	3057.60	1554.80	293.86	2654.05	2654.05	5711.65p	1954
18	522.00	3369.60	1892.80	357.74	3231.01	3231.01	6600.61p	1954
19	516.00	3744.00	2298.40	434.40	3923.37	3571.31	7315.31	1954
20	510.00	4118.40	2704.01	511.06	4615.74	3266.81	7385.21	1954
21	504.00	4492.80	3109.61	587.72	5308.10	3010.64	7503.44	1954
22	498.00	4867.20	3515.21	664.38	6000.47	3002.23	7869.43	1954
23	492.00	5241.60	3920.82	741.03	6692.83	3109.31	8350.91	1954
24	486.00	5616.00	4326.42	817.69	7385.20	3259.81	8875.81	1954
25	480.00	5990.40	4732.03	894.35	8077.57	3167.44	9157.84	38588

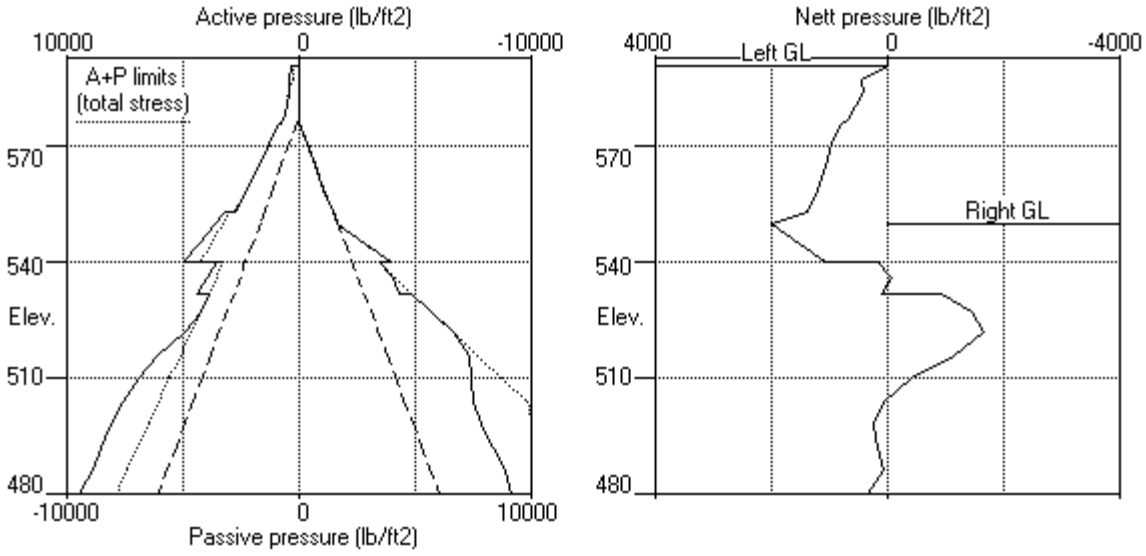
Note: 4271.57a Soil pressure at active limit
6600.61p Soil pressure at passive limit

Units: lb,ft

Stage No.16 Change soil type 8 to soil type 9



Stage No.16 Change soil type 8 to soil type 9



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 480.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	553.00	553.00	---	Conditions not suitable for FoS calc.				
2	565.00	553.00	Cant.	19.899	503.28	542.49	10.51	L to R
3	565.00	553.00		No analysis at this stage				
4	565.00	553.00		No analysis at this stage				
5	576.00	553.00	584.00	18.837	n/a	***	***	L to R
6	591.00	553.00	584.00	2.988	n/a	525.42	27.58	L to R
7	591.00	550.00	584.00	2.944	n/a	524.26	25.74	L to R
8	591.00	550.00	584.00	2.847	n/a	523.83	26.17	L to R
9	591.00	550.00	584.00	2.655	n/a	522.26	27.74	L to R
10	591.00	550.00	584.00	2.664	n/a	522.41	27.59	L to R
11	591.00	550.00	584.00	2.660	n/a	522.37	27.63	L to R
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00	584.00	1.710	n/a	513.06	36.94	L to R
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00	584.00	2.793	n/a	511.47	38.53	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.047	-0.000	0.0	-0.0	2000.0	0.0
2	591.00	0.054	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.068	-0.000	13652.4	-0.0	3456.7	0.0
4	584.00	0.101	-0.000	29015.3	-0.0	5037.5	-28284.0
5	580.50	0.139	-0.000	0.0	-66863.1	0.0	-26527.8
6	577.00	0.176	-0.000	0.0	-156519.8	0.0	-24282.9
7	576.00	0.186	-0.000	0.0	-180432.9	0.0	-23529.4
8	570.50	0.238	-0.000	0.0	-298420.1	0.0	-18503.2
9	565.00	0.280	-0.000	0.0	-385768.2	0.0	-12829.0
10	559.00	0.312	-0.000	1507.5	-441896.2	3728.7	-5857.2
11	553.00	0.327	-0.000	10670.3	-453815.8	9926.5	0.0
12	550.00	0.328	-0.000	16746.1	-439196.7	13669.2	0.0
13	545.00	0.320	-0.000	17799.3	-379163.5	17417.5	-583.6
14	540.00	0.301	0.000	13120.7	-280382.6	23009.6	-1430.3
15	536.00	0.281	0.000	40937.1	-187145.9	23687.4	-779.9
16	532.00	0.257	0.000	101595.2	-94430.1	25422.7	-7.1
17	527.00	0.224	0.000	160251.4	-0.0	17374.8	-339.1
18	522.00	0.192	0.000	190625.4	-0.0	9677.1	-4936.2
19	516.00	0.156	0.000	162133.5	-0.0	1334.0	-7965.9
20	510.00	0.125	0.000	115749.4	0.0	0.0	-7954.9
21	504.00	0.097	-0.000	65224.7	-120.8	0.0	-6875.9
22	498.00	0.072	0.000	36644.0	-1926.4	0.0	-4304.0
23	492.00	0.050	0.000	19091.4	-2250.0	415.4	-2045.3
24	486.00	0.028	0.000	8596.9	-1088.4	492.4	-1222.4
25	480.00	0.010	0.000	0.0	-0.0	38.1	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	504.00	-0.0	516.00	0.0	545.00	-0.0	480.00
2	16824.4	545.00	-187.4	498.00	2614.7	553.00	-1430.3	540.00
3	No calculation at this stage							
4	No calculation at this stage							
5	17799.3	545.00	-25133.4	565.00	4959.5	553.00	-1627.7	584.00
6	94303.3	527.00	-163043.2	565.00	9926.5	553.00	-13612.7	584.00
7	124392.0	527.00	-202495.7	559.00	13711.4	540.00	-15416.6	584.00
8	128641.6	527.00	-211026.9	559.00	14093.5	540.00	-16013.4	584.00
9	152553.1	527.00	-250448.8	559.00	17094.8	540.00	-20264.1	584.00
10	152015.1	527.00	-244399.9	559.00	17048.6	540.00	-20206.8	584.00
11	152103.9	527.00	-244643.4	559.00	17039.6	540.00	-20248.5	584.00
12	No calculation at this stage							
13	190625.4	522.00	-338035.8	559.00	25422.7	532.00	-24036.3	584.00
14	No calculation at this stage							
15	No calculation at this stage							
16	104562.0	516.00	-453815.8	553.00	23327.4	532.00	-28284.0	584.00

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	480.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.021	593.00	0.000	593.00	Fill to elev. 565.00 on LEFT side
3	No calculation at this stage				Install prop no.1 at elev. 584.00
4	No calculation at this stage				Change soil type 10 to soil type 2
5	0.022	580.50	0.000	593.00	Fill to elev. 576.00 on LEFT side
6	0.086	565.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
7	0.105	559.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
8	0.109	559.00	0.000	593.00	Apply water pressure profile no.1
9	0.133	559.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
10	0.133	559.00	0.000	593.00	Apply load no.1 at elev. 593.00
11	0.133	559.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
12	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
13	0.189	559.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
14	No calculation at this stage				Change soil type 3 to soil type 4
15	No calculation at this stage				Change soil type 5 to soil type 6
16	0.328	550.00	0.000	593.00	Change soil type 8 to soil type 9

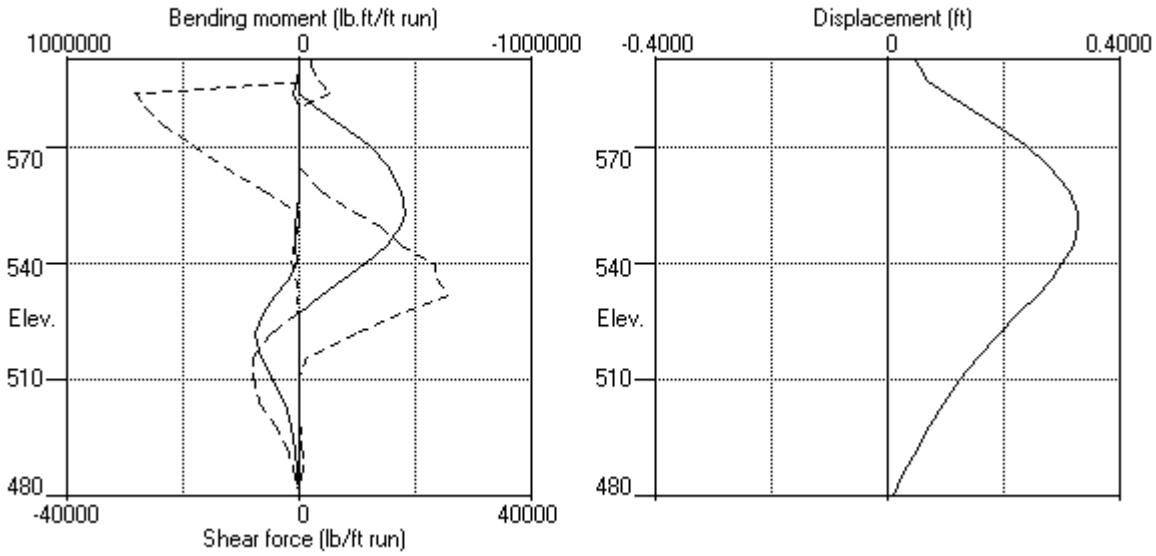
Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
5	1627.68	15137.43
6	14591.31	135699.16
7	16395.24	152475.74
8	16992.04	158025.99
9	22992.98	213834.68
10	24565.38	228458.03
11	24609.63	228869.57
13	28418.93	264296.06
16	33321.53	309890.19

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: C.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	553.00	3 Clay IIA	3 Clay IIA
2	540.00	5 KP - Clay IIA	5 KP - Clay IIA
3	532.00	8 KP - Clay III	8 KP - Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
2	Granular Fill - BW	120.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
3	Clay IIA	130.0	1200000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1000d
4	Clay IIA - L.Term	130.0	47151	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
5	KP - Clay IIA	130.0	600000	0.561	NC (0.490)	0.484 (0.968)	0.000 (2.000)	1000d
6	KP - ClayI-IA.L.Term	130.0	47151	0.561	OC (0.330)	0.189 (0.000)	2.561 (0.000)	
7	Clay III	130.0	1500000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2500d
8	KP - Clay III	130.0	1500000	0.561	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2500d
9	KP - Clay III.LTerm	130.0	68650	0.561	OC (0.330)	0.189 (0.000)	2.561 (0.000)	
10	Granular Fill - Temp	120.0	0 (15000)	0.727	NC (0.330)	0.595 (0.000)	3.000 (0.000)	
11	Clay III - L.Term	130.0	68650	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
2	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
3	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
5	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
6	KP - ClayIIA.L.Term	43.01	0.000	0.00	25.99	0.000	0.00
7	Clay III	0.00	0.000	0.00	0.00	0.000	0.00
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP - Clay III.LTerm	43.01	0.000	0.00	Incompatible values		
10	Granular Fill - Temp	30.00	0.000	27.00	30.00	0.000	0.00
11	Clay III - L.Term	26.00	0.000	0.00	26.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 509.00
Maximum finite element length = 5.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 509.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Fill to elevation 565.00 on LEFT side with soil type 10
3	Install strut or anchor no.1 at elevation 584.00
4	Change properties of soil type 10 to soil type 2 No analysis at this stage Ko pressures will not be reset
5	Fill to elevation 576.00 on LEFT side with soil type 2
6	Fill to elevation 591.00 on LEFT side with soil type 1
7	Excavate to elevation 550.00 on RIGHT side
8	Apply water pressure profile no.1
9	Apply surcharge no.1 at elevation 591.00
10	Apply load no.1 at elevation 593.00
11	Apply surcharge no.4 at elevation 591.00
12	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
13	Apply surcharge no.3 at elevation 591.00
14	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 8 to soil type 9 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Fill to elev. 565.00 on LEFT side	Yes	Yes	Yes
3	Install prop no.1 at elev. 584.00	No	No	No
4	Change soil type 10 to soil type 2	No	No	No
5	Fill to elev. 576.00 on LEFT side	No	No	No
6	Fill to elev. 591.00 on LEFT side	No	No	No
7	Excav. to elev. 550.00 on RIGHT side	Yes	Yes	Yes
8	Apply water pressure profile no.1	Yes	Yes	Yes
9	Apply surcharge no.1 at elev. 591.00	Yes	Yes	Yes
10	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
11	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
12	Apply surcharge no.2 at elev. 591.00	No	No	No
13	Apply surcharge no.3 at elev. 591.00	Yes	Yes	Yes
14	Change soil type 3 to soil type 4	No	No	No
15	Change soil type 5 to soil type 6	No	No	No
16	Change soil type 8 to soil type 9	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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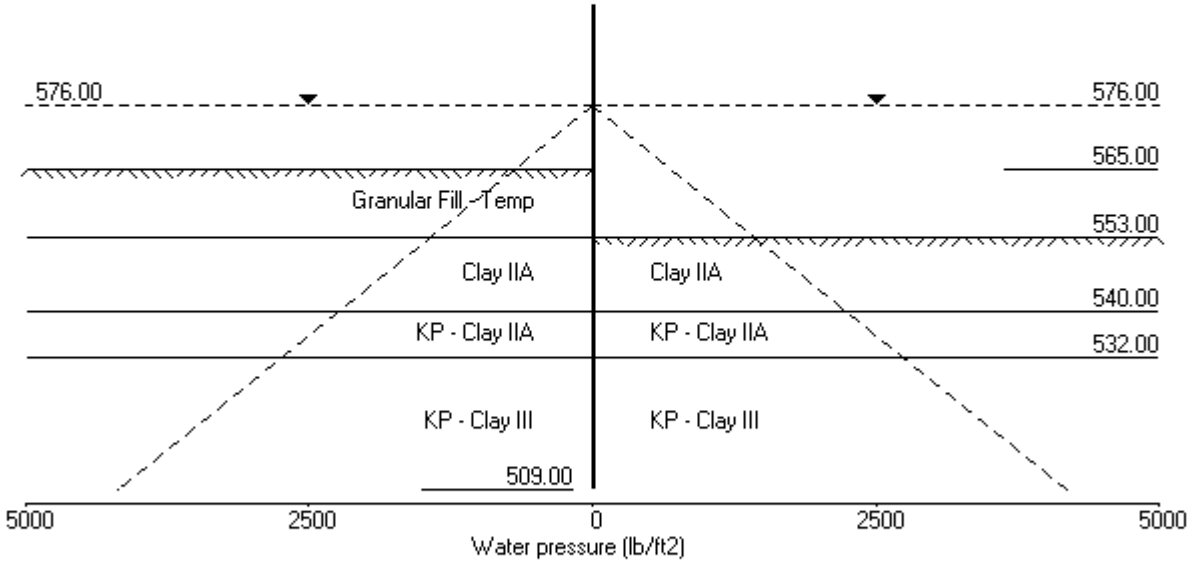
Units: lb,ft

Stage No.2 Fill to elev. 565.00 on LEFT side



Units: lb,ft

Stage No. 2 Fill to elevation 565.00 on LEFT side with soil type 10

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
2	565.00	553.00	Cant.	14.687	521.28	544.67	8.33	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.021	3.76E-04	0.0	0.0		9.18E+08
2	591.00	0.00	0.020	3.76E-04	0.0	-0.0		9.18E+08
3	587.50	0.00	0.019	3.76E-04	0.0	-0.0		9.18E+08
4	584.00	0.00	0.017	3.76E-04	0.0	-0.0		9.18E+08
5	580.50	0.00	0.016	3.76E-04	0.0	-0.0		9.18E+08
6	577.00	0.00	0.015	3.76E-04	0.0	-0.0		9.18E+08
7	576.00	0.00	0.014	3.76E-04	0.0	-0.0		9.18E+08
8	573.00	0.00	0.013	3.76E-04	0.0	-0.0		9.18E+08
9	570.00	0.00	0.012	3.76E-04	0.0	-0.0		9.18E+08
10	565.00	0.00	0.010	3.76E-04	0.0	-0.0		9.18E+08
11	560.00	176.04	0.008	3.74E-04	440.1	872.4		9.18E+08
12	556.50	307.98	0.007	3.65E-04	1287.1	3790.2		9.18E+08
13	553.00	446.54	0.006	3.38E-04	2607.5	10480.7		9.18E+08
		-519.42	0.006	3.38E-04	2607.5	10480.7		
14	550.00	-451.49	0.005	2.94E-04	1151.2	16547.5		9.18E+08
15	545.00	-240.27	0.004	2.03E-04	-578.2	16659.7		9.18E+08
16	540.00	-101.29	0.003	1.29E-04	-1432.1	10765.2		8.07E+08
		143.24	0.003	1.29E-04	-1432.1	10765.2		
17	536.00	179.33	0.002	8.73E-05	-787.0	6182.6		8.07E+08
18	532.00	204.23	0.002	6.09E-05	-19.9	4469.2		8.07E+08
		-71.07	0.002	6.09E-05	-19.9	4469.2		
19	528.50	-32.76	0.002	4.26E-05	-201.6	3964.3		8.07E+08
20	525.00	-6.97	0.002	2.74E-05	-271.1	3058.1		8.07E+08
21	520.00	13.70	0.002	1.30E-05	-254.3	1615.4		8.07E+08
22	515.00	23.40	0.002	6.42E-06	-161.5	515.3		8.07E+08
23	512.00	27.03	0.002	5.21E-06	-85.9	136.0		8.07E+08
24	509.00	30.23	0.002	4.96E-06	-0.0	0.0		---

(continued)

Stage No.2 Fill to elevation 565.00 on LEFT side with soil type 10

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
		686.40	0.00	0.00	0.00	0.00	686.40	658
11	560.00	998.40	288.00	171.36	864.00	176.04	1174.44	3949
12	556.50	1216.80	489.60	291.32	1468.80	307.98	1524.78	6714
13	553.00	1435.20	691.20	411.28	2073.60	446.54	1881.74	9478
		1435.20	691.20	0.00	2691.20	0.00	1435.20a	81563
14	550.00	1622.40	894.00	0.00	2894.00	97.77	1720.17	81563
15	545.00	1934.40	1232.00	0.00	3232.00	389.01	2323.41	81563
16	540.00	2246.40	1570.00	0.00	3570.00	645.49	2891.89	81563
		2246.40	1570.00	0.00	2000.00	763.13	3009.53	40782
17	536.00	2496.00	1840.40	0.00	2000.00	932.19	3428.19	40782
18	532.00	2745.60	2110.80	53.63	2000.00	1095.86	3841.46	40782
		2745.60	2110.80	0.00	5000.00	963.42	3709.02	101954
19	528.50	2964.00	2347.40	0.00	5000.00	1114.58	4078.58	101954
20	525.00	3182.40	2584.00	0.00	5000.00	1259.72	4442.12	101954
21	520.00	3494.40	2922.00	0.00	5000.00	1459.28	4953.68	101954
22	515.00	3806.40	3260.00	0.00	5000.00	1653.57	5459.97	101954
23	512.00	3993.60	3462.80	0.00	5000.00	1769.08	5762.68	101954
24	509.00	4180.80	3665.60	0.00	5000.00	1884.39	6065.19	101954

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
		1435.20	0.00	0.00	2000.00	519.42	1954.62	87972
14	550.00	1622.40	202.80	0.00	2202.80	549.26	2171.66	87972
15	545.00	1934.40	540.80	0.00	2540.80	629.28	2563.68	87972
16	540.00	2246.40	878.80	0.00	2878.80	746.78	2993.18	87972
		2246.40	878.80	0.00	2000.00	619.89	2866.29	43986
17	536.00	2496.00	1149.20	0.00	2000.00	752.86	3248.86	43986
18	532.00	2745.60	1419.60	0.00	2000.00	891.63	3637.23	43986
		2745.60	1419.60	0.00	5000.00	1034.48	3780.08	109965

(continued)

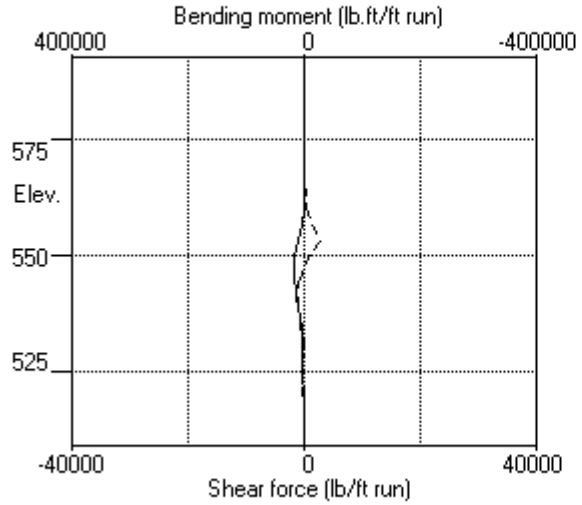
Stage No.2 Fill to elevation 565.00 on LEFT side with soil type 10

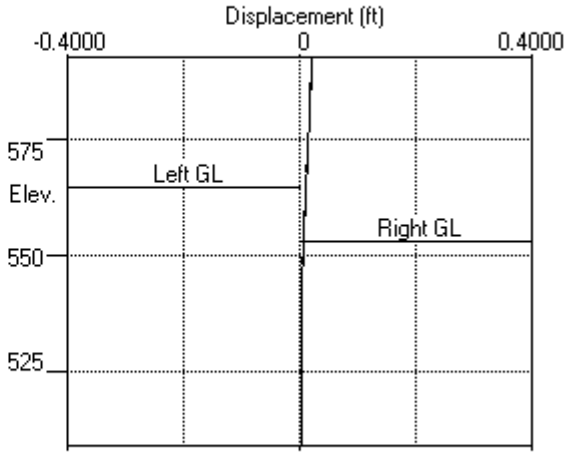
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
19	528.50	2964.00	1656.20	0.00	5000.00	1147.34	4111.34	109965
20	525.00	3182.40	1892.80	0.00	5000.00	1266.69	4449.09	109965
21	520.00	3494.40	2230.80	0.00	5000.00	1445.58	4939.98	109965
22	515.00	3806.40	2568.80	0.00	5000.00	1630.17	5436.57	109965
23	512.00	3993.60	2771.60	0.00	5000.00	1742.06	5735.66	109965
24	509.00	4180.80	2974.40	0.00	5000.00	1854.16	6034.96	109965

Note: 1435.20a Soil pressure at active limit
123.45p Soil pressure at passive limit

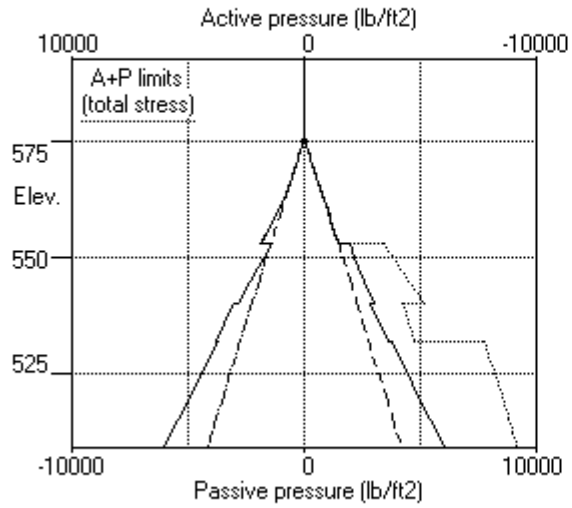
Units: lb,ft

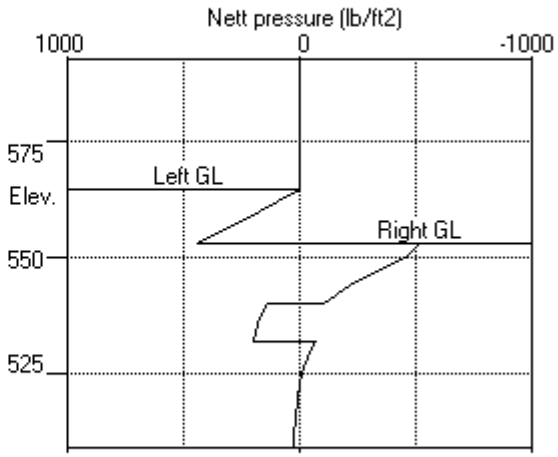
Stage No.2 Fill to elev. 565.00 on LEFT side





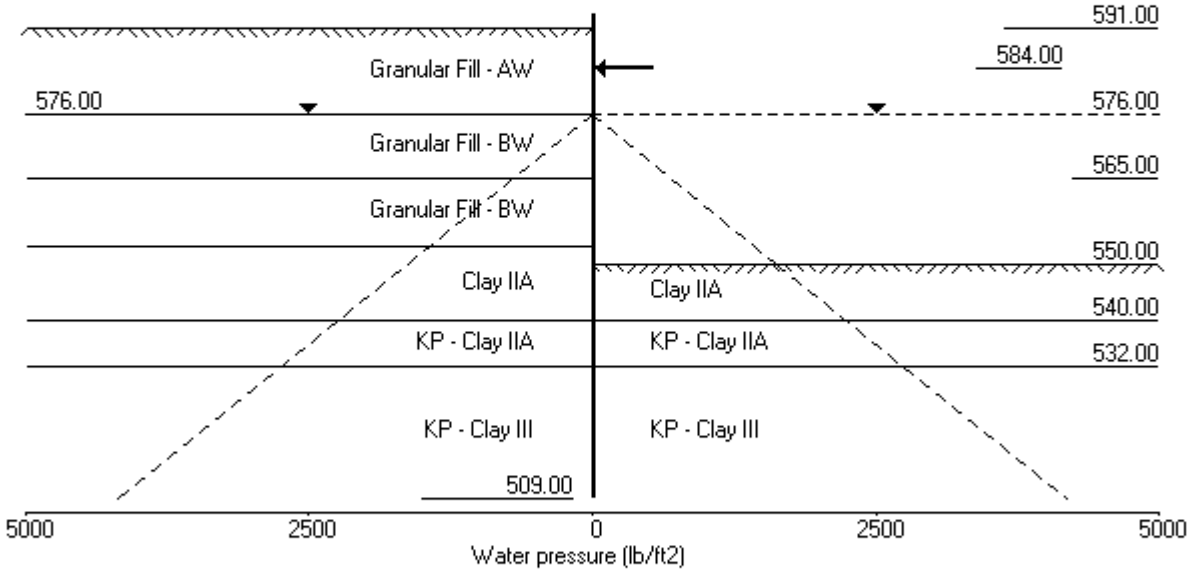
Stage No.2 Fill to elev. 565.00 on LEFT side





Units: lb,ft

Stage No.7 Excav. to elev. 550.00 on RIGHT side



Units: lb,ft

Stage No. 7 Excavate to elevation 550.00 on RIGHT side

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
7	591.00	550.00	584.00	4.260	n/a	528.65	21.35	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.034	-2.28E-03	0.0	0.0		9.18E+08
2	591.00	0.00	0.038	-2.28E-03	0.0	-0.0		9.18E+08
3	587.50	139.80	0.046	-2.28E-03	244.7	285.4		9.18E+08
4	584.00	279.61	0.054	-2.29E-03	978.6	2283.4	-14646.3	9.18E+08
		279.61	0.054	-2.29E-03	-13667.7	2283.4		
5	580.50	419.41	0.062	-2.21E-03	-12444.4	-43555.5		9.18E+08
6	577.00	559.21	0.069	-1.96E-03	-10731.8	-84256.7		9.18E+08
7	576.00	599.15	0.071	-1.87E-03	-10152.7	-94702.3		9.18E+08
		656.57	0.071	-1.87E-03	-10152.7	-94702.3		
8	573.00	706.89	0.076	-1.51E-03	-8107.5	-122120.8		9.18E+08
9	570.00	764.43	0.080	-1.08E-03	-5900.5	-143630.2		9.18E+08
10	565.00	860.34	0.084	-2.49E-04	-1838.5	-163085.8		9.18E+08
11	560.00	956.24	0.083	6.31E-04	2702.9	-160896.8		9.18E+08
12	556.50	1023.38	0.080	1.21E-03	6167.2	-145386.9		9.18E+08
13	553.00	1090.51	0.074	1.71E-03	9866.5	-117359.5		9.18E+08
		1274.80	0.074	1.71E-03	9866.5	-117359.5		
14	550.00	1477.60	0.069	2.03E-03	13995.1	-81308.7		9.18E+08
		-522.40	0.069	2.03E-03	13995.1	-81308.7		
15	545.00	-522.40	0.058	2.31E-03	11383.1	-19094.0		9.18E+08
16	540.00	-522.40	0.046	2.28E-03	8771.1	30364.5		8.07E+08
		-848.48	0.046	2.28E-03	8771.1	30364.5		
17	536.00	-512.69	0.037	2.05E-03	6048.8	59480.9		8.07E+08
18	532.00	-213.78	0.030	1.71E-03	4595.9	79100.6		8.07E+08
		-1998.57	0.030	1.71E-03	4595.9	79100.6		
19	528.50	-1199.90	0.024	1.36E-03	-1001.5	82849.3		8.07E+08
20	525.00	-585.03	0.020	1.03E-03	-4125.1	71918.7		8.07E+08
21	520.00	24.82	0.016	6.72E-04	-5525.6	43817.2		8.07E+08
22	515.00	430.47	0.013	4.86E-04	-4387.4	16380.4		8.07E+08
23	512.00	679.27	0.012	4.46E-04	-2722.8	5133.1		8.07E+08
24	509.00	1135.91	0.010	4.36E-04	0.0	-0.0		---

At elev. 584.00 Prop force = 14646.3 lb/ft run

(continued)

Stage No.7 Excavate to elevation 550.00 on RIGHT side

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	11785
3	587.50	0.00	455.00	139.80	1480.84	139.80	139.80a	4427
4	584.00	0.00	910.00	279.61	2961.68	279.61	279.61a	8855
5	580.50	0.00	1365.00	419.41	4442.51	419.41	419.41a	13282
6	577.00	0.00	1820.00	559.21	5923.35	559.21	559.21a	17709
7	576.00	0.00	1950.00	599.15	6346.45	599.15	599.15a	18974
		0.00	1950.00	649.35	5850.00	656.57	656.57	6777
8	573.00	187.20	2122.80	706.89	6368.40	706.89	894.09a	8132
9	570.00	374.40	2295.60	764.43	6886.80	764.43	1138.83a	9487
10	565.00	686.40	2583.60	860.34	7750.80	860.34	1546.74a	11746
11	560.00	998.40	2871.60	956.24	8614.80	956.24	1954.64a	14005
12	556.50	1216.80	3073.20	1023.38	9219.60	1023.38	2240.18a	15586
13	553.00	1435.20	3274.80	1090.51	9824.40	1090.51	2525.71a	17167
		1435.20	3274.80	1274.80	5274.80	1274.80	2710.00a	49066
14	550.00	1622.40	3477.60	1477.60	5477.60	1477.60	3100.00a	49066
15	545.00	1934.40	3815.60	1815.60	5815.60	1815.60	3750.00a	49066
16	540.00	2246.40	4153.60	2153.60	6153.60	2153.60	4400.00a	49066
		2246.40	4153.60	1042.34	2000.00	1151.52	3397.92	24533
17	536.00	2496.00	4424.00	1173.22	2000.00	1332.68	3828.68	24533
18	532.00	2745.60	4694.40	1304.09	2000.00	1490.61	4236.21	24533
		2745.60	4694.40	0.00	5000.00	1360.09	4105.69	61333
19	528.50	2964.00	4931.00	0.00	5000.00	1772.27	4736.27	61333
20	525.00	3182.40	5167.60	81.12	5000.00	2119.48	5301.88	61333
21	520.00	3494.40	5505.60	244.71	5000.00	2520.68	6015.08	61333
22	515.00	3806.40	5843.60	408.30	5000.00	2849.82	6656.22	61333
23	512.00	3993.60	6046.40	506.46	5000.00	3058.52	7052.12	391886
24	509.00	4180.80	6249.20	604.61	5000.00	3380.01	7560.81	391886

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	2000.00	3622.40p	82501
15	545.00	1934.40	338.00	0.00	2338.00	2338.00	4272.40p	82501
16	540.00	2246.40	676.00	0.00	2676.00	2676.00	4922.40p	82501
		2246.40	676.00	0.00	2000.00	2000.00	4246.40p	41250
17	536.00	2496.00	946.40	0.00	2000.00	1845.37	4341.37	41250

(continued)

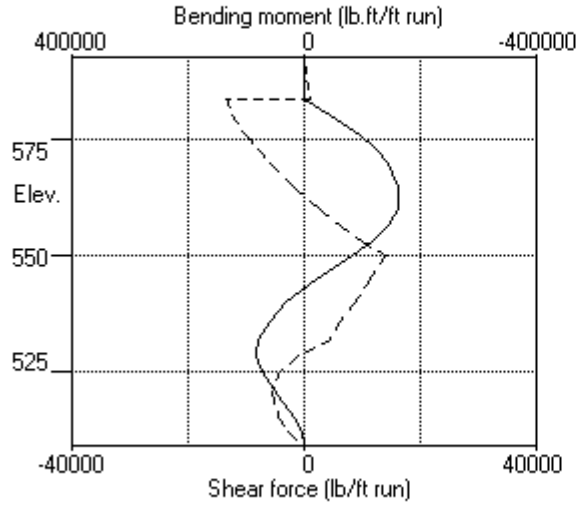
Stage No.7 Excavate to elevation 550.00 on RIGHT side

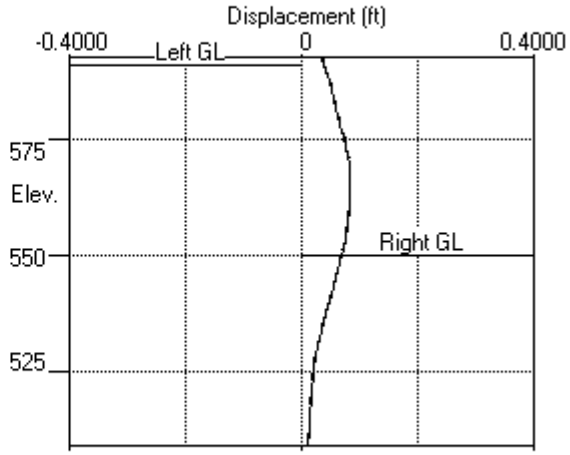
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	1704.39	4449.99	41250
		2745.60	1216.80	0.00	5000.00	3358.66	6104.26	103126
19	528.50	2964.00	1453.40	0.00	5000.00	2972.17	5936.17	103126
20	525.00	3182.40	1690.00	0.00	5000.00	2704.51	5886.91	103126
21	520.00	3494.40	2028.00	0.00	5000.00	2495.86	5990.26	103126
22	515.00	3806.40	2366.00	0.00	5000.00	2419.35	6225.75	103126
23	512.00	3993.60	2568.80	0.00	5000.00	2379.25	6372.85	391886
24	509.00	4180.80	2771.61	0.00	5000.00	2244.11	6424.91	391886

Note: 4400.00a Soil pressure at active limit
4246.40p Soil pressure at passive limit

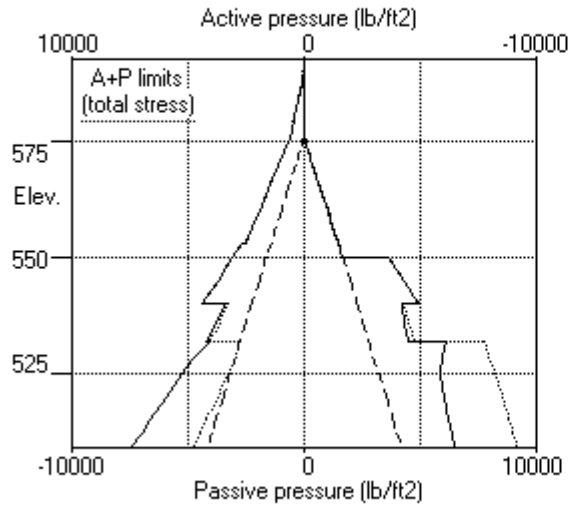
Units: lb,ft

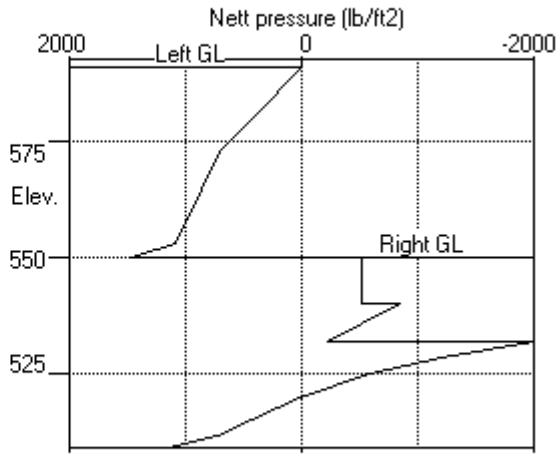
Stage No.7 Excav. to elev. 550.00 on RIGHT side





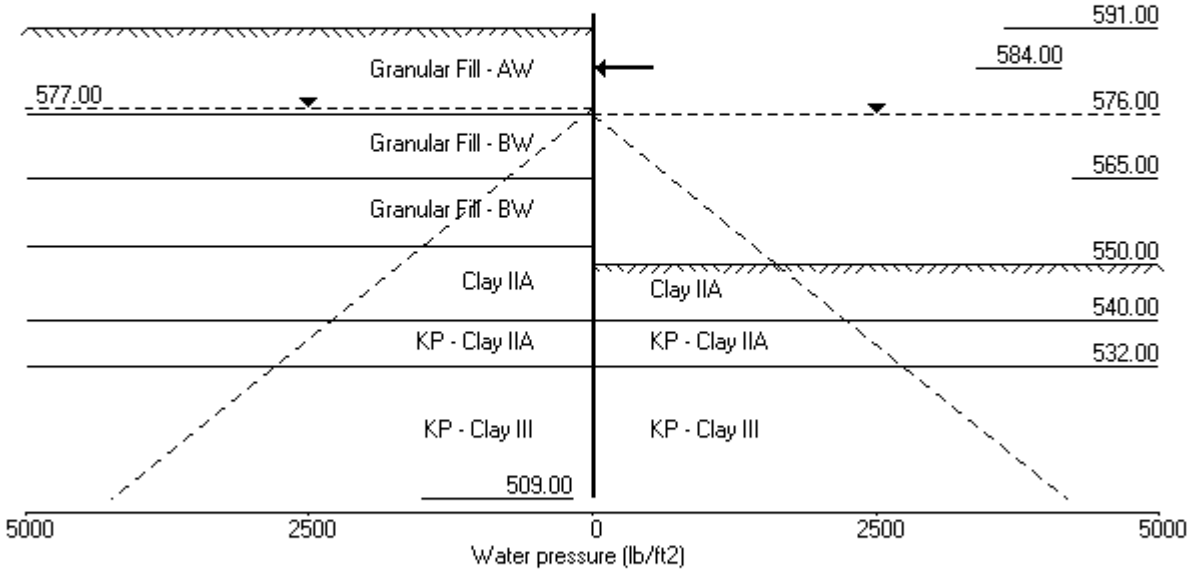
Stage No.7 Excav. to elev. 550.00 on RIGHT side





Units: lb,ft

Stage No.8 Apply water pressure profile no.1



Units: lb,ft

Stage No. 8 Apply water pressure profile no.1

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
8	591.00	550.00	584.00	4.091	n/a	528.42	21.58	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	0.034	-2.38E-03	0.0	0.0		9.18E+08
2	591.00	0.00	0.039	-2.38E-03	0.0	-0.0		9.18E+08
3	587.50	139.80	0.047	-2.38E-03	244.7	285.4		9.18E+08
4	584.00	279.61	0.055	-2.39E-03	978.6	2283.4	-15158.1	9.18E+08
		279.61	0.055	-2.39E-03	-14179.5	2283.4		
5	580.50	419.41	0.064	-2.31E-03	-12956.2	-45346.7		9.18E+08
6	577.00	559.21	0.071	-2.05E-03	-11243.6	-87839.1		9.18E+08
7	576.00	642.38	0.073	-1.95E-03	-10642.8	-98789.2		9.18E+08
		690.97	0.073	-1.95E-03	-10642.8	-98789.2		
8	573.00	748.51	0.079	-1.58E-03	-8483.6	-127512.6		9.18E+08
9	570.00	806.06	0.083	-1.13E-03	-6151.7	-149963.1		9.18E+08
10	565.00	901.96	0.086	-2.62E-04	-1881.7	-170154.7		9.18E+08
11	560.00	997.86	0.085	6.56E-04	2867.9	-167661.3		9.18E+08
12	556.50	1065.00	0.082	1.26E-03	6477.9	-151319.2		9.18E+08
13	553.00	1132.13	0.077	1.78E-03	10322.8	-121949.7		9.18E+08
		1274.80	0.077	1.78E-03	10322.8	-121949.7		
14	550.00	1477.60	0.071	2.12E-03	14451.4	-84530.0		9.18E+08
		-522.40	0.071	2.12E-03	14451.4	-84530.0		
15	545.00	-522.40	0.059	2.40E-03	11839.4	-20033.8		9.18E+08
16	540.00	-522.40	0.047	2.37E-03	9227.4	31706.1		8.07E+08
		-872.99	0.047	2.37E-03	9227.4	31706.1		
17	536.00	-564.80	0.038	2.14E-03	6351.8	62451.5		8.07E+08
18	532.00	-244.90	0.030	1.78E-03	4732.4	82866.4		8.07E+08
		-2080.04	0.030	1.78E-03	4732.4	82866.4		
19	528.50	-1245.99	0.025	1.41E-03	-1088.1	86594.2		8.07E+08
20	525.00	-605.67	0.020	1.06E-03	-4328.5	75078.0		8.07E+08
21	520.00	26.35	0.016	6.90E-04	-5776.8	45701.4		8.07E+08
22	515.00	453.38	0.013	4.95E-04	-4577.5	17027.7		8.07E+08
23	512.00	711.17	0.012	4.54E-04	-2830.7	5313.3		8.07E+08
24	509.00	1175.94	0.010	4.44E-04	0.0	-0.0		---

At elev. 584.00 Prop force = 15158.1 lb/ft run

(continued)

Stage No.8 Apply water pressure profile no.1

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	730
3	587.50	0.00	455.00	139.80	1480.84	139.80	139.80a	4378
4	584.00	0.00	910.00	279.61	2961.68	279.61	279.61a	8755
5	580.50	0.00	1365.00	419.41	4442.51	419.41	419.41a	13133
6	577.00	0.00	1820.00	559.21	5923.35	559.21	559.21a	17511
7	576.00	62.40	1887.60	579.98	6143.36	579.98	642.38a	18761
		62.40	1887.60	628.57	5662.80	628.57	690.97a	6700
8	573.00	249.60	2060.40	686.11	6181.20	686.11	935.71a	8041
9	570.00	436.80	2233.20	743.66	6699.60	743.66	1180.46a	9381
10	565.00	748.80	2521.20	839.56	7563.60	839.56	1588.36a	11614
11	560.00	1060.80	2809.20	935.46	8427.60	935.46	1996.26a	13848
12	556.50	1279.20	3010.80	1002.60	9032.40	1002.60	2281.80a	15411
13	553.00	1497.60	3212.40	1069.73	9637.20	1069.73	2567.33a	16975
		1497.60	3212.40	1212.40	5212.40	1212.40	2710.00a	48595
14	550.00	1684.80	3415.20	1415.20	5415.20	1415.20	3100.00a	48595
15	545.00	1996.80	3753.20	1753.20	5753.20	1753.20	3750.00a	48595
16	540.00	2308.80	4091.20	2091.20	6091.20	2091.20	4400.00a	48595
		2308.80	4091.20	1012.14	2000.00	1064.61	3373.41	24298
17	536.00	2558.40	4361.60	1143.01	2000.00	1254.24	3812.64	24298
18	532.00	2808.00	4632.00	1273.89	2000.00	1419.29	4227.29	24298
		2808.00	4632.00	0.00	5000.00	1271.70	4079.70	60744
19	528.50	3026.40	4868.60	0.00	5000.00	1695.88	4722.28	60744
20	525.00	3244.80	5105.20	50.92	5000.00	2051.70	5296.50	60744
21	520.00	3556.80	5443.20	214.51	5000.00	2460.36	6017.16	79377
22	515.00	3868.80	5781.20	378.10	5000.00	2800.10	6668.90	167746
23	512.00	4056.00	5984.00	476.26	5000.00	3013.29	7069.29	167746
24	509.00	4243.20	6186.80	574.41	5000.00	3338.85	7582.05	167746

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	2000.00	3622.40p	94837
15	545.00	1934.40	338.00	0.00	2338.00	2338.00	4272.40p	94837
16	540.00	2246.40	676.00	0.00	2676.00	2676.00	4922.40p	94837
		2246.40	676.00	0.00	2000.00	2000.00	4246.40p	47418
17	536.00	2496.00	946.40	0.00	2000.00	1881.44	4377.44	47418

(continued)

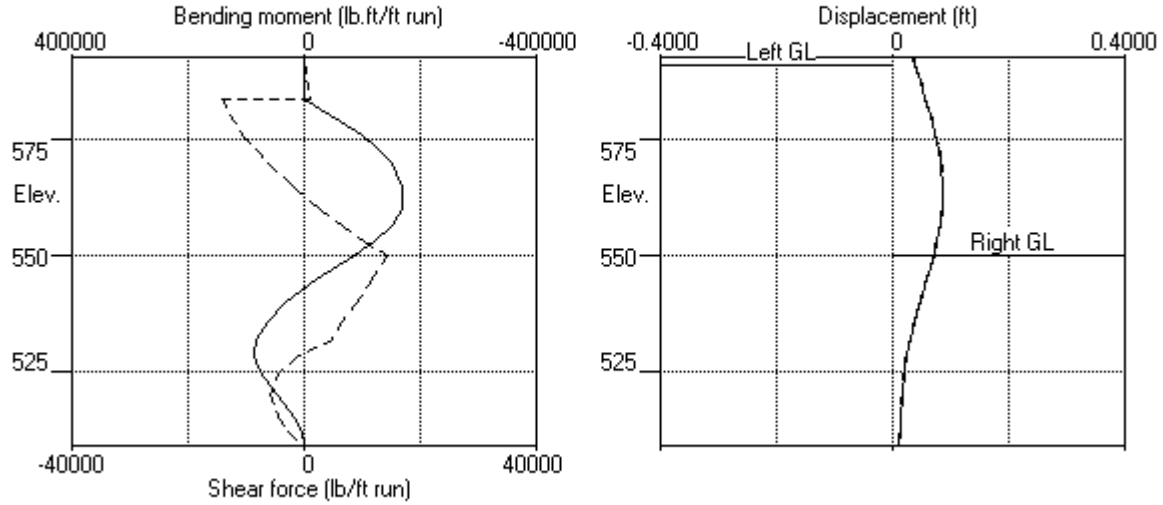
Stage No.8 Apply water pressure profile no.1

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	1726.59	4472.19	47418
		2745.60	1216.80	0.00	5000.00	3414.14	6159.74	118546
19	528.50	2964.00	1453.40	0.00	5000.00	3004.27	5968.27	118546
20	525.00	3182.40	1690.00	0.00	5000.00	2719.77	5902.17	118546
21	520.00	3494.40	2028.00	0.00	5000.00	2496.41	5990.81	118546
22	515.00	3806.40	2366.00	0.00	5000.00	2409.12	6215.52	167746
23	512.00	3993.60	2568.80	0.00	5000.00	2364.53	6358.13	167746
24	509.00	4180.80	2771.61	0.00	5000.00	2225.31	6406.11	167746

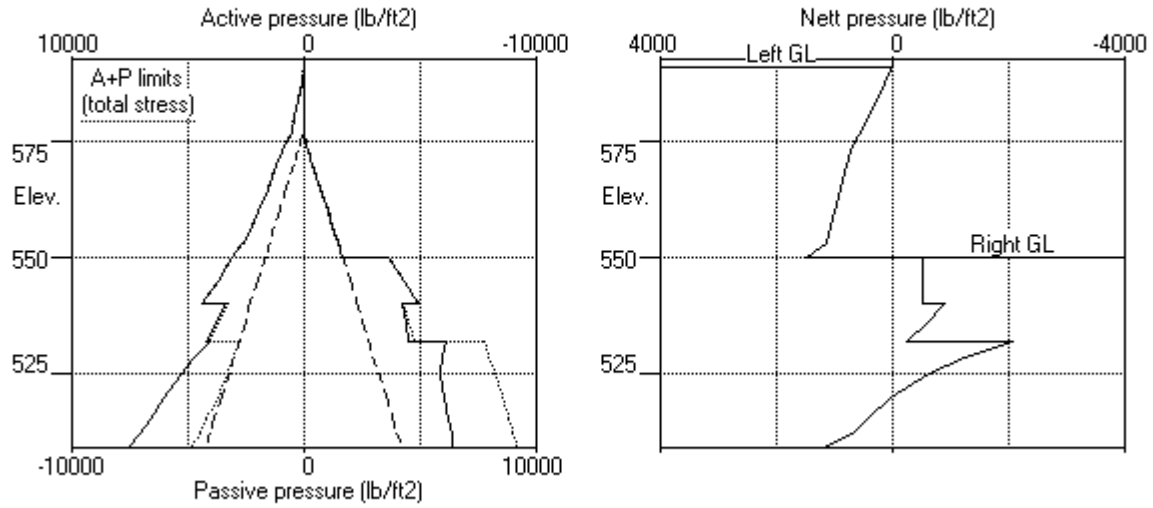
Note: 4400.00a Soil pressure at active limit
4246.40p Soil pressure at passive limit

Units: lb,ft

Stage No.8 Apply water pressure profile no.1

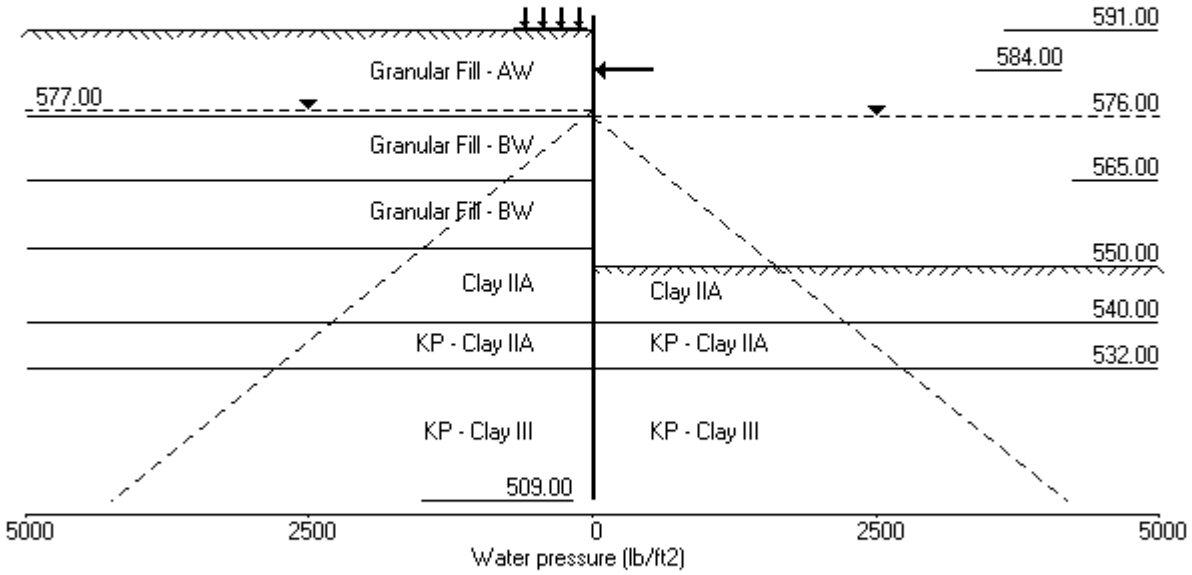


Stage No.8 Apply water pressure profile no.1



Units: lb,ft

Stage No.9 Apply surcharge no.1 at elev. 591.00



Units: lb,ft

Stage No. 9 Apply surcharge no.1 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
9	591.00	550.00	584.00	3.680	n/a	527.47	22.53	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.045	-2.79E-03	0.0	0.0		9.18E+08
2	591.00	0.00	0.050	-2.79E-03	0.0	-0.0		9.18E+08
		227.16	0.050	-2.79E-03	0.0	-0.0		
3	587.50	394.94	0.060	-2.79E-03	1088.7	1825.5		9.18E+08
4	584.00	537.71	0.070	-2.81E-03	2720.8	8477.6	-21036.5	9.18E+08
		537.71	0.070	-2.81E-03	-18315.7	8477.6		
5	580.50	662.10	0.080	-2.73E-03	-16216.1	-51924.1		9.18E+08
6	577.00	698.61	0.089	-2.43E-03	-13834.8	-104372.9		9.18E+08
7	576.00	768.10	0.091	-2.31E-03	-13101.5	-117893.6		9.18E+08
		990.60	0.091	-2.31E-03	-13101.5	-117893.6		
8	573.00	987.64	0.098	-1.87E-03	-10134.1	-152691.8		9.18E+08
9	570.00	986.14	0.102	-1.33E-03	-7173.4	-179062.3		9.18E+08
10	565.00	1003.31	0.107	-2.92E-04	-2199.8	-203139.1		9.18E+08
11	560.00	1087.19	0.105	8.07E-04	3026.4	-201019.6		9.18E+08
12	556.50	1147.23	0.101	1.53E-03	6936.6	-183589.9		9.18E+08
13	553.00	1208.18	0.095	2.17E-03	11058.6	-152123.7		9.18E+08
		1503.18	0.095	2.17E-03	11058.6	-152123.7		
14	550.00	1691.94	0.087	2.60E-03	15851.3	-111490.0		9.18E+08
		-308.06	0.087	2.60E-03	15851.3	-111490.0		
15	545.00	-328.25	0.073	3.01E-03	14260.5	-37399.5		9.18E+08
16	540.00	-345.19	0.058	3.03E-03	12576.9	28802.1		8.07E+08
		-839.69	0.058	3.03E-03	12576.9	28802.1		
17	536.00	-699.50	0.046	2.78E-03	9498.5	73248.3		8.07E+08
18	532.00	-454.96	0.036	2.34E-03	7189.6	105461.2		8.07E+08
		-2838.06	0.036	2.34E-03	7189.6	105461.2		
19	528.50	-1724.21	0.029	1.86E-03	-794.4	113129.8		8.07E+08
20	525.00	-865.85	0.023	1.40E-03	-5327.0	99697.8		8.07E+08
21	520.00	-19.94	0.017	9.07E-04	-7541.5	62037.9		8.07E+08
22	515.00	541.50	0.013	6.41E-04	-6237.6	23928.2		8.07E+08
23	512.00	964.48	0.011	5.83E-04	-3978.6	7623.3		8.07E+08
24	509.00	1687.91	0.010	5.68E-04	0.0	-0.0		---

At elev. 584.00 Prop force = 21036.5 lb/ft run

(continued)

Stage No.9 Apply surcharge no.1 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	227.16	227.16	663
3	587.50	0.00	952.47	292.65	3099.88	394.94	394.94	3981
4	584.00	0.00	1392.99	428.01	4533.62	537.71	537.71	7961
5	580.50	0.00	1820.14	559.25	5923.80	662.10	662.10	11942
6	577.00	0.00	2239.75	688.18	7289.45	698.61	698.61	15923
7	576.00	62.40	2296.75	705.70	7474.98	705.70	768.10a	17060
		62.40	2296.75	764.82	6890.26	928.20	990.60	6093
8	573.00	249.60	2438.09	811.88	7314.26	925.24	1174.84	7311
9	570.00	436.80	2581.18	859.53	7743.54	923.74	1360.54	8530
10	565.00	748.80	2825.54	940.91	8476.63	940.91	1689.71a	10561
11	560.00	1060.80	3077.45	1024.79	9232.34	1024.79	2085.59a	12592
12	556.50	1279.20	3257.74	1084.83	9773.21	1084.83	2364.03a	14014
13	553.00	1497.60	3440.78	1145.78	10322.33	1145.78	2643.38a	15435
		1497.60	3440.78	1440.78	5440.78	1440.78	2938.38a	44898
14	550.00	1684.80	3629.54	1629.54	5629.54	1629.54	3314.34a	44898
15	545.00	1996.80	3947.35	1947.35	5947.35	1947.35	3944.15a	44898
16	540.00	2308.80	4268.41	2268.41	6268.41	2268.41	4577.21a	44898
		2308.80	4268.41	1097.91	2000.00	1097.91	3406.71a	22449
17	536.00	2558.40	4527.14	1223.14	2000.00	1238.10	3796.50	22449
18	532.00	2808.00	4787.25	1349.03	2000.00	1447.44	4255.44	22449
		2808.00	4787.25	0.00	5000.00	1109.21	3917.21	56123
19	528.50	3026.40	5015.80	7.65	5000.00	1625.48	4651.88	56123
20	525.00	3244.80	5245.11	118.63	5000.00	2052.41	5297.21	56123
21	520.00	3556.80	5573.83	277.73	5000.00	2529.44	6086.24	56123
22	515.00	3868.80	5903.67	437.38	5000.00	2910.62	6779.42	56123
23	512.00	4056.00	6102.04	533.39	5000.00	3198.97	7254.97	348441
24	509.00	4243.20	6300.70	629.54	5000.00	3651.79	7894.99	348441

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	2000.00	3622.40p	84154
15	545.00	1934.40	338.00	0.00	2338.00	2338.00	4272.40p	84154
16	540.00	2246.40	676.00	0.00	2676.00	2676.00	4922.40p	84154
		2246.40	676.00	0.00	2000.00	2000.00	4246.40p	42077
17	536.00	2496.00	946.40	0.00	2000.00	2000.00	4496.00p	42077

(continued)

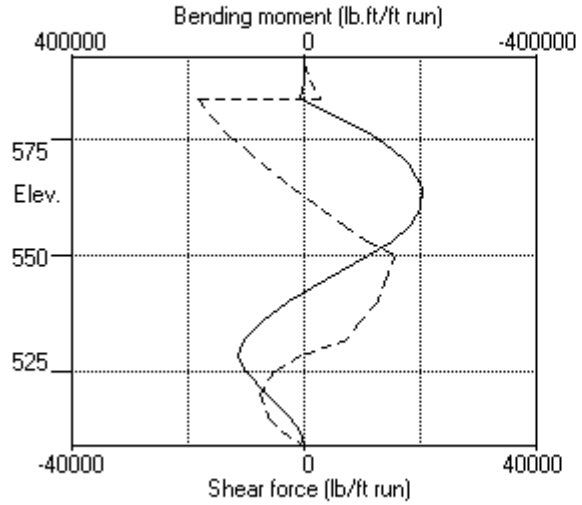
Stage No.9 Apply surcharge no.1 at elevation 591.00

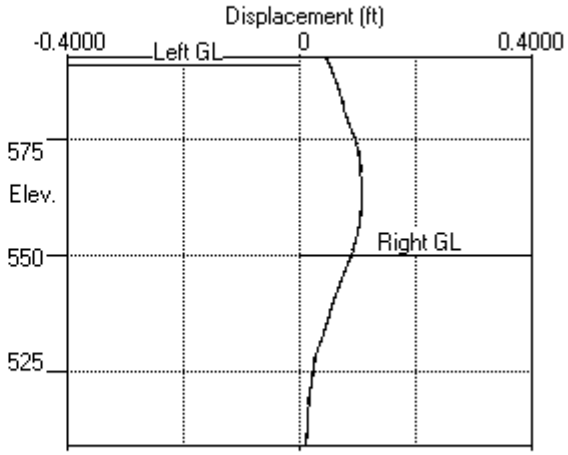
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	1964.80	4710.40	42077
		2745.60	1216.80	0.00	5000.00	4009.68	6755.28	105192
19	528.50	2964.00	1453.40	0.00	5000.00	3412.09	6376.09	105192
20	525.00	3182.40	1690.00	0.00	5000.00	2980.67	6163.07	105192
21	520.00	3494.40	2028.00	0.00	5000.00	2611.78	6106.18	105192
22	515.00	3806.40	2366.00	0.00	5000.00	2431.52	6237.92	105192
23	512.00	3993.60	2568.80	0.00	5000.00	2296.89	6290.49	348441
24	509.00	4180.80	2771.61	0.00	5000.00	2026.28	6207.08	348441

Note: 3406.71a Soil pressure at active limit
4496.00p Soil pressure at passive limit

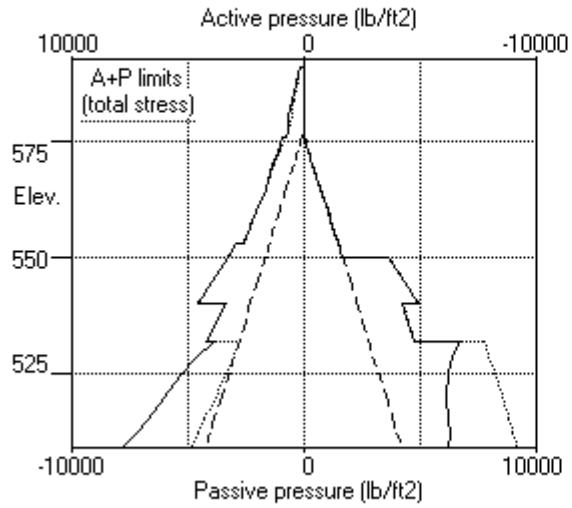
Units: lb,ft

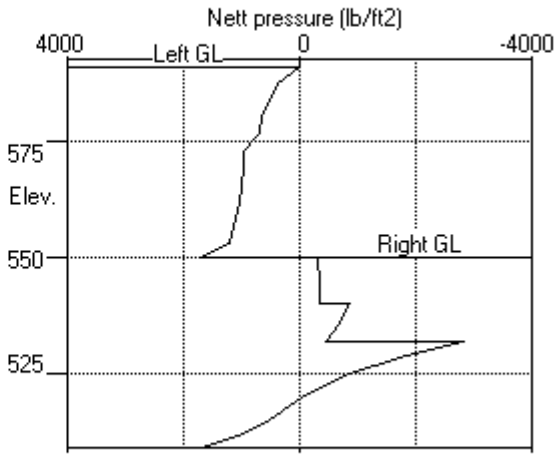
Stage No.9 Apply surcharge no.1 at elev. 591.00





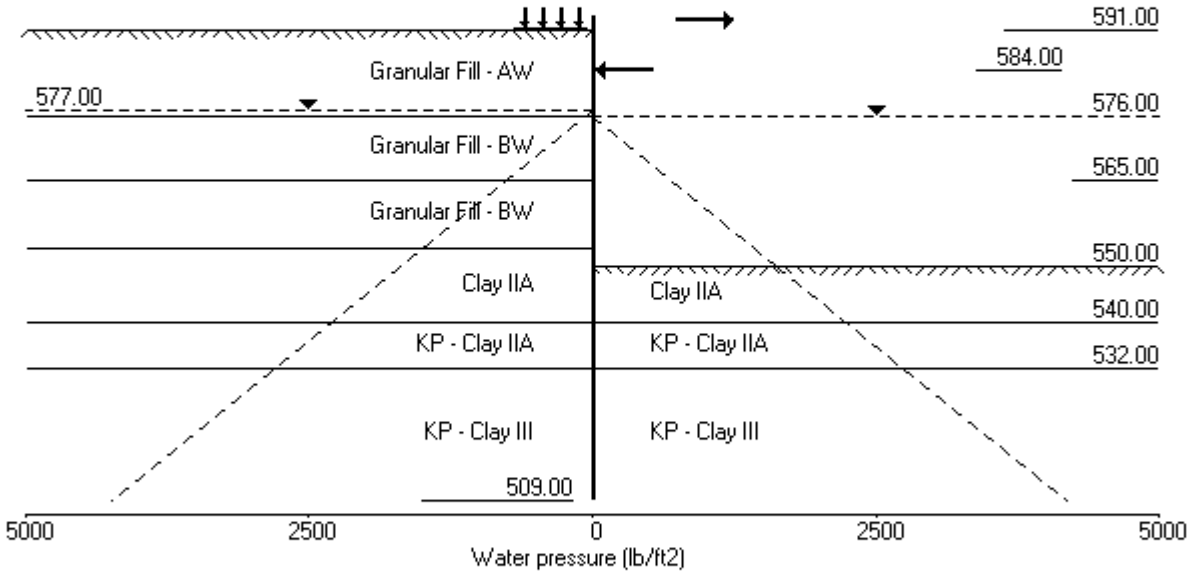
Stage No.9 Apply surcharge no.1 at elev. 591.00





Units: lb,ft

Stage No.10 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No. 10 Apply load no.1 at elevation 593.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
10	591.00	550.00	584.00	3.708	n/a	527.57	22.43	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.053	-2.34E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.057	-2.34E-03	2000.0	4000.0		9.18E+08
		214.89	0.057	-2.34E-03	2000.0	4000.0		
3	587.50	337.78	0.066	-2.37E-03	2967.2	12750.4		9.18E+08
4	584.00	453.21	0.074	-2.45E-03	4351.4	25627.0	-22598.6	9.18E+08
		453.21	0.074	-2.45E-03	-18247.2	25627.0		
5	580.50	573.16	0.083	-2.43E-03	-16451.0	-35052.3		9.18E+08
6	577.00	688.18	0.091	-2.19E-03	-14243.7	-88889.5		9.18E+08
7	576.00	768.10	0.093	-2.09E-03	-13515.6	-102822.5		9.18E+08
		964.64	0.093	-2.09E-03	-13515.6	-102822.5		
8	573.00	968.31	0.099	-1.69E-03	-10616.1	-138979.9		9.18E+08
9	570.00	974.27	0.103	-1.19E-03	-7702.3	-166883.5		9.18E+08
10	565.00	1003.31	0.107	-2.18E-04	-2758.4	-193752.9		9.18E+08
11	560.00	1092.27	0.105	8.37E-04	2480.6	-194426.0		9.18E+08
12	556.50	1154.39	0.101	1.54E-03	6412.3	-178875.5		9.18E+08
13	553.00	1216.18	0.094	2.17E-03	10560.8	-149200.7		9.18E+08
		1525.23	0.094	2.17E-03	10560.8	-149200.7		
14	550.00	1712.11	0.087	2.59E-03	15416.7	-109961.4		9.18E+08
		-256.53	0.087	2.59E-03	15416.7	-109961.4		
15	545.00	-289.93	0.073	2.99E-03	14050.6	-37399.4		9.18E+08
16	540.00	-320.83	0.058	3.02E-03	12523.7	28231.6		8.07E+08
		-827.51	0.058	3.02E-03	12523.7	28231.6		
17	536.00	-692.03	0.046	2.77E-03	9484.6	72562.3		8.07E+08
18	532.00	-451.07	0.036	2.33E-03	7198.4	104779.1		8.07E+08
		-2828.33	0.036	2.33E-03	7198.4	104779.1		
19	528.50	-1719.98	0.028	1.86E-03	-761.1	112538.0		8.07E+08
20	525.00	-865.21	0.023	1.40E-03	-5285.2	99248.3		8.07E+08
21	520.00	-22.22	0.017	9.06E-04	-7503.8	61805.2		8.07E+08
22	515.00	538.00	0.013	6.40E-04	-6214.3	23855.4		8.07E+08
23	512.00	960.60	0.012	5.82E-04	-3966.5	7604.4		8.07E+08
24	509.00	1683.71	0.010	5.68E-04	0.0	-0.0		---

At elev. 584.00 Prop force = 22598.6 lb/ft run

(continued)

Stage No.10 Apply load no.1 at elevation 593.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	214.89	214.89	1803
3	587.50	0.00	952.47	292.65	3099.88	337.78	337.78	10818
4	584.00	0.00	1392.99	428.01	4533.62	453.21	453.21	21636
5	580.50	0.00	1820.14	559.25	5923.80	573.16	573.16	32454
6	577.00	0.00	2239.75	688.18	7289.45	688.18	688.18a	43272
7	576.00	62.40	2296.75	705.70	7474.98	705.70	768.10a	46363
		62.40	2296.75	764.82	6890.26	902.24	964.64	16558
8	573.00	249.60	2438.09	811.88	7314.26	905.91	1155.51	19870
9	570.00	436.80	2581.18	859.53	7743.54	911.87	1348.67	23182
10	565.00	748.80	2825.54	940.91	8476.63	940.91	1689.71a	16690
11	560.00	1060.80	3077.45	1024.79	9232.34	1029.87	2090.67	19900
12	556.50	1279.20	3257.74	1084.83	9773.21	1091.99	2371.19	22147
13	553.00	1497.60	3440.78	1145.78	10322.33	1153.78	2651.38	24394
		1497.60	3440.78	1440.78	5440.78	1462.83	2960.43	67208
14	550.00	1684.80	3629.54	1629.54	5629.54	1649.71	3334.51	67208
15	545.00	1996.80	3947.35	1947.35	5947.35	1962.34	3959.14	67208
16	540.00	2308.80	4268.41	2268.41	6268.41	2277.94	4586.74	67208
		2308.80	4268.41	1097.91	2000.00	1102.68	3411.48	33604
17	536.00	2558.40	4527.14	1223.14	2000.00	1241.03	3799.43	33604
18	532.00	2808.00	4787.25	1349.03	2000.00	1448.96	4256.96	33604
		2808.00	4787.25	0.00	5000.00	1113.02	3921.02	84010
19	528.50	3026.40	5015.80	7.65	5000.00	1627.14	4653.54	84010
20	525.00	3244.80	5245.11	118.63	5000.00	2052.67	5297.47	84010
21	520.00	3556.80	5573.83	277.73	5000.00	2528.30	6085.10	117693
22	515.00	3868.80	5903.67	437.38	5000.00	2908.87	6777.67	117693
23	512.00	4056.00	6102.04	533.39	5000.00	3197.03	7253.03	117693
24	509.00	4243.20	6300.70	629.54	5000.00	3649.69	7892.89	117693

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	1968.63	3591.03	104553
15	545.00	1934.40	338.00	0.00	2338.00	2314.68	4249.08	104553
16	540.00	2246.40	676.00	0.00	2676.00	2661.17	4907.57	104553
		2246.40	676.00	0.00	2000.00	1992.59	4238.99	52276
17	536.00	2496.00	946.40	0.00	2000.00	1995.45	4491.45	52276

(continued)

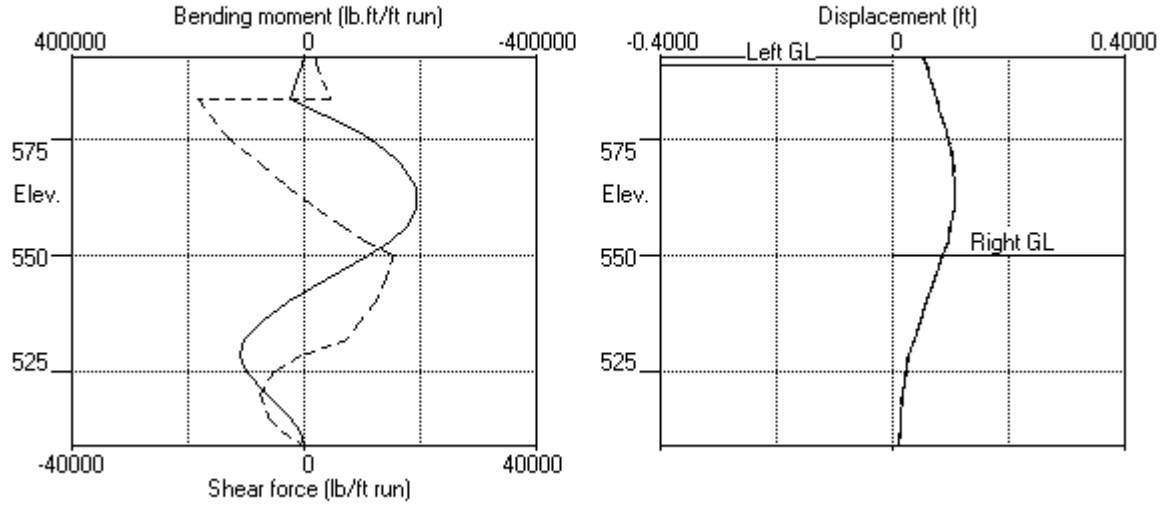
Stage No.10 Apply load no.1 at elevation 593.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	1962.43	4708.03	52276
		2745.60	1216.80	0.00	5000.00	4003.76	6749.36	130691
19	528.50	2964.00	1453.40	0.00	5000.00	3409.52	6373.52	130691
20	525.00	3182.40	1690.00	0.00	5000.00	2980.28	6162.68	130691
21	520.00	3494.40	2028.00	0.00	5000.00	2612.92	6107.32	117693
22	515.00	3806.40	2366.00	0.00	5000.00	2433.27	6239.67	117693
23	512.00	3993.60	2568.80	0.00	5000.00	2298.83	6292.43	117693
24	509.00	4180.80	2771.61	0.00	5000.00	2028.38	6209.18	117693

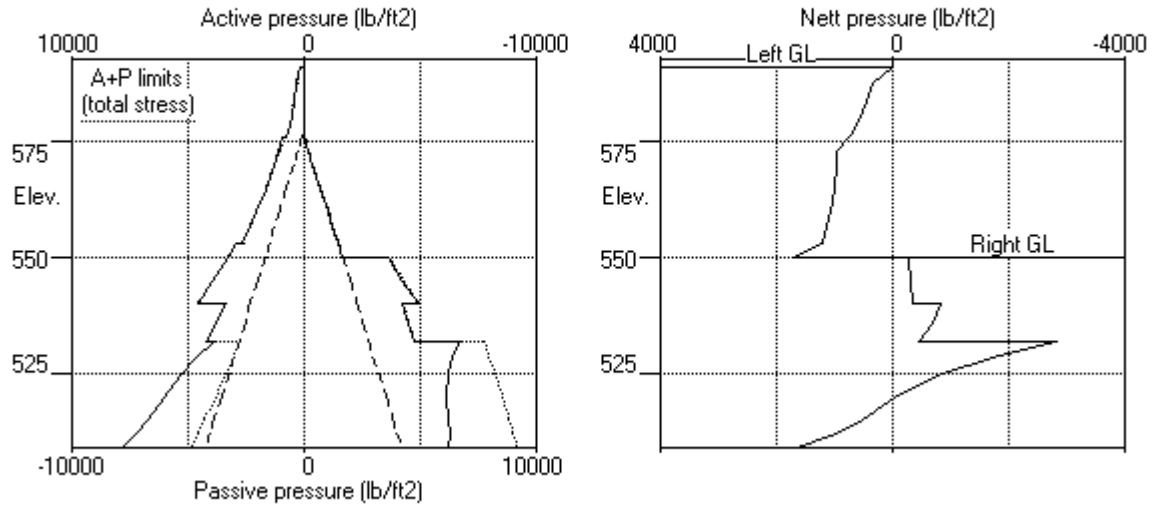
Note: 1689.71a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.10 Apply load no.1 at elev. 593.00

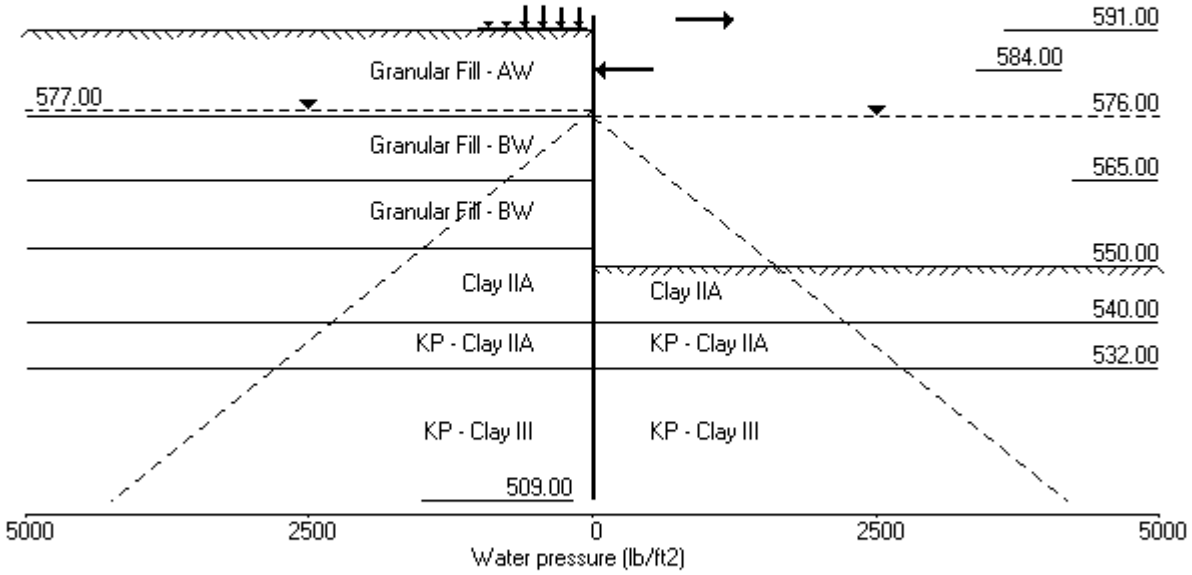


Stage No.10 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No.11 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No. 11 Apply surcharge no.4 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
11	591.00	550.00	584.00	3.700	n/a	527.55	22.45	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.053	-2.34E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.057	-2.35E-03	2000.0	4000.0		9.18E+08
		214.82	0.057	-2.35E-03	2000.0	4000.0		
3	587.50	337.92	0.066	-2.38E-03	2967.3	12751.1		9.18E+08
4	584.00	454.47	0.074	-2.45E-03	4354.0	25632.6	-22642.9	9.18E+08
		454.47	0.074	-2.45E-03	-18288.9	25632.6		
5	580.50	575.13	0.083	-2.43E-03	-16487.1	-35182.5		9.18E+08
6	577.00	690.21	0.091	-2.20E-03	-14272.8	-89132.5		9.18E+08
7	576.00	770.05	0.093	-2.09E-03	-13542.7	-103093.5		9.18E+08
		968.19	0.093	-2.09E-03	-13542.7	-103093.5		
8	573.00	971.87	0.099	-1.70E-03	-10632.6	-139315.9		9.18E+08
9	570.00	977.68	0.103	-1.19E-03	-7708.2	-167252.7		9.18E+08
10	565.00	1006.33	0.107	-2.16E-04	-2748.2	-194109.7		9.18E+08
11	560.00	1094.92	0.105	8.41E-04	2504.9	-194695.5		9.18E+08
12	556.50	1156.85	0.101	1.55E-03	6445.5	-179044.1		9.18E+08
13	553.00	1218.54	0.094	2.17E-03	10602.5	-149238.3		9.18E+08
		1524.64	0.094	2.17E-03	10602.5	-149238.3		
14	550.00	1712.03	0.087	2.60E-03	15457.5	-109876.7		9.18E+08
		-264.33	0.087	2.60E-03	15457.5	-109876.7		
15	545.00	-294.84	0.073	3.00E-03	14059.5	-37209.7		9.18E+08
16	540.00	-323.49	0.058	3.02E-03	12513.7	28403.6		8.07E+08
		-827.22	0.058	3.02E-03	12513.7	28403.6		
17	536.00	-691.17	0.046	2.77E-03	9476.9	72696.2		8.07E+08
18	532.00	-449.82	0.036	2.33E-03	7195.0	104888.9		8.07E+08
		-2829.57	0.036	2.33E-03	7195.0	104888.9		
19	528.50	-1720.46	0.029	1.86E-03	-767.6	112627.9		8.07E+08
20	525.00	-865.18	0.023	1.40E-03	-5292.5	99312.3		8.07E+08
21	520.00	-21.72	0.017	9.06E-04	-7509.7	61832.6		8.07E+08
22	515.00	538.81	0.013	6.41E-04	-6217.0	23858.6		8.07E+08
23	512.00	961.59	0.012	5.82E-04	-3966.4	7603.2		8.07E+08
24	509.00	1682.68	0.010	5.68E-04	0.0	-0.0		---

At elev. 584.00 Prop force = 22642.9 lb/ft run

(continued)

Stage No.11 Apply surcharge no.4 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	214.82	214.82	715
3	587.50	0.00	953.04	292.83	3101.75	337.92	337.92	4287
4	584.00	0.00	1395.20	428.69	4540.80	454.47	454.47	8574
5	580.50	0.00	1823.69	560.34	5935.35	575.13	575.13	12861
6	577.00	0.00	2244.06	689.51	7303.48	690.21	690.21	17148
7	576.00	62.40	2301.20	707.06	7489.45	707.65	770.05	18373
		62.40	2301.20	766.30	6903.59	905.79	968.19	6562
8	573.00	249.60	2442.76	813.44	7328.28	909.47	1159.07	7874
9	570.00	436.80	2585.91	861.11	7757.73	915.28	1352.08	9187
10	565.00	748.80	2830.14	942.44	8490.42	943.93	1692.73	11374
11	560.00	1060.80	3081.79	1026.24	9245.37	1032.52	2093.32	13561
12	556.50	1279.20	3261.87	1086.20	9785.62	1094.45	2373.65	15092
13	553.00	1497.60	3444.71	1147.09	10334.13	1156.14	2653.74	16623
		1497.60	3444.71	1444.71	5444.71	1462.24	2959.84	47742
14	550.00	1684.80	3633.30	1633.30	5633.30	1649.63	3334.43	47742
15	545.00	1996.80	3950.84	1950.84	5950.84	1963.05	3959.85	47742
16	540.00	2308.80	4271.65	2271.65	6271.65	2279.23	4588.03	47742
		2308.80	4271.65	1099.48	2000.00	1104.94	3413.74	23871
17	536.00	2558.40	4530.21	1224.62	2000.00	1243.36	3801.76	23871
18	532.00	2808.00	4790.15	1350.43	2000.00	1451.32	4259.32	23871
		2808.00	4790.15	0.00	5000.00	1114.55	3922.55	59678
19	528.50	3026.40	5018.57	8.99	5000.00	1628.83	4655.23	59678
20	525.00	3244.80	5247.76	119.91	5000.00	2054.45	5299.25	59678
21	520.00	3556.80	5576.32	278.94	5000.00	2530.13	6086.93	59678
22	515.00	3868.80	5906.02	438.51	5000.00	2910.71	6779.51	59678
23	512.00	4056.00	6104.31	534.48	5000.00	3198.87	7254.87	59678
24	509.00	4243.20	6302.90	630.60	5000.00	3649.35	7892.55	59678

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	1976.36	3598.76	96307
15	545.00	1934.40	338.00	0.00	2338.00	2320.29	4254.69	96307
16	540.00	2246.40	676.00	0.00	2676.00	2665.12	4911.52	96307
		2246.40	676.00	0.00	2000.00	1994.56	4240.96	48153
17	536.00	2496.00	946.40	0.00	2000.00	1996.93	4492.93	48153

(continued)

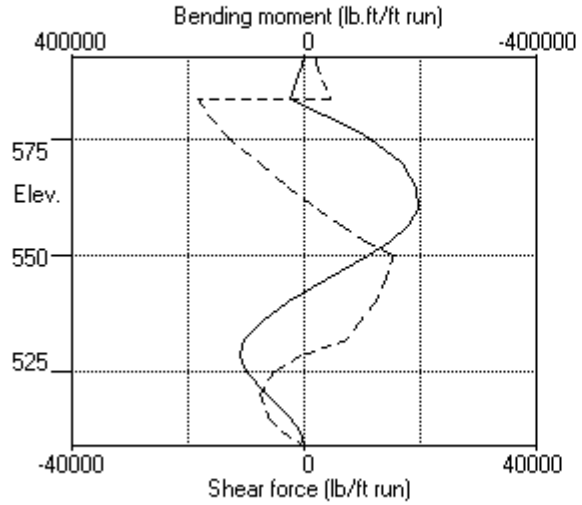
Stage No.11 Apply surcharge no.4 at elevation 591.00

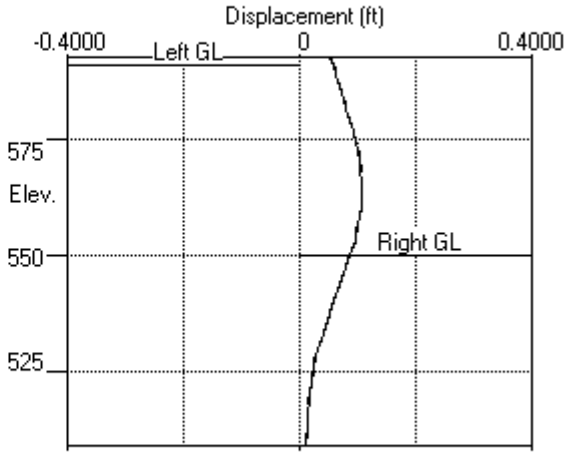
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	1963.54	4709.14	48153
		2745.60	1216.80	0.00	5000.00	4006.52	6752.12	120384
19	528.50	2964.00	1453.40	0.00	5000.00	3411.69	6375.69	120384
20	525.00	3182.40	1690.00	0.00	5000.00	2982.03	6164.43	120384
21	520.00	3494.40	2028.00	0.00	5000.00	2614.25	6108.65	120384
22	515.00	3806.40	2366.00	0.00	5000.00	2434.29	6240.69	120384
23	512.00	3993.60	2568.80	0.00	5000.00	2299.68	6293.28	120384
24	509.00	4180.80	2771.61	0.00	5000.00	2029.06	6209.86	120384

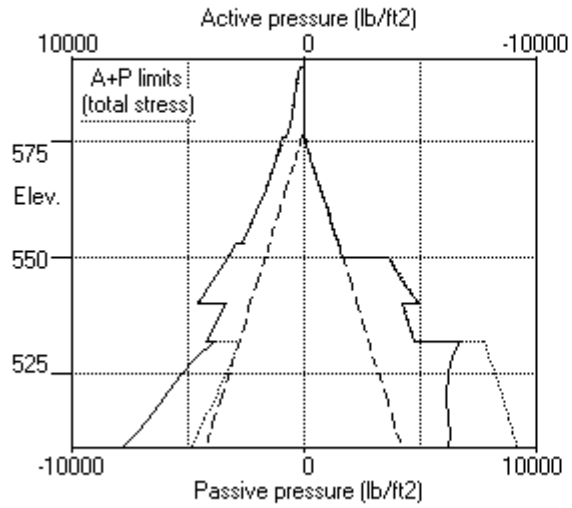
Units: lb,ft

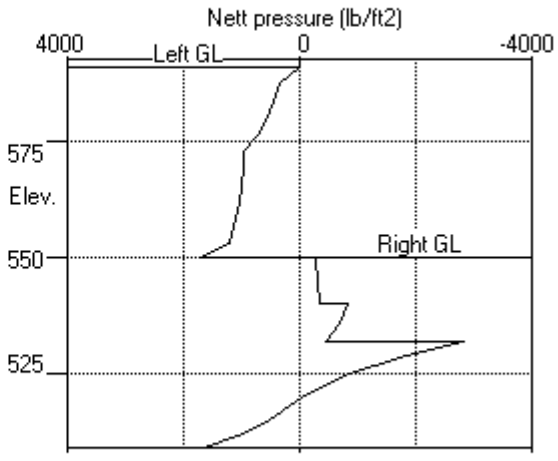
Stage No.11 Apply surcharge no.4 at elev. 591.00





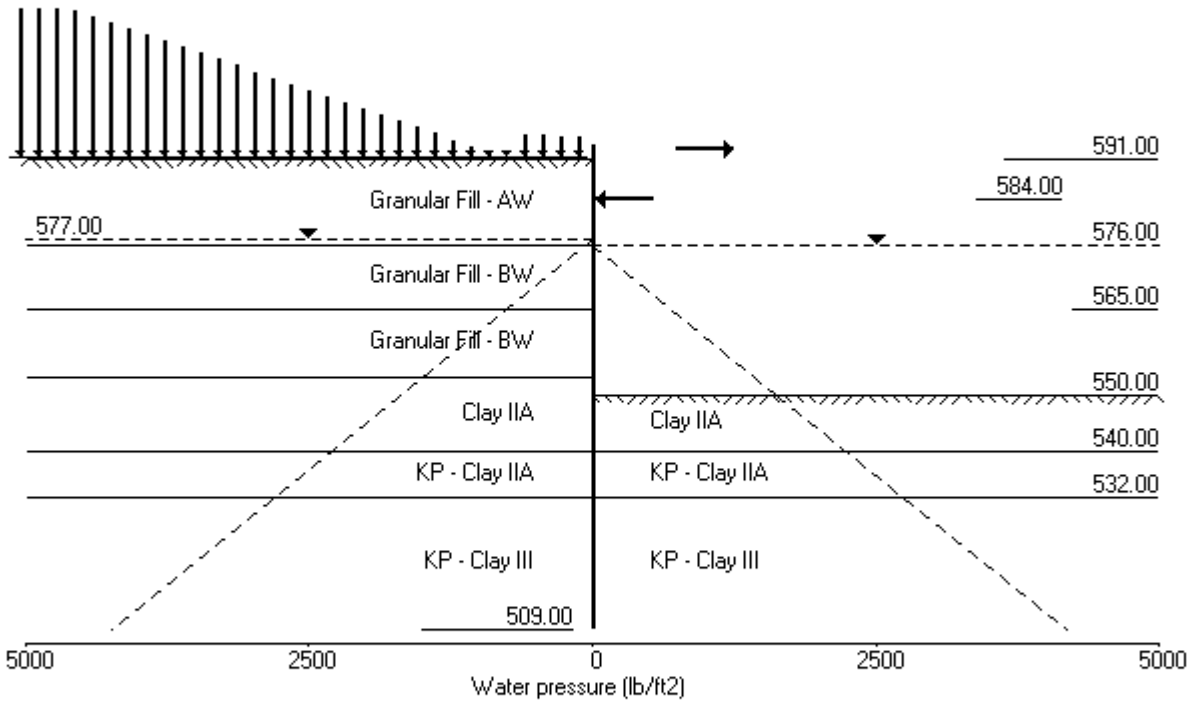
Stage No.11 Apply surcharge no.4 at elev. 591.00





Units: lb,ft

Stage No.13 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No. 13 Apply surcharge no.3 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
13	591.00	550.00	584.00	2.432	n/a	523.60	26.40	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.046	-3.86E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.054	-3.86E-03	2000.0	4000.0		9.18E+08
		231.54	0.054	-3.86E-03	2000.0	4000.0		
3	587.50	332.08	0.067	-3.89E-03	2986.3	12856.9		9.18E+08
4	584.00	432.36	0.081	-3.97E-03	4324.1	25720.6	-25477.9	9.18E+08
		432.36	0.081	-3.97E-03	-21153.8	25720.6		
5	580.50	571.20	0.095	-3.93E-03	-19397.6	-45219.8		9.18E+08
6	577.00	711.58	0.108	-3.64E-03	-17152.7	-109328.6		9.18E+08
7	576.00	795.39	0.112	-3.51E-03	-16399.2	-126158.2		9.18E+08
		930.86	0.112	-3.51E-03	-16399.2	-126158.2		
8	573.00	920.72	0.122	-3.02E-03	-13621.8	-171054.7		9.18E+08
9	570.00	981.66	0.130	-2.40E-03	-10768.3	-208373.5		9.18E+08
10	565.00	1092.49	0.139	-1.15E-03	-5582.9	-250138.5		9.18E+08
11	560.00	1207.93	0.141	2.38E-04	168.1	-263708.9		9.18E+08
12	556.50	1290.66	0.139	1.22E-03	4540.7	-255501.5		9.18E+08
13	553.00	1374.47	0.133	2.15E-03	9204.6	-231498.0		9.18E+08
		2002.54	0.133	2.15E-03	9204.6	-231498.0		
14	550.00	2250.03	0.125	2.85E-03	15583.5	-194089.3		9.18E+08
		250.03	0.125	2.85E-03	15583.5	-194089.3		
15	545.00	326.59	0.109	3.68E-03	17025.0	-113916.8		9.18E+08
16	540.00	404.08	0.089	4.06E-03	18851.7	-25266.0		8.07E+08
		-477.04	0.089	4.06E-03	18851.7	-25266.0		
17	536.00	-316.32	0.073	4.01E-03	17264.9	47245.7		8.07E+08
18	532.00	-156.04	0.058	3.61E-03	16320.2	113372.9		8.07E+08
		-4203.59	0.058	3.61E-03	16320.2	113372.9		
19	528.50	-3253.99	0.046	3.05E-03	3269.4	146785.8		8.07E+08
20	525.00	-1784.34	0.036	2.43E-03	-5547.6	138325.9		8.07E+08
21	520.00	-202.15	0.026	1.73E-03	-10513.9	88412.9		8.07E+08
22	515.00	870.02	0.018	1.35E-03	-8844.2	33024.6		8.07E+08
23	512.00	1441.50	0.014	1.27E-03	-5376.9	10148.9		8.07E+08
24	509.00	2143.13	0.011	1.25E-03	0.0	-0.0		---

At elev. 584.00 Prop force = 25477.9 lb/ft run

(continued)

Stage No.13 Apply surcharge no.3 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	231.54	231.54	4745
3	587.50	0.00	954.67	293.33	3107.07	332.08	332.08	4196
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	8393
5	580.50	0.00	1859.04	571.20	6050.40	571.20	571.20a	12589
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	16786
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	17985
		62.40	2385.59	794.40	7156.77	868.46	930.86	6423
8	573.00	249.60	2569.43	855.62	7708.30	858.32	1107.92	7708
9	570.00	436.80	2760.54	919.26	8281.61	919.26	1356.06a	8992
10	565.00	748.80	3093.36	1030.09	9280.08	1030.09	1778.89a	11133
11	560.00	1060.80	3440.02	1145.53	10320.06	1145.53	2206.33a	13274
12	556.50	1279.20	3688.46	1228.26	11065.37	1228.26	2507.46a	14773
13	553.00	1497.60	3940.14	1312.07	11820.41	1312.07	2809.67a	16272
		1497.60	3940.14	1940.14	5940.14	1940.14	3437.74a	46893
14	550.00	1684.80	4187.63	2187.63	6187.63	2187.63	3872.43a	46893
15	545.00	1996.80	4602.19	2602.19	6602.19	2602.19	4598.99a	46893
16	540.00	2308.80	5017.68	3017.68	7017.68	3017.68	5326.48a	46893
		2308.80	5017.68	1460.56	2000.00	1460.56	3769.36a	23446
17	536.00	2558.40	5349.74	1621.28	2000.00	1621.28	4179.68a	23446
18	532.00	2808.00	5680.91	1781.56	2000.00	1781.56	4589.56a	23446
		2808.00	5680.91	329.56	5000.00	734.01	3542.01	58616
19	528.50	3026.40	5969.62	469.30	5000.00	1563.37	4589.77	58616
20	525.00	3244.80	6257.10	608.43	5000.00	2274.78	5519.58	58616
21	520.00	3556.80	6665.33	806.02	5000.00	3099.77	6656.57	58616
22	515.00	3868.80	7070.37	1002.06	5000.00	3670.03	7538.83	58616
23	512.00	4056.00	7311.76	1118.89	5000.00	3928.79	7984.79	58616
24	509.00	4243.20	7551.89	1235.11	5000.00	4184.73	8427.93	58616

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	2000.00	2000.00	3622.40p	67723
15	545.00	1934.40	338.00	0.00	2338.00	2338.00	4272.40p	67723
16	540.00	2246.40	676.00	0.00	2676.00	2676.00	4922.40p	67723
		2246.40	676.00	0.00	2000.00	2000.00	4246.40p	33862
17	536.00	2496.00	946.40	0.00	2000.00	2000.00	4496.00p	33862

(continued)

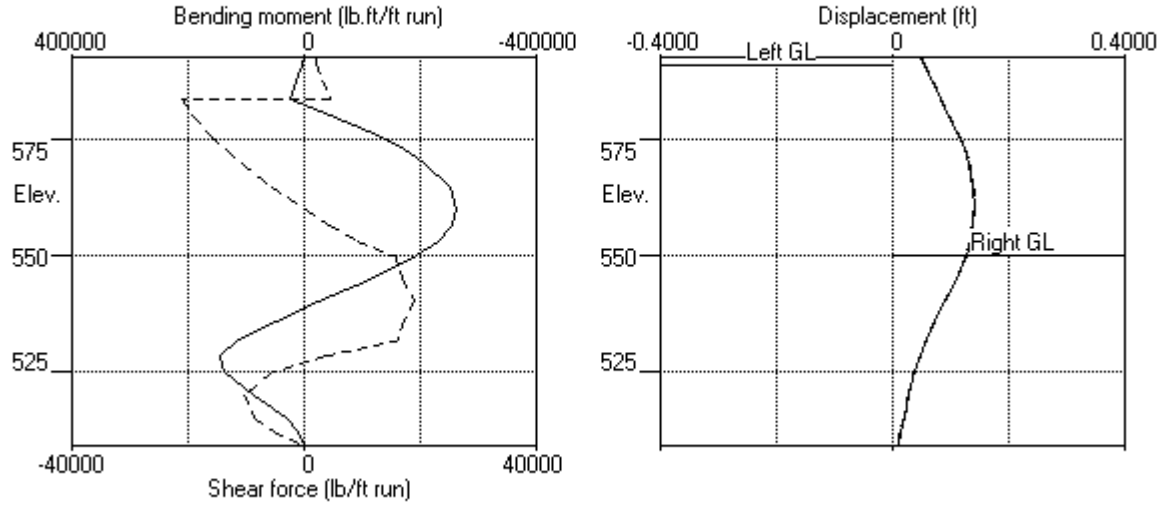
Stage No.13 Apply surcharge no.3 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
18	532.00	2745.60	1216.80	0.00	2000.00	2000.00	4745.60p	33862
		2745.60	1216.80	0.00	5000.00	5000.00	7745.60p	84654
19	528.50	2964.00	1453.40	0.00	5000.00	4879.76	7843.76	84654
20	525.00	3182.40	1690.00	0.00	5000.00	4121.52	7303.92	84654
21	520.00	3494.40	2028.00	0.00	5000.00	3364.33	6858.73	84654
22	515.00	3806.40	2366.00	0.00	5000.00	2862.42	6668.82	84654
23	512.00	3993.60	2568.80	0.00	5000.00	2549.69	6543.29	84654
24	509.00	4180.80	2771.61	0.00	5000.00	2103.99	6284.79	84654

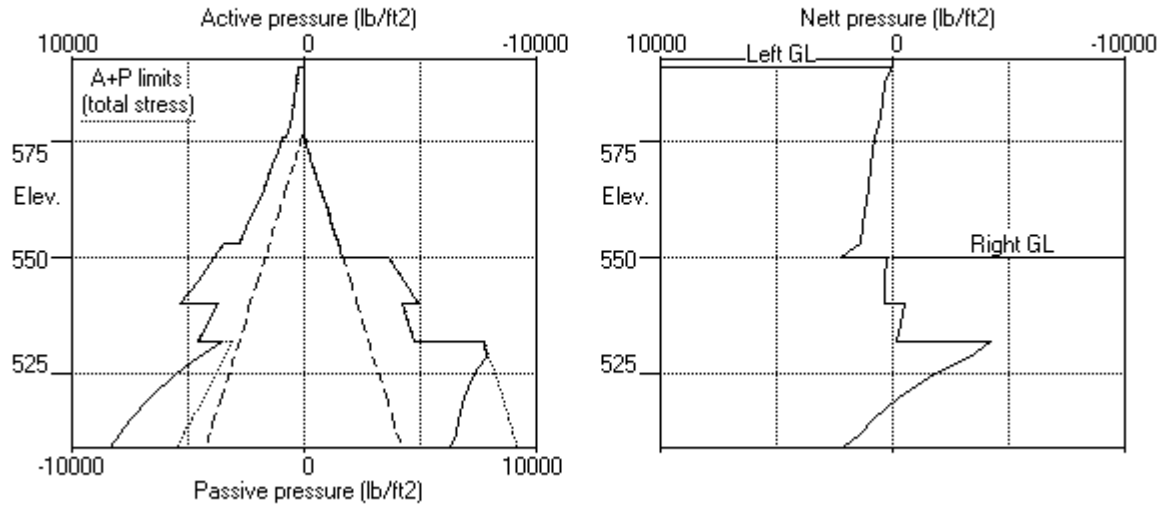
Note: 4589.56a Soil pressure at active limit
7745.60p Soil pressure at passive limit

Units: lb,ft

Stage No.13 Apply surcharge no.3 at elev. 591.00

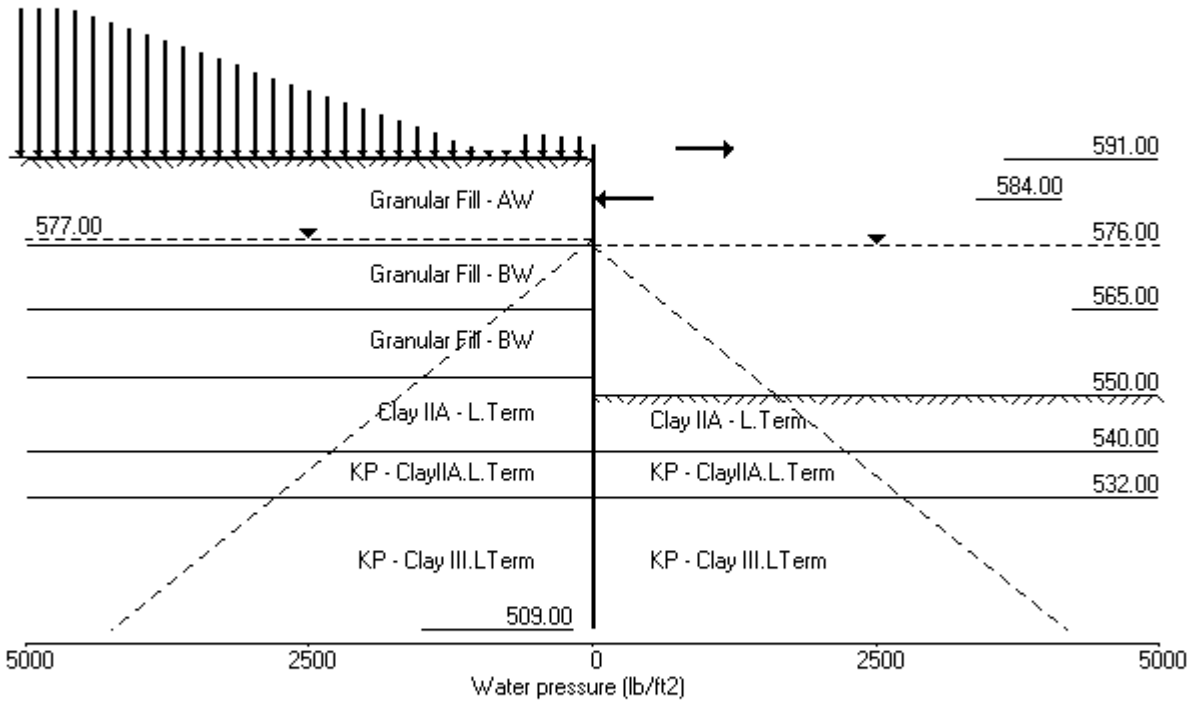


Stage No.13 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No.16 Change soil type 8 to soil type 9



Units: lb,ft

Stage No. 16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
16	591.00	550.00	584.00	2.378	n/a	520.97	29.03	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.011	-9.37E-03	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.030	-9.37E-03	2000.0	4000.0		9.18E+08
		347.45	0.030	-9.37E-03	2000.0	4000.0		
3	587.50	473.65	0.062	-9.41E-03	3436.9	13566.8		9.18E+08
4	584.00	432.36	0.096	-9.49E-03	5022.4	28874.7	-31227.4	9.18E+08
		432.36	0.096	-9.49E-03	-26205.0	28874.7		
5	580.50	571.20	0.129	-9.43E-03	-24448.8	-59745.0		9.18E+08
6	577.00	711.58	0.161	-9.04E-03	-22203.9	-141533.2		9.18E+08
7	576.00	795.39	0.170	-8.88E-03	-21450.4	-163414.0		9.18E+08
		856.80	0.170	-8.88E-03	-21450.4	-163414.0		
8	573.00	918.02	0.196	-8.25E-03	-18788.2	-223690.4		9.18E+08
9	570.00	981.66	0.219	-7.43E-03	-15938.7	-276516.4		9.18E+08
10	565.00	1092.49	0.253	-5.74E-03	-10753.3	-344133.4		9.18E+08
11	560.00	1207.93	0.276	-3.76E-03	-5002.3	-383555.8		9.18E+08
12	556.50	1290.66	0.287	-2.28E-03	-629.8	-393444.9		9.18E+08
13	553.00	1374.47	0.292	-7.98E-04	4034.2	-387537.8		9.18E+08
		1734.21	0.292	-7.98E-04	4034.2	-387537.8		
14	550.00	1968.14	0.293	4.33E-04	9587.7	-366847.8		9.18E+08
15	545.00	1500.78	0.286	2.24E-03	18260.0	-297375.9		9.18E+08
16	540.00	1042.52	0.271	3.56E-03	24618.3	-190071.1		8.07E+08
		-427.16	0.271	3.56E-03	24618.3	-190071.1		
17	536.00	-793.91	0.256	4.27E-03	22176.1	-94810.6		8.07E+08
18	532.00	-627.36	0.238	4.53E-03	19333.6	-12859.2		8.07E+08
		-1980.13	0.238	4.53E-03	19333.6	-12859.2		
19	528.50	-2404.42	0.222	4.47E-03	11660.6	42543.1		8.07E+08
20	525.00	-2288.98	0.207	4.24E-03	3447.2	65870.8		8.07E+08
21	520.00	-813.06	0.186	3.86E-03	-4307.9	55484.5		8.07E+08
22	515.00	301.20	0.168	3.62E-03	-5587.6	23489.4		8.07E+08
23	512.00	898.69	0.157	3.56E-03	-3787.8	7823.9		8.07E+08
24	509.00	1626.48	0.146	3.54E-03	0.0	0.0		---

At elev. 584.00 Prop force = 31227.4 lb/ft run

(continued)

Stage No.16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	347.45	347.45	4785
3	587.50	0.00	954.67	293.33	3107.07	473.65	473.65	28713
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	7491
5	580.50	0.00	1859.04	571.20	6050.40	571.20	571.20a	11237
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	14982
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	16052
		62.40	2385.59	794.40	7156.77	794.40	856.80a	5733
8	573.00	249.60	2569.43	855.62	7708.30	855.62	1105.22a	6880
9	570.00	436.80	2760.54	919.26	8281.61	919.26	1356.06a	8026
10	565.00	748.80	3093.36	1030.09	9280.08	1030.09	1778.89a	9937
11	560.00	1060.80	3440.02	1145.53	10320.06	1145.53	2206.33a	11848
12	556.50	1279.20	3688.46	1228.26	11065.37	1228.26	2507.46a	13186
13	553.00	1497.60	3940.14	1312.07	11820.41	1312.07	2809.67a	14523
		1497.60	3940.14	1538.47	10090.97	1671.81	3169.41	1681
14	550.00	1684.80	4187.63	1635.11	10724.80	1905.74	3590.54	1681
15	545.00	1996.80	4602.19	1796.98	11786.53	2304.02	4300.82	1681
16	540.00	2308.80	5017.68	1959.21	12850.63	2711.40	5020.20	1681
		2308.80	5017.68	948.34	12850.27	1241.67	3550.47	1201
17	536.00	2558.40	5349.74	1011.10	13700.70	1401.86	3960.26	1201
18	532.00	2808.00	5680.91	1073.69	14548.82	1565.03	4373.03	1201
		2808.00	5680.91	1073.69	14548.82	1073.69	3881.69a	1749
19	528.50	3026.40	5969.62	1128.26	15288.19	1255.34	4281.74	1749
20	525.00	3244.80	6257.10	1182.59	16024.43	1976.71	5221.51	1749
21	520.00	3556.80	6665.33	1259.75	17069.91	2819.11	6375.91	1749
22	515.00	3868.80	7070.37	1336.30	18107.21	3408.71	7277.51	1749
23	512.00	4056.00	7311.76	1381.92	18725.42	3679.41	7735.41	1749
24	509.00	4243.20	7551.89	1427.31	19340.38	3947.36	8190.56	1749

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	580.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	565.00	686.40	0.00	0.00	0.00	0.00	686.40	0.0
11	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
12	556.50	1216.80	0.00	0.00	0.00	0.00	1216.80	0.0
13	553.00	1435.20	0.00	0.00	0.00	0.00	1435.20	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	1920
15	545.00	1934.40	338.00	131.98	865.64	865.64	2800.04p	1920
16	540.00	2246.40	676.00	263.95	1731.28	1731.28	3977.68p	1920
		2246.40	676.00	127.76	1731.24	1731.24	3977.64p	1414

(continued)

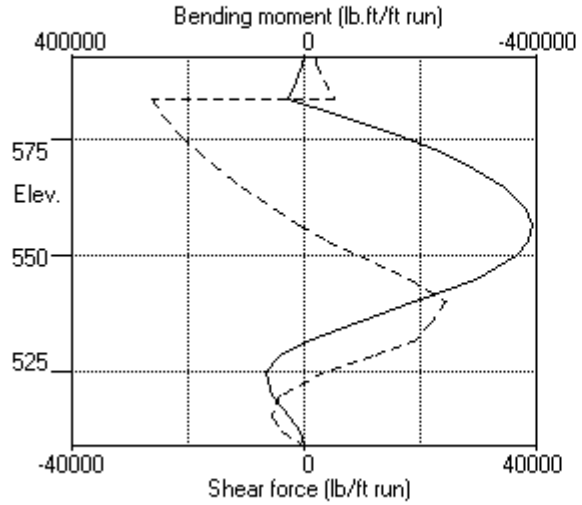
Stage No.16 Change properties of soil type 8 to soil type 9
Ko pressures will not be reset

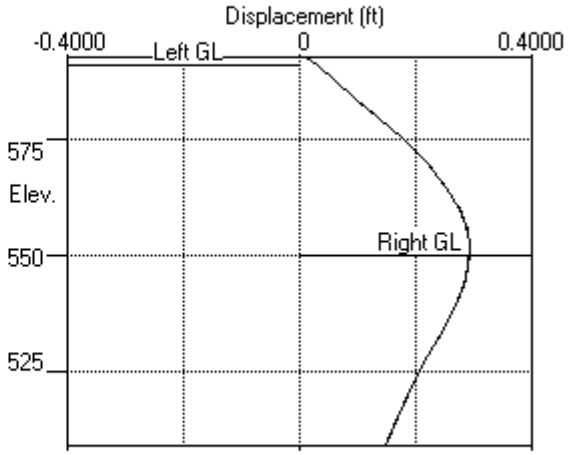
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
17	536.00	2496.00	946.40	178.87	2423.73	2258.17	4754.17	1414
18	532.00	2745.60	1216.80	229.98	3116.23	2254.79	5000.39	1414
		2745.60	1216.80	229.98	3116.23	3116.23	5861.83p	2058
19	528.50	2964.00	1453.40	274.69	3722.16	3722.16	6686.16p	2058
20	525.00	3182.40	1690.00	319.41	4328.09	4328.09	7510.49p	2058
21	520.00	3494.40	2028.00	383.29	5193.71	3694.57	7188.97	2058
22	515.00	3806.40	2366.00	447.17	6059.34	3169.91	6976.31	2058
23	512.00	3993.60	2568.80	485.50	6578.71	2843.12	6836.72	2058
24	509.00	4180.80	2771.61	523.83	7098.08	2383.29	6564.09	2058

Note: 3881.69a Soil pressure at active limit
7510.49p Soil pressure at passive limit

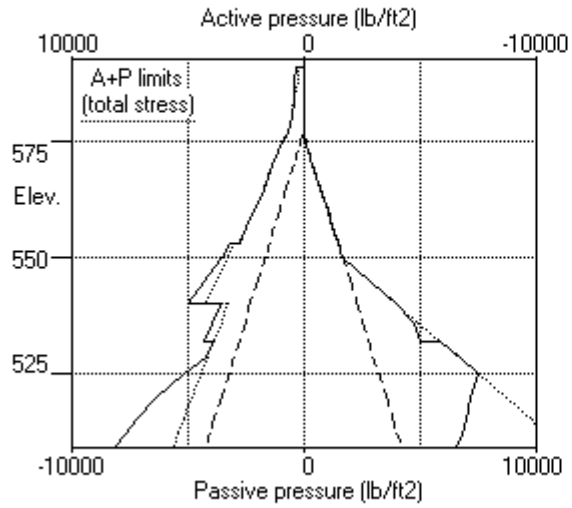
Units: lb,ft

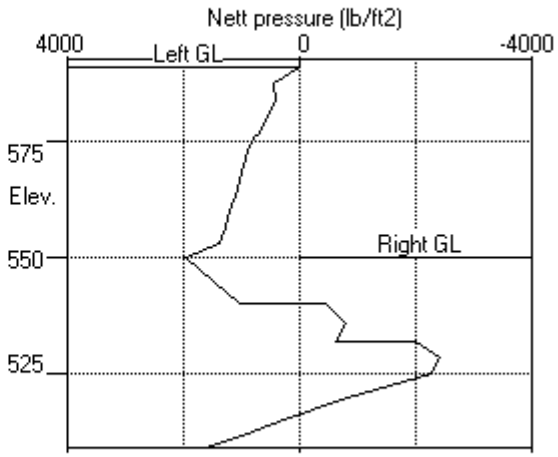
Stage No.16 Change soil type 8 to soil type 9





Stage No.16 Change soil type 8 to soil type 9





Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	553.00	553.00	---	Conditions not suitable for FoS calc.				
2	565.00	553.00	Cant.	14.687	521.28	544.67	8.33	L to R
3	565.00	553.00		No analysis at this stage				
4	565.00	553.00		No analysis at this stage				
5	576.00	553.00	584.00	40.416	n/a	550.40	2.60	L to R
6	591.00	553.00	584.00	4.394	n/a	529.71	23.29	L to R
7	591.00	550.00	584.00	4.260	n/a	528.65	21.35	L to R
8	591.00	550.00	584.00	4.091	n/a	528.42	21.58	L to R
9	591.00	550.00	584.00	3.680	n/a	527.47	22.53	L to R
10	591.00	550.00	584.00	3.708	n/a	527.57	22.43	L to R
11	591.00	550.00	584.00	3.700	n/a	527.55	22.45	L to R
12	591.00	550.00		No analysis at this stage				
13	591.00	550.00	584.00	2.432	n/a	523.60	26.40	L to R
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00	584.00	2.378	n/a	520.97	29.03	L to R

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.053	-0.000	0.0	-0.0	2000.0	0.0
2	591.00	0.057	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.067	-0.000	13566.8	-0.0	3436.9	0.0
4	584.00	0.096	-0.000	28874.7	-0.0	5022.4	-26205.0
5	580.50	0.129	-0.000	0.0	-59745.0	0.0	-24448.8
6	577.00	0.161	-0.000	0.0	-141533.2	0.0	-22203.9
7	576.00	0.170	-0.000	0.0	-163414.0	0.0	-21450.4
8	573.00	0.196	-0.000	0.0	-223690.4	0.0	-18788.2
9	570.00	0.219	-0.000	0.0	-276516.4	0.0	-15938.7
10	565.00	0.253	-0.000	0.0	-344133.4	251.5	-10753.3
11	560.00	0.276	-0.000	872.4	-383555.8	4792.9	-5002.3
12	556.50	0.287	-0.000	3790.2	-393444.9	8257.2	-629.8
13	553.00	0.292	-0.000	10480.7	-387537.8	11956.5	0.0
14	550.00	0.293	-0.000	16547.5	-366847.8	15851.3	0.0
15	545.00	0.286	0.000	17640.5	-297375.9	18260.0	-578.2
16	540.00	0.271	0.000	37623.1	-190071.1	24618.3	-1700.8
17	536.00	0.256	0.000	73248.3	-94810.6	22176.1	-787.0
18	532.00	0.238	0.000	113372.9	-12859.2	19333.6	-19.9
19	528.50	0.222	0.000	146785.8	-0.0	11660.6	-1229.3
20	525.00	0.207	0.000	138325.9	-0.0	3447.2	-5547.6
21	520.00	0.186	0.000	88412.9	-0.0	0.0	-10513.9
22	515.00	0.168	0.000	33024.6	-0.0	0.0	-8844.2
23	512.00	0.157	0.000	10148.9	-0.0	0.0	-5376.9
24	509.00	0.146	0.000	0.0	-0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	545.00	-0.0	520.00	0.0	545.00	-0.0	509.00
2	16659.7	545.00	-0.0	576.00	2607.5	553.00	-1432.1	540.00
3	No calculation at this stage							
4	No calculation at this stage							
5	17640.5	545.00	-24798.0	565.00	4973.3	553.00	-1700.8	540.00
6	51758.0	532.00	-125590.9	565.00	11956.5	553.00	-11809.9	584.00
7	82849.3	528.50	-163085.8	565.00	13995.1	550.00	-13667.7	584.00
8	86594.2	528.50	-170154.7	565.00	14451.4	550.00	-14179.5	584.00
9	113129.8	528.50	-203139.1	565.00	15851.3	550.00	-18315.7	584.00
10	112538.0	528.50	-194426.0	560.00	15416.7	550.00	-18247.2	584.00
11	112627.9	528.50	-194695.5	560.00	15457.5	550.00	-18288.9	584.00
12	No calculation at this stage							
13	146785.8	528.50	-263708.9	560.00	18851.7	540.00	-21153.8	584.00
14	No calculation at this stage							
15	No calculation at this stage							
16	65870.8	525.00	-393444.9	556.50	24618.3	540.00	-26205.0	584.00

Maximum and minimum displacement at each stage

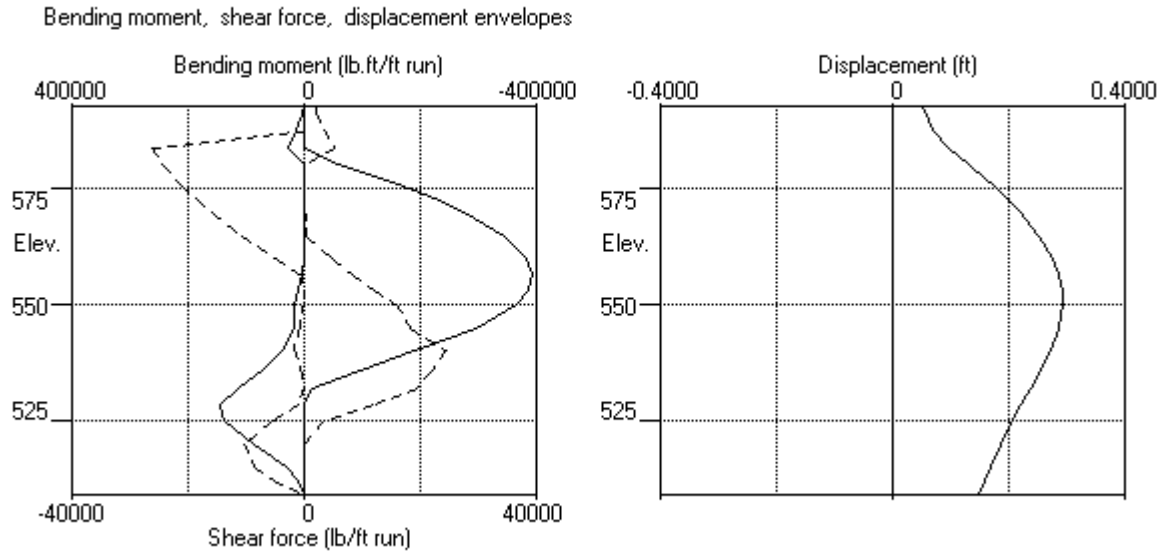
Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	512.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.021	593.00	0.000	593.00	Fill to elev. 565.00 on LEFT side
3	No calculation at this stage				Install prop no.1 at elev. 584.00
4	No calculation at this stage				Change soil type 10 to soil type 2
5	0.022	577.00	0.000	593.00	Fill to elev. 576.00 on LEFT side
6	0.066	565.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
7	0.084	565.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
8	0.086	565.00	0.000	593.00	Apply water pressure profile no.1
9	0.107	565.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
10	0.107	565.00	0.000	593.00	Apply load no.1 at elev. 593.00
11	0.107	565.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
12	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
13	0.141	560.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
14	No calculation at this stage				Change soil type 3 to soil type 4
15	No calculation at this stage				Change soil type 5 to soil type 6
16	0.293	550.00	0.000	593.00	Change soil type 8 to soil type 9

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
5	1605.99	14935.75
6	12788.50	118933.09
7	14646.32	136210.74
8	15158.09	140970.20
9	21036.52	195639.66
10	22598.57	210166.72
11	22642.93	210579.23
13	25477.90	236944.48
16	31227.45	290415.24

Units: lb,ft


Bending moment, shear force, displacement envelopes
Bending moment (lb.ft/ft run)
400000
0
-400000
575
Elev.
550
525
-40000
0
40000
Shear force (lb/ft run)
Displacement (ft)
-0.4000
0
0.4000
575
Elev.
550
525

GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: D.1 – EMBEDMENT CHECK

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side		Soil types Right side	
1	570.00	12	Sediment	12	Sediment
2	566.00	3	Clay I	3	Clay I
3	551.00	5	Clay IIA	5	Clay IIA
4	540.00	7	KP - Clay IIA	7	KP - Clay IIA
5	518.00	8	KP - Clay III	8	KP - Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing Fill	130.0	1200000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I - L. Term	130.0	1200000	0.531	OC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1500d
6	Clay IIA - L.Term	130.0	600000	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	KP - Clay IIA	130.0	600000	0.560	NC (0.490)	0.484 (0.968)	0.000 (1.330)	1500d
8	KP - Clay III	130.0	1300000	0.560	NC (0.490)	0.484 (0.968)	0.000 (1.330)	2500d
9	KP - ClayI-IA.L.Term	130.0	47151	0.560	NC (0.330)	0.189 (0.000)	1.707 (0.000)	0.0d
10	KP - Clay III.LTerm	130.0	68650	0.560	NC (0.330)	0.189 (0.000)	1.707 (0.000)	0.0d
11	Exist. Fill - L.Term	130.0	1200000	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Sediment	80.00	36000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	60.00d
13	Sediment - L.Term	80.00	0 (36000)	0.500	NC (0.490)	0.422 (0.000)	2.371 (0.000)	
14	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
15	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
	------- Soil type -------	Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I - L.Term	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
7	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP - ClayIIA.L.Term	43.01	0.000	0.00	15.14	0.000	0.00
10	KP - Clay III.LTerm	43.01	0.000	0.00	15.14	0.000	0.00
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Sediment	0.00	0.000	0.00	0.00	0.000	0.00
13	Sediment - L.Term	24.00	0.000	0.00	24.00	0.000	0.00
14	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
15	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 490.00
Maximum finite element length = 6.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 490.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Fill to elevation 576.00 on LEFT side with soil type 15
3	Fill to elevation 581.00 on LEFT side with soil type 14
4	Install strut or anchor no.1 at elevation 584.00
5	Fill to elevation 591.00 on LEFT side with soil type 14
6	Excavate to elevation 550.00 on RIGHT side
7	Apply water pressure profile no.1
8	Apply surcharge no.1 at elevation 591.00
9	Apply load no.1 at elevation 593.00
10	Apply surcharge no.4 at elevation 591.00
11	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
12	Apply surcharge no.3 at elevation 591.00
13	Change properties of soil type 12 to soil type 13 No analysis at this stage Ko pressures will not be reset
14	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
17	Change properties of soil type 8 to soil type 10 Ko pressures will be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Fill to elev. 576.00 on LEFT side	No	No	No
3	Fill to elev. 581.00 on LEFT side	No	No	No
4	Install prop no.1 at elev. 584.00	No	No	No
5	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
6	Excav. to elev. 550.00 on RIGHT side	No	No	No
7	Apply water pressure profile no.1	No	No	No
8	Apply surcharge no.1 at elev. 591.00	No	No	No
9	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
10	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
11	Apply surcharge no.2 at elev. 591.00	No	No	No
12	Apply surcharge no.3 at elev. 591.00	No	No	No
13	Change soil type 12 to soil type 13	No	No	No
14	Change soil type 3 to soil type 4	No	No	No
15	Change soil type 5 to soil type 6	No	No	No
16	Change soil type 7 to soil type 9	No	No	No
17	Change soil type 8 to soil type 10	No	No	No
*	Summary output	Yes	-	Yes

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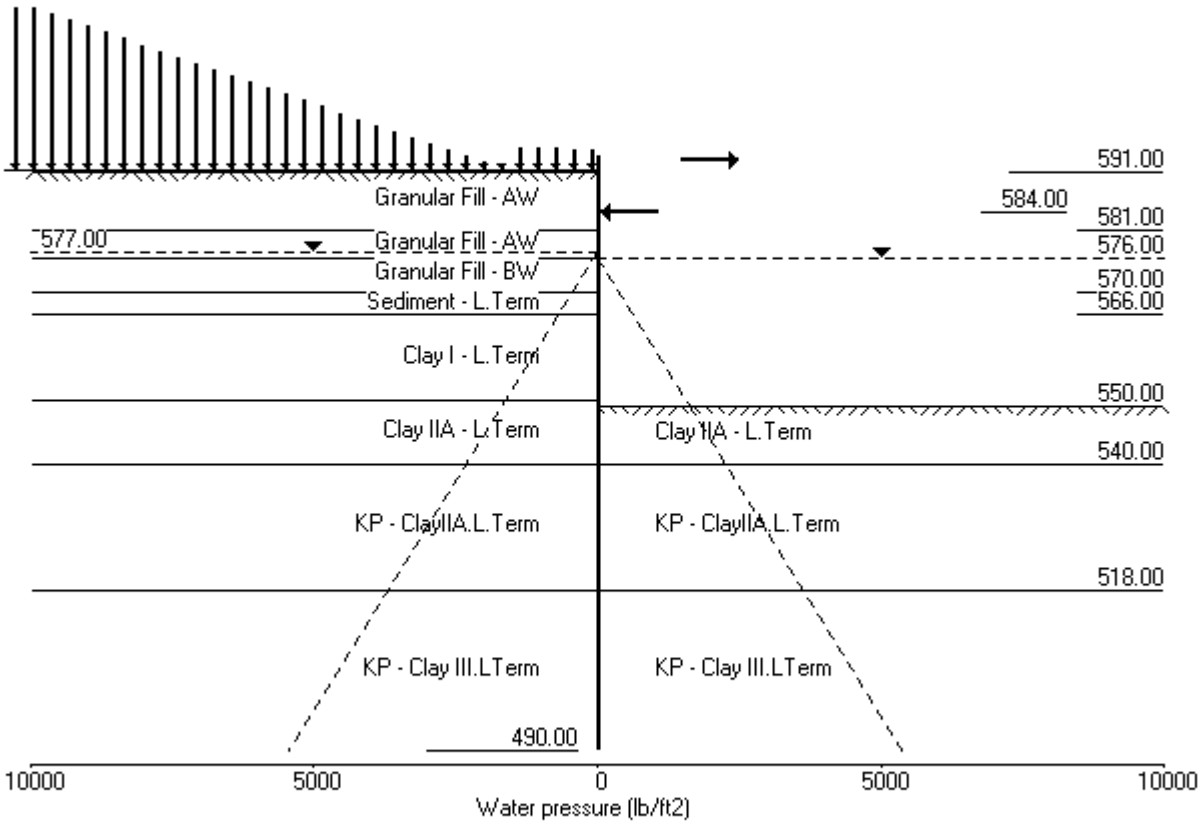
Units: lb,ft

Stage No.17 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 490.00 Factor of Safety	FoS for toe elev. = 490.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
17	591.00	550.00	584.00	2.415	n/a	511.18	38.82	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft	EI of wall lb.ft2/ft
1	593.00	0.00	-0.015	-1.41E-02	2000.0	-0.0	2000.0	9.18E+08
2	591.00	0.00	0.013	-1.41E-02	2000.0	4000.0		9.18E+08
		492.92	0.013	-1.41E-02	2000.0	4000.0		
3	587.50	701.03	0.063	-1.42E-02	4089.4	14587.4		9.18E+08
4	584.00	432.36	0.113	-1.43E-02	6072.9	33760.1	-33283.4	9.18E+08
		432.36	0.113	-1.43E-02	-27210.5	33760.1		
5	581.00	551.32	0.156	-1.42E-02	-25735.0	-45519.0		9.18E+08
6	577.00	711.58	0.212	-1.38E-02	-23209.2	-144367.6		9.18E+08
7	576.00	795.39	0.226	-1.37E-02	-22455.8	-167204.5		9.18E+08
		857.60	0.226	-1.37E-02	-22455.8	-167204.5		
8	570.00	992.58	0.304	-1.22E-02	-16905.2	-285829.3		9.18E+08
		1239.25	0.304	-1.22E-02	-16905.2	-285829.3		
9	566.00	1283.53	0.350	-1.08E-02	-11859.7	-343443.0		9.18E+08
		1107.78	0.350	-1.08E-02	-11859.7	-343443.0		
10	562.00	1221.32	0.391	-9.29E-03	-7201.5	-381241.1		9.18E+08
11	558.00	1337.40	0.425	-7.58E-03	-2084.0	-401190.4		9.18E+08
12	554.50	1440.45	0.449	-6.05E-03	2777.2	-400689.3		9.18E+08
13	551.00	1544.44	0.467	-4.56E-03	8000.7	-382361.4		9.18E+08
		1665.21	0.467	-4.56E-03	8000.7	-382361.4		
14	550.00	1697.47	0.471	-4.15E-03	9682.1	-373531.4		9.18E+08
15	545.00	993.70	0.487	-2.29E-03	16410.0	-308838.4		9.18E+08
16	540.00	290.29	0.495	-8.62E-04	19620.0	-219239.2		8.07E+08
		-90.77	0.495	-8.62E-04	19620.0	-219239.2		
17	534.00	-605.04	0.496	3.48E-04	17532.5	-106825.0		8.07E+08
18	528.00	-1152.04	0.492	8.02E-04	12261.3	-15443.4		8.07E+08
19	523.00	-1022.11	0.488	7.58E-04	6825.9	29747.2		8.07E+08
20	518.00	-764.74	0.485	5.13E-04	2358.8	49463.0		8.07E+08
		-524.34	0.485	5.13E-04	2358.8	49463.0		
21	514.00	-583.86	0.484	2.53E-04	142.4	55465.0		8.07E+08
22	510.00	-349.67	0.483	-1.01E-05	-1724.7	50992.1		8.07E+08
23	504.00	-61.52	0.484	-3.23E-04	-2958.3	33322.5		8.07E+08

(continued)

Stage No.17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
24	498.00	177.91	0.487	-4.97E-04	-2609.1	13600.7		8.07E+08
25	494.00	324.04	0.489	-5.42E-04	-1605.2	4348.0		8.07E+08
26	490.00	478.57	0.491	-5.52E-04	0.0	0.0		---
At elev. 584.00				Prop force =	33283.4 lb/ft run			

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	492.92	492.92	4663
3	587.50	0.00	954.67	293.33	3107.07	701.03	701.03	27978
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	6881
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	9831
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	13763
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	14746
		62.40	2385.59	795.20	7156.77	795.20	857.60a	5266
8	570.00	436.80	2790.54	930.18	8371.61	930.18	1366.98a	7373
		436.80	2790.54	1176.85	6616.88	1176.85	1613.65a	25324
9	566.00	686.40	2895.53	1221.13	6865.84	1221.13	1907.53a	30148
		686.40	2895.53	1045.38	8020.12	1045.38	1731.78a	40197
10	562.00	936.00	3210.00	1158.92	8891.15	1158.92	2094.92a	40197
11	558.00	1185.60	3531.52	1275.00	9781.69	1275.00	2460.60a	40197
12	554.50	1404.00	3816.95	1378.05	10572.29	1378.05	2782.05a	40197
13	551.00	1622.40	4104.99	1482.04	11370.10	1482.04	3104.44a	40197
		1622.40	4104.99	1602.81	10513.16	1602.81	3225.21a	20098
14	550.00	1684.80	4187.63	1635.07	10724.80	1635.07	3319.87a	20098
15	545.00	1996.80	4602.19	1796.94	11786.53	1796.94	3793.74a	20098
16	540.00	2308.80	5017.68	1959.17	12850.63	1959.17	4267.97a	20098
		2308.80	5017.68	948.34	8565.18	1000.76	3309.56	1104
17	534.00	2683.20	5515.47	1042.42	9414.91	1178.85	3862.05	1104
18	528.00	3057.60	6010.77	1136.03	10260.38	1210.61	4268.21	1104
19	523.00	3369.60	6420.75	1213.52	10960.23	1241.15	4610.75	1104
20	518.00	3681.60	6827.74	1290.44	11654.96	1359.71	5041.31	1104
		3681.60	6827.74	1290.44	11654.96	3105.87	6787.47	1607
21	514.00	3931.20	7150.97	1351.53	12206.71	3283.10	7214.30	1607
22	510.00	4180.80	7471.99	1412.21	12754.68	3458.19	7638.99	1607
23	504.00	4555.20	7949.24	1502.41	13569.35	3716.83	8272.03	1607
24	498.00	4929.60	8421.29	1591.62	14375.14	3971.16	8900.76	1607
25	494.00	5179.20	8733.10	1650.56	14907.41	4138.71	9317.91	1607
26	490.00	5428.80	9042.63	1709.06	15435.78	4304.88	9733.68	1607

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

(continued)

Stage No.17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

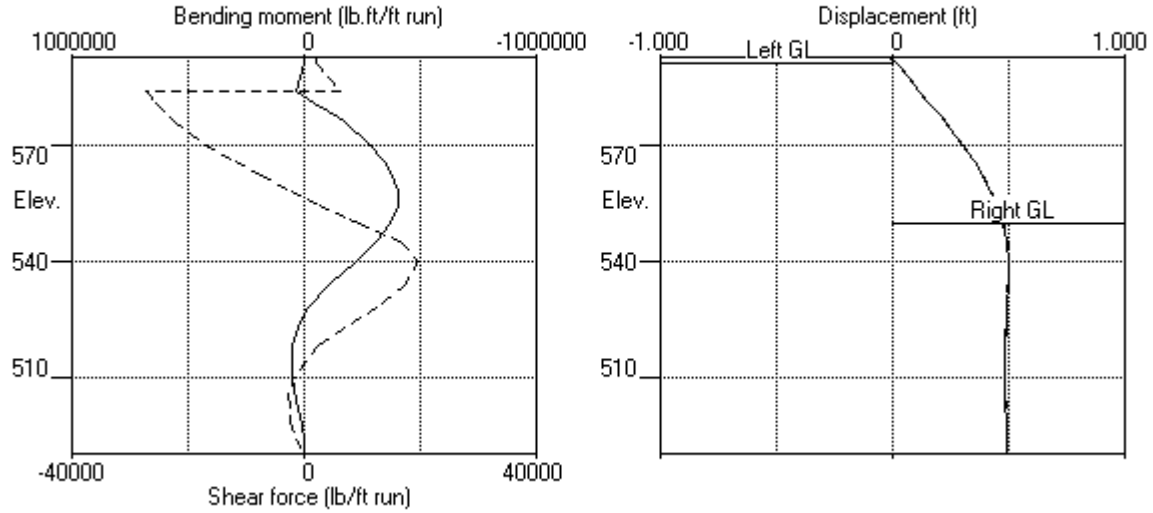
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
9	566.00	624.00	0.00	0.00	0.00	0.00	624.00	0.0
10	562.00	873.60	0.00	0.00	0.00	0.00	873.60	0.0
11	558.00	1123.20	0.00	0.00	0.00	0.00	1123.20	0.0
12	554.50	1341.60	0.00	0.00	0.00	0.00	1341.60	0.0
13	551.00	1560.00	0.00	0.00	0.00	0.00	1560.00	0.0
14	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	21456
15	545.00	1934.40	338.00	131.97	865.64	865.64	2800.04p	21456
16	540.00	2246.40	676.00	263.95	1731.28	1731.28	3977.68p	21456
		2246.40	676.00	127.76	1153.93	1153.93	3400.33p	1206
17	534.00	2620.80	1081.60	204.42	1846.29	1846.29	4467.09p	1206
18	528.00	2995.20	1487.21	281.08	2538.66	2425.06	5420.26	1206
19	523.00	3307.20	1825.21	344.96	3115.63	2325.67	5632.87	1206
20	518.00	3619.20	2163.22	408.85	3692.61	2186.86	5806.06	1206
		3619.20	2163.22	408.85	3692.61	3692.61	7311.81p	1756
21	514.00	3868.80	2433.62	459.95	4154.19	3929.36	7798.16	1756
22	510.00	4118.40	2704.03	511.06	4615.78	3870.26	7988.66	1756
23	504.00	4492.80	3109.65	587.72	5308.17	3840.75	8333.55	1756
24	498.00	4867.20	3515.27	664.39	6000.56	3855.65	8722.85	1756
25	494.00	5116.80	3785.69	715.49	6462.17	3877.07	8993.87	1756
26	490.00	5366.40	4056.11	766.60	6923.77	3888.71	9255.11	1756

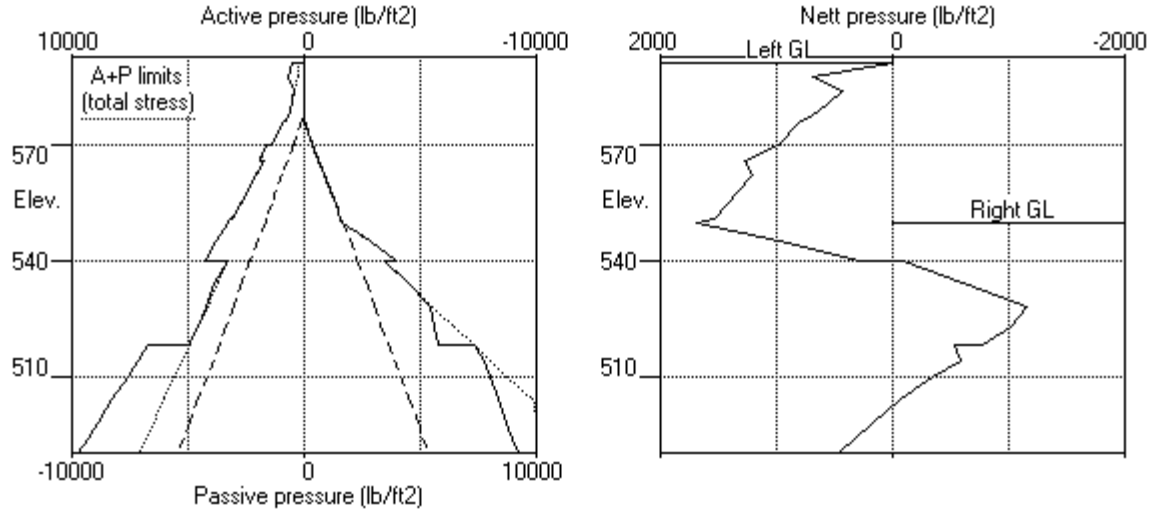
Note: 4267.97a Soil pressure at active limit
7311.81p Soil pressure at passive limit

Units: lb,ft

Stage No.17 Change soil type 8 to soil type 10



Stage No.17 Change soil type 8 to soil type 10



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 490.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	570.00	570.00	---	Conditions not suitable for FoS calc.				
2	576.00	570.00	Cant.	55.770	502.52	563.45	6.55	L to R
3	581.00	570.00	Cant.	13.822	499.88	556.15	13.85	L to R
4	581.00	570.00		No analysis at this stage				
5	591.00	570.00	584.00	3.908	n/a	562.48	7.52	L to R
6	591.00	550.00	584.00	3.225	n/a	545.62	4.38	L to R
7	591.00	550.00	584.00	3.101	n/a	545.28	4.72	L to R
8	591.00	550.00	584.00	2.851	n/a	543.48	6.52	L to R
9	591.00	550.00	584.00	2.864	n/a	543.94	6.06	L to R
10	591.00	550.00	584.00	2.860	n/a	543.91	6.09	L to R
11	591.00	550.00		No analysis at this stage				
12	591.00	550.00	584.00	1.805	n/a	514.19	35.81	L to R
13	591.00	550.00		No analysis at this stage				
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00		No analysis at this stage				
17	591.00	550.00	584.00	2.415	n/a	511.18	38.82	L to R

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.070	-0.015	0.0	-0.0	2000.0	0.0
2	591.00	0.072	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.076	-0.000	14587.4	-0.0	4089.4	0.0
4	584.00	0.113	-0.000	33760.1	-0.0	6072.9	-27210.5
5	581.00	0.156	-0.000	0.0	-45519.0	0.0	-25735.0
6	577.00	0.212	-0.000	426.1	-144367.6	319.5	-23209.2
7	576.00	0.226	-0.000	832.2	-167204.5	499.3	-22455.8
8	570.00	0.304	-0.000	9775.0	-285829.3	3190.9	-16905.2
9	566.00	0.350	0.000	26887.0	-343443.0	11814.9	-11859.7
10	562.00	0.391	0.000	43610.6	-381241.1	6908.6	-7201.5
11	558.00	0.425	0.000	46952.3	-401190.4	7158.2	-2084.0
12	554.50	0.449	0.000	43911.8	-400689.3	7376.6	-2440.5
13	551.00	0.467	0.000	30732.6	-382361.4	8000.7	-4916.4
14	550.00	0.471	0.000	25990.5	-373531.4	9682.1	-4556.7
15	545.00	0.487	0.000	14144.0	-308838.4	16410.0	-2533.8
16	540.00	0.495	0.000	27975.3	-219239.2	19620.0	-1569.8
17	534.00	0.496	0.000	33391.9	-106825.0	17532.5	-417.1
18	528.00	0.492	0.000	30518.9	-15443.4	12261.3	-461.4
19	523.00	0.488	0.000	29747.2	-2510.2	6825.9	-455.6
20	518.00	0.485	0.000	49463.0	-136.3	2358.8	-1160.7
21	514.00	0.484	0.000	55465.0	-3913.8	254.7	-727.3
22	510.00	0.483	0.000	50992.1	-5090.5	61.8	-1724.7
23	504.00	0.484	0.000	33322.5	-3984.9	545.2	-2958.3
24	498.00	0.487	0.000	13600.7	-1573.7	554.2	-2609.1
25	494.00	0.489	0.000	4348.0	-174.8	343.5	-1605.2
26	490.00	0.491	0.000	0.0	-0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	518.00	-0.0	545.00	0.0	566.00	-0.0	551.00
2	10729.2	558.00	-3641.7	528.00	1584.9	566.00	-1009.7	551.00
3	44909.6	558.00	-7029.6	534.00	6070.6	566.00	-3608.8	551.00
4	No calculation at this stage							
5	46952.3	558.00	-32715.5	576.00	11814.9	566.00	-5954.4	584.00
6	23064.5	528.00	-110962.9	570.00	6209.5	550.00	-11355.1	584.00
7	25168.9	534.00	-115888.9	570.00	6935.2	550.00	-11748.4	584.00
8	33391.9	534.00	-134132.6	570.00	8324.3	550.00	-15266.1	584.00
9	32799.4	534.00	-122214.9	570.00	7998.4	550.00	-15146.8	584.00
10	32841.4	534.00	-122500.8	570.00	8009.4	550.00	-15184.4	584.00
11	No calculation at this stage							
12	27526.9	528.00	-140292.8	570.00	8258.1	550.00	-16499.8	584.00
13	No calculation at this stage							
14	No calculation at this stage							
15	No calculation at this stage							
16	No calculation at this stage							
17	55465.0	514.00	-401190.4	558.00	19620.0	540.00	-27210.5	584.00

Maximum and minimum displacement at each stage

Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	490.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.010	593.00	0.000	593.00	Fill to elev. 576.00 on LEFT side
3	0.037	593.00	0.000	593.00	Fill to elev. 581.00 on LEFT side
4	No calculation at this stage				Install prop no.1 at elev. 584.00
5	0.052	593.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
6	0.074	566.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
7	0.076	566.00	0.000	593.00	Apply water pressure profile no.1
8	0.088	570.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
9	0.088	570.00	0.000	593.00	Apply load no.1 at elev. 593.00
10	0.088	570.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
11	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
12	0.101	566.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
13	No calculation at this stage				Change soil type 12 to soil type 13
14	No calculation at this stage				Change soil type 3 to soil type 4
15	No calculation at this stage				Change soil type 5 to soil type 6
16	No calculation at this stage				Change soil type 7 to soil type 9
17	0.496	534.00	-0.015	593.00	Change soil type 8 to soil type 10

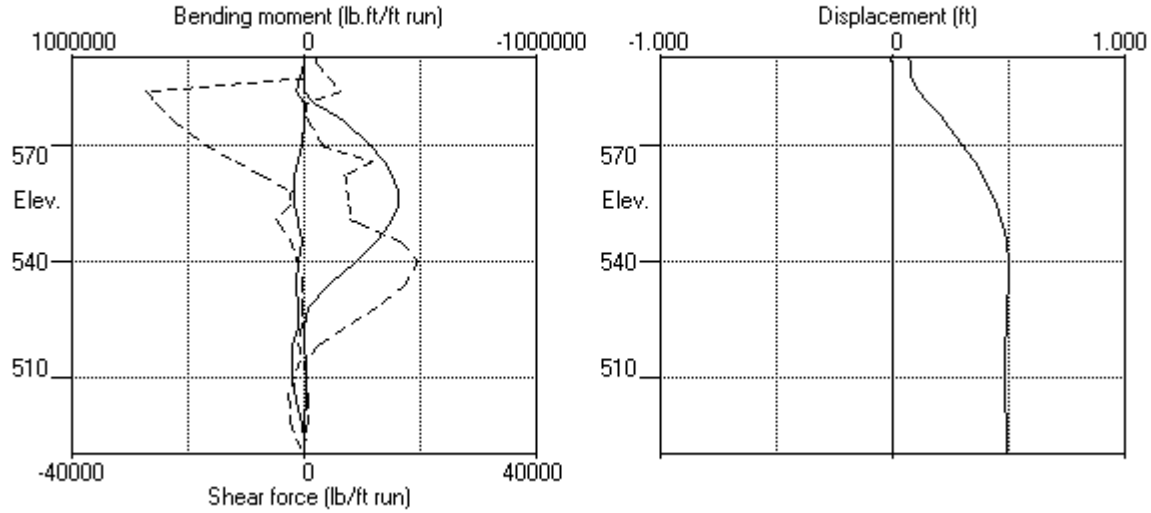
Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
5	6993.31	65037.80
6	12333.72	114703.60
7	12727.06	118361.67
8	17967.03	167093.40
9	19483.72	181198.58
10	19524.42	181577.10
12	20831.17	193729.87
17	33283.40	309535.63

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

WALLAP ANALYSIS: D.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side		Soil types Right side	
1	570.00	12	Sediment	12	Sediment
2	566.00	3	Clay I	3	Clay I
3	551.00	5	Clay IIA	5	Clay IIA
4	540.00	7	KP - Clay IIA	7	KP - Clay IIA
5	518.00	8	KP - Clay III	8	KP - Clay III

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Not defined							
2	Existing Fill	130.0	1200000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000u
3	Clay I	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I - L. Term	130.0	1200000	0.531	OC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1500d
6	Clay IIA - L.Term	130.0	600000	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	KP - Clay IIA	130.0	600000	0.560	NC (0.490)	0.484 (0.968)	0.000 (2.000)	1500d
8	KP - Clay III	130.0	1500000	0.560	NC (0.490)	0.484 (0.968)	0.000 (2.000)	2500d
9	KP - ClayI-IA.L.Term	130.0	600000	0.560	NC (0.490)	0.189 (0.000)	2.561 (0.000)	0.0d
10	KP - Clay III.LTerm	130.0	1500000	0.560	NC (0.490)	0.189 (0.000)	2.561 (0.000)	0.0d
11	Exist. Fill - L.Term	130.0	1200000	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
12	Sediment	80.00	36000	0.500	NC (0.490)	1.000 (2.000)	1.000 (2.000)	60.00d
13	Sediment - L.Term	80.00	0 (36000)	0.500	NC (0.490)	0.422 (0.000)	2.371 (0.000)	
14	Granular Fill - AW	130.0	0 (42000)	0.470	NC (0.330)	0.307 (0.000)	3.255 (0.000)	
15	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	

Additional soil parameters associated with Ka and Kp

		--- parameters for Ka ---			--- parameters for Kp ---		
------- Soil type -------		Soil friction	Wall adhesion	Back-fill	Soil friction	Wall adhesion	Back-fill
No.	Description	angle	coeff.	angle	angle	coeff.	angle
1	Not defined						
2	Existing Fill	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I - L.Term	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA - L.Term	26.00	0.000	0.00	26.00	0.000	0.00
7	KP - Clay IIA	28.06	-0.627	0.00	Incompatible values		
8	KP - Clay III	28.06	-0.627	0.00	Incompatible values		
9	KP - ClayIIA.L.Term	43.01	0.000	0.00	26.00	0.000	0.00
10	KP - Clay III.LTerm	43.01	0.000	0.00	26.00	0.000	0.00
11	Exist. Fill - L.Term	30.00	0.000	0.00	30.00	0.000	0.00
12	Sediment	0.00	0.000	0.00	0.00	0.000	0.00
13	Sediment - L.Term	24.00	0.000	0.00	24.00	0.000	0.00
14	Granular Fill - AW	32.00	0.000	0.00	32.00	0.000	0.00
15	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	576.00	576.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	577.00	577.00	0.0	1	576.00	576.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 509.00
Maximum finite element length = 5.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.22000 ft4/ft run
E.I = 9.1872E+08 lb.ft2/ft run
Yield Moment of wall = Not defined

STRUTS and ANCHORS

Prop no.	Elev.	Prop spacing ft	Cross-section area sq.ft	Youngs modulus lb/ft2	Free length ft	Inclin-ation (degs)	Pre-stress /prop lb	Strut or Anchor	Allow tension ?	L/R
1	584.00	9.30	0.066810	4.176E+09	75.00	0.00	0	Anchor	n/a	R

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	593.00	2000	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	15.00	500.00	=	N/A	N/A
2	591.00	15.00(L)	1000.00	84.00	0.00	3600.00	N/A	N/A
3	591.00	99.00(L)	1000.00	150.00	3600.00	=	N/A	N/A
4	591.00	6.00(L)	1000.00	15.00	10.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Change EI of wall to 8.0771E+08 lb.ft2/ft run From elevation 540.00 to 509.00 Yield moment not defined Reset wall displacements to zero at this stage
2	Fill to elevation 576.00 on LEFT side with soil type 15
3	Fill to elevation 581.00 on LEFT side with soil type 14
4	Install strut or anchor no.1 at elevation 584.00
5	Fill to elevation 591.00 on LEFT side with soil type 14
6	Excavate to elevation 550.00 on RIGHT side
7	Apply water pressure profile no.1
8	Apply surcharge no.1 at elevation 591.00
9	Apply load no.1 at elevation 593.00
10	Apply surcharge no.4 at elevation 591.00
11	Apply surcharge no.2 at elevation 591.00 No analysis at this stage
12	Apply surcharge no.3 at elevation 591.00
13	Change properties of soil type 12 to soil type 13 No analysis at this stage Ko pressures will not be reset
14	Change properties of soil type 3 to soil type 4 No analysis at this stage Ko pressures will not be reset
15	Change properties of soil type 5 to soil type 6 No analysis at this stage Ko pressures will not be reset
16	Change properties of soil type 7 to soil type 9 No analysis at this stage Ko pressures will not be reset
17	Change properties of soil type 8 to soil type 10 Ko pressures will be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 71.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Change EI of wall to 8.0771E+08lb.ft2/	No	No	No
2	Fill to elev. 576.00 on LEFT side	No	No	No
3	Fill to elev. 581.00 on LEFT side	No	No	No
4	Install prop no.1 at elev. 584.00	No	No	No
5	Fill to elev. 591.00 on LEFT side	Yes	Yes	Yes
6	Excav. to elev. 550.00 on RIGHT side	No	No	No
7	Apply water pressure profile no.1	No	No	No
8	Apply surcharge no.1 at elev. 591.00	No	No	No
9	Apply load no.1 at elev. 593.00	Yes	Yes	Yes
10	Apply surcharge no.4 at elev. 591.00	Yes	Yes	Yes
11	Apply surcharge no.2 at elev. 591.00	No	No	No
12	Apply surcharge no.3 at elev. 591.00	Yes	Yes	Yes
13	Change soil type 12 to soil type 13	No	No	No
14	Change soil type 3 to soil type 4	No	No	No
15	Change soil type 5 to soil type 6	No	No	No
16	Change soil type 7 to soil type 9	No	No	No
17	Change soil type 8 to soil type 10	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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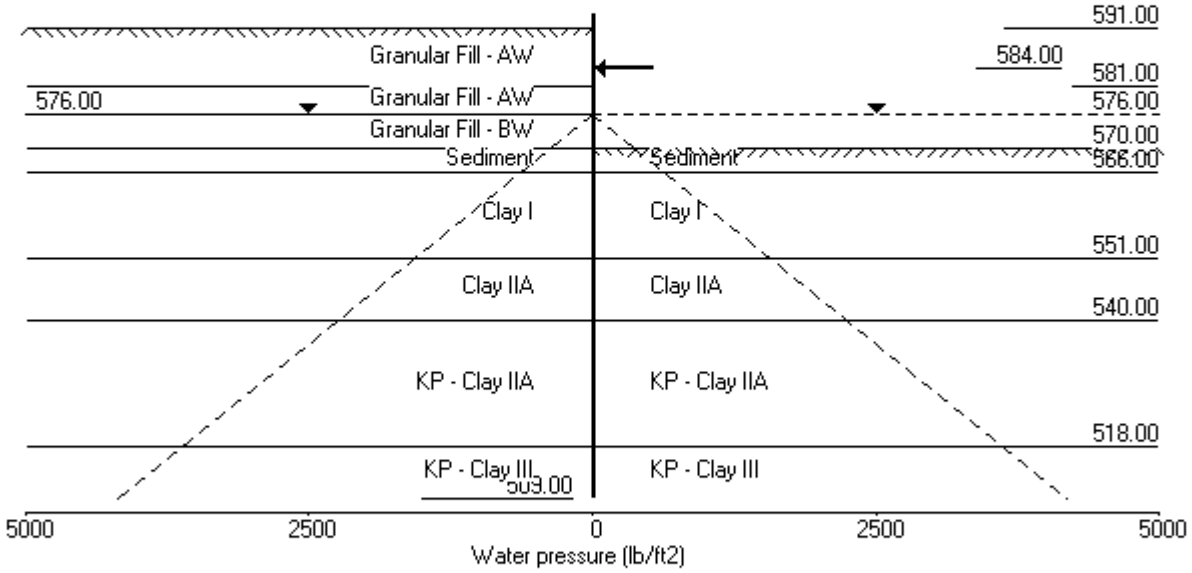
Units: lb,ft

Stage No.5 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No. 5 Fill to elevation 591.00 on LEFT side with soil type 14

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
5	591.00	570.00	584.00	5.304	n/a	562.47	7.53	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.050	4.41E-04	0.0	0.0		9.18E+08
2	591.00	0.00	0.049	4.41E-04	0.0	-0.0		9.18E+08
3	587.50	159.28	0.048	4.40E-04	278.7	436.6		9.18E+08
4	584.00	308.84	0.046	4.34E-04	1097.9	2824.4	-7002.8	9.18E+08
		308.84	0.046	4.34E-04	-5904.8	2824.4		
5	581.00	429.30	0.045	4.51E-04	-4797.6	-13225.4		9.18E+08
6	577.00	581.68	0.043	5.42E-04	-2775.7	-28329.8		9.18E+08
7	576.00	619.03	0.042	5.74E-04	-2175.3	-30804.5		9.18E+08
		868.76	0.042	5.74E-04	-2175.3	-30804.5		
8	573.00	937.35	0.041	6.78E-04	533.8	-33233.6		9.18E+08
9	570.00	1007.15	0.038	7.77E-04	3450.6	-27242.2		9.18E+08
		2138.15	0.038	7.77E-04	3450.6	-27242.2		
10	566.00	2181.45	0.035	8.28E-04	12089.8	3759.2		9.18E+08
		-1590.89	0.035	8.28E-04	12089.8	3759.2		
11	563.00	-1387.59	0.033	7.67E-04	7622.1	33718.3		9.18E+08
12	560.00	-1210.45	0.031	6.30E-04	3725.0	50155.3		9.18E+08
13	555.50	-1019.70	0.028	3.74E-04	-1292.8	54237.7		9.18E+08
14	551.00	-922.09	0.027	1.49E-04	-5661.9	37887.7		9.18E+08
		226.17	0.027	1.49E-04	-5661.9	37887.7		
15	550.00	231.79	0.027	1.11E-04	-5432.9	32338.4		9.18E+08
16	545.00	242.15	0.027	1.09E-06	-4248.0	8053.4		9.18E+08
17	540.00	241.68	0.027	6.74E-06	-3038.4	-10132.1		8.07E+08
		239.36	0.027	6.74E-06	-3038.4	-10132.1		
18	535.00	249.29	0.027	1.07E-04	-1816.8	-22303.7		8.07E+08
19	530.00	285.20	0.026	2.63E-04	-480.6	-28273.5		8.07E+08
20	525.00	354.48	0.024	4.35E-04	1118.6	-27160.0		8.07E+08
21	521.50	396.11	0.022	5.39E-04	2432.1	-21158.3		8.07E+08
22	518.00	343.92	0.020	6.08E-04	3727.2	-10530.3		8.07E+08
		-696.59	0.020	6.08E-04	3727.2	-10530.3		
23	513.50	-415.65	0.017	6.40E-04	1224.6	-1052.8		8.07E+08
24	509.00	-128.64	0.014	6.43E-04	0.0	0.0		---

At elev. 584.00 Prop force = 7002.8 lb/ft run

(continued)

Stage No.5 Fill to elevation 591.00 on LEFT side with soil type 14

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	0.00	0.00	0.00	0.00	0.00	566
3	587.50	0.00	455.00	139.80	1480.84	159.28	159.28	3395
4	584.00	0.00	910.00	279.61	2961.68	308.84	308.84	6789
5	581.00	0.00	1300.00	399.44	4230.96	429.30	429.30	9699
6	577.00	0.00	1820.00	559.21	5923.35	581.68	581.68	13579
7	576.00	0.00	1950.00	599.15	6346.45	619.03	619.03	14549
		0.00	1950.00	650.00	5850.00	868.76	868.76	5196
8	573.00	187.20	2137.80	712.60	6413.40	937.35	1124.55	6235
9	570.00	374.40	2325.60	775.20	6976.80	1007.15	1381.55	7274
		374.40	2325.60	2205.60	2445.60	2205.60	2580.00a	1195
10	566.00	624.00	2396.00	2276.00	2516.00	2276.00	2900.00a	1195
		624.00	2396.00	0.00	6396.00	424.88	1048.88	39831
11	563.00	811.20	2598.80	0.00	6598.80	546.80	1358.00	39831
12	560.00	998.40	2801.60	0.00	6801.60	671.75	1670.15	39831
13	555.50	1279.20	3105.80	0.00	7105.80	855.78	2134.98	39831
14	551.00	1560.00	3410.00	0.00	7410.00	1030.24	2590.24	39831
		1560.00	3410.00	410.00	6410.00	1522.77	3082.77	19915
15	550.00	1622.40	3477.60	477.60	6477.60	1561.52	3183.92	19915
16	545.00	1934.40	3815.60	815.60	6815.60	1753.68	3688.08	19915
17	540.00	2246.40	4153.60	1153.60	7153.60	1946.68	4193.08	19915
		2246.40	4153.60	558.34	3000.00	1942.53	4188.93	19915
18	535.00	2558.40	4491.60	721.93	3000.00	2140.41	4698.81	19915
19	530.00	2870.40	4829.60	885.53	3000.00	2346.88	5217.28	19915
20	525.00	3182.40	5167.60	1049.12	3000.00	2563.35	5745.75	19915
21	521.50	3400.80	5404.20	1163.63	3000.00	2694.16	6094.96	19915
22	518.00	3619.20	5640.80	1278.15	3000.00	2722.29	6341.49	19915
		3619.20	5640.80	310.15	5000.00	2464.58	6083.78	49788
23	513.50	3900.00	5945.00	457.38	5000.00	2731.68	6631.68	49788
24	509.00	4180.80	6249.20	604.61	5000.00	3000.46	7181.26	49788

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
		374.40	0.00	0.00	120.00	67.45	441.85	1291
10	566.00	624.00	70.40	0.00	190.40	94.55	718.55	1291
		624.00	70.40	0.00	4070.40	2015.78	2639.78	43025
11	563.00	811.20	273.20	0.00	4273.20	1934.39	2745.59	43025
12	560.00	998.40	476.00	0.00	4476.00	1882.20	2880.60	43025
13	555.50	1279.20	780.20	0.00	4780.20	1875.48	3154.68	43025
14	551.00	1560.00	1084.40	0.00	5084.40	1952.33	3512.33	43025
		1560.00	1084.40	0.00	4084.40	1296.61	2856.61	21512

(continued)

Stage No.5 Fill to elevation 591.00 on LEFT side with soil type 14

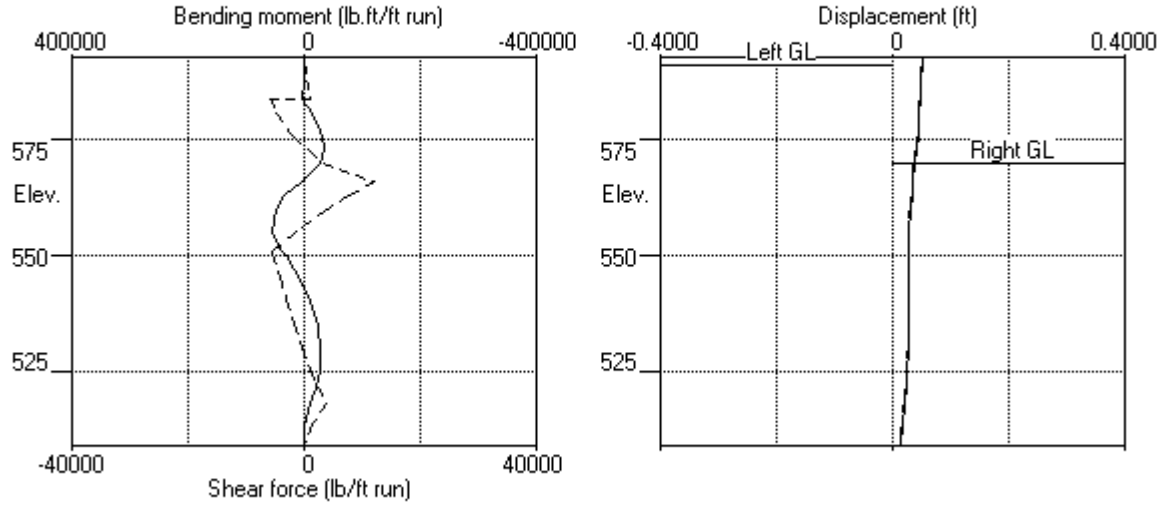
RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
15	550.00	1622.40	1152.00	0.00	4152.00	1329.74	2952.14	21512
16	545.00	1934.40	1490.00	0.00	4490.00	1511.52	3445.92	21512
17	540.00	2246.40	1828.00	0.00	4828.00	1705.00	3951.40	21512
		2246.40	1828.00	0.00	3000.00	1703.17	3949.57	21512
18	535.00	2558.40	2166.00	0.00	3000.00	1891.12	4449.52	21512
19	530.00	2870.40	2504.00	0.00	3000.00	2061.68	4932.08	21512
20	525.00	3182.40	2842.00	0.00	3000.00	2208.87	5391.27	21512
21	521.50	3400.80	3078.60	38.04	3000.00	2298.05	5698.85	21512
22	518.00	3619.20	3315.20	152.56	3000.00	2378.37	5997.57	21512
		3619.20	3315.20	0.00	5000.00	3161.16	6780.36	53781
23	513.50	3900.00	3619.40	0.00	5000.00	3147.33	7047.33	53781
24	509.00	4180.80	3923.60	0.00	5000.00	3129.10	7309.90	53781

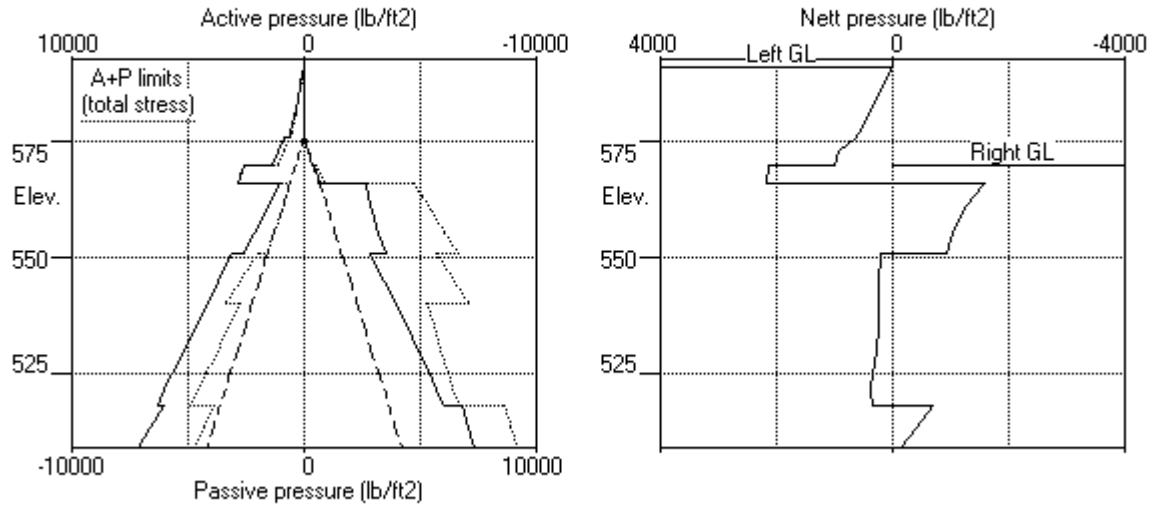
Note: 2900.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.5 Fill to elev. 591.00 on LEFT side

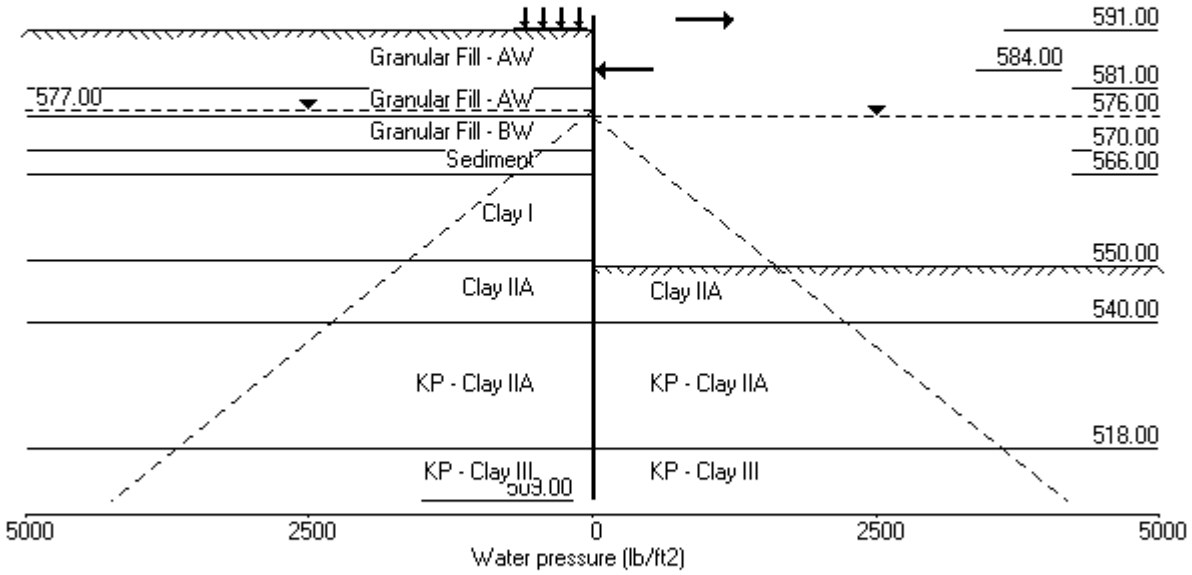


Stage No.5 Fill to elev. 591.00 on LEFT side



Units: lb,ft

Stage No.9 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No. 9 Apply load no.1 at elevation 593.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00: Factor of Safety	FoS for toe elev. = 509.00: Moment equilib. at elev.	Toe elev. for FoS = 1.500	Wall Penetration	Direction of failure
9	591.00	550.00	584.00	3.557	n/a	543.94	6.06	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.067	-1.10E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.069	-1.11E-03	2000.0	4000.0		9.18E+08
		213.29	0.069	-1.11E-03	2000.0	4000.0		
3	587.50	334.06	0.073	-1.14E-03	2957.9	12852.0		9.18E+08
4	584.00	457.41	0.078	-1.21E-03	4342.9	25804.6	-19506.5	9.18E+08
		457.41	0.078	-1.21E-03	-15163.5	25804.6		
5	581.00	576.02	0.081	-1.23E-03	-13613.4	-17274.9		9.18E+08
6	577.00	688.18	0.086	-1.04E-03	-11085.0	-66633.8		9.18E+08
7	576.00	768.10	0.087	-9.71E-04	-10356.9	-77354.8		9.18E+08
		1008.68	0.087	-9.71E-04	-10356.9	-77354.8		
8	573.00	1010.01	0.089	-6.75E-04	-7328.8	-104068.3		9.18E+08
9	570.00	1036.29	0.091	-3.06E-04	-4259.4	-121393.4		9.18E+08
		2553.58	0.091	-3.06E-04	-4259.4	-121393.4		
10	566.00	2588.45	0.091	2.14E-04	6024.7	-117930.9		9.18E+08
		62.40	0.091	2.14E-04	6024.7	-117930.9		
11	563.00	72.79	0.090	5.68E-04	6227.5	-99032.3		9.18E+08
12	560.00	80.59	0.088	8.61E-04	6457.5	-80473.1		9.18E+08
13	555.50	85.68	0.083	1.18E-03	6831.6	-51666.2		9.18E+08
14	551.00	85.42	0.077	1.36E-03	7216.6	-20593.7		9.18E+08
		640.35	0.077	1.36E-03	7216.6	-20593.7		
15	550.00	703.19	0.076	1.38E-03	7888.4	-13051.4		9.18E+08
		-1220.93	0.076	1.38E-03	7888.4	-13051.4		
16	545.00	-842.11	0.069	1.38E-03	2730.8	11126.7		9.18E+08
17	540.00	-474.27	0.062	1.31E-03	-560.2	14281.7		8.07E+08
		-506.85	0.062	1.31E-03	-560.2	14281.7		
18	535.00	-150.52	0.056	1.25E-03	-2203.6	5114.1		8.07E+08
19	530.00	184.70	0.049	1.26E-03	-2118.1	-7838.5		8.07E+08
20	525.00	516.89	0.043	1.33E-03	-364.2	-16213.2		8.07E+08
21	521.50	729.69	0.038	1.40E-03	1817.3	-14419.9		8.07E+08
22	518.00	842.40	0.033	1.44E-03	4568.5	-3912.8		8.07E+08
		-1305.13	0.033	1.44E-03	4568.5	-3912.8		
23	513.50	-505.59	0.027	1.44E-03	494.4	3165.4		8.07E+08

(continued)

Stage No.9 Apply load no.1 at elevation 593.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
24	509.00	285.87	0.020	1.43E-03	0.0	0.0		---
At elev. 584.00				Prop force =	19506.5 lb/ft run			

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	213.29	213.29	1823
3	587.50	0.00	952.47	292.65	3099.88	334.06	334.06	10939
4	584.00	0.00	1392.99	428.01	4533.62	457.41	457.41	21879
5	581.00	0.00	1759.74	540.70	5727.24	576.02	576.02	31255
6	577.00	0.00	2239.75	688.18	7289.45	688.18	688.18a	43757
7	576.00	62.40	2296.75	705.70	7474.98	705.70	768.10a	46883
		62.40	2296.75	765.58	6890.26	946.28	1008.68	16744
8	573.00	249.60	2453.09	817.70	7359.26	947.61	1197.21	20093
9	570.00	436.80	2611.18	870.39	7833.54	973.89	1410.69	23441
		436.80	2611.18	2491.18	2731.18	2491.18	2927.98a	3402
10	566.00	686.40	2646.05	2526.05	2766.05	2526.05	3212.45a	3402
		686.40	2646.05	0.00	6646.05	0.00	686.40a	113400
11	563.00	873.60	2825.44	0.00	6825.44	10.39	883.99	61460
12	560.00	1060.80	3007.45	0.00	7007.45	18.19	1078.99	61460
13	555.50	1341.60	3284.77	0.00	7284.77	23.28	1364.88	61460
14	551.00	1622.40	3566.45	0.00	7566.45	23.02	1645.42	61460
		1622.40	3566.45	566.45	6566.45	577.95	2200.35	30730
15	550.00	1684.80	3629.54	629.54	6629.54	640.79	2325.59	30730
16	545.00	1996.80	3947.35	947.35	6947.35	956.56	2953.36	30730
17	540.00	2308.80	4268.41	1268.41	7268.41	1275.10	3583.90	30730
		2308.80	4268.41	613.91	3000.00	1240.69	3549.49	30730
18	535.00	2620.80	4592.05	770.55	3000.00	1567.22	4188.02	30730
19	530.00	2932.80	4917.75	928.19	3000.00	1885.73	4818.53	30730
20	525.00	3244.80	5245.11	1086.63	3000.00	2201.43	5446.23	30730
21	521.50	3463.20	5475.08	1197.94	3000.00	2397.57	5860.77	30730
22	518.00	3681.60	5705.64	1309.53	3000.00	2489.18	6170.78	30730
		3681.60	5705.64	341.53	5000.00	1780.86	5462.46	76825
23	513.50	3962.40	6002.81	485.36	5000.00	2254.20	6216.60	224092
24	509.00	4243.20	6300.70	629.54	5000.00	2723.83	6967.03	224092

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	566.00	624.00	0.00	0.00	0.00	0.00	624.00	0.0
11	563.00	811.20	0.00	0.00	0.00	0.00	811.20	0.0

(continued)

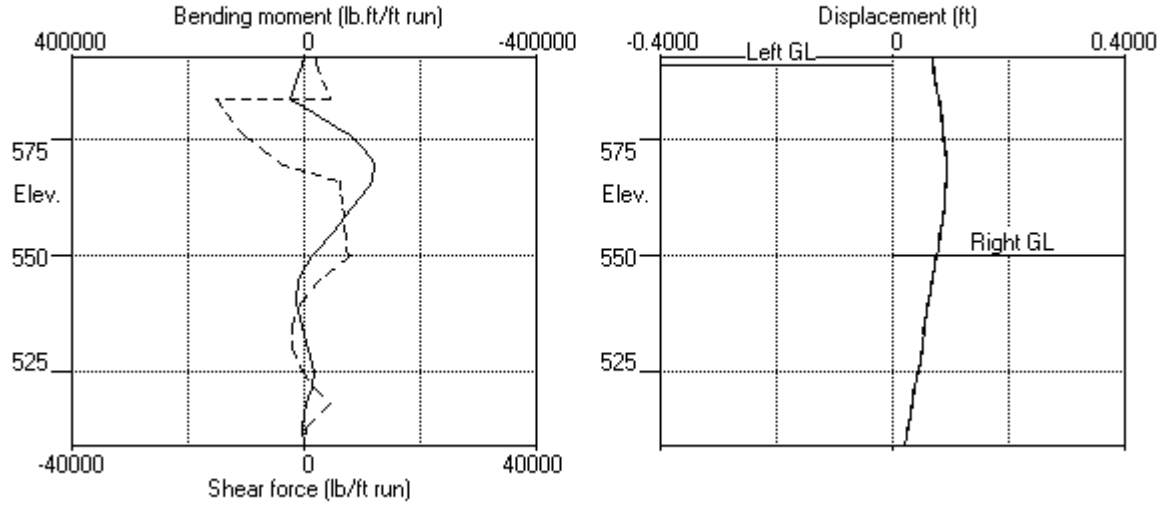
Stage No.9 Apply load no.1 at elevation 593.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
12	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
13	555.50	1279.20	0.00	0.00	0.00	0.00	1279.20	0.0
14	551.00	1560.00	0.00	0.00	0.00	0.00	1560.00	0.0
15	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	3000.00	1924.11	3546.51	44711
16	545.00	1934.40	338.00	0.00	3338.00	1861.07	3795.47	44711
17	540.00	2246.40	676.00	0.00	3676.00	1811.76	4058.16	44711
		2246.40	676.00	0.00	3000.00	1809.93	4056.33	44711
18	535.00	2558.40	1014.00	0.00	3000.00	1780.14	4338.54	44711
19	530.00	2870.40	1352.00	0.00	3000.00	1763.42	4633.82	44711
20	525.00	3182.40	1690.01	0.00	3000.00	1746.94	4929.34	44711
21	521.50	3400.80	1926.61	0.00	3000.00	1730.28	5131.08	44711
22	518.00	3619.20	2163.22	0.00	3000.00	1709.18	5328.38	44711
		3619.20	2163.22	0.00	5000.00	3148.39	6767.59	111777
23	513.50	3900.00	2467.42	0.00	5000.00	2822.19	6722.19	224092
24	509.00	4180.80	2771.63	0.00	5000.00	2500.36	6681.16	224092

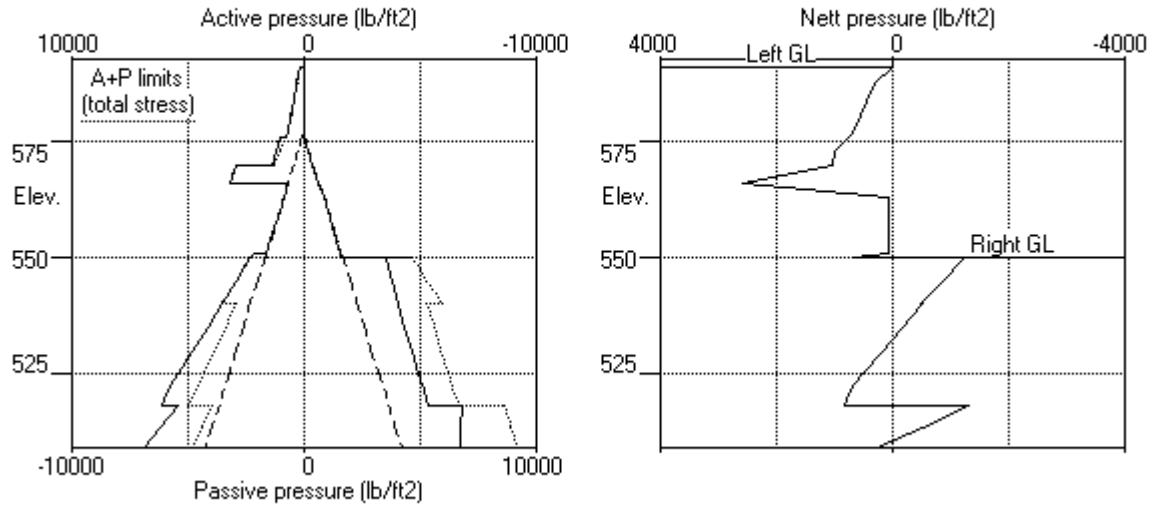
Note: 686.40a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.9 Apply load no.1 at elev. 593.00

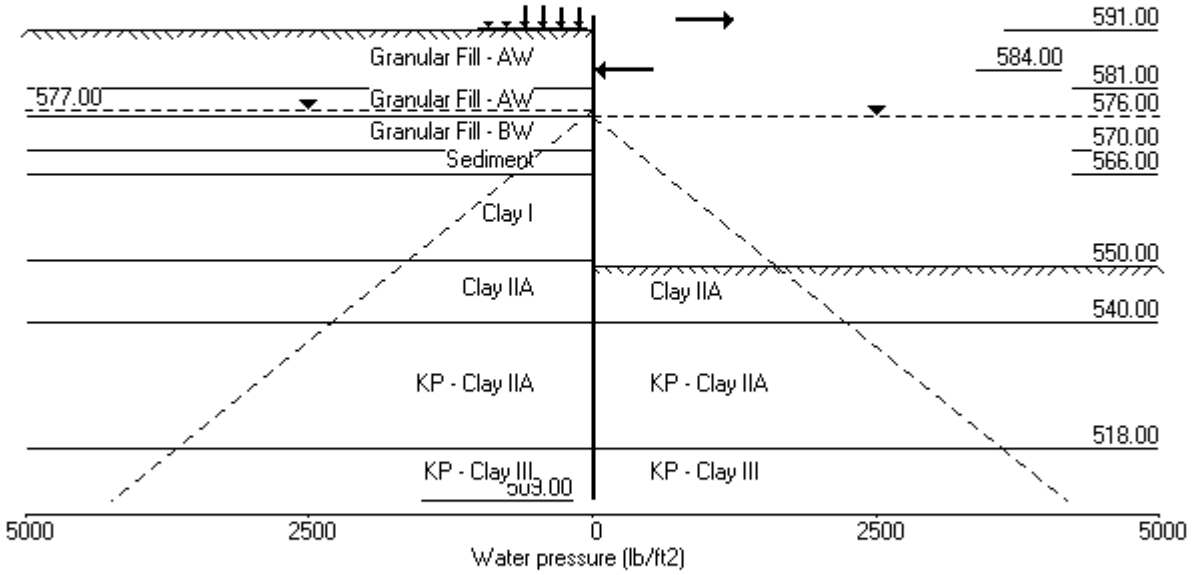


Stage No.9 Apply load no.1 at elev. 593.00



Units: lb,ft

Stage No.10 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No. 10 Apply surcharge no.4 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
10	591.00	550.00	584.00	3.550	n/a	543.91	6.09	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.067	-1.11E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.070	-1.11E-03	2000.0	4000.0		9.18E+08
		213.24	0.070	-1.11E-03	2000.0	4000.0		
3	587.50	334.27	0.073	-1.14E-03	2958.1	12852.9		9.18E+08
4	584.00	458.82	0.078	-1.22E-03	4346.1	25811.1	-19547.0	9.18E+08
		458.82	0.078	-1.22E-03	-15200.9	25811.1		
5	581.00	578.18	0.081	-1.23E-03	-13645.4	-17372.4		9.18E+08
6	577.00	690.60	0.086	-1.05E-03	-11107.9	-66839.7		9.18E+08
7	576.00	770.48	0.087	-9.73E-04	-10377.3	-77582.3		9.18E+08
		1012.39	0.087	-9.73E-04	-10377.3	-77582.3		
8	573.00	1013.76	0.089	-6.76E-04	-7338.1	-104340.3		9.18E+08
9	570.00	1039.93	0.091	-3.07E-04	-4257.6	-121676.2		9.18E+08
		2558.31	0.091	-3.07E-04	-4257.6	-121676.2		
10	566.00	2593.09	0.091	2.14E-04	6045.2	-118168.9		9.18E+08
		62.40	0.091	2.14E-04	6045.2	-118168.9		
11	563.00	71.76	0.090	5.69E-04	6246.5	-99201.9		9.18E+08
12	560.00	79.64	0.088	8.63E-04	6473.5	-80590.6		9.18E+08
13	555.50	84.90	0.083	1.18E-03	6843.8	-51722.3		9.18E+08
14	551.00	84.89	0.077	1.36E-03	7225.8	-20603.9		9.18E+08
		642.00	0.077	1.36E-03	7225.8	-20603.9		
15	550.00	704.83	0.076	1.38E-03	7899.2	-13051.7		9.18E+08
		-1222.43	0.076	1.38E-03	7899.2	-13051.7		
16	545.00	-843.18	0.069	1.38E-03	2735.1	11160.5		9.18E+08
17	540.00	-474.92	0.062	1.31E-03	-560.1	14322.9		8.07E+08
		-507.50	0.062	1.31E-03	-560.1	14322.9		
18	535.00	-150.79	0.056	1.25E-03	-2205.8	5146.6		8.07E+08
19	530.00	184.78	0.049	1.26E-03	-2120.9	-7821.4		8.07E+08
20	525.00	517.31	0.043	1.34E-03	-365.6	-16209.4		8.07E+08
21	521.50	730.35	0.038	1.40E-03	1817.8	-14418.9		8.07E+08
22	518.00	843.32	0.033	1.44E-03	4571.7	-3906.4		8.07E+08
		-1306.48	0.033	1.44E-03	4571.7	-3906.4		
23	513.50	-505.95	0.027	1.44E-03	493.7	3172.2		8.07E+08

(continued)

Stage No.10 Apply surcharge no.4 at elevation 591.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
24	509.00	286.50	0.020	1.44E-03	0.0	0.0		---

At elev. 584.00 Prop force = 19547.0 lb/ft run

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	213.24	213.24	654
3	587.50	0.00	953.04	292.83	3101.75	334.27	334.27	3925
4	584.00	0.00	1395.20	428.69	4540.80	458.82	458.82	7850
5	581.00	0.00	1763.13	541.74	5738.28	578.18	578.18	11214
6	577.00	0.00	2244.06	689.51	7303.48	690.60	690.60	15699
7	576.00	62.40	2301.20	707.06	7489.45	708.08	770.48	16820
		62.40	2301.20	767.07	6903.59	949.99	1012.39	6007
8	573.00	249.60	2457.76	819.25	7373.28	951.36	1200.96	7209
9	570.00	436.80	2615.91	871.97	7847.73	977.53	1414.33	8410
		436.80	2615.91	2495.91	2735.91	2495.91	2932.71a	1332
10	566.00	686.40	2650.69	2530.69	2770.69	2530.69	3217.09a	1332
		686.40	2650.69	0.00	6650.69	0.00	686.40a	44389
11	563.00	873.60	2829.95	0.00	6829.95	9.36	882.96	44389
12	560.00	1060.80	3011.79	0.00	7011.79	17.24	1078.04	44389
13	555.50	1341.60	3288.85	0.00	7288.85	22.50	1364.10	44389
14	551.00	1622.40	3570.26	0.00	7570.26	22.49	1644.89	44389
		1622.40	3570.26	570.26	6570.26	579.60	2202.00	22195
15	550.00	1684.80	3633.30	633.30	6633.30	642.43	2327.23	22195
16	545.00	1996.80	3950.84	950.84	6950.84	958.21	2955.01	22195
17	540.00	2308.80	4271.65	1271.65	7271.65	1276.77	3585.57	22195
		2308.80	4271.65	615.48	3000.00	1242.37	3551.17	22195
18	535.00	2620.80	4595.07	772.01	3000.00	1568.92	4189.72	22195
19	530.00	2932.80	4920.57	929.56	3000.00	1887.45	4820.25	22195
20	525.00	3244.80	5247.76	1087.91	3000.00	2203.18	5447.98	22195
21	521.50	3463.20	5477.62	1199.17	3000.00	2399.36	5862.56	22195
22	518.00	3681.60	5708.07	1310.71	3000.00	2491.00	6172.60	22195
		3681.60	5708.07	342.71	5000.00	1781.77	5463.37	55486
23	513.50	3962.40	6005.12	486.48	5000.00	2255.43	6217.83	55486
24	509.00	4243.20	6302.90	630.60	5000.00	2725.40	6968.60	55486

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	566.00	624.00	0.00	0.00	0.00	0.00	624.00	0.0
11	563.00	811.20	0.00	0.00	0.00	0.00	811.20	0.0

(continued)

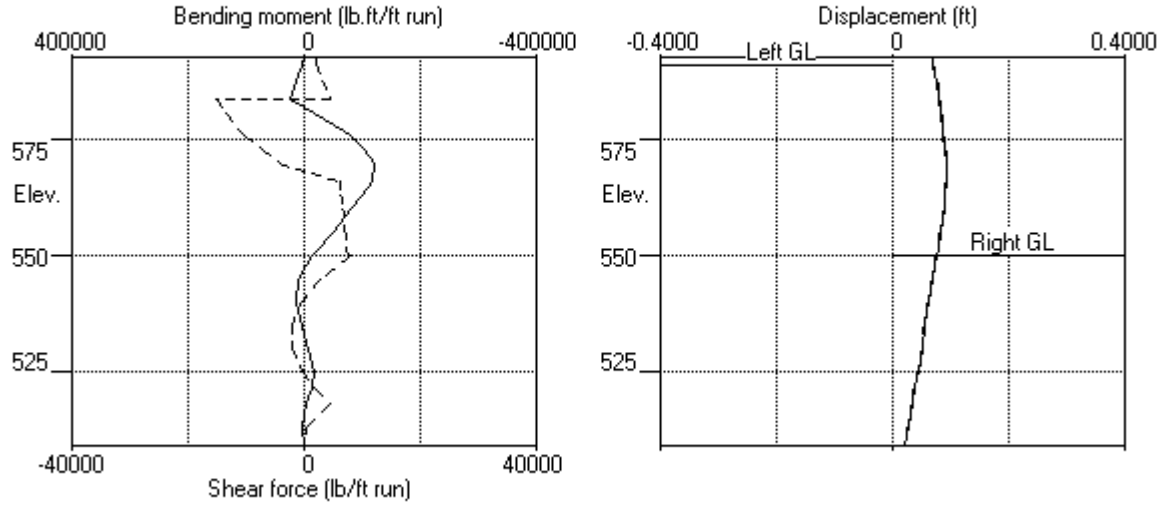
Stage No.10 Apply surcharge no.4 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
12	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
13	555.50	1279.20	0.00	0.00	0.00	0.00	1279.20	0.0
14	551.00	1560.00	0.00	0.00	0.00	0.00	1560.00	0.0
15	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	3000.00	1927.26	3549.66	33021
16	545.00	1934.40	338.00	0.00	3338.00	1863.80	3798.20	33021
17	540.00	2246.40	676.00	0.00	3676.00	1814.09	4060.49	33021
		2246.40	676.00	0.00	3000.00	1812.26	4058.66	33021
18	535.00	2558.40	1014.00	0.00	3000.00	1782.11	4340.51	33021
19	530.00	2870.40	1352.00	0.00	3000.00	1765.07	4635.47	33021
20	525.00	3182.40	1690.01	0.00	3000.00	1748.27	4930.67	33021
21	521.50	3400.80	1926.61	0.00	3000.00	1731.40	5132.20	33021
22	518.00	3619.20	2163.22	0.00	3000.00	1710.08	5329.28	33021
		3619.20	2163.22	0.00	5000.00	3150.65	6769.85	82553
23	513.50	3900.00	2467.42	0.00	5000.00	2823.78	6723.78	82553
24	509.00	4180.80	2771.63	0.00	5000.00	2501.29	6682.09	82553

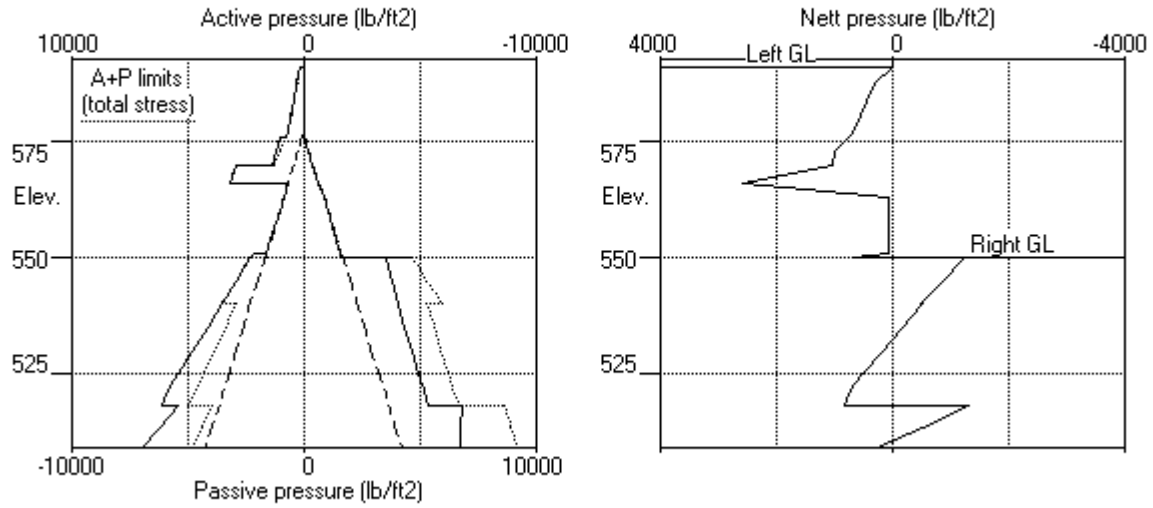
Note: 686.40a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.10 Apply surcharge no.4 at elev. 591.00

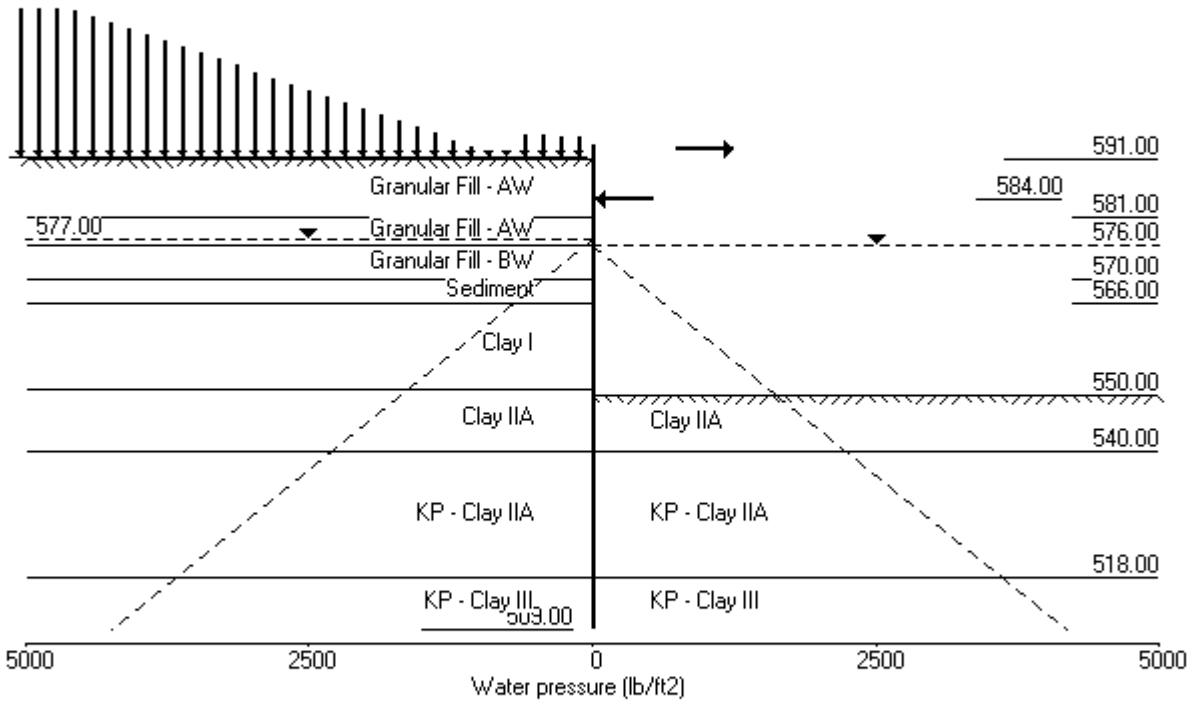


Stage No.10 Apply surcharge no.4 at elev. 591.00



Units: lb,ft

Stage No.12 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No. 12 Apply surcharge no.3 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 509.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
12	591.00	550.00	584.00	2.315	n/a	537.37	12.63	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.064	-1.87E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.068	-1.87E-03	2000.0	4000.0		9.18E+08
		227.25	0.068	-1.87E-03	2000.0	4000.0		
3	587.50	333.17	0.074	-1.90E-03	2980.7	12942.0		9.18E+08
4	584.00	445.61	0.081	-1.98E-03	4343.6	25993.6	-20903.4	9.18E+08
		445.61	0.081	-1.98E-03	-16559.9	25993.6		
5	581.00	551.32	0.087	-1.98E-03	-15064.5	-21384.3		9.18E+08
6	577.00	711.58	0.095	-1.77E-03	-12538.7	-76615.1		9.18E+08
7	576.00	795.39	0.096	-1.68E-03	-11785.2	-88777.3		9.18E+08
		1043.71	0.096	-1.68E-03	-11785.2	-88777.3		
8	573.00	1062.60	0.101	-1.34E-03	-8625.7	-119554.5		9.18E+08
9	570.00	1108.42	0.104	-9.21E-04	-5369.2	-140461.5		9.18E+08
		2732.94	0.104	-9.21E-04	-5369.2	-140461.5		
10	566.00	2837.93	0.107	-3.11E-04	5772.5	-139816.4		9.18E+08
		62.40	0.107	-3.11E-04	5772.5	-139816.4		
11	563.00	62.40	0.107	1.15E-04	5959.7	-121681.5		9.18E+08
12	560.00	62.40	0.106	4.84E-04	6146.9	-103984.3		9.18E+08
13	555.50	62.40	0.103	9.26E-04	6427.7	-76778.0		9.18E+08
14	551.00	167.39	0.098	1.23E-03	6944.8	-47405.1		9.18E+08
		1167.39	0.098	1.23E-03	6944.8	-47405.1		
15	550.00	1250.03	0.097	1.27E-03	8153.5	-39867.9		9.18E+08
		-1201.89	0.097	1.27E-03	8153.5	-39867.9		
16	545.00	-728.04	0.090	1.42E-03	3328.7	-13715.8		9.18E+08
17	540.00	-250.29	0.083	1.47E-03	882.8	-5742.7		8.07E+08
		-712.55	0.083	1.47E-03	882.8	-5742.7		
18	535.00	-214.26	0.075	1.52E-03	-1434.2	-9886.1		8.07E+08
19	530.00	281.23	0.067	1.61E-03	-1266.8	-19423.0		8.07E+08
20	525.00	573.46	0.059	1.74E-03	869.9	-22871.0		8.07E+08
21	521.50	658.19	0.053	1.83E-03	3025.3	-16812.7		8.07E+08
22	518.00	749.14	0.046	1.87E-03	5488.2	-2702.8		8.07E+08
		-1694.77	0.046	1.87E-03	5488.2	-2702.8		
23	513.50	-605.96	0.038	1.86E-03	311.5	4792.5		8.07E+08

(continued)

Stage No.12 Apply surcharge no.3 at elevation 591.00

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
24	509.00	467.50	0.029	1.85E-03	0.0	-0.0		---

At elev. 584.00 Prop force = 20903.4 lb/ft run

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	227.25	227.25	7263
3	587.50	0.00	954.67	293.33	3107.07	333.17	333.17	3749
4	584.00	0.00	1407.14	432.36	4579.66	445.61	445.61	7417
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	10596
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	14834
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	15894
		62.40	2385.59	795.20	7156.77	981.31	1043.71	5676
8	573.00	249.60	2584.43	861.48	7753.30	1000.20	1249.80	6812
9	570.00	436.80	2790.54	930.18	8371.61	1046.02	1482.82	7947
		436.80	2790.54	2670.54	2910.54	2670.54	3107.34a	1274
10	566.00	686.40	2895.53	2775.53	3015.53	2775.53	3461.93a	1274
		686.40	2895.53	0.00	6895.53	0.00	686.40a	42458
11	563.00	873.60	3130.63	0.00	7130.63	0.00	873.60a	42458
12	560.00	1060.80	3370.02	0.00	7370.02	0.00	1060.80a	42458
13	555.50	1341.60	3735.09	0.00	7735.09	0.00	1341.60a	42458
14	551.00	1622.40	4104.99	104.99	8104.99	104.99	1727.39a	42458
		1622.40	4104.99	1104.99	7104.99	1104.99	2727.39a	21229
15	550.00	1684.80	4187.63	1187.63	7187.63	1187.63	2872.43a	21229
16	545.00	1996.80	4602.19	1602.19	7602.19	1602.19	3598.99a	21229
17	540.00	2308.80	5017.68	2017.68	8017.68	2017.68	4326.48a	21229
		2308.80	5017.68	976.56	3000.00	1553.59	3862.39	21229
18	535.00	2620.80	5432.64	1177.40	3000.00	1994.56	4615.36	21229
19	530.00	2932.80	5846.03	1377.48	3000.00	2433.91	5366.71	21229
20	525.00	3244.80	6257.10	1576.43	3000.00	2661.39	5906.19	21229
21	521.50	3463.20	6543.18	1714.90	3000.00	2692.41	6155.61	21229
22	518.00	3681.60	6827.74	1852.63	3000.00	2724.25	6405.85	21229
		3681.60	6827.74	884.63	5000.00	2212.05	5893.65	53073
23	513.50	3962.40	7191.22	1060.55	5000.00	2853.56	6815.96	53073
24	509.00	4243.20	7551.89	1235.11	5000.00	3486.13	7729.33	53073

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	566.00	624.00	0.00	0.00	0.00	0.00	624.00	0.0
11	563.00	811.20	0.00	0.00	0.00	0.00	811.20	0.0

(continued)

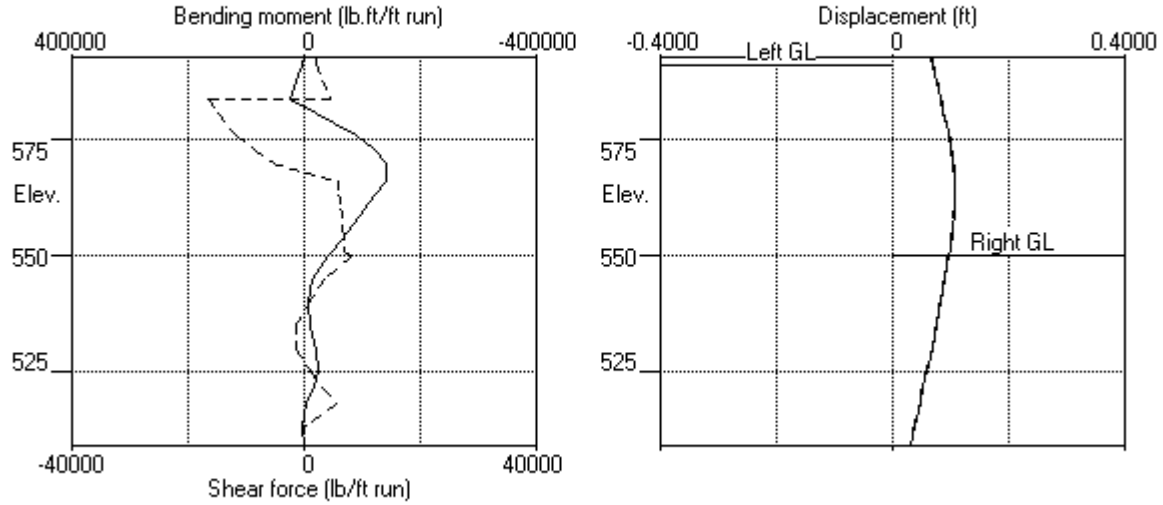
Stage No.12 Apply surcharge no.3 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
12	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
13	555.50	1279.20	0.00	0.00	0.00	0.00	1279.20	0.0
14	551.00	1560.00	0.00	0.00	0.00	0.00	1560.00	0.0
15	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	3000.00	2451.92	4074.32	25207
16	545.00	1934.40	338.00	0.00	3338.00	2392.63	4327.03	25207
17	540.00	2246.40	676.00	0.00	3676.00	2330.37	4576.77	25207
		2246.40	676.00	0.00	3000.00	2328.54	4574.94	25207
18	535.00	2558.40	1014.00	0.00	3000.00	2271.23	4829.63	25207
19	530.00	2870.40	1352.00	0.00	3000.00	2215.08	5085.48	25207
20	525.00	3182.40	1690.01	0.00	3000.00	2150.33	5332.73	25207
21	521.50	3400.80	1926.61	0.00	3000.00	2096.62	5497.42	25207
22	518.00	3619.20	2163.22	0.00	3000.00	2037.51	5656.71	25207
		3619.20	2163.22	0.00	5000.00	3969.22	7588.42	63017
23	513.50	3900.00	2467.42	0.00	5000.00	3521.92	7421.92	63017
24	509.00	4180.80	2771.63	0.00	5000.00	3081.03	7261.83	63017

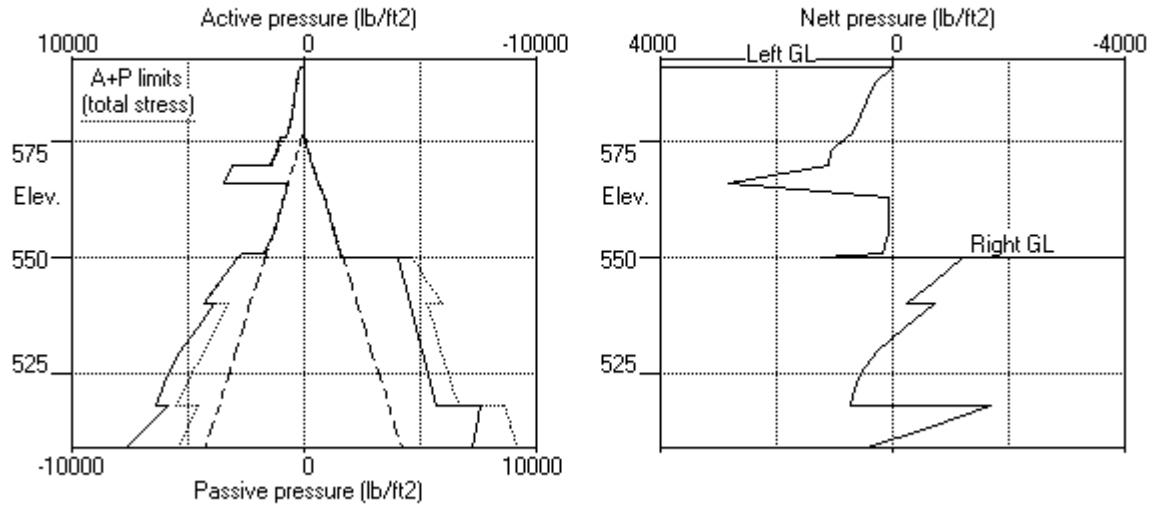
Note: 4326.48a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.12 Apply surcharge no.3 at elev. 591.00

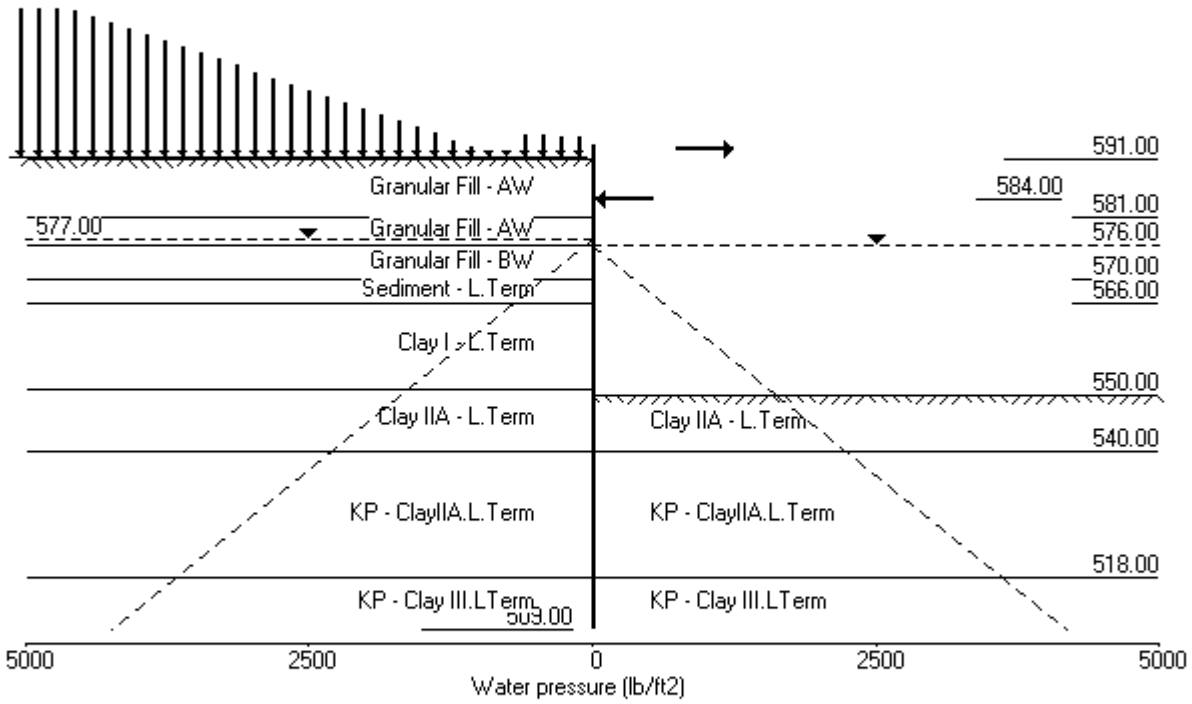


Stage No.12 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No.17 Change soil type 8 to soil type 10



Units: lb,ft

Stage No. 17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	FoS for toe elev. = 509.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
17	591.00	550.00	584.00	2.358	n/a	520.72	29.28	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

*** Wall displacements reset to zero at stage 1

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
1	593.00	0.00	0.046	-5.97E-03	2000.0	0.0	2000.0	9.18E+08
2	591.00	0.00	0.058	-5.97E-03	2000.0	4000.0		9.18E+08
		301.65	0.058	-5.97E-03	2000.0	4000.0		
3	587.50	310.82	0.079	-6.01E-03	3071.8	13397.7		9.18E+08
4	584.00	432.36	0.101	-6.08E-03	4372.4	26604.1	-28732.8	9.18E+08
		432.36	0.101	-6.08E-03	-24360.4	26604.1		
5	581.00	551.32	0.119	-6.05E-03	-22884.9	-44215.3		9.18E+08
6	577.00	711.58	0.142	-5.67E-03	-20359.1	-130728.0		9.18E+08
7	576.00	795.39	0.148	-5.52E-03	-19605.7	-150710.7		9.18E+08
		857.60	0.148	-5.52E-03	-19605.7	-150710.7		
8	573.00	923.88	0.164	-4.94E-03	-16933.4	-205715.7		9.18E+08
9	570.00	992.58	0.178	-4.19E-03	-14058.8	-252135.8		9.18E+08
		1239.25	0.178	-4.19E-03	-14058.8	-252135.8		
10	566.00	1283.53	0.192	-2.99E-03	-9013.2	-298360.4		9.18E+08
		1107.78	0.192	-2.99E-03	-9013.2	-298360.4		
11	563.00	1192.66	0.199	-1.98E-03	-5562.5	-319751.1		9.18E+08
12	560.00	1279.09	0.204	-9.24E-04	-1854.9	-331404.8		9.18E+08
13	555.50	1410.89	0.204	6.89E-04	4197.6	-327442.9		9.18E+08
14	551.00	1544.44	0.198	2.21E-03	10847.1	-294355.9		9.18E+08
		1665.21	0.198	2.21E-03	10847.1	-294355.9		
15	550.00	1697.47	0.195	2.52E-03	12528.4	-282675.9		9.18E+08
16	545.00	993.70	0.179	3.84E-03	19256.3	-203313.9		9.18E+08
17	540.00	290.29	0.158	4.67E-03	22466.3	-99102.2		8.07E+08
		-720.50	0.158	4.67E-03	22466.3	-99102.2		
18	535.00	-1507.69	0.133	4.98E-03	16895.8	-783.7		8.07E+08
19	530.00	-1957.17	0.109	4.78E-03	8233.7	65353.6		8.07E+08
20	525.00	-1058.06	0.086	4.31E-03	695.6	86625.5		8.07E+08
21	521.50	-481.54	0.072	3.94E-03	-1998.7	82080.7		8.07E+08
22	518.00	13.00	0.058	3.61E-03	-2818.6	71625.8		8.07E+08
		-1923.62	0.058	3.61E-03	-2818.6	71625.8		
23	513.50	-211.00	0.043	3.30E-03	-7621.5	37945.5		8.07E+08

(continued)

Stage No.17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

Node no.	Y coord	Nett pressure	Wall disp.	Wall rotation	Shear force	Bending moment	Prop forces	EI of wall
		lb/ft2	ft	rad.	lb/ft	lb.ft/ft	lb/ft	lb.ft2/ft
24	509.00	3598.33	0.028	3.20E-03	0.0	-0.0		---

At elev. 584.00 Prop force = 28732.8 lb/ft run

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		0.00	500.00	153.63	1627.29	301.65	301.65	8128
3	587.50	0.00	954.67	293.33	3107.07	310.82	310.82	4292
4	584.00	0.00	1407.14	432.36	4579.66	432.36	432.36a	8584
5	581.00	0.00	1794.30	551.32	5839.72	551.32	551.32a	12263
6	577.00	0.00	2315.91	711.58	7537.34	711.58	711.58a	17168
7	576.00	62.40	2385.59	732.99	7764.11	732.99	795.39a	18394
		62.40	2385.59	795.20	7156.77	795.20	857.60a	6569
8	573.00	249.60	2584.43	861.48	7753.30	861.48	1111.08a	7883
9	570.00	436.80	2790.54	930.18	8371.61	930.18	1366.98a	9197
		436.80	2790.54	1176.85	6616.88	1176.85	1613.65a	30107
10	566.00	686.40	2895.53	1221.13	6865.84	1221.13	1907.53a	35841
		686.40	2895.53	1045.38	8020.12	1045.38	1731.78a	47788
11	563.00	873.60	3130.63	1130.26	8671.31	1130.26	2003.86a	47788
12	560.00	1060.80	3370.02	1216.69	9334.37	1216.69	2277.49a	47788
13	555.50	1341.60	3735.09	1348.49	10345.54	1348.49	2690.09a	47788
14	551.00	1622.40	4104.99	1482.04	11370.10	1482.04	3104.44a	47788
		1622.40	4104.99	1602.81	10513.16	1602.81	3225.21a	23894
15	550.00	1684.80	4187.63	1635.07	10724.80	1635.07	3319.87a	23894
16	545.00	1996.80	4602.19	1796.94	11786.53	1796.94	3793.74a	23894
17	540.00	2308.80	5017.68	1959.17	12850.63	1959.17	4267.97a	23894
		2308.80	5017.68	948.34	12850.27	948.34	3257.14a	23894
18	535.00	2620.80	5432.64	1026.77	13912.99	1026.77	3647.57a	23894
19	530.00	2932.80	5846.03	1104.90	14971.68	1442.91	4375.71	23894
20	525.00	3244.80	6257.10	1182.59	16024.43	2014.03	5258.83	23894
21	521.50	3463.20	6543.18	1236.66	16757.09	2240.19	5703.39	23894
22	518.00	3681.60	6827.74	1290.44	17485.85	2432.16	6113.76	23894
		3681.60	6827.74	1290.44	17485.85	3093.32	6774.92	59736
23	513.50	3962.40	7191.22	1359.14	18416.71	3718.16	7680.56	59736
24	509.00	4243.20	7551.89	1427.31	19340.38	5423.01	9666.21	1174620

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	593.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
2	591.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
3	587.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0
4	584.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
5	581.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
6	577.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
7	576.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
8	573.00	187.20	0.00	0.00	0.00	0.00	187.20	0.0
9	570.00	374.40	0.00	0.00	0.00	0.00	374.40	0.0
10	566.00	624.00	0.00	0.00	0.00	0.00	624.00	0.0

(continued)

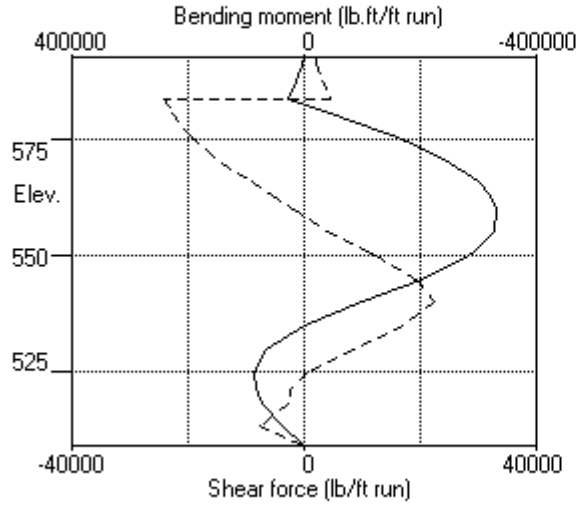
Stage No.17 Change properties of soil type 8 to soil type 10
Ko pressures will be reset

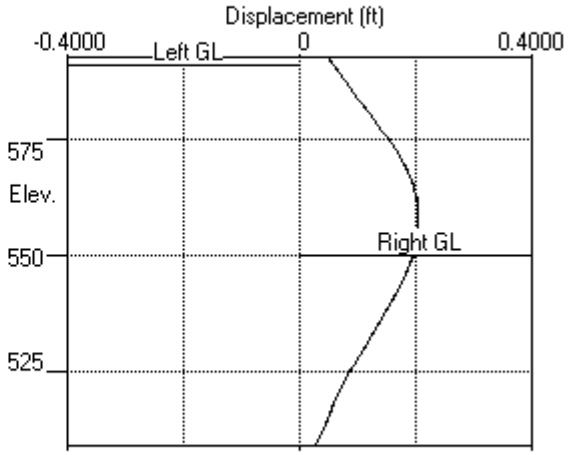
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
11	563.00	811.20	0.00	0.00	0.00	0.00	811.20	0.0
12	560.00	998.40	0.00	0.00	0.00	0.00	998.40	0.0
13	555.50	1279.20	0.00	0.00	0.00	0.00	1279.20	0.0
14	551.00	1560.00	0.00	0.00	0.00	0.00	1560.00	0.0
15	550.00	1622.40	0.00	0.00	0.00	0.00	1622.40	0.0
		1622.40	0.00	0.00	0.00	0.00	1622.40	36325
16	545.00	1934.40	338.00	131.97	865.64	865.64	2800.04p	36325
17	540.00	2246.40	676.00	263.95	1731.28	1731.28	3977.68p	36325
		2246.40	676.00	127.76	1731.24	1731.24	3977.64p	36325
18	535.00	2558.40	1014.00	191.65	2596.86	2596.86	5155.26p	36325
19	530.00	2870.40	1352.00	255.53	3462.48	3462.48	6332.88p	36325
20	525.00	3182.40	1690.01	319.41	4328.11	3134.49	6316.89	36325
21	521.50	3400.80	1926.61	364.13	4934.05	2784.13	6184.93	36325
22	518.00	3619.20	2163.22	408.85	5540.00	2481.56	6100.76	36325
		3619.20	2163.22	408.85	5540.00	5079.34	8698.54	90814
23	513.50	3900.00	2467.42	466.34	6319.07	3991.56	7891.56	90814
24	509.00	4180.80	2771.63	523.84	7098.15	1887.08	6067.88	1174620

Note: 3647.57a Soil pressure at active limit
6332.88p Soil pressure at passive limit

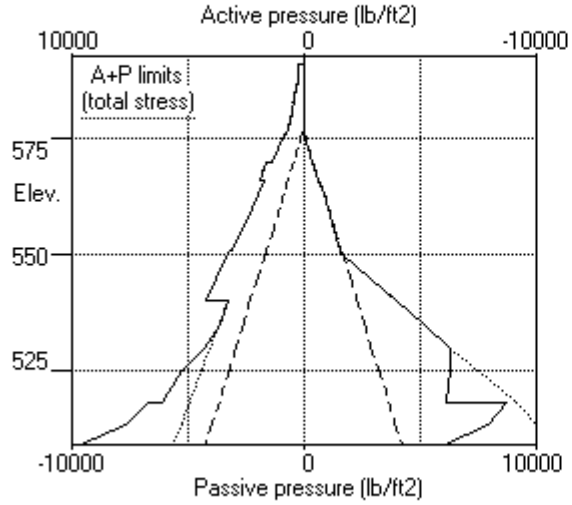
Units: lb,ft

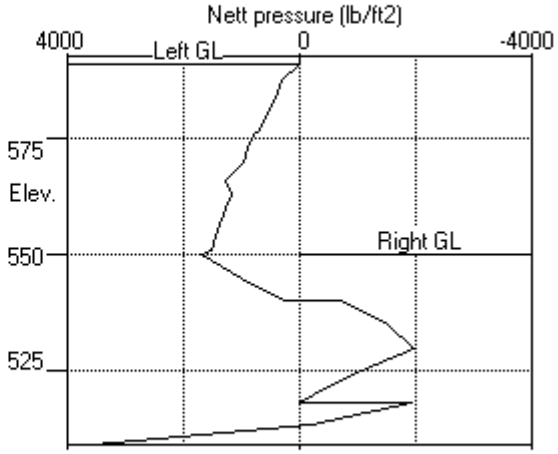
Stage No.17 Change soil type 8 to soil type 10





Stage No.17 Change soil type 8 to soil type 10





Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 509.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	570.00	570.00	---	Conditions not suitable for FoS calc.				
2	576.00	570.00	Cant.	57.509	512.71	563.05	6.95	L to R
3	581.00	570.00	Cant.	13.926	514.54	556.05	13.95	L to R
4	581.00	570.00		No analysis at this stage				
5	591.00	570.00	584.00	5.304	n/a	562.47	7.53	L to R
6	591.00	550.00	584.00	4.106	n/a	545.62	4.38	L to R
7	591.00	550.00	584.00	3.934	n/a	545.28	4.72	L to R
8	591.00	550.00	584.00	3.529	n/a	543.48	6.52	L to R
9	591.00	550.00	584.00	3.557	n/a	543.94	6.06	L to R
10	591.00	550.00	584.00	3.550	n/a	543.91	6.09	L to R
11	591.00	550.00		No analysis at this stage				
12	591.00	550.00	584.00	2.315	n/a	537.37	12.63	L to R
13	591.00	550.00		No analysis at this stage				
14	591.00	550.00		No analysis at this stage				
15	591.00	550.00		No analysis at this stage				
16	591.00	550.00		No analysis at this stage				
17	591.00	550.00	584.00	2.358	n/a	520.72	29.28	L to R

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	593.00	0.067	-0.000	0.0	0.0	2000.0	0.0
2	591.00	0.070	-0.000	4000.0	-0.0	2000.0	0.0
3	587.50	0.079	-0.000	13397.7	-0.0	3071.8	0.0
4	584.00	0.101	-0.000	26604.1	-0.0	4372.4	-24360.4
5	581.00	0.119	-0.000	0.0	-44215.3	0.0	-22884.9
6	577.00	0.142	-0.000	426.1	-130728.0	319.5	-20359.1
7	576.00	0.148	-0.000	832.2	-150710.7	499.3	-19605.7
8	573.00	0.164	-0.000	3674.4	-205715.7	1399.7	-16933.4
9	570.00	0.178	-0.000	9533.1	-252135.8	3450.6	-14058.8
10	566.00	0.192	-0.000	26654.2	-298360.4	12089.8	-9013.2
11	563.00	0.199	0.000	40768.3	-319751.1	7622.1	-5562.5
12	560.00	0.204	0.000	50155.3	-331404.8	6993.6	-1854.9
13	555.50	0.204	0.000	54237.7	-327442.9	7274.4	-1899.9
14	551.00	0.198	0.000	37887.7	-294355.9	10847.1	-5661.9
15	550.00	0.195	0.000	32338.4	-282675.9	12528.4	-5432.9
16	545.00	0.179	0.000	11160.5	-203313.9	19256.3	-4248.0
17	540.00	0.158	0.000	14526.7	-99102.2	22466.3	-3038.4
18	535.00	0.133	0.000	5674.8	-22303.7	16895.8	-2205.8
19	530.00	0.109	0.000	65353.6	-28273.5	8233.7	-2123.3
20	525.00	0.086	0.000	86625.5	-27160.0	1118.6	-391.7
21	521.50	0.072	0.000	82080.7	-21158.3	3025.3	-1998.7
22	518.00	0.058	0.000	71625.8	-10530.3	5488.2	-2818.6
23	513.50	0.043	0.000	37945.5	-1052.8	1224.6	-7621.5
24	509.00	0.029	0.000	0.0	-0.0	0.0	-0.0

Summary of results (continued)

Maximum and minimum bending moment and shear force at each stage

Stage	Bending moment				Shear force			
no.	maximum	elev.	minimum	elev.	maximum	elev.	minimum	elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	0.0	513.50	-0.0	530.00	0.0	566.00	-0.0	509.00
2	10562.4	560.00	-4658.5	530.00	1583.6	566.00	-1023.7	551.00
3	45635.0	560.00	-11540.1	525.00	6074.6	566.00	-3554.8	551.00
4	No calculation at this stage							
5	54237.7	555.50	-33233.6	573.00	12089.8	566.00	-5904.8	584.00
6	2526.1	584.00	-109330.4	570.00	6096.5	550.00	-11306.5	584.00
7	4805.9	540.00	-114404.5	570.00	6831.1	550.00	-11719.9	584.00
8	14526.7	540.00	-133334.4	570.00	8215.6	550.00	-15279.8	584.00
9	25804.6	584.00	-121393.4	570.00	7888.4	550.00	-15163.5	584.00
10	25811.1	584.00	-121676.2	570.00	7899.2	550.00	-15200.9	584.00
11	No calculation at this stage							
12	25993.6	584.00	-140461.5	570.00	8153.5	550.00	-16559.9	584.00
13	No calculation at this stage							
14	No calculation at this stage							
15	No calculation at this stage							
16	No calculation at this stage							
17	86625.5	525.00	-331404.8	560.00	22466.3	540.00	-24360.4	584.00

Maximum and minimum displacement at each stage

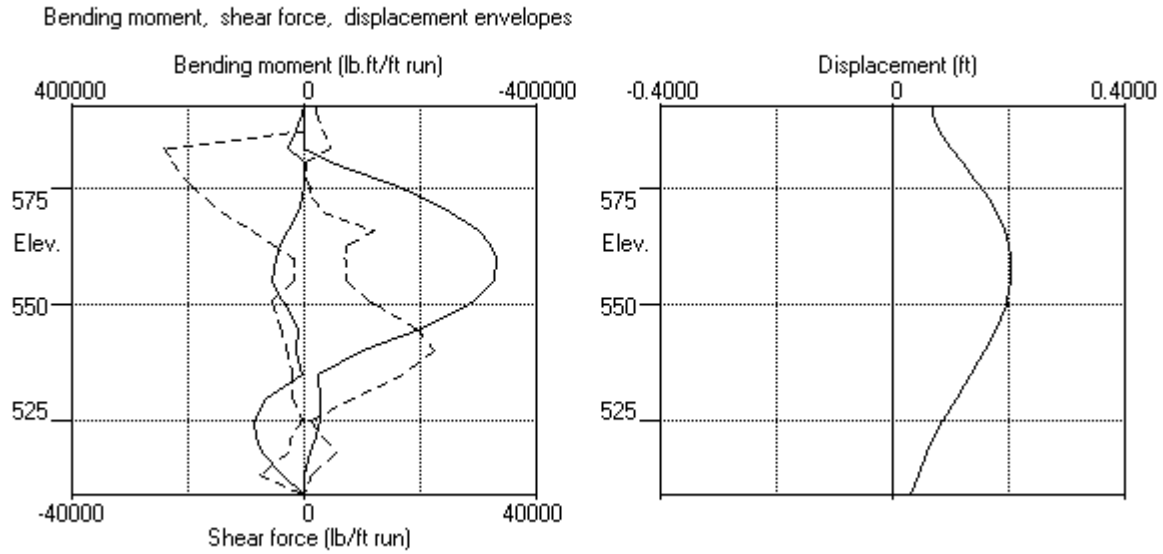
Stage	Displacement				
no.	maximum	elev.	minimum	elev.	Stage description
	ft		ft		
1	0.000	530.00	-0.000	593.00	Change EI of wall to 8.0771E+08lb.ft2/ft run
2	0.010	593.00	0.000	593.00	Fill to elev. 576.00 on LEFT side
3	0.036	593.00	0.000	593.00	Fill to elev. 581.00 on LEFT side
4	No calculation at this stage				Install prop no.1 at elev. 584.00
5	0.050	593.00	0.000	593.00	Fill to elev. 591.00 on LEFT side
6	0.077	566.00	0.000	593.00	Excav. to elev. 550.00 on RIGHT side
7	0.079	566.00	0.000	593.00	Apply water pressure profile no.1
8	0.091	566.00	0.000	593.00	Apply surcharge no.1 at elev. 591.00
9	0.091	566.00	0.000	593.00	Apply load no.1 at elev. 593.00
10	0.091	566.00	0.000	593.00	Apply surcharge no.4 at elev. 591.00
11	No calculation at this stage				Apply surcharge no.2 at elev. 591.00
12	0.107	563.00	0.000	593.00	Apply surcharge no.3 at elev. 591.00
13	No calculation at this stage				Change soil type 12 to soil type 13
14	No calculation at this stage				Change soil type 3 to soil type 4
15	No calculation at this stage				Change soil type 5 to soil type 6
16	No calculation at this stage				Change soil type 7 to soil type 9
17	0.204	555.50	0.000	593.00	Change soil type 8 to soil type 10

Summary of results (continued)

Prop forces at each stage (horizontal components)

Stage no.	-- Anchor no. 1 --- at elev. 584.00 lb/ft run	lb/prop
5	7002.77	65125.80
6	12285.07	114251.14
7	12698.56	118096.61
8	17987.28	167281.68
9	19506.48	181410.24
10	19546.99	181786.99
12	20903.45	194402.05
17	28732.82	267215.26

Units: lb,ft


Bending moment, shear force, displacement envelopes
Bending moment (lb.ft/ft run)
400000
0
-400000
575
Elev.
550
525
-40000
0
40000
Shear force (lb/ft run)
Displacement (ft)
-0.4000
0
0.4000
575
Elev.
550
525

GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

DEADMAN SHEETING WALLAP ANALYSIS

GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

DEADMAN WALLAP ANALYSIS: BL-14-22 – X.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	591.00	9 Struc Fill_null	9 Struc Fill_null
2	585.00	2 Existing Fill_und	1 Struc Fill
3	581.00	2 Existing Fill_und	2 Existing Fill_und
4	577.00	3 Clay I_und	3 Clay I_und
5	554.00	5 Clay IIA_und	5 Clay IIA_und

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Struc Fill	125.0	0	0.441	NC	0.283	3.537	
			(31000)		(0.300)	(0.000)	(0.000)	
2	Existing Fill_und	130.0	1200000	0.500	NC	1.000	1.000	2000d
					(0.490)	(2.000)	(2.000)	
3	Clay I_und	130.0	1200000	0.531	NC	1.000	1.000	2000d
					(0.490)	(2.000)	(2.000)	
4	Clay I_drnd	130.0	1200000	0.531	OC	0.361	2.770	
					(0.490)	(0.000)	(0.000)	
5	Clay IIA_und	130.0	600000	0.561	NC	1.000	1.000	1000d
					(0.490)	(2.000)	(2.000)	
6	Clay IIA_drnd	130.0	600000	0.561	OC	0.390	2.561	
					(0.490)	(0.000)	(0.000)	
7	Exist. Fill_drnd	130.0	1200000	0.500	NC	0.333	3.000	0.0d
					(0.490)	(1.155)	(3.464)	
8	Limestone	100.0	0	0.293	NC	0.172	5.828	
			(21000)		(0.290)	(0.000)	(0.000)	
9	Struc Fill_null	125.0	0	0.000	NC	0.000	0.000	
			(31000)		(0.300)	(0.000)	(0.000)	
10	Existing Fill_null	130.0	0	0.000	NC	0.000	0.000	
			(21000)		(0.290)	(0.000)	(0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Struc Fill	34.00	0.000	0.00	34.00	0.000	0.00
2	Existing Fill_und	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I_und	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I_drnd	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA_und	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA_drnd	26.00	0.000	0.00	26.00	0.000	0.00
7	Exist. Fill_drnd	30.00	0.000	0.00	30.00	0.000	0.00
8	Limestone	45.00	0.000	0.00	45.00	0.000	0.00
9	Struc Fill_null	Incompatible values			Incompatible values		
10	Existing Fill_null	0.00	0.000	0.00	0.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	577.00	577.00

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 555.00
Maximum finite element length = 2.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 8.2800E-03 ft4/ft run
E.I = 3.4577E+07 lb.ft2/ft run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	581.50	34500	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	-0.00(R)	1000.00	50.00	2143.00	0.00	N/A	N/A
2	591.00	0.00(L)	1000.00	34.00	2143.00	3600.00	N/A	N/A
3	591.00	34.00(L)	1000.00	150.00	3600.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply load no.1 at elevation 581.50
2	Apply surcharge no.1 at elevation 591.00 No analysis at this stage
3	Apply surcharge no.2 at elevation 591.00
4	Apply surcharge no.3 at elevation 591.00
5	Change properties of soil type 2 to soil type 7 No analysis at this stage Ko pressures will not be reset
6	Change properties of soil type 3 to soil type 4 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 33.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply load no.1 at elev. 581.50	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 591.00	No	No	No
3	Apply surcharge no.2 at elev. 591.00	Yes	Yes	Yes
4	Apply surcharge no.3 at elev. 591.00	Yes	Yes	Yes
5	Change soil type 2 to soil type 7	No	No	No
6	Change soil type 3 to soil type 4	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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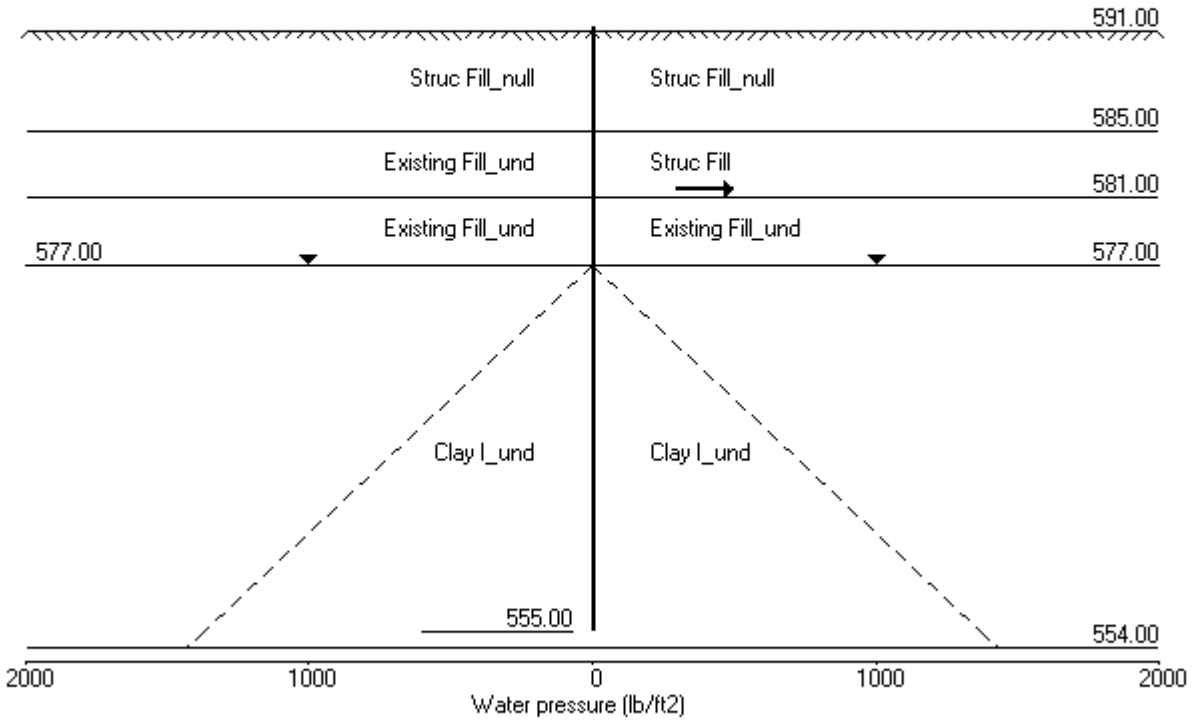
Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No. 1 Apply load no.1 at elevation 581.50

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.920	563.07	561.83	29.17	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.180	1.12E-02	0.0	0.0	
2	589.50	0.00	0.164	1.12E-02	0.0	0.0	
3	588.00	0.00	0.147	1.12E-02	0.0	-0.0	
4	586.50	0.00	0.130	1.12E-02	0.0	0.0	
5	585.00	0.00	0.113	1.12E-02	0.0	-0.0	
		-2401.87	0.113	1.12E-02	0.0	0.0	
6	583.25	-2633.97	0.093	1.13E-02	-4406.4	-3727.1	
7	581.50	-2641.45	0.073	1.18E-02	-9022.3	-15520.7	34500.0
		-2641.45	0.073	1.18E-02	25477.7	-15520.7	
8	581.00	-2598.10	0.067	1.19E-02	24167.8	-3113.2	
		-5250.00	0.067	1.19E-02	24167.8	-3113.2	
9	579.00	-5510.00	0.044	1.10E-02	13407.8	34549.0	
10	577.00	-4661.97	0.024	8.52E-03	3235.8	53427.8	
		-4716.84	0.024	8.52E-03	3235.8	53427.8	
11	575.50	-3011.66	0.013	6.22E-03	-2560.6	52954.9	
12	574.00	-1581.47	0.005	4.07E-03	-6005.4	46102.5	
13	572.00	269.90	-0.001	1.84E-03	-7317.0	30928.8	
14	570.00	1005.82	-0.003	4.62E-04	-6041.3	16834.6	
15	568.00	1055.10	-0.003	-2.20E-04	-3980.4	6763.6	
16	566.00	811.49	-0.002	-4.42E-04	-2113.8	913.1	
17	564.00	510.84	-0.001	-4.19E-04	-791.4	-1691.5	
18	562.00	263.19	-0.001	-3.05E-04	-17.4	-2252.7	
19	560.00	97.01	-0.000	-1.89E-04	342.8	-1761.1	
20	558.00	-21.76	0.000	-1.12E-04	418.0	-881.5	
21	556.50	-143.83	0.000	-8.77E-05	293.8	-279.0	
22	555.00	-247.96	0.000	-8.17E-05	-0.0	-0.0	

(continued)

Stage No.1 Apply load no.1 at elevation 581.50

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	764
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	4586
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	9173
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	13759
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	18346
		0.00	750.00	0.00	4750.00	0.00	0.00a	159067
6	583.25	0.00	977.50	0.00	4977.50	0.00	0.00a	159067
7	581.50	0.00	1205.00	0.00	5205.00	0.00	0.00a	159067
8	581.00	0.00	1270.00	0.00	5270.00	0.00	0.00a	159067
9	579.00	0.00	1530.00	0.00	5530.00	0.00	0.00a	159067
10	577.00	0.00	1790.00	0.00	5790.00	0.00	0.00a	159067
11	575.50	93.60	1891.40	0.00	5891.40	0.00	93.60a	159067
12	574.00	187.20	1992.80	0.00	5992.80	262.13	449.33	159067
13	572.00	312.00	2128.00	0.00	6128.00	1259.61	1571.61	169536
14	570.00	436.80	2263.20	0.00	6263.20	1699.36	2136.16	169536
15	568.00	561.60	2398.40	0.00	6398.40	1795.79	2357.39	169536
16	566.00	686.40	2533.60	0.00	6533.60	1745.78	2432.18	169536
17	564.00	811.20	2668.80	0.00	6668.80	1667.24	2478.44	169536
18	562.00	936.00	2804.00	0.00	6804.00	1615.21	2551.21	169536
19	560.00	1060.80	2939.20	0.00	6939.20	1603.91	2664.71	169536
20	558.00	1185.60	3074.40	0.00	7074.40	1616.32	2801.92	414445
21	556.50	1279.20	3175.80	0.00	7175.80	1609.12	2888.32	414445
22	555.00	1372.80	3277.20	0.00	7277.20	1610.91	2983.71	414445

RIGHT side

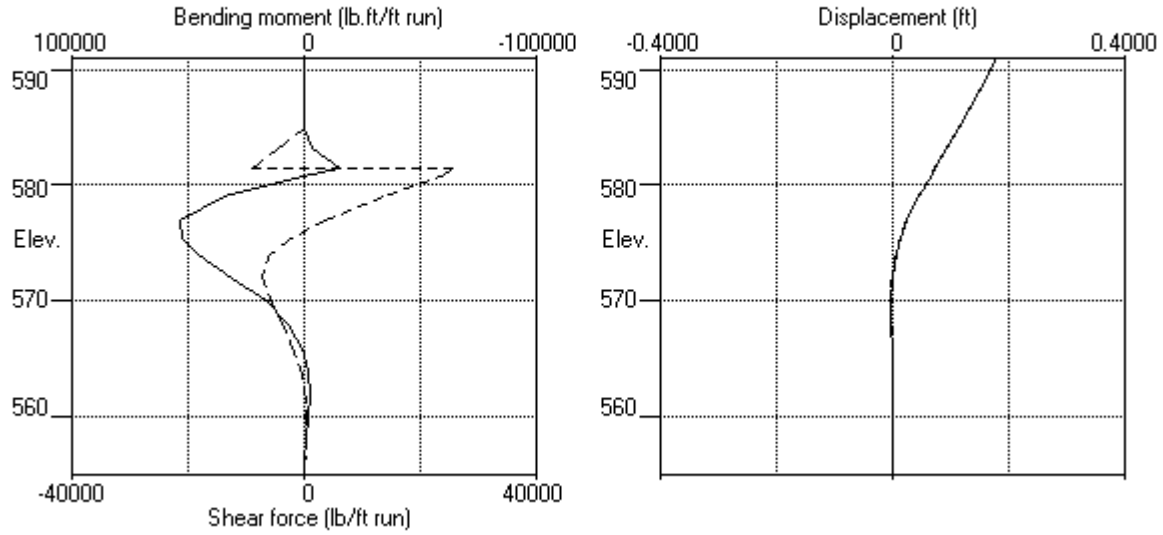
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	764
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	4586
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	9173
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	13759
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	18346
		0.00	750.00	212.25	2652.75	2401.87	2401.87	18346
6	583.25	0.00	968.75	274.16	3426.47	2633.97	2633.97	23697
7	581.50	0.00	1187.50	336.06	4200.19	2641.45	2641.45	29047
8	581.00	0.00	1250.00	353.75	4421.25	2598.10	2598.10	30576
		0.00	1250.00	0.00	5250.00	5250.00	5250.00p	159067
9	579.00	0.00	1510.00	0.00	5510.00	5510.00	5510.00p	159067
10	577.00	0.00	1770.00	0.00	5770.00	4661.97	4661.97	159067
		0.00	1770.00	0.00	5770.00	4716.84	4716.84	159067
11	575.50	93.60	1871.40	0.00	5871.40	3011.66	3105.26	159067
12	574.00	187.20	1972.80	0.00	5972.80	1843.60	2030.80	159067
13	572.00	312.00	2108.00	0.00	6108.00	989.71	1301.71	169536
14	570.00	436.80	2243.20	0.00	6243.20	693.54	1130.34	169536
15	568.00	561.60	2378.40	0.00	6378.40	740.69	1302.29	169536
16	566.00	686.40	2513.60	0.00	6513.60	934.29	1620.69	169536
17	564.00	811.20	2648.80	0.00	6648.80	1156.40	1967.60	169536
18	562.00	936.00	2784.00	0.00	6784.00	1352.02	2288.02	169536
19	560.00	1060.80	2919.20	0.00	6919.20	1506.90	2567.70	169536
20	558.00	1185.60	3054.40	0.00	7054.40	1638.08	2823.68	414445
21	556.50	1279.20	3155.80	0.00	7155.80	1752.96	3032.16	414445
22	555.00	1372.80	3257.20	0.00	7257.20	1858.86	3231.66	414445

(continued)

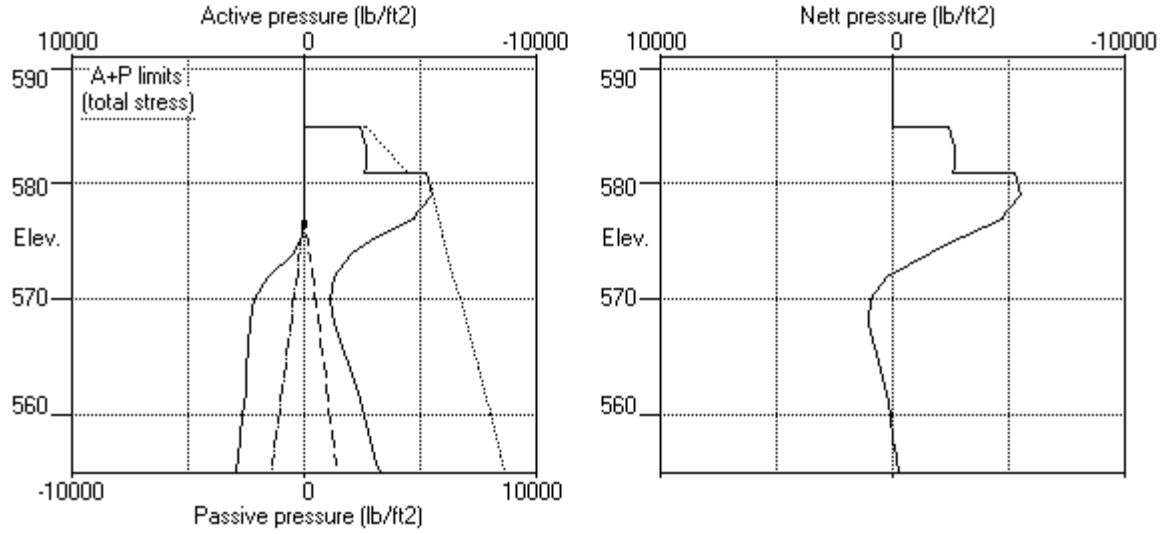
Stage No.1 Apply load no.1 at elevation 581.50
Note: 93.60a Soil pressure at active limit
5510.00p Soil pressure at passive limit

Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50

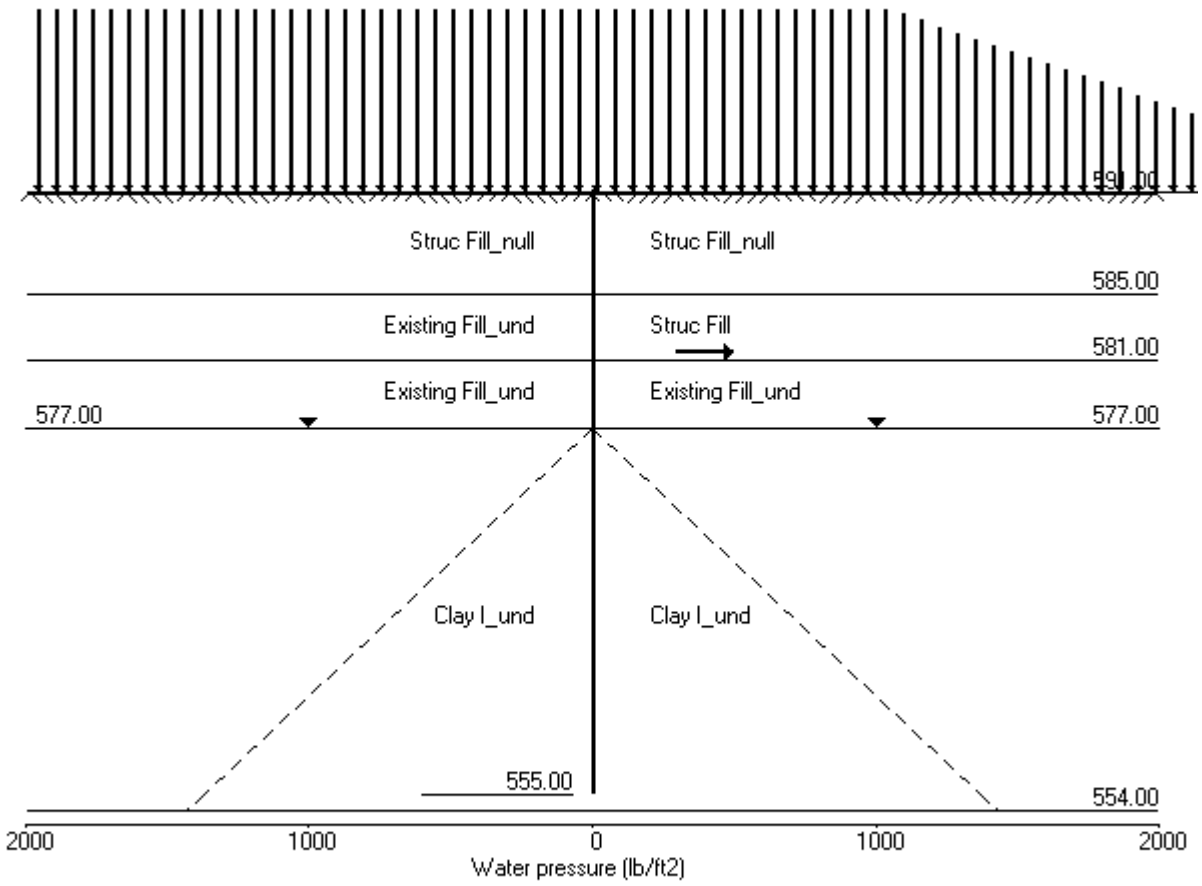


Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No. 3 Apply surcharge no.2 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
3	591.00	591.00	Cant.	3.074	561.47	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.197	1.19E-02	0.0	0.0	
2	589.50	0.00	0.179	1.19E-02	0.0	-0.0	
3	588.00	0.00	0.161	1.19E-02	0.0	0.0	
4	586.50	0.00	0.143	1.19E-02	0.0	0.0	
5	585.00	0.00	0.125	1.19E-02	0.0	-0.0	
		-2585.00	0.125	1.19E-02	0.0	0.0	
6	583.25	-2647.63	0.104	1.20E-02	-4578.6	-3162.4	
7	581.50	-2386.80	0.083	1.25E-02	-8983.7	-15212.3	34500.0
		-2386.80	0.083	1.25E-02	25516.3	-15212.3	
8	581.00	-2266.38	0.077	1.26E-02	24353.0	-2752.1	
		-5935.76	0.077	1.26E-02	24353.0	-2752.1	
9	579.00	-5698.91	0.052	1.17E-02	12718.3	34004.5	
10	577.00	-4338.20	0.031	9.29E-03	2681.2	51219.2	
		-4262.66	0.031	9.29E-03	2681.2	51219.2	
11	575.50	-2181.10	0.018	7.08E-03	-2151.6	50447.1	
12	574.00	-706.14	0.009	5.01E-03	-4317.0	45025.9	
13	572.00	-193.45	0.002	2.74E-03	-5216.6	33761.2	
14	570.00	235.06	-0.002	1.11E-03	-5175.0	22463.2	
15	568.00	540.07	-0.003	1.01E-04	-4399.9	12560.4	
16	566.00	709.67	-0.003	-4.06E-04	-3150.1	5010.6	
17	564.00	658.74	-0.002	-5.61E-04	-1781.7	335.3	
18	562.00	490.86	-0.001	-5.20E-04	-632.1	-1742.3	
19	560.00	260.69	0.000	-4.14E-04	119.4	-1912.5	
20	558.00	30.04	0.001	-3.28E-04	410.2	-1072.9	
21	556.50	-137.35	0.001	-2.96E-04	329.7	-378.4	
22	555.00	-302.24	0.002	-2.88E-04	-0.0	-0.0	

(continued)

Stage No.3 Apply surcharge no.2 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	612
2	589.50	0.00	2371.23	0.00	0.00	0.00	0.00	3671
3	588.00	0.00	2598.57	0.00	0.00	0.00	0.00	7341
4	586.50	0.00	2824.07	0.00	0.00	0.00	0.00	11012
5	585.00	0.00	3046.91	0.00	0.00	0.00	0.00	14682
		0.00	3046.91	0.00	7046.91	0.00	0.00a	129887
6	583.25	0.00	3311.33	0.00	7311.33	199.01	199.01	129887
7	581.50	0.00	3570.26	0.00	7570.26	486.98	486.98	129887
8	581.00	0.00	3643.13	0.00	7643.13	567.90	567.90	129887
9	579.00	0.00	3929.38	0.00	7929.38	887.89	887.89	129887
10	577.00	0.00	4206.98	206.98	8206.98	1213.63	1213.63	129887
		0.00	4206.98	206.98	8206.98	1344.04	1344.04	129887
11	575.50	93.60	4315.86	315.86	8315.86	1561.14	1654.74	129887
12	574.00	187.20	4419.97	419.97	8419.97	1794.46	1981.66	129887
13	572.00	312.00	4551.71	551.71	8551.71	2108.85	2420.85	129887
14	570.00	436.80	4675.99	675.99	8675.99	2379.51	2816.31	129887
15	568.00	561.60	4793.59	793.59	8793.59	2586.99	3148.59	232599
16	566.00	686.40	4905.39	905.39	8905.39	2725.60	3412.00	232599
17	564.00	811.20	5012.28	1012.28	9012.28	2753.00	3564.20	232599
18	562.00	936.00	5115.09	1115.09	9115.09	2721.23	3657.23	232599
19	560.00	1060.80	5214.63	1214.63	9214.63	2657.81	3718.61	261629
20	558.00	1185.60	5311.63	1311.63	9311.63	2593.85	3779.45	261629
21	556.50	1279.20	5383.10	1383.10	9383.10	2548.59	3827.79	261629
22	555.00	1372.80	5453.73	1453.73	9453.73	2504.56	3877.36	261629

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	612
2	589.50	0.00	2289.55	0.00	0.00	0.00	0.00	3671
3	588.00	0.00	2436.22	0.00	0.00	0.00	0.00	7341
4	586.50	0.00	2583.03	0.00	0.00	0.00	0.00	11012
5	585.00	0.00	2730.05	0.00	0.00	0.00	0.00	14682
		0.00	2730.05	772.60	9656.18	2585.00	2585.00	14682
6	583.25	0.00	2901.94	821.25	10264.16	2846.64	2846.64	18964
7	581.50	0.00	3074.33	870.03	10873.89	2873.78	2873.78	23247
8	581.00	0.00	3123.68	884.00	11048.46	2834.29	2834.29	24470
		0.00	3123.68	0.00	7123.68	6503.66	6503.66	129887
9	579.00	0.00	3331.64	0.00	7331.64	6586.80	6586.80	129887
10	577.00	0.00	3540.52	0.00	7540.52	5551.83	5551.83	129887
		0.00	3540.52	0.00	7540.52	5606.70	5606.70	129887
11	575.50	93.60	3604.27	0.00	7604.27	3742.24	3835.84	129887
12	574.00	187.20	3668.66	0.00	7668.66	2500.60	2687.80	129887
13	572.00	312.00	3755.55	0.00	7755.55	2302.30	2614.30	129887
14	570.00	436.80	3843.71	0.00	7843.71	2144.45	2581.25	129887
15	568.00	561.60	3933.19	0.00	7933.19	2046.92	2608.52	232599
16	566.00	686.40	4024.03	24.03	8024.03	2015.93	2702.33	232599
17	564.00	811.20	4116.28	116.28	8116.28	2094.26	2905.46	232599
18	562.00	936.00	4209.93	209.93	8209.93	2230.36	3166.36	232599
19	560.00	1060.80	4305.00	305.00	8305.00	2397.12	3457.92	261629
20	558.00	1185.60	4401.49	401.49	8401.49	2563.81	3749.41	261629
21	556.50	1279.20	4474.77	474.77	8474.77	2685.94	3965.14	261629

(continued)

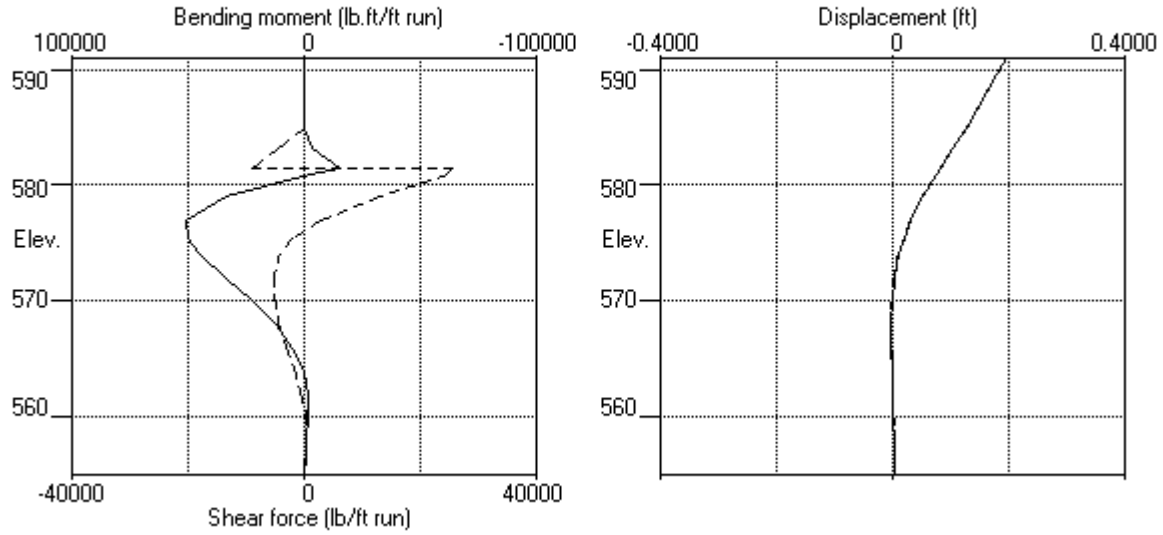
Stage No.3 Apply surcharge no.2 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
22	555.00	1372.80	4548.82	548.82	8548.82	2806.80	4179.60	261629

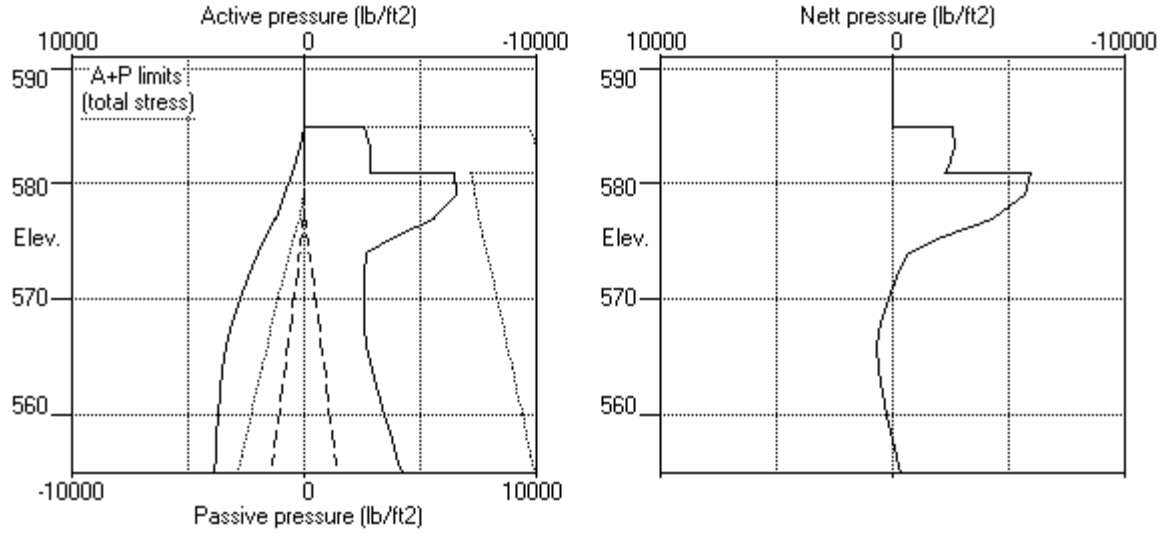
Note: 0.00a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00

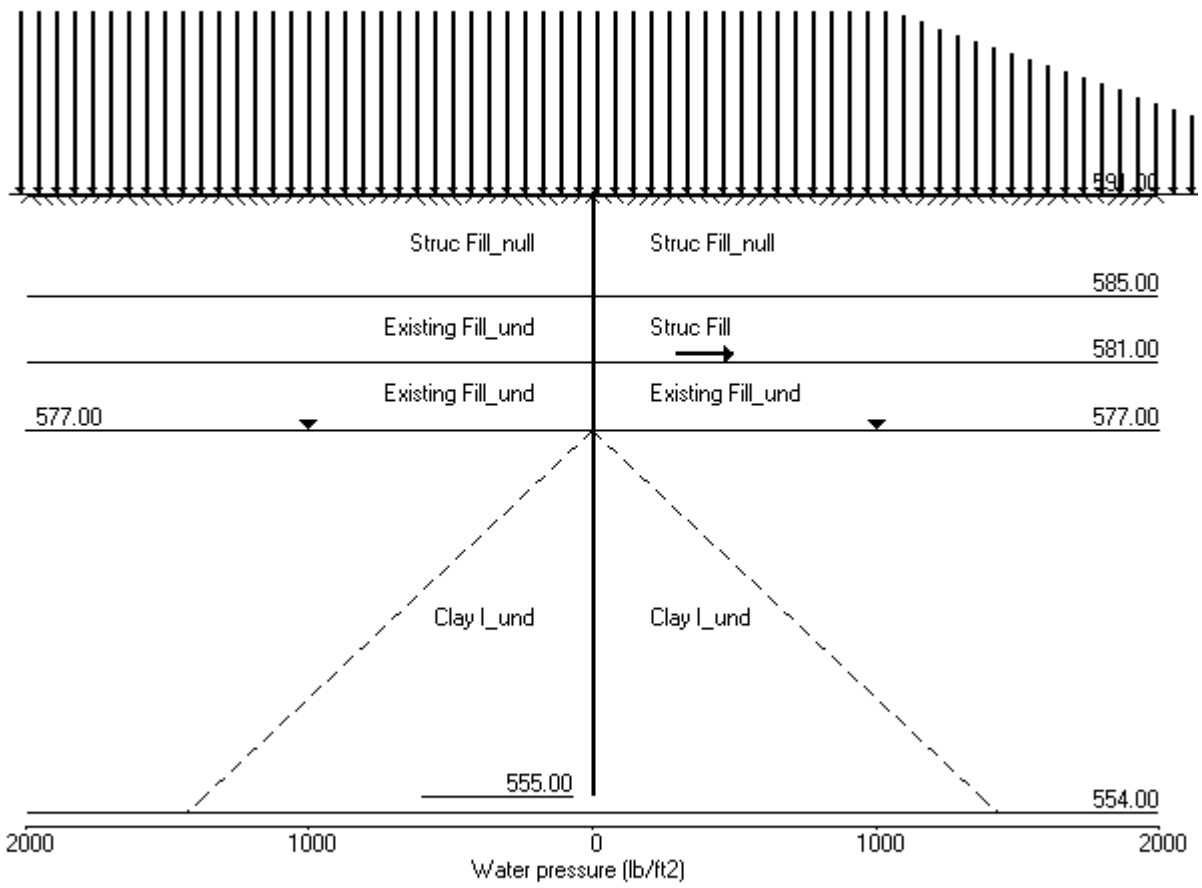


Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No.4 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No. 4 Apply surcharge no.3 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
4	591.00	591.00	Cant.	3.044	560.17	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.197	1.19E-02	0.0	0.0	
2	589.50	0.00	0.179	1.19E-02	0.0	-0.0	
3	588.00	0.00	0.161	1.19E-02	0.0	0.0	
4	586.50	0.00	0.143	1.19E-02	0.0	0.0	
5	585.00	0.00	0.125	1.19E-02	0.0	-0.0	
		-2581.95	0.125	1.19E-02	0.0	0.0	
6	583.25	-2646.53	0.104	1.20E-02	-4574.9	-3153.2	
7	581.50	-2384.02	0.083	1.25E-02	-8976.6	-15188.2	34500.0
		-2384.02	0.083	1.25E-02	25523.4	-15188.2	
8	581.00	-2262.42	0.077	1.26E-02	24361.7	-2724.0	
		-5952.67	0.077	1.26E-02	24361.7	-2724.0	
9	579.00	-5715.72	0.052	1.17E-02	12693.4	34031.6	
10	577.00	-4348.84	0.031	9.26E-03	2628.8	51182.5	
		-4273.30	0.031	9.26E-03	2628.8	51182.5	
11	575.50	-2181.67	0.019	7.06E-03	-2212.4	50329.8	
12	574.00	-690.09	0.010	4.99E-03	-4366.2	44828.0	
13	572.00	-142.52	0.002	2.73E-03	-5198.9	33527.4	
14	570.00	325.42	-0.002	1.11E-03	-5016.0	22394.3	
15	568.00	514.15	-0.003	9.46E-05	-4176.4	12913.2	
16	566.00	619.91	-0.002	-4.44E-04	-3042.3	5726.6	
17	564.00	585.42	-0.001	-6.42E-04	-1837.0	1128.8	
18	562.00	458.57	-0.000	-6.42E-04	-793.0	-1125.9	
19	560.00	273.35	0.001	-5.64E-04	-61.1	-1581.8	
20	558.00	72.06	0.002	-4.90E-04	284.3	-977.7	
21	556.50	-80.32	0.003	-4.60E-04	278.1	-383.7	
22	555.00	-290.52	0.004	-4.52E-04	-0.0	-0.0	

(continued)

Stage No.4 Apply surcharge no.3 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	1617
2	589.50	0.00	2371.36	0.00	0.00	0.00	0.00	9704
3	588.00	0.00	2599.60	0.00	0.00	0.00	0.00	19407
4	586.50	0.00	2827.51	0.00	0.00	0.00	0.00	29111
5	585.00	0.00	3054.95	0.00	0.00	0.00	0.00	22524
		0.00	3054.95	0.00	7054.95	3.57	3.57	192662
6	583.25	0.00	3328.24	0.00	7328.24	202.19	202.19	192662
7	581.50	0.00	3600.50	0.00	7600.50	494.05	494.05	192662
8	581.00	0.00	3678.06	0.00	7678.06	576.91	576.91	192662
9	579.00	0.00	3987.27	0.00	7987.27	908.43	908.43	192662
10	577.00	0.00	4294.61	294.61	8294.61	1252.13	1252.13	192662
		0.00	4294.61	294.61	8294.61	1382.54	1382.54	192662
11	575.50	93.60	4430.21	430.21	8430.21	1618.03	1711.63	192662
12	574.00	187.20	4564.63	564.63	8564.63	1874.82	2062.02	192662
13	572.00	312.00	4741.97	741.97	8741.97	2229.44	2541.44	192662
14	570.00	436.80	4917.12	917.12	8917.12	2540.43	2977.23	192662
15	568.00	561.60	5090.07	1090.07	9090.07	2631.95	3193.55	192662
16	566.00	686.40	5260.86	1260.86	9260.86	2714.68	3401.08	192662
17	564.00	811.20	5429.51	1429.51	9429.51	2781.37	3592.57	192662
18	562.00	936.00	5596.11	1596.11	9596.11	2830.23	3766.23	192662
19	560.00	1060.80	5760.71	1760.71	9760.71	2864.70	3925.50	192662
20	558.00	1185.60	5923.40	1923.40	9923.40	2890.60	4076.20	192662
21	556.50	1279.20	6044.21	2044.21	10044.21	2907.55	4186.75	192662
22	555.00	1372.80	6164.03	2164.03	10164.03	2865.57	4238.37	192662

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	1617
2	589.50	0.00	2289.55	0.00	0.00	0.00	0.00	9704
3	588.00	0.00	2436.22	0.00	0.00	0.00	0.00	19407
4	586.50	0.00	2583.03	0.00	0.00	0.00	0.00	29111
5	585.00	0.00	2730.05	0.00	0.00	0.00	0.00	22524
		0.00	2730.05	772.60	9656.18	2585.53	2585.53	22524
6	583.25	0.00	2901.94	821.25	10264.16	2848.72	2848.72	29094
7	581.50	0.00	3074.33	870.03	10873.89	2878.07	2878.07	35663
8	581.00	0.00	3123.68	884.00	11048.46	2839.34	2839.34	37540
		0.00	3123.68	0.00	7123.68	6529.58	6529.58	192662
9	579.00	0.00	3331.64	0.00	7331.64	6624.15	6624.15	192662
10	577.00	0.00	3540.52	0.00	7540.52	5600.97	5600.97	192662
		0.00	3540.52	0.00	7540.52	5655.84	5655.84	192662
11	575.50	93.60	3604.27	0.00	7604.27	3799.70	3893.30	192662
12	574.00	187.20	3668.66	0.00	7668.66	2564.90	2752.10	192662
13	572.00	312.00	3755.55	0.00	7755.55	2371.97	2683.97	192662
14	570.00	436.80	3843.71	0.00	7843.71	2215.01	2651.81	192662
15	568.00	561.60	3933.19	0.00	7933.19	2117.80	2679.40	192662
16	566.00	686.40	4024.03	24.03	8024.03	2094.77	2781.17	192662
17	564.00	811.20	4116.28	116.28	8116.28	2195.96	3007.16	192662
18	562.00	936.00	4209.93	209.93	8209.93	2371.66	3307.66	192662
19	560.00	1060.80	4305.00	305.00	8305.00	2591.35	3652.15	192662
20	558.00	1185.60	4401.49	401.49	8401.49	2818.54	4004.14	192662
21	556.50	1279.20	4474.77	474.77	8474.77	2987.87	4267.07	192662

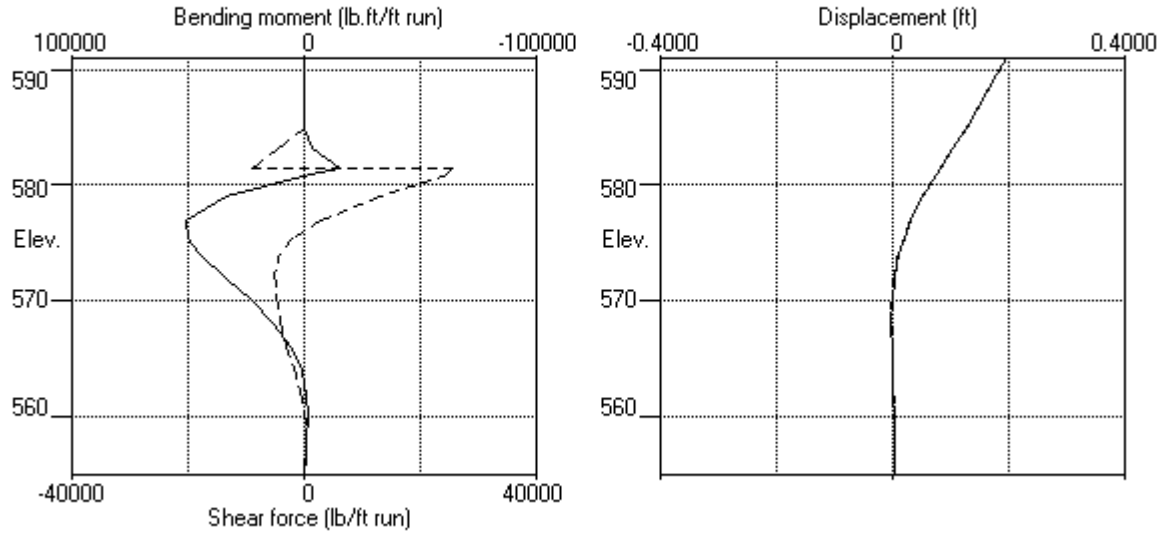
(continued)

Stage No.4 Apply surcharge no.3 at elevation 591.00

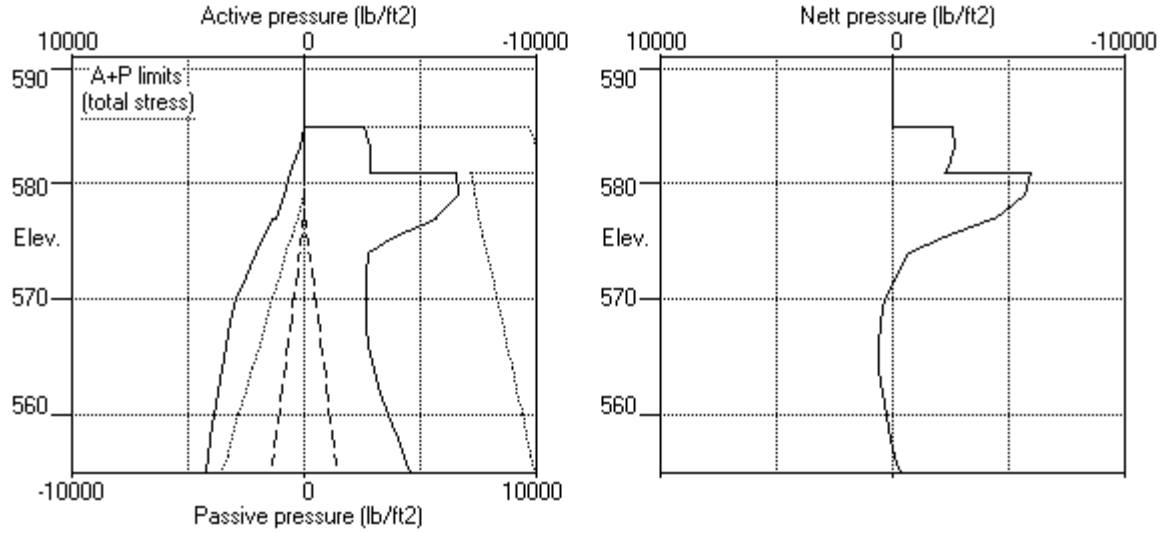
		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
22	555.00	1372.80	4548.82	548.82	8548.82	3156.09	4528.89	192662

Units: lb,ft

Stage No.4 Apply surcharge no.3 at elev. 591.00

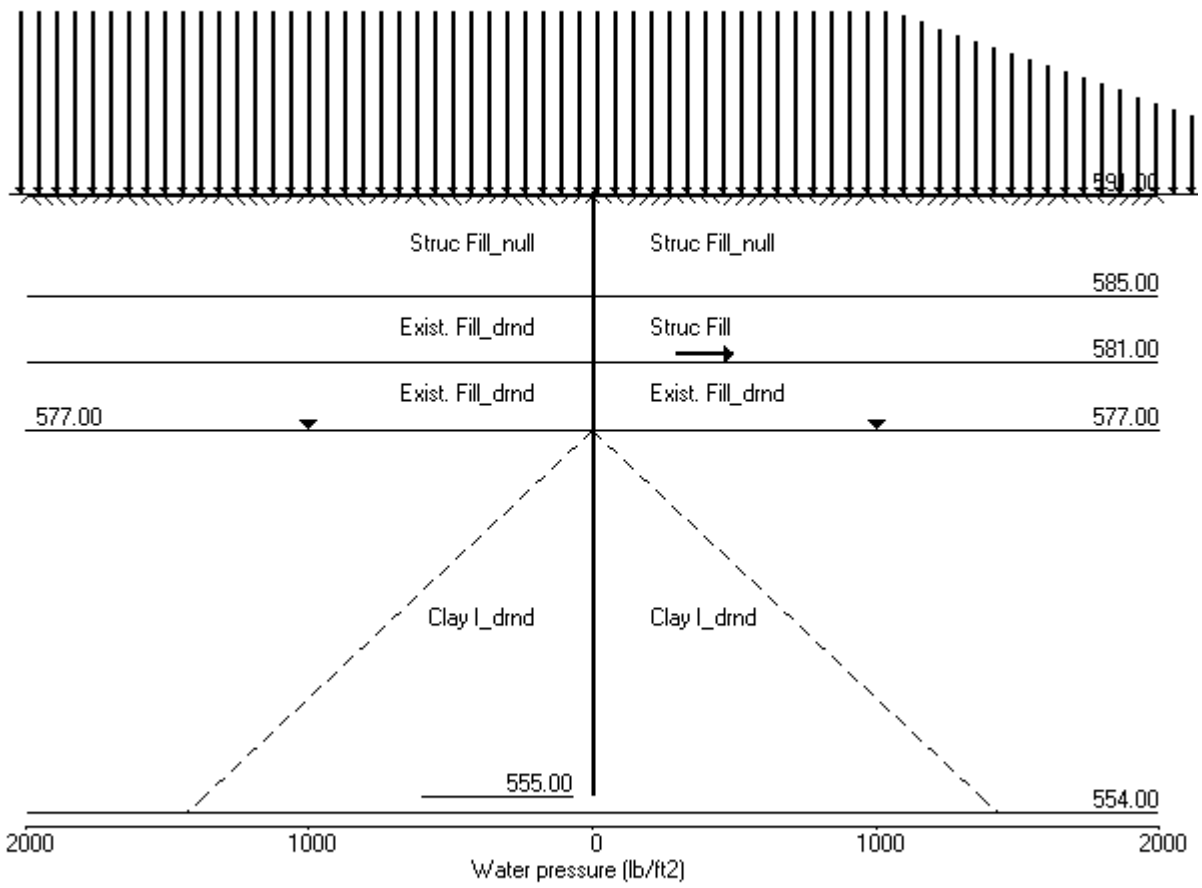


Stage No.4 Apply surcharge no.3 at elev. 591.00



Units: lb,ft

Stage No.6 Change soil type 3 to soil type 4



Units: lb,ft

Stage No. 6 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
6	591.00	591.00	Cant.	2.690	560.12	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.226	1.40E-02	0.0	0.0	
2	589.50	0.00	0.205	1.40E-02	0.0	-0.0	
3	588.00	0.00	0.184	1.40E-02	0.0	0.0	
4	586.50	0.00	0.163	1.40E-02	0.0	0.0	
5	585.00	0.00	0.142	1.40E-02	0.0	0.0	
		-1899.22	0.142	1.40E-02	0.0	0.0	
6	583.25	-2077.04	0.118	1.40E-02	-3479.2	-2162.7	
7	581.50	-1983.74	0.093	1.44E-02	-7032.4	-11510.8	34500.0
		-1983.74	0.093	1.44E-02	27467.6	-11510.8	
8	581.00	-1904.34	0.086	1.44E-02	26495.6	1973.2	
		-6809.83	0.086	1.44E-02	26495.6	1973.2	
9	579.00	-6226.37	0.057	1.32E-02	13459.4	41129.8	
10	577.00	-4658.59	0.034	1.03E-02	2574.4	58630.7	
		-4594.50	0.034	1.03E-02	2574.4	58630.7	
11	575.50	-2452.07	0.020	7.84E-03	-2710.5	57265.1	
12	574.00	-870.45	0.010	5.49E-03	-5202.4	50719.0	
13	572.00	-87.34	0.002	2.94E-03	-6160.2	37385.3	
14	570.00	462.52	-0.002	1.16E-03	-5785.0	24439.9	
15	568.00	650.74	-0.003	5.90E-05	-4671.7	13695.0	
16	566.00	722.32	-0.003	-5.04E-04	-3298.7	5790.9	
17	564.00	648.54	-0.002	-6.97E-04	-1927.8	885.2	
18	562.00	490.19	-0.000	-6.81E-04	-789.1	-1424.8	
19	560.00	284.17	0.001	-5.88E-04	-14.7	-1809.7	
20	558.00	69.07	0.002	-5.04E-04	338.5	-1091.2	
21	556.50	-99.13	0.003	-4.71E-04	316.0	-419.3	
22	555.00	-322.16	0.004	-4.62E-04	-0.0	-0.0	

(continued)

Stage No.6 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	821
2	589.50	0.00	2371.36	0.00	0.00	0.00	0.00	4924
3	588.00	0.00	2599.60	0.00	0.00	0.00	0.00	9849
4	586.50	0.00	2827.51	0.00	0.00	0.00	0.00	14773
5	585.00	0.00	3054.95	0.00	0.00	0.00	0.00	19697
		0.00	3054.95	1018.32	9164.84	1018.32	1018.32a	169911
6	583.25	0.00	3328.24	1109.41	9984.73	1109.41	1109.41a	169911
7	581.50	0.00	3600.50	1200.17	10801.49	1200.17	1200.17a	169911
8	581.00	0.00	3678.06	1226.02	11034.19	1226.02	1226.02a	169911
9	579.00	0.00	3987.27	1329.09	11961.80	1329.09	1329.09a	169911
10	577.00	0.00	4294.61	1431.54	12883.84	1431.54	1431.54a	169911
		0.00	4294.61	1550.50	11895.33	1550.50	1550.50a	169911
11	575.50	93.60	4430.21	1599.45	12270.91	1599.45	1693.05a	169911
12	574.00	187.20	4564.63	1647.98	12643.23	1784.64	1971.84	169911
13	572.00	312.00	4741.97	1712.01	13134.43	2257.04	2569.04	166712
14	570.00	436.80	4917.12	1775.24	13619.56	2608.98	3045.78	166712
15	568.00	561.60	5090.07	1837.69	14098.62	2700.25	3261.85	166712
16	566.00	686.40	5260.86	1899.35	14571.66	2765.88	3452.28	166712
17	564.00	811.20	5429.51	1960.24	15038.81	2812.94	3624.14	166712
18	562.00	936.00	5596.11	2020.38	15500.24	2846.04	3782.04	166712
19	560.00	1060.80	5760.71	2079.81	15956.16	2870.11	3930.91	166712
20	558.00	1185.60	5923.40	2138.54	16406.78	2889.10	4074.70	339433
21	556.50	1279.20	6044.21	2182.16	16741.41	2898.14	4177.34	415850
22	555.00	1372.80	6164.03	2225.42	17073.30	2849.75	4222.55	415850

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	821
2	589.50	0.00	2289.55	0.00	0.00	0.00	0.00	4924
3	588.00	0.00	2436.22	0.00	0.00	0.00	0.00	9849
4	586.50	0.00	2583.03	0.00	0.00	0.00	0.00	14773
5	585.00	0.00	2730.05	0.00	0.00	0.00	0.00	19697
		0.00	2730.05	772.60	9656.18	2917.53	2917.53	19697
6	583.25	0.00	2901.94	821.25	10264.16	3186.45	3186.45	25442
7	581.50	0.00	3074.33	870.03	10873.89	3183.90	3183.90	31188
8	581.00	0.00	3123.68	884.00	11048.46	3130.37	3130.37	32829
		0.00	3123.68	1041.23	9371.05	8035.85	8035.85	169911
9	579.00	0.00	3331.64	1110.55	9994.91	7555.46	7555.46	169911
10	577.00	0.00	3540.52	1180.17	10621.57	6090.13	6090.13	169911
		0.00	3540.52	1278.25	9806.64	6145.00	6145.00	169911
11	575.50	93.60	3604.27	1301.26	9983.21	4051.52	4145.12	169911
12	574.00	187.20	3668.66	1324.51	10161.54	2655.08	2842.28	169911
13	572.00	312.00	3755.55	1355.88	10402.22	2344.38	2656.38	166712
14	570.00	436.80	3843.71	1387.71	10646.40	2146.46	2583.26	166712
15	568.00	561.60	3933.19	1420.01	10894.24	2049.51	2611.11	166712
16	566.00	686.40	4024.03	1452.81	11145.88	2043.56	2729.96	166712
17	564.00	811.20	4116.28	1486.11	11401.37	2164.39	2975.59	166712
18	562.00	936.00	4209.93	1519.93	11660.78	2355.85	3291.85	166712
19	560.00	1060.80	4305.00	1554.25	11924.11	2585.94	3646.74	166712
20	558.00	1185.60	4401.49	1589.08	12191.35	2820.03	4005.63	339433

(continued)

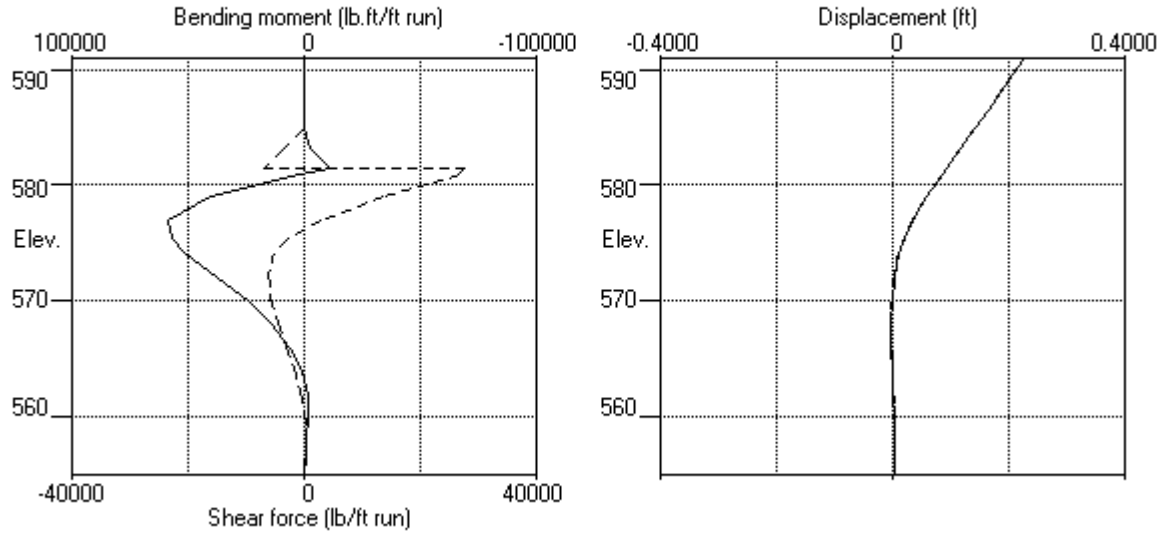
Stage No.6 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
21	556.50	1279.20	4474.77	1615.54	12394.32	2997.27	4276.47	415850
22	555.00	1372.80	4548.82	1642.28	12599.45	3171.91	4544.71	415850

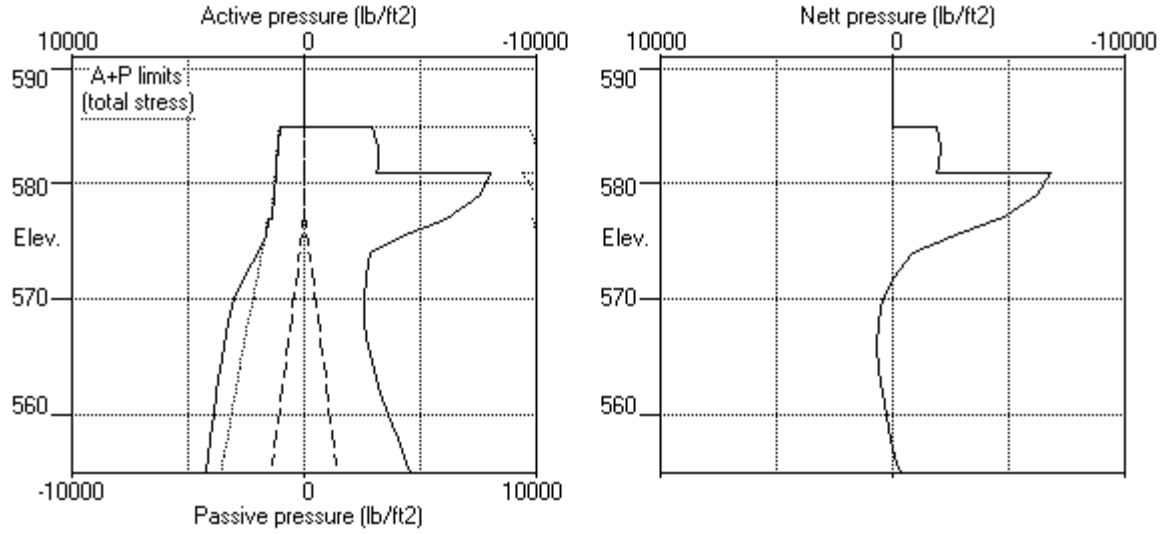
Note: 1693.05a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.6 Change soil type 3 to soil type 4



Stage No.6 Change soil type 3 to soil type 4



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	Moment equilib. at elev.	Toe Elev. for FoS = 1.500 Toe elev.	Wall Penetr -ation	Direction of failure
1	591.00	591.00	Cant.	1.920	563.07	561.83	29.17	L to R
2	591.00	591.00		No analysis at this stage				
3	591.00	591.00	Cant.	3.074	561.47	***	***	L to R
4	591.00	591.00	Cant.	3.044	560.17	***	***	L to R
5	591.00	591.00		No analysis at this stage				
6	591.00	591.00	Cant.	2.690	560.12	***	***	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	591.00	0.226	0.000	0.0	0.0	0.0	0.0
2	589.50	0.205	0.000	0.0	-0.0	0.0	0.0
3	588.00	0.184	0.000	0.0	-0.0	0.0	0.0
4	586.50	0.163	0.000	0.0	-0.0	0.0	0.0
5	585.00	0.142	0.000	0.0	-0.0	0.0	0.0
6	583.25	0.118	0.000	0.0	-3727.1	0.0	-4578.6
7	581.50	0.093	0.000	0.0	-15520.7	27467.6	-9022.3
8	581.00	0.086	0.000	1973.2	-3113.2	26495.6	0.0
9	579.00	0.057	0.000	41129.8	0.0	13459.4	0.0
10	577.00	0.034	0.000	58630.7	0.0	3235.8	0.0
11	575.50	0.020	0.000	57265.1	0.0	0.0	-2710.5
12	574.00	0.010	0.000	50719.0	0.0	0.0	-6005.4
13	572.00	0.002	-0.001	37385.3	0.0	0.0	-7317.0
14	570.00	0.000	-0.003	24439.9	0.0	0.0	-6041.3
15	568.00	0.000	-0.003	13695.0	0.0	0.0	-4671.7
16	566.00	0.000	-0.003	5790.9	0.0	0.0	-3298.7
17	564.00	0.000	-0.002	1128.8	-1691.5	0.0	-1927.8
18	562.00	0.000	-0.001	0.0	-2252.7	0.0	-793.0
19	560.00	0.001	-0.000	0.0	-1912.5	342.8	-61.1
20	558.00	0.002	0.000	0.0	-1091.2	418.0	0.0
21	556.50	0.003	0.000	0.0	-419.3	329.7	0.0
22	555.00	0.004	0.000	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	53427.8	577.00	-15520.7	581.50	25477.7	581.50	-9022.3	581.50
2	No calculation at this stage							
3	51219.2	577.00	-15212.3	581.50	25516.3	581.50	-8983.7	581.50
4	51182.5	577.00	-15188.2	581.50	25523.4	581.50	-8976.6	581.50
5	No calculation at this stage							
6	58630.7	577.00	-11510.8	581.50	27467.6	581.50	-7032.4	581.50

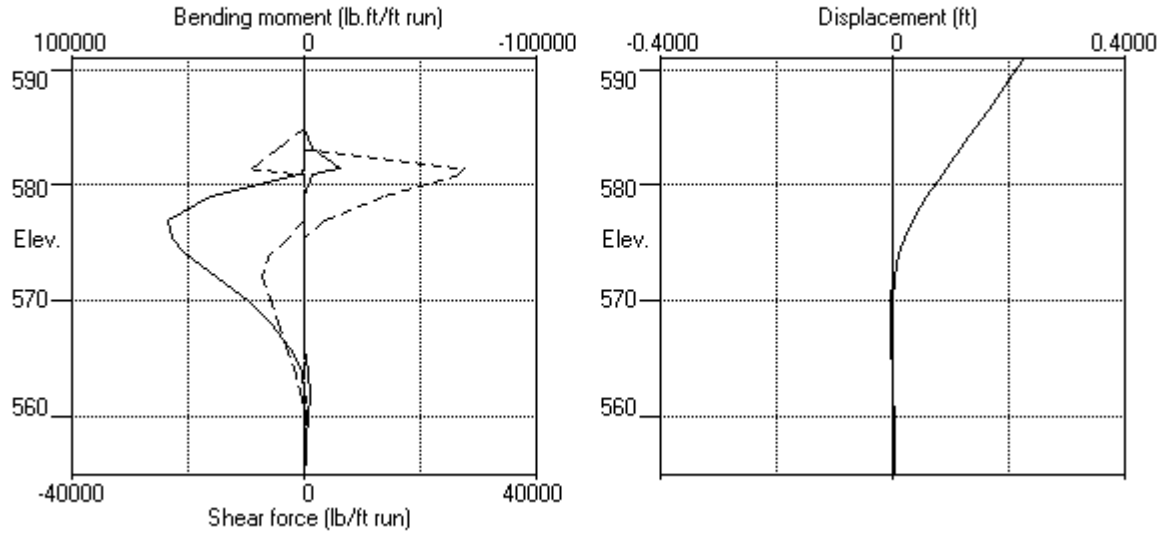
Summary of results (continued)

Maximum and minimum displacement at each stage

Stage no.	Displacement maximum ft	elev.	minimum ft	elev.	Stage description
1	0.180	591.00	-0.003	568.00	Apply load no.1 at elev. 581.50
2	No calculation at this stage				Apply surcharge no.1 at elev. 591.00
3	0.197	591.00	-0.003	568.00	Apply surcharge no.2 at elev. 591.00
4	0.197	591.00	-0.003	568.00	Apply surcharge no.3 at elev. 591.00
5	No calculation at this stage				Change soil type 2 to soil type 7
6	0.226	591.00	-0.003	568.00	Change soil type 3 to soil type 4

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

DEADMAN WALLAP ANALYSIS: BL-14-22 – X.3

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	591.00	9 Struc Fill_null	9 Struc Fill_null
2	585.00	2 Granular Fill - BW	1 Struc Fill
3	581.00	2 Granular Fill - BW	2 Granular Fill - BW
4	553.00	5 Clay IIA_und	5 Clay IIA_und

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Struc Fill	125.0	1000000	0.441	OC (0.300)	0.283 (0.000)	3.537 (0.000)	
2	Granular Fill - BW	125.0	0 (15000)	0.500	NC (0.330)	0.333 (0.000)	3.000 (0.000)	
3	Clay I_und	130.0	1200000	0.531	NC (0.490)	1.000 (2.000)	1.000 (2.000)	2000d
4	Clay I_drnd	130.0	1200000	0.531	OC (0.490)	0.361 (0.000)	2.770 (0.000)	
5	Clay IIA_und	130.0	600000	0.561	NC (0.490)	1.000 (2.000)	1.000 (2.000)	1000d
6	Clay IIA_drnd	130.0	600000	0.561	OC (0.490)	0.390 (0.000)	2.561 (0.000)	
7	Exist. Fill_drnd	130.0	1200000	0.500	NC (0.490)	0.333 (1.155)	3.000 (3.464)	0.0d
8	Limestone	100.0	0 (21000)	0.293	NC (0.290)	0.172 (0.000)	5.828 (0.000)	
9	Struc Fill_null	125.0	0 (31000)	0.000	NC (0.300)	0.000 (0.000)	0.000 (0.000)	
10	Existing Fill_null	130.0	0 (21000)	0.000	NC (0.290)	0.000 (0.000)	0.000 (0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Struc Fill	34.00	0.000	0.00	34.00	0.000	0.00
2	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
3	Clay I_und	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I_drnd	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA_und	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA_drnd	26.00	0.000	0.00	26.00	0.000	0.00
7	Exist. Fill_drnd	30.00	0.000	0.00	30.00	0.000	0.00
8	Limestone	45.00	0.000	0.00	45.00	0.000	0.00
9	Struc Fill_null	Incompatible values			Incompatible values		
10	Existing Fill_null	0.00	0.000	0.00	0.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	577.00	577.00

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2	Right side Point no.	Elev. ft	Piezo elev. ft	Water press. lb/ft2
1	1	582.00	582.00	0.0	1	582.00	582.00	0.0

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 555.00
Maximum finite element length = 2.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.013653 ft4/ft run
E.I = 5.7013E+07 lb.ft2/ft run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	581.50	34500	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	45.00	0.00	4000.00	N/A	N/A
2	591.00	45.00(L)	1000.00	100.00	4000.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply load no.1 at elevation 581.50
2	Apply surcharge no.1 at elevation 591.00
	No analysis at this stage
3	Apply surcharge no.2 at elevation 591.00
4	Apply water pressure profile no.1

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 33.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement Bending mom. Shear force	Active, Passive pressures	Graph. output
1	Apply load no.1 at elev. 581.50	No	No	No
2	Apply surcharge no.1 at elev. 591.00	No	No	No
3	Apply surcharge no.2 at elev. 591.00	Yes	Yes	Yes
4	Apply water pressure profile no.1	No	No	No
*	Summary output	Yes	-	Yes

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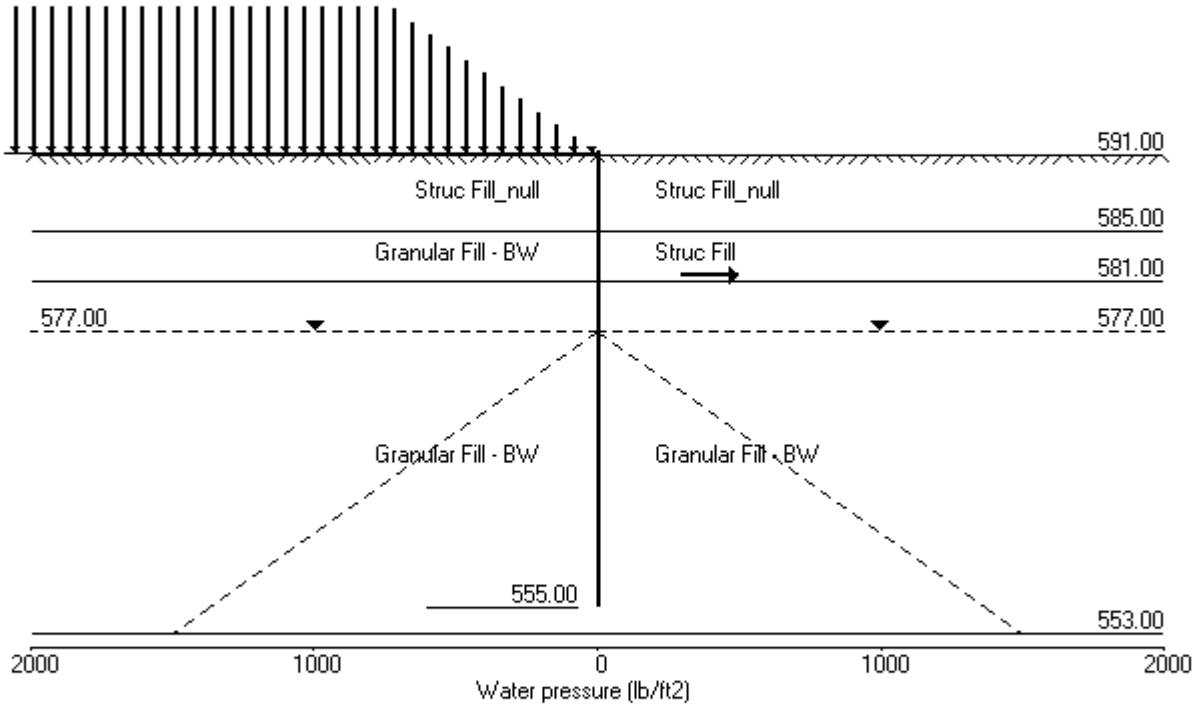
Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No. 3 Apply surcharge no.2 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
3	591.00	591.00	Cant.	1.611	559.59	557.30	33.70	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.448	2.10E-02	0.0	0.0	
2	589.50	0.00	0.417	2.10E-02	0.0	0.0	
3	588.00	0.00	0.385	2.10E-02	0.0	0.0	
4	586.50	0.00	0.354	2.10E-02	0.0	0.0	
5	585.00	0.00	0.322	2.10E-02	0.0	-0.0	
		-2290.28	0.322	2.10E-02	0.0	-0.0	
6	583.50	-2863.33	0.291	2.10E-02	-3865.2	-2791.5	
7	582.00	-3436.71	0.259	2.12E-02	-8590.2	-12025.5	
8	581.50	-3627.91	0.249	2.13E-02	-10356.4	-16758.2	34500.0
		-3627.91	0.249	2.13E-02	24143.6	-16758.2	
9	581.00	-3819.16	0.238	2.14E-02	22281.8	-5147.9	
		-3086.60	0.238	2.14E-02	22281.8	-5147.9	
10	579.00	-3035.19	0.195	2.09E-02	16160.0	33238.5	
11	577.00	-2790.67	0.155	1.93E-02	10334.2	59763.1	
12	575.50	-2496.60	0.127	1.76E-02	6368.7	72139.2	
13	574.00	-2152.63	0.102	1.56E-02	2881.8	78897.6	
14	572.00	-1656.49	0.073	1.28E-02	-927.3	80388.1	
15	570.00	-1159.46	0.051	1.00E-02	-3743.3	75251.6	
16	568.00	-695.06	0.033	7.63E-03	-5597.8	65476.1	
17	566.00	-282.50	0.020	5.55E-03	-6575.4	53044.7	
18	564.00	83.79	0.010	3.93E-03	-6774.1	39193.0	
19	562.00	428.54	0.004	2.79E-03	-6261.7	25701.4	
20	560.00	725.49	-0.001	2.09E-03	-5107.7	13965.1	
21	558.00	979.02	-0.005	1.75E-03	-3403.2	5481.0	
22	556.50	1132.04	-0.007	1.66E-03	-1819.9	1467.1	
23	555.00	1294.50	-0.010	1.64E-03	-0.0	0.0	

(continued)

Stage No.3 Apply surcharge no.2 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	517
2	589.50	0.00	272.35	0.00	0.00	0.00	0.00	3102
3	588.00	0.00	544.50	0.00	0.00	0.00	0.00	6203
4	586.50	0.00	816.25	0.00	0.00	0.00	0.00	9305
5	585.00	0.00	1087.42	0.00	0.00	0.00	0.00	12406
		0.00	1087.42	362.47	3262.25	362.47	362.47a	6239
6	583.50	0.00	1357.81	452.60	4073.43	452.60	452.60a	7799
7	582.00	0.00	1627.26	542.42	4881.77	542.42	542.42a	9358
8	581.50	0.00	1716.83	572.28	5150.50	572.28	572.28a	9878
9	581.00	0.00	1806.28	602.09	5418.84	602.09	602.09a	10398
10	579.00	0.00	2162.66	720.89	6487.97	720.89	720.89a	12478
11	577.00	0.00	2516.55	838.85	7549.64	849.63	849.63	14558
12	575.50	93.60	2686.55	895.52	8059.66	924.09	1017.69	16117
13	574.00	187.20	2854.89	951.63	8564.67	1002.60	1189.80	17677
14	572.00	312.00	3076.59	1025.53	9229.78	1113.40	1425.40	19757
15	570.00	436.80	3295.00	1098.33	9885.00	1231.55	1668.35	21836
16	568.00	561.60	3509.99	1170.00	10529.96	1357.84	1919.44	23916
17	566.00	686.40	3721.46	1240.49	11164.39	1492.93	2179.33	25996
18	564.00	811.20	3929.38	1309.79	11788.14	1636.71	2447.91	28075
19	562.00	936.00	4133.72	1377.91	12401.16	1788.36	2724.36	30155
20	560.00	1060.80	4334.49	1444.83	13003.47	1947.02	3007.82	32235
21	558.00	1185.60	4531.73	1510.58	13595.18	2112.34	3297.94	34314
22	556.50	1279.20	4677.37	1559.12	14032.10	2240.91	3520.11	35874
23	555.00	1372.80	4821.08	1607.03	14463.23	2373.72	3746.52	37434

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	517
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	3102
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	6203
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	9305
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	12406
		0.00	750.00	212.25	2652.75	2652.75	2652.75p	66699
6	583.50	0.00	937.50	265.31	3315.94	3315.94	3315.94p	66699
7	582.00	0.00	1125.00	318.38	3979.13	3979.13	3979.13p	66699
8	581.50	0.00	1187.50	336.06	4200.19	4200.19	4200.19p	66699
9	581.00	0.00	1250.00	353.75	4421.25	4421.25	4421.25p	66699
		0.00	1250.00	416.67	3750.00	3688.69	3688.69	10398
10	579.00	0.00	1500.00	500.00	4500.00	3756.08	3756.08	12478
11	577.00	0.00	1750.00	583.33	5250.00	3640.30	3640.30	14558
12	575.50	93.60	1843.90	614.63	5531.70	3420.69	3514.29	16117
13	574.00	187.20	1937.80	645.93	5813.40	3155.23	3342.43	17677
14	572.00	312.00	2063.00	687.67	6189.00	2769.89	3081.89	19757
15	570.00	436.80	2188.20	729.40	6564.60	2391.01	2827.81	21836
16	568.00	561.60	2313.40	771.13	6940.20	2052.91	2614.51	23916
17	566.00	686.40	2438.60	812.87	7315.80	1775.43	2461.83	25996
18	564.00	811.20	2563.80	854.60	7691.40	1552.92	2364.12	28075
19	562.00	936.00	2689.00	896.33	8067.00	1359.82	2295.82	30155
20	560.00	1060.80	2814.20	938.07	8442.60	1221.53	2282.33	32235
21	558.00	1185.60	2939.40	979.80	8818.20	1133.32	2318.92	34314
22	556.50	1279.20	3033.30	1011.10	9099.90	1108.87	2388.07	35874

(continued)

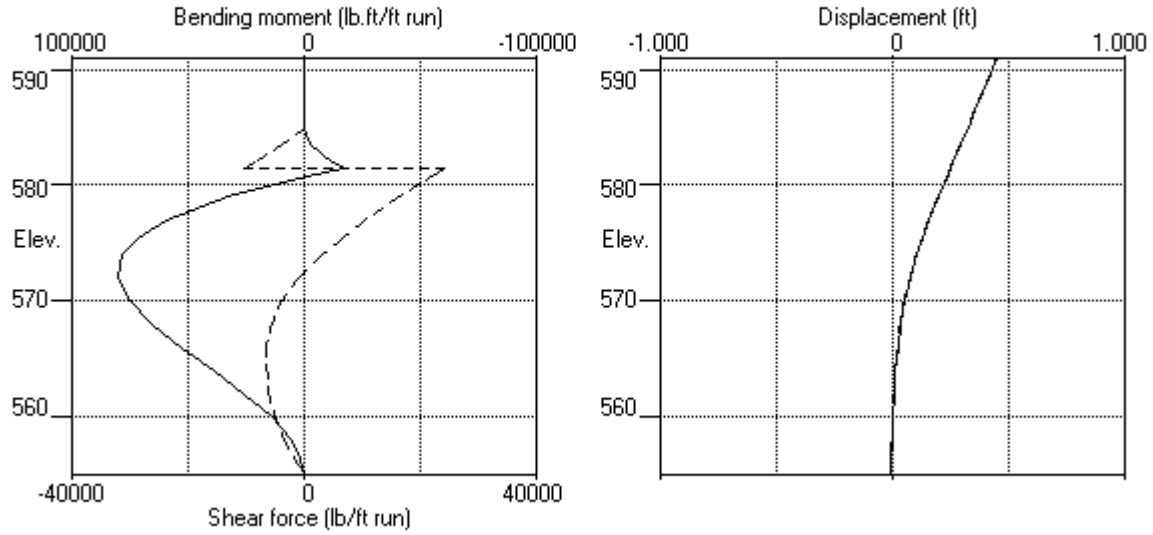
Stage No.3 Apply surcharge no.2 at elevation 591.00

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
23	555.00	1372.80	3127.20	1042.40	9381.60	1079.22	2452.02	37434

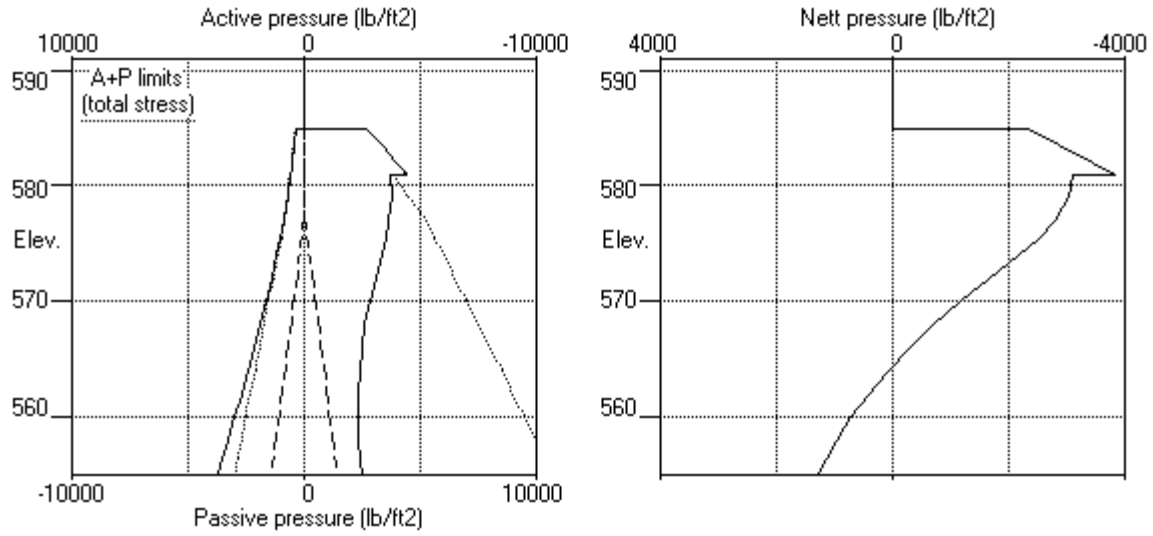
Note: 720.89a Soil pressure at active limit
4421.25p Soil pressure at passive limit

Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.573	562.33	556.50	34.50	L to R
2	591.00	591.00		No analysis at this stage				
3	591.00	591.00	Cant.	1.611	559.59	557.30	33.70	L to R
4	591.00	591.00	Cant.	1.470	559.33	***	***	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	591.00	0.455	0.000	0.0	0.0	0.0	0.0
2	589.50	0.423	0.000	0.0	0.0	0.0	0.0
3	588.00	0.391	0.000	0.0	0.0	0.0	0.0
4	586.50	0.359	0.000	0.0	0.0	0.0	0.0
5	585.00	0.327	0.000	0.0	-0.0	0.0	0.0
6	583.50	0.295	0.000	0.0	-2928.4	0.0	-4054.6
7	582.00	0.263	0.000	0.0	-12614.4	0.0	-9010.3
8	581.50	0.252	0.000	0.0	-17578.5	24168.6	-10862.4
9	581.00	0.241	0.000	0.0	-6243.6	22381.8	0.0
10	579.00	0.198	0.000	33631.7	0.0	16348.9	0.0
11	577.00	0.157	0.000	60507.6	0.0	10503.7	0.0
12	575.50	0.129	0.000	73127.7	0.0	6602.7	0.0
13	574.00	0.103	0.000	80091.7	0.0	3249.2	0.0
14	572.00	0.074	0.000	81751.8	0.0	0.0	-927.3
15	570.00	0.051	0.000	76590.8	0.0	0.0	-3788.3
16	568.00	0.033	0.000	66659.8	0.0	0.0	-5694.5
17	566.00	0.020	0.000	53996.9	0.0	0.0	-6787.1
18	564.00	0.010	-0.001	39883.3	0.0	0.0	-7049.9
19	562.00	0.004	-0.005	26135.1	0.0	0.0	-6409.6
20	560.00	0.000	-0.008	14182.0	0.0	0.0	-5200.0
21	558.00	0.000	-0.009	5545.7	0.0	0.0	-3457.9
22	556.50	0.000	-0.010	1473.7	0.0	0.0	-1839.9
23	555.00	0.000	-0.011	0.0	0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	79401.1	572.00	-17578.5	581.50	23637.6	581.50	-10862.4	581.50
2	No calculation at this stage							
3	80388.1	572.00	-16758.2	581.50	24143.6	581.50	-10356.4	581.50
4	81751.8	572.00	-16754.0	581.50	24168.6	581.50	-10331.4	581.50

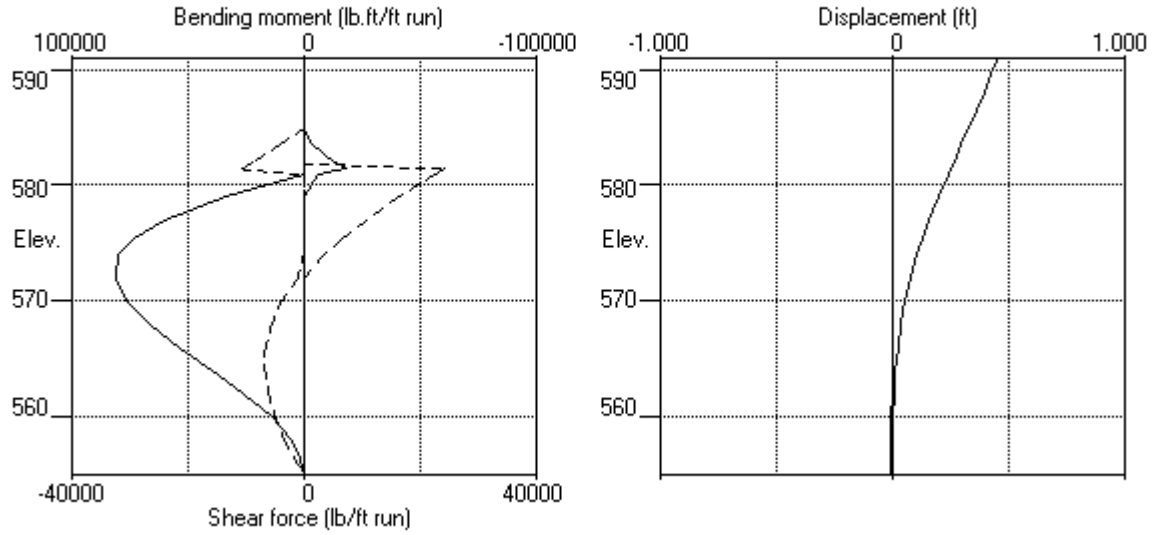
Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	Displacement elev.	Displacement minimum	Displacement elev.	Stage description
	ft		ft		
1	0.399	591.00	-0.011	555.00	Apply load no.1 at elev. 581.50
2	No calculation at this stage				Apply surcharge no.1 at elev. 591.00
3	0.448	591.00	-0.010	555.00	Apply surcharge no.2 at elev. 591.00
4	0.455	591.00	-0.010	555.00	Apply water pressure profile no.1

Summary of results (continued)

Units: lb,ft

Bending moment, shear force, displacement envelopes



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

DEADMAN WALLAP ANALYSIS: Fill – X.1

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	591.00	9 Struc Fill_null	9 Struc Fill_null
2	585.00	2 Granular Fill - BW	1 Struc Fill
3	581.00	2 Granular Fill - BW	2 Granular Fill - BW
4	553.00	5 Clay IIA_und	5 Clay IIA_und

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Struc Fill	125.0	0	0.441	NC	0.283	3.537	
			(31000)		(0.300)	(0.000)	(0.000)	
2	Granular Fill - BW	125.0	0	0.500	NC	0.333	3.000	
			(15000)		(0.330)	(0.000)	(0.000)	
3	Clay I_und	130.0	1200000	0.531	NC	1.000	1.000	2000d
					(0.490)	(2.000)	(2.000)	
4	Clay I_drnd	130.0	1200000	0.531	OC	0.361	2.770	
					(0.490)	(0.000)	(0.000)	
5	Clay IIA_und	130.0	600000	0.561	NC	1.000	1.000	1000d
					(0.490)	(2.000)	(2.000)	
6	Clay IIA_drnd	130.0	600000	0.561	OC	0.390	2.561	
					(0.490)	(0.000)	(0.000)	
7	Exist. Fill_drnd	130.0	1200000	0.500	NC	0.333	3.000	0.0d
					(0.490)	(1.155)	(3.464)	
8	Limestone	100.0	0	0.293	NC	0.172	5.828	
			(21000)		(0.290)	(0.000)	(0.000)	
9	Struc Fill_null	125.0	0	0.000	NC	0.000	0.000	
			(31000)		(0.300)	(0.000)	(0.000)	
10	Existing Fill_null	130.0	0	0.000	NC	0.000	0.000	
			(21000)		(0.290)	(0.000)	(0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Struc Fill	34.00	0.000	0.00	34.00	0.000	0.00
2	Granular Fill - BW	30.00	0.000	0.00	30.00	0.000	0.00
3	Clay I_und	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I_drnd	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA_und	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA_drnd	26.00	0.000	0.00	26.00	0.000	0.00
7	Exist. Fill_drnd	30.00	0.000	0.00	30.00	0.000	0.00
8	Limestone	45.00	0.000	0.00	45.00	0.000	0.00
9	Struc Fill_null	Incompatible values			Incompatible values		
10	Existing Fill_null	0.00	0.000	0.00	0.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	577.00	577.00

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 555.00
Maximum finite element length = 2.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 0.013653 ft4/ft run
E.I = 5.7013E+07 lb.ft2/ft run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	581.50	34500	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	-0.00(R)	1000.00	50.00	2143.00	0.00	N/A	N/A
2	591.00	0.00(L)	1000.00	34.00	2143.00	3600.00	N/A	N/A
3	591.00	34.00(L)	1000.00	150.00	3600.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply load no.1 at elevation 581.50
2	Apply surcharge no.1 at elevation 591.00
	No analysis at this stage
3	Apply surcharge no.2 at elevation 591.00
	No analysis at this stage

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 33.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply load no.1 at elev. 581.50	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 591.00	No	No	No
3	Apply surcharge no.2 at elev. 591.00	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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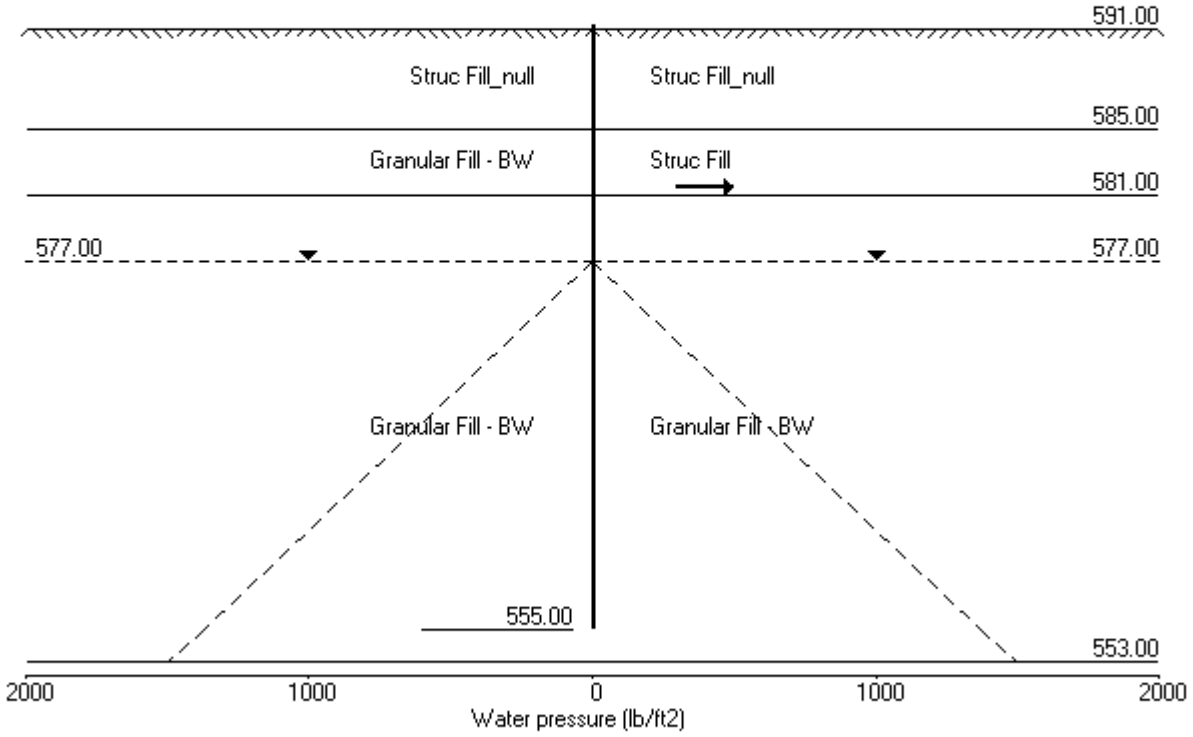
Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No. 1 Apply load no.1 at elevation 581.50

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.573	562.33	556.50	34.50	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.399	1.94E-02	0.0	0.0	
2	589.50	0.00	0.370	1.94E-02	0.0	0.0	
3	588.00	0.00	0.340	1.94E-02	0.0	0.0	
4	586.50	0.00	0.311	1.94E-02	0.0	-0.0	
5	585.00	0.00	0.282	1.94E-02	0.0	0.0	
		-2402.75	0.282	1.94E-02	0.0	-0.0	
6	583.25	-3103.55	0.248	1.94E-02	-4818.0	-4036.9	
7	581.50	-3804.35	0.214	1.98E-02	-10862.4	-17578.5	34500.0
		-3804.35	0.214	1.98E-02	23637.6	-17578.5	
8	581.00	-4004.58	0.204	1.99E-02	21685.3	-6243.6	
		-2918.37	0.204	1.99E-02	21685.3	-6243.6	
9	579.00	-2869.55	0.164	1.94E-02	15897.4	31262.6	
10	577.00	-2648.23	0.127	1.79E-02	10379.6	57290.5	
11	575.50	-2386.82	0.101	1.62E-02	6603.3	69874.8	
12	574.00	-2084.46	0.078	1.43E-02	3249.9	77088.8	
13	572.00	-1657.38	0.052	1.15E-02	-492.0	79405.7	
14	570.00	-1245.76	0.032	8.87E-03	-3395.1	75093.1	
15	568.00	-884.74	0.016	6.40E-03	-5525.6	65797.5	
16	566.00	-376.90	0.006	4.32E-03	-6787.2	53233.8	
17	564.00	113.70	-0.001	2.70E-03	-7050.4	38905.5	
18	562.00	526.30	-0.005	1.58E-03	-6410.4	25032.0	
19	560.00	811.70	-0.008	9.10E-04	-5072.4	13263.7	
20	558.00	1001.35	-0.009	5.89E-04	-3259.4	5068.9	
21	556.50	1086.47	-0.010	5.05E-04	-1693.5	1312.1	
22	555.00	1171.57	-0.011	4.88E-04	-0.0	-0.0	

(continued)

Stage No.1 Apply load no.1 at elevation 581.50

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	663
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	3978
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	7956
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	11934
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	15912
		0.00	750.00	250.00	2250.00	250.00	250.00a	7977
6	583.25	0.00	968.75	322.92	2906.25	322.92	322.92a	10304
7	581.50	0.00	1187.50	395.83	3562.50	395.83	395.83a	12630
8	581.00	0.00	1250.00	416.67	3750.00	416.67	416.67a	13295
9	579.00	0.00	1500.00	500.00	4500.00	500.00	500.00a	15954
10	577.00	0.00	1750.00	583.33	5250.00	583.33	583.33a	18613
11	575.50	93.60	1843.90	614.63	5531.70	614.63	708.23a	20607
12	574.00	187.20	1937.80	645.93	5813.40	645.93	833.13a	22602
13	572.00	312.00	2063.00	687.67	6189.00	687.67	999.67a	25261
14	570.00	436.80	2188.20	729.40	6564.60	729.40	1166.20a	27920
15	568.00	561.60	2313.40	771.13	6940.20	771.13	1332.73a	30579
16	566.00	686.40	2438.60	812.87	7315.80	1030.85	1717.25	33238
17	564.00	811.20	2563.80	854.60	7691.40	1338.75	2149.95	44741
18	562.00	936.00	2689.00	896.33	8067.00	1607.65	2543.65	48055
19	560.00	1060.80	2814.20	938.07	8442.60	1812.95	2873.75	51369
20	558.00	1185.60	2939.40	979.80	8818.20	1981.15	3166.75	54684
21	556.50	1279.20	3033.30	1011.10	9099.90	2097.57	3376.77	57169
22	555.00	1372.80	3127.20	1042.40	9381.60	2213.97	3586.77	59655

RIGHT side

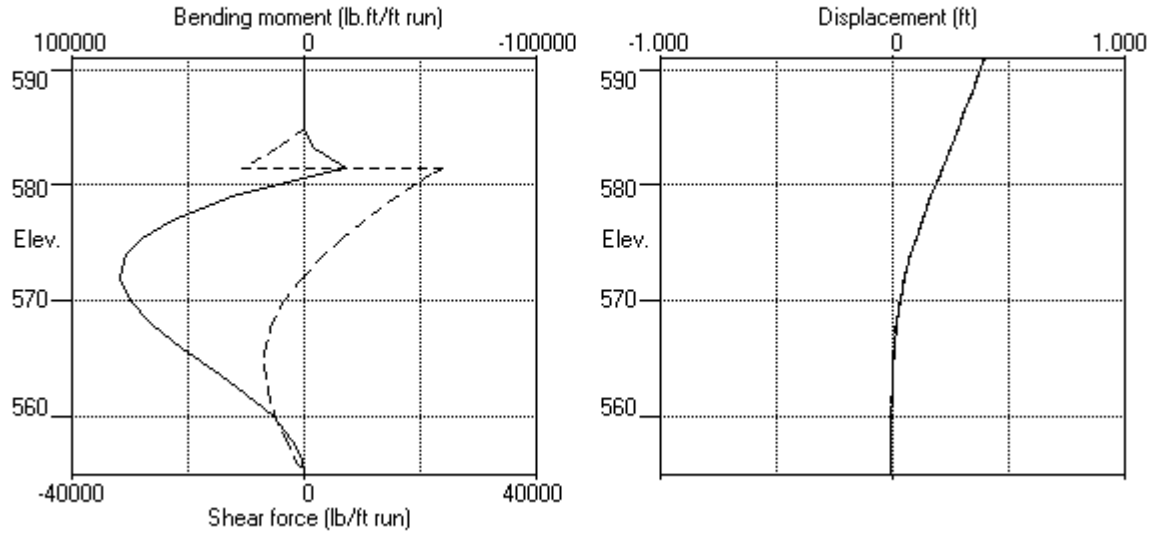
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	663
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	3978
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	7956
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	11934
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	15912
		0.00	750.00	212.25	2652.75	2652.75	2652.75p	15912
6	583.25	0.00	968.75	274.16	3426.47	3426.47	3426.47p	20552
7	581.50	0.00	1187.50	336.06	4200.19	4200.19	4200.19p	25193
8	581.00	0.00	1250.00	353.75	4421.25	4421.25	4421.25p	26519
		0.00	1250.00	416.67	3750.00	3335.04	3335.04	13295
9	579.00	0.00	1500.00	500.00	4500.00	3369.55	3369.55	15954
10	577.00	0.00	1750.00	583.33	5250.00	3231.56	3231.56	18613
11	575.50	93.60	1843.90	614.63	5531.70	3001.46	3095.06	20607
12	574.00	187.20	1937.80	645.93	5813.40	2730.39	2917.59	22602
13	572.00	312.00	2063.00	687.67	6189.00	2345.05	2657.05	25261
14	570.00	436.80	2188.20	729.40	6564.60	1975.16	2411.96	27920
15	568.00	561.60	2313.40	771.13	6940.20	1655.88	2217.48	30579
16	566.00	686.40	2438.60	812.87	7315.80	1407.75	2094.15	33238
17	564.00	811.20	2563.80	854.60	7691.40	1225.05	2036.25	44741
18	562.00	936.00	2689.00	896.33	8067.00	1081.35	2017.35	48055
19	560.00	1060.80	2814.20	938.07	8442.60	1001.25	2062.05	51369
20	558.00	1185.60	2939.40	979.80	8818.20	979.80	2165.40a	54684
21	556.50	1279.20	3033.30	1011.10	9099.90	1011.10	2290.30a	57169
22	555.00	1372.80	3127.20	1042.40	9381.60	1042.40	2415.20a	59655

(continued)

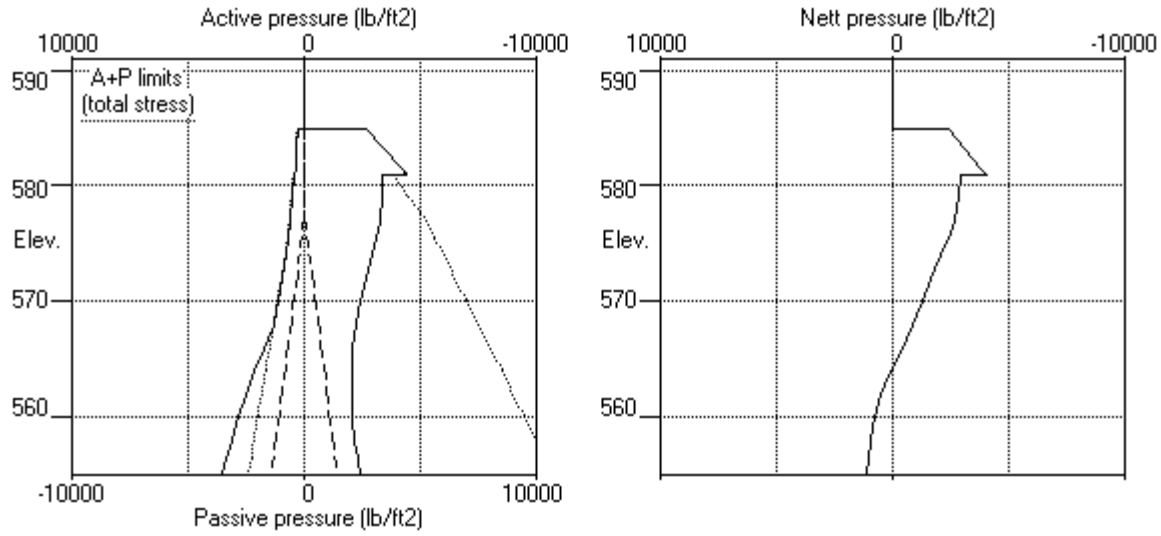
Stage No.1 Apply load no.1 at elevation 581.50
Note: 2415.20a Soil pressure at active limit
4421.25p Soil pressure at passive limit

Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50

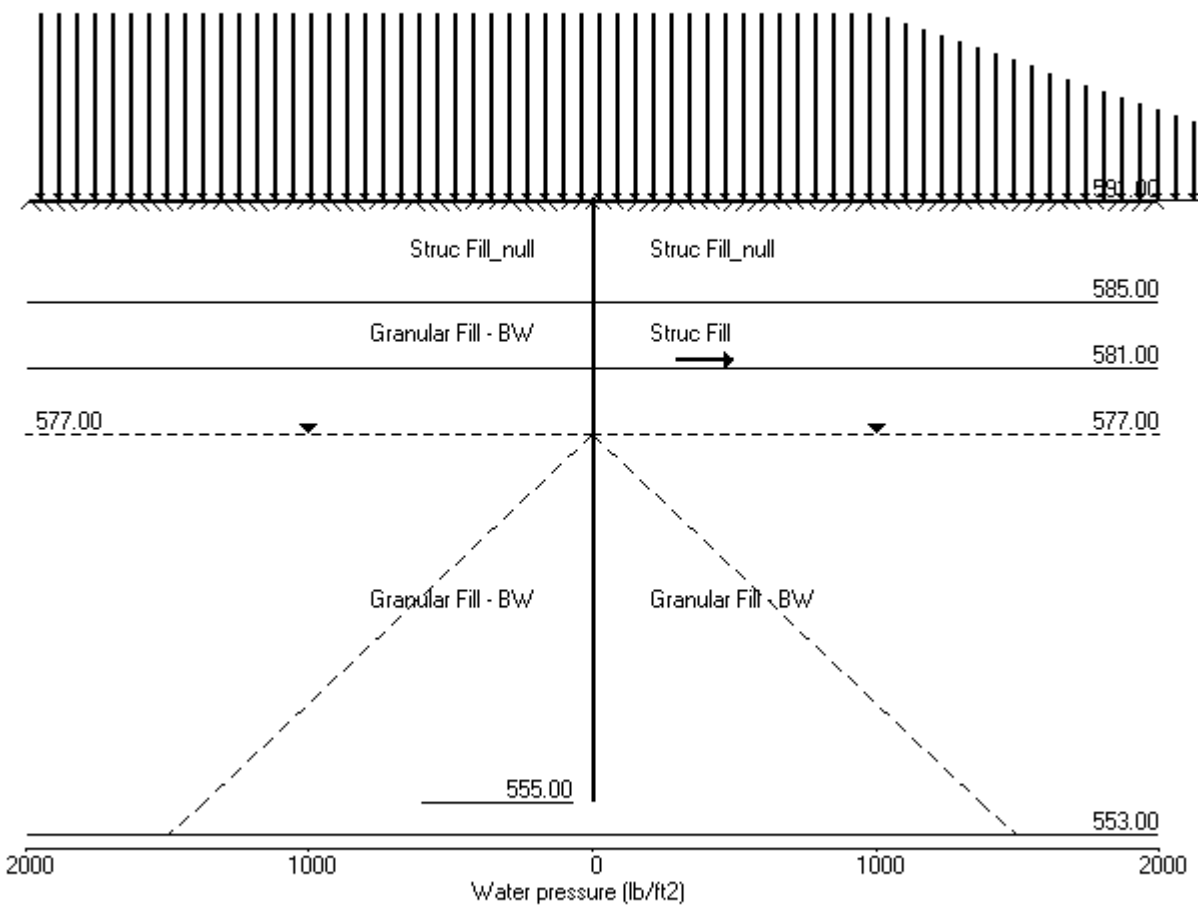


Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No. 3 Apply surcharge no.2 at elevation 591.00
No analysis at this stage

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
3	591.00	591.00	Cant.	2.792	561.17	***	***	L to R

Legend: *** Result not found

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.481	2.18E-02	0.0	0.0	
2	589.50	0.00	0.448	2.18E-02	0.0	0.0	
3	588.00	0.00	0.415	2.18E-02	0.0	0.0	
4	586.50	0.00	0.383	2.18E-02	0.0	-0.0	
5	585.00	0.00	0.350	2.18E-02	0.0	0.0	
		-2380.80	0.350	2.18E-02	0.0	-0.0	
6	583.25	-3291.93	0.312	2.18E-02	-4963.6	-3975.3	
7	581.50	-4160.69	0.273	2.22E-02	-11484.7	-18033.5	34500.0
		-4160.69	0.273	2.22E-02	23015.3	-18033.5	
8	581.00	-4401.07	0.262	2.23E-02	20874.9	-7053.6	
		-2722.46	0.262	2.23E-02	20874.9	-7053.6	
9	579.00	-2729.21	0.218	2.19E-02	15423.2	28826.7	
10	577.00	-2539.69	0.175	2.04E-02	10154.3	54190.9	
11	575.50	-2286.57	0.145	1.89E-02	6534.6	66827.0	
12	574.00	-1963.98	0.118	1.70E-02	3346.7	74057.1	
13	572.00	-1467.81	0.087	1.44E-02	-85.1	76821.5	
14	570.00	-937.77	0.061	1.17E-02	-2490.6	73712.1	
15	568.00	-688.88	0.040	9.30E-03	-4117.3	66663.9	
16	566.00	-480.17	0.023	7.13E-03	-5286.3	56977.0	
17	564.00	-241.80	0.011	5.34E-03	-6008.3	45121.9	
18	562.00	13.76	0.002	3.98E-03	-6236.3	32349.6	
19	560.00	277.26	-0.005	3.07E-03	-5945.3	19715.7	
20	558.00	844.49	-0.011	2.57E-03	-4823.6	8579.9	
21	556.50	1674.52	-0.015	2.43E-03	-2934.3	2268.2	
22	555.00	2237.92	-0.018	2.40E-03	-0.0	-0.0	

(continued)

Stage No.3 Apply surcharge no.2 at elevation 591.00
No analysis at this stage

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	512
2	589.50	0.00	2371.23	0.00	0.00	0.00	0.00	3070
3	588.00	0.00	2598.57	0.00	0.00	0.00	0.00	6139
4	586.50	0.00	2824.07	0.00	0.00	0.00	0.00	9209
5	585.00	0.00	3046.91	0.00	0.00	0.00	0.00	12278
		0.00	3046.91	1015.64	9140.72	1104.63	1104.63	6176
6	583.25	0.00	3302.58	1100.86	9907.75	1143.71	1143.71	7977
7	581.50	0.00	3552.76	1184.25	10658.28	1195.13	1195.13	9778
8	581.00	0.00	3623.13	1207.71	10869.39	1212.07	1212.07	10293
9	579.00	0.00	3899.38	1299.79	11698.13	1299.79	1299.79a	12352
10	577.00	0.00	4166.98	1388.99	12500.93	1388.99	1388.99a	14410
11	575.50	93.60	4268.36	1422.79	12805.09	1424.53	1518.13	15954
12	574.00	187.20	4364.97	1454.99	13094.92	1474.45	1661.65	17498
13	572.00	312.00	4486.71	1495.57	13460.14	1560.30	1872.30	19557
14	570.00	436.80	4600.99	1533.66	13802.96	1668.94	2105.74	21615
15	568.00	561.60	4708.59	1569.53	14125.77	1799.76	2361.36	23674
16	566.00	686.40	4810.39	1603.46	14431.18	1949.77	2636.17	25732
17	564.00	811.20	4907.28	1635.76	14721.83	2113.74	2924.94	27791
18	562.00	936.00	5000.09	1666.70	15000.27	2285.64	3221.64	29849
19	560.00	1060.80	5089.63	1696.54	15268.90	2461.04	3521.84	31908
20	558.00	1185.60	5176.63	1725.54	15529.89	2788.02	3973.62	132849
21	556.50	1279.20	5240.60	1746.87	15721.79	3235.48	4514.68	138888
22	555.00	1372.80	5303.73	1767.91	15911.20	3710.86	5083.66	144926

RIGHT side

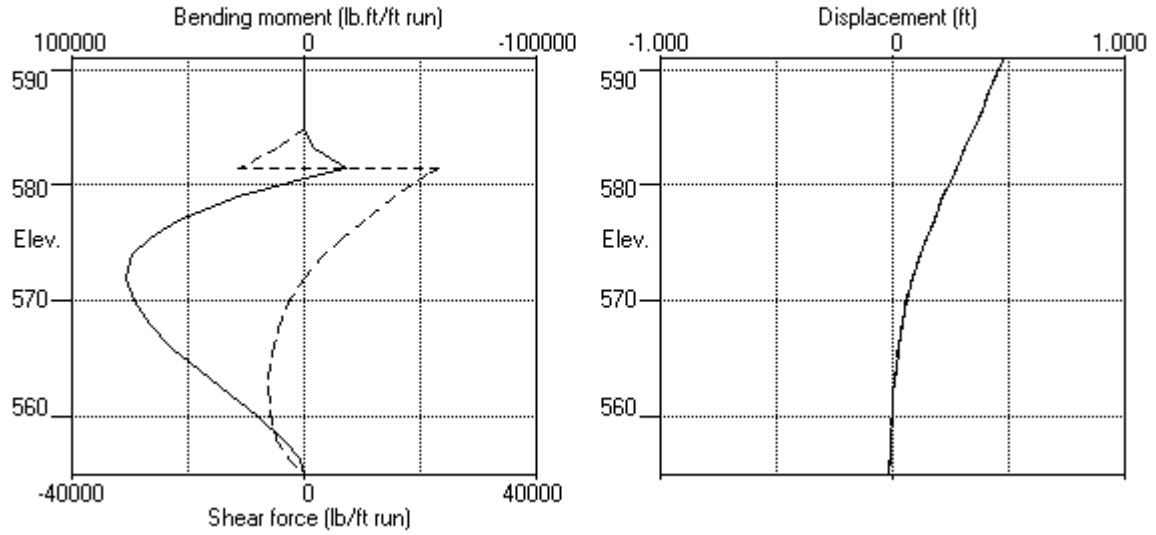
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	2143.00	0.00	0.00	0.00	0.00	512
2	589.50	0.00	2289.55	0.00	0.00	0.00	0.00	3070
3	588.00	0.00	2436.22	0.00	0.00	0.00	0.00	6139
4	586.50	0.00	2583.03	0.00	0.00	0.00	0.00	9209
5	585.00	0.00	2730.05	0.00	0.00	0.00	0.00	12278
		0.00	2730.05	772.60	9656.18	3485.44	3485.44	12278
6	583.25	0.00	2901.94	821.25	10264.16	4435.63	4435.63	15860
7	581.50	0.00	3074.33	870.03	10873.89	5355.81	5355.81	19441
8	581.00	0.00	3123.68	884.00	11048.46	5613.14	5613.14	20464
		0.00	3123.68	1041.23	9371.05	3934.53	3934.53	10293
9	579.00	0.00	3321.64	1107.21	9964.91	4029.00	4029.00	12352
10	577.00	0.00	3520.52	1173.51	10561.57	3928.68	3928.68	14410
11	575.50	93.60	3576.77	1192.26	10730.32	3711.10	3804.70	15954
12	574.00	187.20	3633.66	1211.22	10900.97	3438.43	3625.63	17498
13	572.00	312.00	3710.55	1236.85	11131.65	3028.11	3340.11	19557
14	570.00	436.80	3788.71	1262.90	11366.12	2606.71	3043.51	21615
15	568.00	561.60	3868.19	1289.40	11604.56	2488.63	3050.23	23674
16	566.00	686.40	3949.03	1316.34	11847.10	2429.94	3116.34	25732
17	564.00	811.20	4031.28	1343.76	12093.83	2355.54	3166.74	27791
18	562.00	936.00	4114.93	1371.64	12344.80	2271.87	3207.87	29849
19	560.00	1060.80	4200.00	1400.00	12600.01	2183.78	3244.58	31908
20	558.00	1185.60	4286.49	1428.83	12859.46	1943.54	3129.14	132849
21	556.50	1279.20	4352.27	1450.76	13056.80	1560.96	2840.16	138888
22	555.00	1372.80	4418.82	1472.94	13256.47	1472.94	2845.74a	144926

(continued)

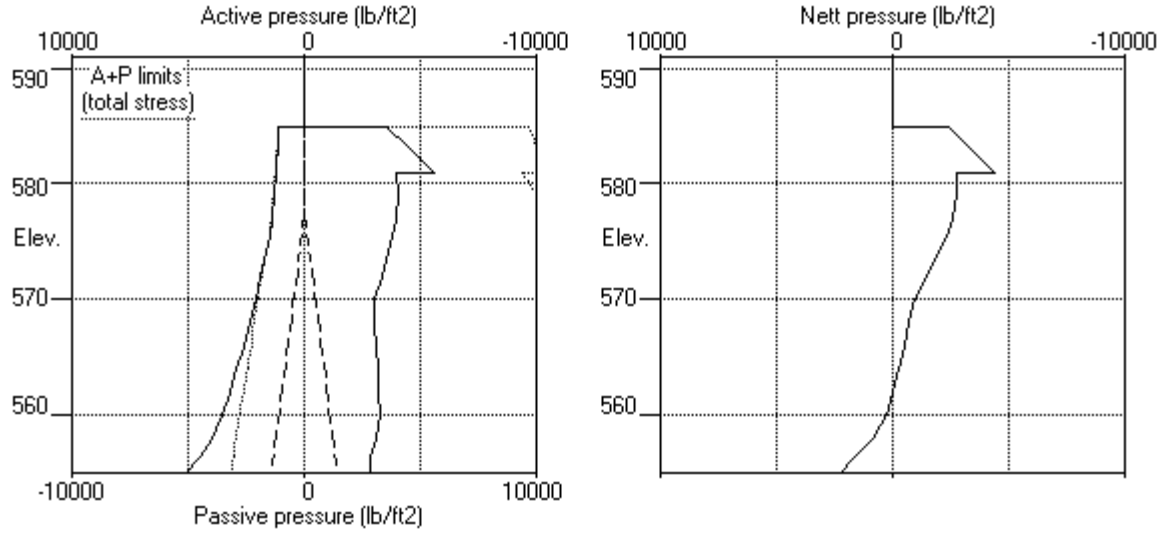
Stage No.3 Apply surcharge no.2 at elevation 591.00
No analysis at this stage
Note: 2845.74a Soil pressure at active limit
123.45p Soil pressure at passive limit

Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 555.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.573	562.33	556.50	34.50	L to R
2	591.00	591.00		No analysis at this stage				
3	591.00	591.00	Cant.	2.792	561.17	***	***	L to R

Legend: *** Result not found

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	591.00	0.481	0.000	0.0	0.0	0.0	0.0
2	589.50	0.448	0.000	0.0	0.0	0.0	0.0
3	588.00	0.415	0.000	0.0	0.0	0.0	0.0
4	586.50	0.383	0.000	0.0	-0.0	0.0	0.0
5	585.00	0.350	0.000	0.0	-0.0	0.0	0.0
6	583.25	0.312	0.000	0.0	-4036.9	0.0	-4963.6
7	581.50	0.273	0.000	0.0	-18033.5	23637.6	-11484.7
8	581.00	0.262	0.000	0.0	-7053.6	21685.3	0.0
9	579.00	0.218	0.000	31262.6	0.0	15897.4	0.0
10	577.00	0.175	0.000	57290.5	0.0	10379.6	0.0
11	575.50	0.145	0.000	69874.8	0.0	6603.3	0.0
12	574.00	0.118	0.000	77088.8	0.0	3346.7	0.0
13	572.00	0.087	0.000	79405.7	0.0	0.0	-492.0
14	570.00	0.061	0.000	75093.1	0.0	0.0	-3395.1
15	568.00	0.040	0.000	66663.9	0.0	0.0	-5525.6
16	566.00	0.023	0.000	56977.0	0.0	0.0	-6787.2
17	564.00	0.011	-0.001	45121.9	0.0	0.0	-7050.4
18	562.00	0.002	-0.005	32349.6	0.0	0.0	-6410.4
19	560.00	0.000	-0.008	19715.7	0.0	0.0	-5945.3
20	558.00	0.000	-0.011	8579.9	0.0	0.0	-4823.6
21	556.50	0.000	-0.015	2268.2	0.0	0.0	-2934.3
22	555.00	0.000	-0.018	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	79405.7	572.00	-17578.5	581.50	23637.6	581.50	-10862.4	581.50
2	No calculation at this stage							
3	76821.5	572.00	-18033.5	581.50	23015.3	581.50	-11484.7	581.50

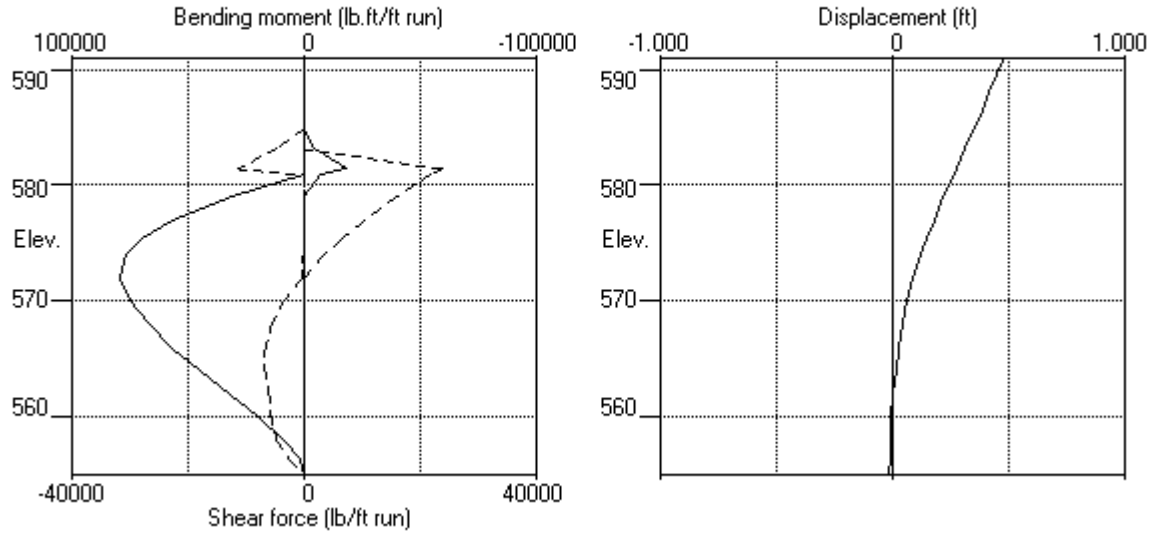
Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	Displacement elev.	Displacement minimum	Displacement elev.	Stage description
	ft		ft		
1	0.399	591.00	-0.011	555.00	Apply load no.1 at elev. 581.50
2	No calculation at this stage				Apply surcharge no.1 at elev. 591.00
3	0.481	591.00	-0.018	555.00	Apply surcharge no.2 at elev. 591.00

Summary of results (continued)

Units: lb,ft

Bending moment, shear force, displacement envelopes



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	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

DEADMAN WALLAP ANALYSIS: Fill – X.3

Units: lb,ft

INPUT DATA

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Right side
1	591.00	9 Struc Fill_null	9 Struc Fill_null
2	585.00	2 Existing Fill_und	1 Struc Fill
3	581.00	2 Existing Fill_und	2 Existing Fill_und
4	577.00	3 Clay I_und	3 Clay I_und
5	554.00	5 Clay IIA_und	5 Clay IIA_und

SOIL PROPERTIES

-- Soil type -- No.	Description (Datum elev.)	Bulk density lb/ft3	Young's Modulus Eh,lb/ft2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion lb/ft2 (dc/dy)
1	Struc Fill	125.0	0	0.441	NC	0.283	3.537	
			(31000)		(0.300)	(0.000)	(0.000)	
2	Existing Fill_und	130.0	1200000	0.500	NC	1.000	1.000	2000d
					(0.490)	(2.000)	(2.000)	
3	Clay I_und	130.0	1200000	0.531	NC	1.000	1.000	2000d
					(0.490)	(2.000)	(2.000)	
4	Clay I_drnd	130.0	1200000	0.531	OC	0.361	2.770	
					(0.490)	(0.000)	(0.000)	
5	Clay IIA_und	130.0	600000	0.561	NC	1.000	1.000	1000d
					(0.490)	(2.000)	(2.000)	
6	Clay IIA_drnd	130.0	600000	0.561	OC	0.390	2.561	
					(0.490)	(0.000)	(0.000)	
7	Exist. Fill_drnd	130.0	1200000	0.500	NC	0.333	3.000	0.0d
					(0.490)	(1.155)	(3.464)	
8	Limestone	100.0	0	0.293	NC	0.172	5.828	
			(21000)		(0.290)	(0.000)	(0.000)	
9	Struc Fill_null	125.0	0	0.000	NC	0.000	0.000	
			(31000)		(0.300)	(0.000)	(0.000)	
10	Existing Fill_null	130.0	0	0.000	NC	0.000	0.000	
			(21000)		(0.290)	(0.000)	(0.000)	

Additional soil parameters associated with Ka and Kp

------- Soil type ------- No.	Description	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Struc Fill	34.00	0.000	0.00	34.00	0.000	0.00
2	Existing Fill_und	0.00	0.000	0.00	0.00	0.000	0.00
3	Clay I_und	0.00	0.000	0.00	0.00	0.000	0.00
4	Clay I_drnd	28.00	0.000	0.00	28.00	0.000	0.00
5	Clay IIA_und	0.00	0.000	0.00	0.00	0.000	0.00
6	Clay IIA_drnd	26.00	0.000	0.00	26.00	0.000	0.00
7	Exist. Fill_drnd	30.00	0.000	0.00	30.00	0.000	0.00
8	Limestone	45.00	0.000	0.00	45.00	0.000	0.00
9	Struc Fill_null	Incompatible values			Incompatible values		
10	Existing Fill_null	0.00	0.000	0.00	0.00	0.000	0.00

GROUND WATER CONDITIONS

Density of water = 62.40 lb/ft3

	Left side	Right side
Initial water table elevation	577.00	577.00

Automatic water pressure balancing at toe of wall : No

WALL PROPERTIES

Type of structure = Fully Embedded Wall
Elevation of toe of wall = 555.00
Maximum finite element length = 2.00 ft
Youngs modulus of wall E = 4.1760E+09 lb/ft2
Moment of inertia of wall I = 8.2800E-03 ft4/ft run
E.I = 3.4577E+07 lb.ft2/ft run
Yield Moment of wall = Not defined

HORIZONTAL and MOMENT LOADS/RESTRAINTS

Load no.	Elevation	Horizontal load lb/ft run	Moment load lb.ft/ft run	Moment restraint lb.ft/ft/rad	Partial factor (Category)
1	581.50	34500	0	0	N/A

SURCHARGE LOADS

Surch-arge no.	Elev.	Distance from wall	Length parallel to wall	Width perpend. to wall	Surcharge lb/ft2 Near edge	Surcharge lb/ft2 Far edge	Equiv. soil type	Partial factor/ Category
1	591.00	0.00(L)	1000.00	45.00	0.00	4000.00	N/A	N/A
2	591.00	45.00(L)	1000.00	100.00	4000.00	=	N/A	N/A

Note: L = Left side, R = Right side
A trapezoidal surcharge is defined by two values:
N = at edge near to wall, F = at edge far from wall

CONSTRUCTION STAGES

Construction stage no.	Stage description
1	Apply load no.1 at elevation 581.50
2	Apply surcharge no.1 at elevation 591.00 No analysis at this stage
3	Apply surcharge no.2 at elevation 591.00
4	Change properties of soil type 2 to soil type 7 No analysis at this stage Ko pressures will not be reset
5	Change properties of soil type 3 to soil type 4 Ko pressures will not be reset

FACTORS OF SAFETY and ANALYSIS OPTIONS

Stability analysis:
Method of analysis - CP2
Factor on passive for calculating wall depth = 1.50

Parameters for undrained strata:
Minimum equivalent fluid density = 0.00 lb/ft3
Maximum depth of water filled tension crack = 0.00 ft

Bending moment and displacement calculation:
Method - Subgrade reaction model using Influence Coefficients
Open Tension Crack analysis? - No
Non-linear Modulus Parameter (L) = 33.00 ft

Boundary conditions:
Length of wall (normal to plane of analysis) = 1000.00 ft

Width of excavation on Left side of wall = 1000.00 ft
Width of excavation on Right side of wall = 1000.00 ft

Distance to rigid boundary on Left side = 1000.00 ft
Distance to rigid boundary on Right side = 1000.00 ft

OUTPUT OPTIONS

Stage no.	Stage description	Output options: Displacement, Bending mom., Shear force	Active, Passive pressures	Graph. output
1	Apply load no.1 at elev. 581.50	Yes	Yes	Yes
2	Apply surcharge no.1 at elev. 591.00	No	No	No
3	Apply surcharge no.2 at elev. 591.00	Yes	Yes	Yes
4	Change soil type 2 to soil type 7	No	No	No
5	Change soil type 3 to soil type 4	Yes	Yes	Yes
*	Summary output	Yes	-	Yes

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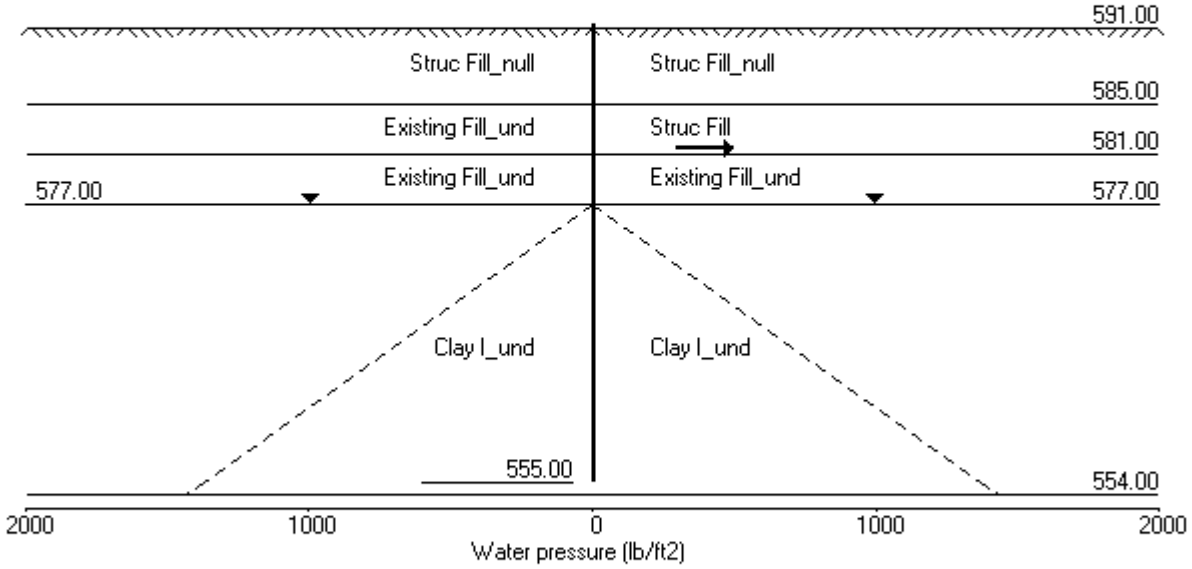
Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No. 1 Apply load no.1 at elevation 581.50

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.920	563.07	561.83	29.17	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.180	1.12E-02	0.0	0.0	
2	589.50	0.00	0.164	1.12E-02	0.0	0.0	
3	588.00	0.00	0.147	1.12E-02	0.0	-0.0	
4	586.50	0.00	0.130	1.12E-02	0.0	0.0	
5	585.00	0.00	0.113	1.12E-02	0.0	-0.0	
		-2401.87	0.113	1.12E-02	0.0	0.0	
6	583.25	-2633.97	0.093	1.13E-02	-4406.4	-3727.1	
7	581.50	-2641.45	0.073	1.18E-02	-9022.3	-15520.7	34500.0
		-2641.45	0.073	1.18E-02	25477.7	-15520.7	
8	581.00	-2598.10	0.067	1.19E-02	24167.8	-3113.2	
		-5250.00	0.067	1.19E-02	24167.8	-3113.2	
9	579.00	-5510.00	0.044	1.10E-02	13407.8	34549.0	
10	577.00	-4661.97	0.024	8.52E-03	3235.8	53427.8	
		-4716.84	0.024	8.52E-03	3235.8	53427.8	
11	575.50	-3011.66	0.013	6.22E-03	-2560.6	52954.9	
12	574.00	-1581.47	0.005	4.07E-03	-6005.4	46102.5	
13	572.00	269.90	-0.001	1.84E-03	-7317.0	30928.8	
14	570.00	1005.82	-0.003	4.62E-04	-6041.3	16834.6	
15	568.00	1055.10	-0.003	-2.20E-04	-3980.4	6763.6	
16	566.00	811.49	-0.002	-4.42E-04	-2113.8	913.1	
17	564.00	510.84	-0.001	-4.19E-04	-791.4	-1691.5	
18	562.00	263.19	-0.001	-3.05E-04	-17.4	-2252.7	
19	560.00	97.01	-0.000	-1.89E-04	342.8	-1761.1	
20	558.00	-21.76	0.000	-1.12E-04	418.0	-881.5	
21	556.50	-143.83	0.000	-8.77E-05	293.8	-279.0	
22	555.00	-247.96	0.000	-8.17E-05	-0.0	-0.0	

(continued)

Stage No.1 Apply load no.1 at elevation 581.50

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	764
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	4586
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	9173
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	13759
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	18346
		0.00	750.00	0.00	4750.00	0.00	0.00a	159067
6	583.25	0.00	977.50	0.00	4977.50	0.00	0.00a	159067
7	581.50	0.00	1205.00	0.00	5205.00	0.00	0.00a	159067
8	581.00	0.00	1270.00	0.00	5270.00	0.00	0.00a	159067
9	579.00	0.00	1530.00	0.00	5530.00	0.00	0.00a	159067
10	577.00	0.00	1790.00	0.00	5790.00	0.00	0.00a	159067
11	575.50	93.60	1891.40	0.00	5891.40	0.00	93.60a	159067
12	574.00	187.20	1992.80	0.00	5992.80	262.13	449.33	159067
13	572.00	312.00	2128.00	0.00	6128.00	1259.61	1571.61	169536
14	570.00	436.80	2263.20	0.00	6263.20	1699.36	2136.16	169536
15	568.00	561.60	2398.40	0.00	6398.40	1795.79	2357.39	169536
16	566.00	686.40	2533.60	0.00	6533.60	1745.78	2432.18	169536
17	564.00	811.20	2668.80	0.00	6668.80	1667.24	2478.44	169536
18	562.00	936.00	2804.00	0.00	6804.00	1615.21	2551.21	169536
19	560.00	1060.80	2939.20	0.00	6939.20	1603.91	2664.71	169536
20	558.00	1185.60	3074.40	0.00	7074.40	1616.32	2801.92	414445
21	556.50	1279.20	3175.80	0.00	7175.80	1609.12	2888.32	414445
22	555.00	1372.80	3277.20	0.00	7277.20	1610.91	2983.71	414445

RIGHT side

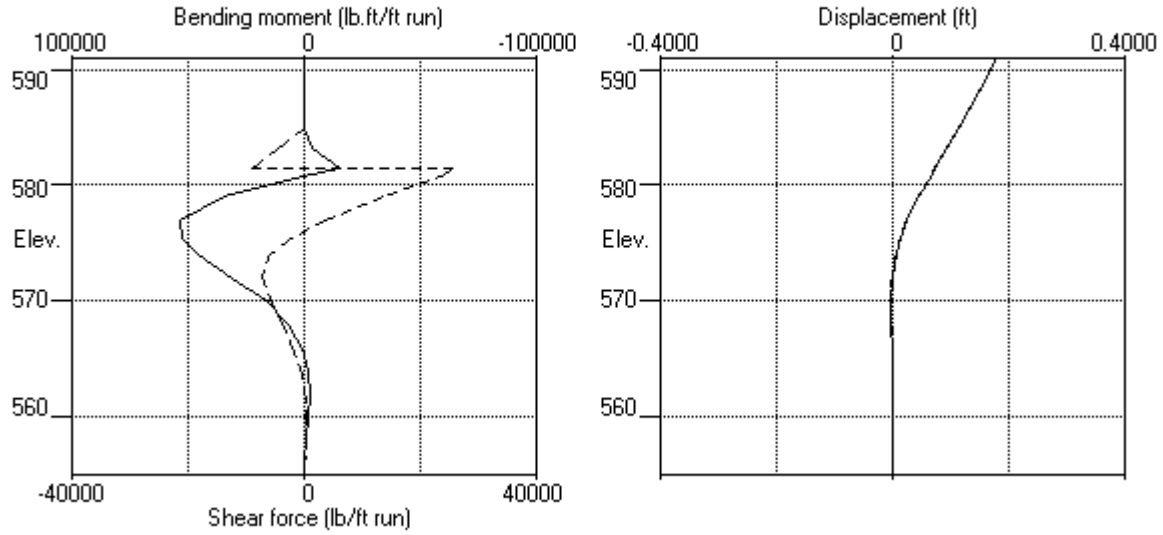
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	764
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	4586
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	9173
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	13759
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	18346
		0.00	750.00	212.04	2652.75	2401.87	2401.87	18346
6	583.25	0.00	968.75	273.88	3426.47	2633.97	2633.97	23697
7	581.50	0.00	1187.50	335.72	4200.19	2641.45	2641.45	29047
8	581.00	0.00	1250.00	353.39	4421.25	2598.10	2598.10	30576
		0.00	1250.00	0.00	5250.00	5250.00	5250.00p	159067
9	579.00	0.00	1510.00	0.00	5510.00	5510.00	5510.00p	159067
10	577.00	0.00	1770.00	0.00	5770.00	4661.97	4661.97	159067
		0.00	1770.00	0.00	5770.00	4716.84	4716.84	159067
11	575.50	93.60	1871.40	0.00	5871.40	3011.66	3105.26	159067
12	574.00	187.20	1972.80	0.00	5972.80	1843.60	2030.80	159067
13	572.00	312.00	2108.00	0.00	6108.00	989.71	1301.71	169536
14	570.00	436.80	2243.20	0.00	6243.20	693.54	1130.34	169536
15	568.00	561.60	2378.40	0.00	6378.40	740.69	1302.29	169536
16	566.00	686.40	2513.60	0.00	6513.60	934.29	1620.69	169536
17	564.00	811.20	2648.80	0.00	6648.80	1156.40	1967.60	169536
18	562.00	936.00	2784.00	0.00	6784.00	1352.02	2288.02	169536
19	560.00	1060.80	2919.20	0.00	6919.20	1506.90	2567.70	169536
20	558.00	1185.60	3054.40	0.00	7054.40	1638.08	2823.68	414445
21	556.50	1279.20	3155.80	0.00	7155.80	1752.96	3032.16	414445
22	555.00	1372.80	3257.20	0.00	7257.20	1858.86	3231.66	414445

(continued)

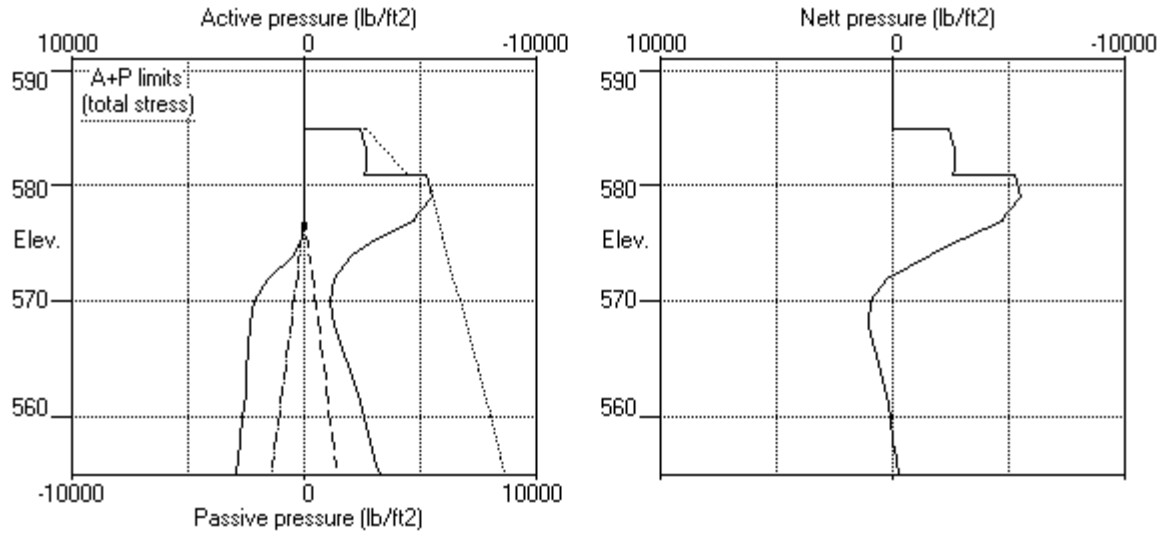
Stage No.1 Apply load no.1 at elevation 581.50
Note: 93.60a Soil pressure at active limit
5510.00p Soil pressure at passive limit

Units: lb,ft

Stage No.1 Apply load no.1 at elev. 581.50

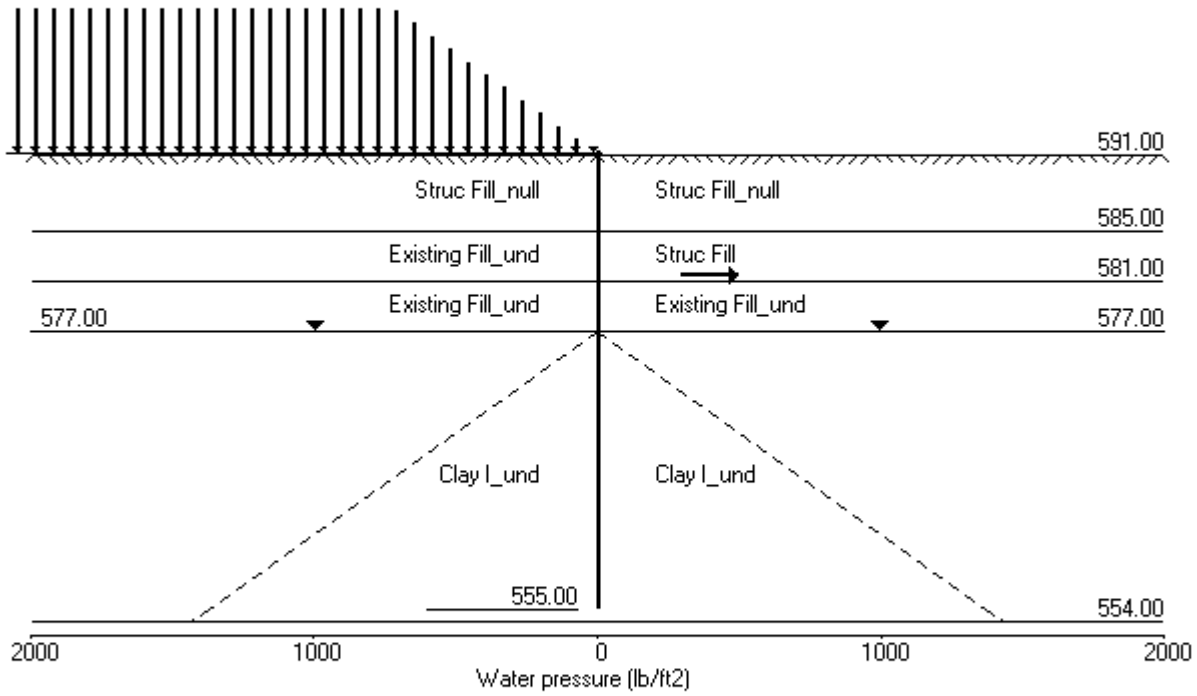


Stage No.1 Apply load no.1 at elev. 581.50



Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No. 3 Apply surcharge no.2 at elevation 591.00

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method

Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Toe elev. for FoS = 1.500 Wall Penetr-ation	Direction of failure
3	591.00	591.00	Cant.	2.015	561.99	562.82	28.18	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.189	1.15E-02	0.0	0.0	
2	589.50	0.00	0.172	1.15E-02	0.0	0.0	
3	588.00	0.00	0.155	1.15E-02	0.0	-0.0	
4	586.50	0.00	0.137	1.15E-02	0.0	0.0	
5	585.00	0.00	0.120	1.15E-02	0.0	-0.0	
		-2465.50	0.120	1.15E-02	0.0	0.0	
6	583.25	-2710.23	0.100	1.16E-02	-4528.8	-3824.5	
7	581.50	-2727.00	0.079	1.21E-02	-9286.3	-15679.0	34500.0
		-2727.00	0.079	1.21E-02	25213.7	-15679.0	
8	581.00	-2645.84	0.073	1.22E-02	23870.5	-3413.0	
		-5209.34	0.073	1.22E-02	23870.5	-3413.0	
9	579.00	-5307.80	0.049	1.14E-02	13353.3	33806.8	
10	577.00	-4693.74	0.028	8.89E-03	3351.8	53050.4	
		-4748.61	0.028	8.89E-03	3351.8	53050.4	
11	575.50	-2869.78	0.017	6.59E-03	-2362.0	52744.2	
12	574.00	-1265.81	0.008	4.44E-03	-5463.7	46377.2	
13	572.00	201.24	0.002	2.16E-03	-6528.3	32579.2	
14	570.00	710.09	-0.001	6.53E-04	-5617.0	19712.8	
15	568.00	818.95	-0.001	-2.03E-04	-4087.9	9914.4	
16	566.00	718.78	-0.000	-5.91E-04	-2550.2	3488.2	
17	564.00	537.45	0.001	-6.90E-04	-1294.0	-45.1	
18	562.00	347.19	0.002	-6.47E-04	-409.3	-1447.6	
19	560.00	178.51	0.004	-5.62E-04	116.4	-1489.7	
20	558.00	25.14	0.005	-4.95E-04	320.0	-834.8	
21	556.50	-108.67	0.005	-4.71E-04	257.4	-293.3	
22	555.00	-234.51	0.006	-4.64E-04	-0.0	-0.0	

(continued)

Stage No.3 Apply surcharge no.2 at elevation 591.00

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	374
2	589.50	0.00	272.35	0.00	0.00	0.00	0.00	2242
3	588.00	0.00	544.50	0.00	0.00	0.00	0.00	4484
4	586.50	0.00	816.25	0.00	0.00	0.00	0.00	6727
5	585.00	0.00	1087.42	0.00	0.00	0.00	0.00	8969
		0.00	1087.42	0.00	5087.42	0.00	0.00a	87198
6	583.25	0.00	1411.54	0.00	5411.54	0.00	0.00a	87198
7	581.50	0.00	1734.33	0.00	5734.33	0.56	0.56	87198
8	581.00	0.00	1826.28	0.00	5826.28	40.66	40.66	87198
9	579.00	0.00	2192.66	0.00	6192.66	202.20	202.20	87198
10	577.00	0.00	2556.55	0.00	6556.55	367.39	367.39	87198
11	575.50	93.60	2734.05	0.00	6734.05	492.27	585.87	87198
12	574.00	187.20	2909.89	0.00	6909.89	878.51	1065.71	87198
13	572.00	312.00	3141.59	0.00	7141.59	1429.57	1741.57	87198
14	570.00	436.80	3370.00	0.00	7370.00	1596.55	2033.35	87198
15	568.00	561.60	3594.99	0.00	7594.99	1734.29	2295.89	87198
16	566.00	686.40	3816.46	0.00	7816.46	1839.81	2526.21	87198
17	564.00	811.20	4034.38	34.38	8034.38	1918.05	2729.25	87198
18	562.00	936.00	4248.72	248.72	8248.72	1977.64	2913.64	87198
19	560.00	1060.80	4459.49	459.49	8459.49	2026.70	3087.50	87198
20	558.00	1185.60	4666.73	666.73	8666.73	2070.62	3256.22	87198
21	556.50	1279.20	4819.87	819.87	8819.87	2101.82	3381.02	87198
22	555.00	1372.80	4971.08	971.08	8971.08	2132.00	3504.80	87198

RIGHT side

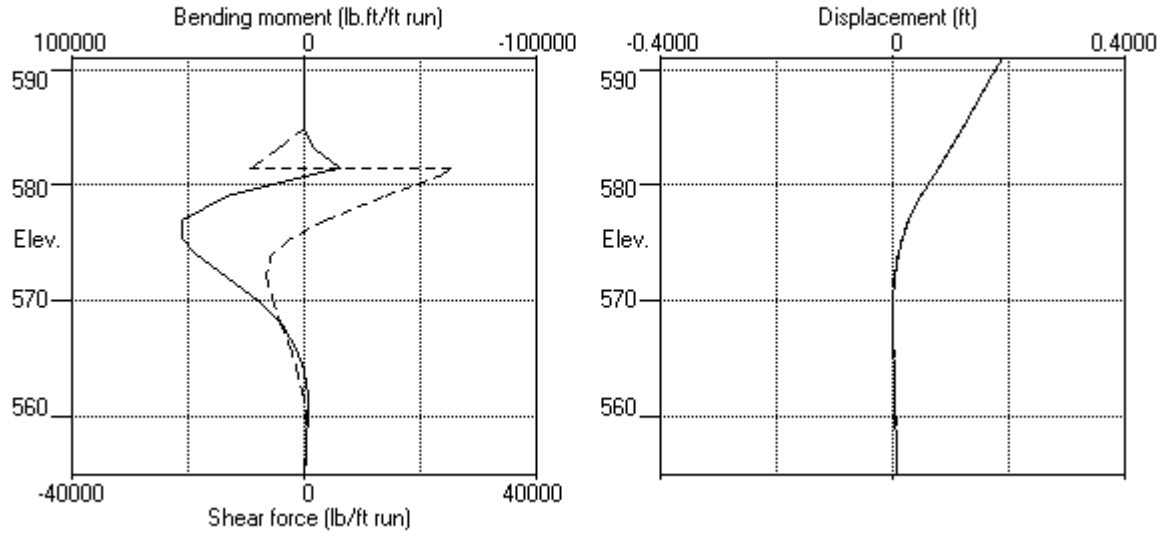
Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	374
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	2242
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	4484
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	6727
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	8969
		0.00	750.00	212.04	2652.75	2465.50	2465.50	8969
6	583.25	0.00	968.75	273.88	3426.47	2710.23	2710.23	11585
7	581.50	0.00	1187.50	335.72	4200.19	2727.56	2727.56	14201
8	581.00	0.00	1250.00	353.39	4421.25	2686.50	2686.50	14948
		0.00	1250.00	0.00	5250.00	5250.00	5250.00p	87198
9	579.00	0.00	1510.00	0.00	5510.00	5510.00	5510.00p	87198
10	577.00	0.00	1770.00	0.00	5770.00	5061.13	5061.13	87198
		0.00	1770.00	0.00	5770.00	5116.00	5116.00	87198
11	575.50	93.60	1871.40	0.00	5871.40	3362.05	3455.65	87198
12	574.00	187.20	1972.80	0.00	5972.80	2144.32	2331.52	87198
13	572.00	312.00	2108.00	0.00	6108.00	1228.33	1540.33	87198
14	570.00	436.80	2243.20	0.00	6243.20	886.46	1323.26	87198
15	568.00	561.60	2378.40	0.00	6378.40	915.34	1476.94	87198
16	566.00	686.40	2513.60	0.00	6513.60	1121.02	1807.42	87198
17	564.00	811.20	2648.80	0.00	6648.80	1380.61	2191.81	87198
18	562.00	936.00	2784.00	0.00	6784.00	1630.45	2566.45	87198
19	560.00	1060.80	2919.20	0.00	6919.20	1848.19	2908.99	87198
20	558.00	1185.60	3054.40	0.00	7054.40	2045.48	3231.08	87198
21	556.50	1279.20	3155.80	0.00	7155.80	2210.49	3489.69	87198
22	555.00	1372.80	3257.20	0.00	7257.20	2366.51	3739.31	87198

(continued)

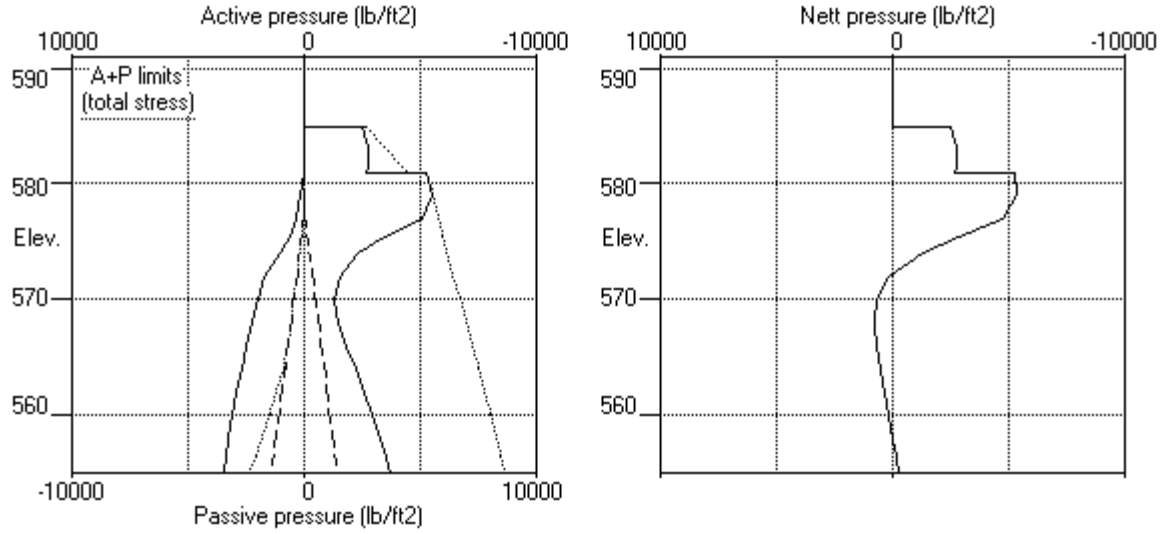
Stage No.3 Apply surcharge no.2 at elevation 591.00
Note: 0.00a Soil pressure at active limit
5510.00p Soil pressure at passive limit

Units: lb,ft

Stage No.3 Apply surcharge no.2 at elev. 591.00

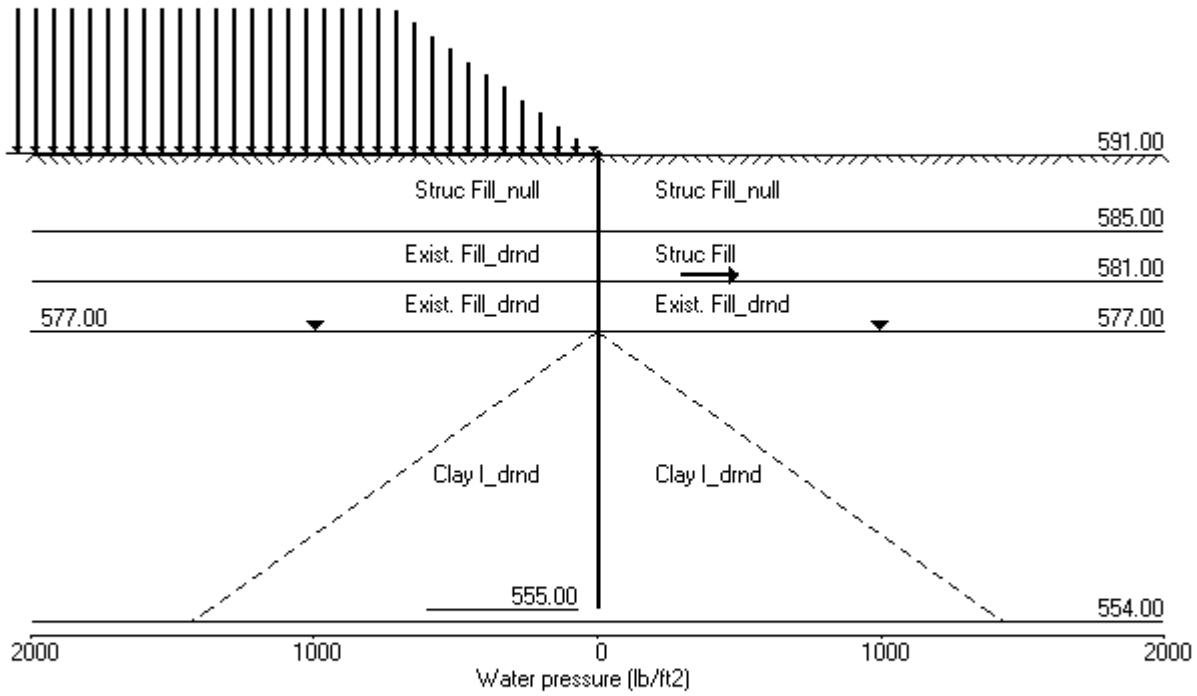


Stage No.3 Apply surcharge no.2 at elev. 591.00



Units: lb,ft

Stage No.5 Change soil type 3 to soil type 4



Units: lb,ft

Stage No. 5 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	FoS for toe elev. = 555.00 Factor of Safety	FoS for toe elev. = 555.00 Moment equilib. at elev.	Toe elev. for FoS = 1.500 Toe elev.	Wall Penetr-ation	Direction of failure
5	591.00	591.00	Cant.	1.538	559.50	555.87	35.13	L to R

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall
Analysis options
Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Node no.	Y coord	Nett pressure lb/ft2	Wall disp. ft	Wall rotation rad.	Shear force lb/ft	Bending moment lb.ft/ft	Prop forces lb/ft
1	591.00	0.00	0.282	1.65E-02	0.0	0.0	
2	589.50	0.00	0.257	1.65E-02	0.0	0.0	
3	588.00	0.00	0.232	1.65E-02	0.0	-0.0	
4	586.50	0.00	0.208	1.65E-02	0.0	0.0	
5	585.00	0.00	0.183	1.65E-02	0.0	-0.0	
		-2290.28	0.183	1.65E-02	0.0	0.0	
6	583.25	-2955.96	0.154	1.66E-02	-4590.5	-3771.1	
7	581.50	-3356.97	0.125	1.70E-02	-10114.3	-15689.5	34500.0
		-3356.97	0.125	1.70E-02	24385.7	-15689.5	
8	581.00	-3279.67	0.116	1.72E-02	22726.6	-3916.7	
		-3141.24	0.116	1.72E-02	22726.6	-3916.7	
9	579.00	-3799.11	0.082	1.63E-02	15786.2	34778.6	
10	577.00	-4457.82	0.052	1.35E-02	7529.3	61056.9	
		-3979.59	0.052	1.35E-02	7529.3	61056.9	
11	575.50	-4196.37	0.033	1.07E-02	1397.3	67096.3	
12	574.00	-2699.80	0.019	7.92E-03	-3774.8	65437.9	
13	572.00	-845.71	0.007	4.53E-03	-7320.3	51838.0	
14	570.00	284.74	0.001	2.00E-03	-7881.3	35490.6	
15	568.00	948.98	-0.002	3.90E-04	-6647.6	20350.6	
16	566.00	1091.49	-0.001	-4.59E-04	-4607.1	9027.4	
17	564.00	913.03	-0.000	-7.81E-04	-2602.6	2125.7	
18	562.00	632.43	0.002	-8.10E-04	-1057.1	-1142.8	
19	560.00	354.34	0.003	-7.22E-04	-70.3	-1910.0	
20	558.00	103.24	0.004	-6.29E-04	387.2	-1276.9	
21	556.50	-79.90	0.005	-5.90E-04	404.8	-546.7	
22	555.00	-459.77	0.006	-5.78E-04	-0.0	-0.0	

(continued)

Stage No.5 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

LEFT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	698
2	589.50	0.00	272.35	0.00	0.00	0.00	0.00	4187
3	588.00	0.00	544.50	0.00	0.00	0.00	0.00	8373
4	586.50	0.00	816.25	0.00	0.00	0.00	0.00	12560
5	585.00	0.00	1087.42	0.00	0.00	0.00	0.00	16747
		0.00	1087.42	362.47	3262.25	362.47	362.47a	146282
6	583.25	0.00	1411.54	470.51	4234.62	470.51	470.51a	146282
7	581.50	0.00	1734.33	578.11	5203.00	578.11	578.11a	146282
8	581.00	0.00	1826.28	608.76	5478.84	608.76	608.76a	146282
9	579.00	0.00	2192.66	730.89	6577.97	730.89	730.89a	146282
10	577.00	0.00	2556.55	852.18	7669.64	852.18	852.18a	146282
		0.00	2556.55	923.00	7081.19	923.00	923.00a	146282
11	575.50	93.60	2734.05	987.08	7572.85	987.08	1080.68a	146282
12	574.00	187.20	2909.89	1050.57	8059.89	1050.57	1237.77a	146282
13	572.00	312.00	3141.59	1134.22	8701.67	1134.22	1446.22a	146282
14	570.00	436.80	3370.00	1216.68	9334.32	1383.88	1820.68	146282
15	568.00	561.60	3594.99	1297.91	9957.49	1807.66	2369.26	166413
16	566.00	686.40	3816.46	1377.87	10570.94	2026.16	2712.56	166413
17	564.00	811.20	4034.38	1456.55	11174.53	2105.84	2917.04	166413
18	562.00	936.00	4248.72	1533.93	11768.21	2120.26	3056.26	166413
19	560.00	1060.80	4459.49	1610.03	12352.01	2114.62	3175.42	166413
20	558.00	1185.60	4666.73	1684.84	12926.02	2109.67	3295.27	166413
21	556.50	1279.20	4819.87	1740.13	13350.19	2116.20	3395.40	315249
22	555.00	1372.80	4971.08	1794.73	13769.02	2019.37	3392.17	882551

RIGHT side

Node no.	Y coord	Water press.	Effective stresses: Vertic-al	Active limit	Passive limit	Earth pressure	Total earth pressure	Coeff. of subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
1	591.00	0.00	0.00	0.00	0.00	0.00	0.00	698
2	589.50	0.00	187.50	0.00	0.00	0.00	0.00	4187
3	588.00	0.00	375.00	0.00	0.00	0.00	0.00	8373
4	586.50	0.00	562.50	0.00	0.00	0.00	0.00	12560
5	585.00	0.00	750.00	0.00	0.00	0.00	0.00	16747
		0.00	750.00	212.04	2652.75	2652.75	2652.75p	16747
6	583.25	0.00	968.75	273.88	3426.47	3426.47	3426.47p	21631
7	581.50	0.00	1187.50	335.72	4200.19	3935.08	3935.08	26516
8	581.00	0.00	1250.00	353.39	4421.25	3888.43	3888.43	27911
		0.00	1250.00	416.67	3750.00	3750.00	3750.00p	146282
9	579.00	0.00	1510.00	503.33	4530.00	4530.00	4530.00p	146282
10	577.00	0.00	1770.00	590.00	5310.00	5310.00	5310.00p	146282
		0.00	1770.00	639.03	4902.59	4902.59	4902.59p	146282
11	575.50	93.60	1871.40	675.64	5183.45	5183.45	5277.05p	146282
12	574.00	187.20	1972.80	712.25	5464.31	3750.37	3937.57	146282
13	572.00	312.00	2108.00	761.06	5838.79	1979.93	2291.93	146282
14	570.00	436.80	2243.20	809.87	6213.27	1099.14	1535.94	146282
15	568.00	561.60	2378.40	858.68	6587.75	858.68	1420.28a	166413
16	566.00	686.40	2513.60	907.49	6962.24	934.67	1621.07	166413
17	564.00	811.20	2648.80	956.31	7336.72	1192.81	2004.01	166413
18	562.00	936.00	2784.00	1005.12	7711.20	1487.83	2423.83	166413
19	560.00	1060.80	2919.20	1053.93	8085.68	1760.27	2821.07	166413
20	558.00	1185.60	3054.40	1102.74	8460.16	2006.43	3192.03	166413

(continued)

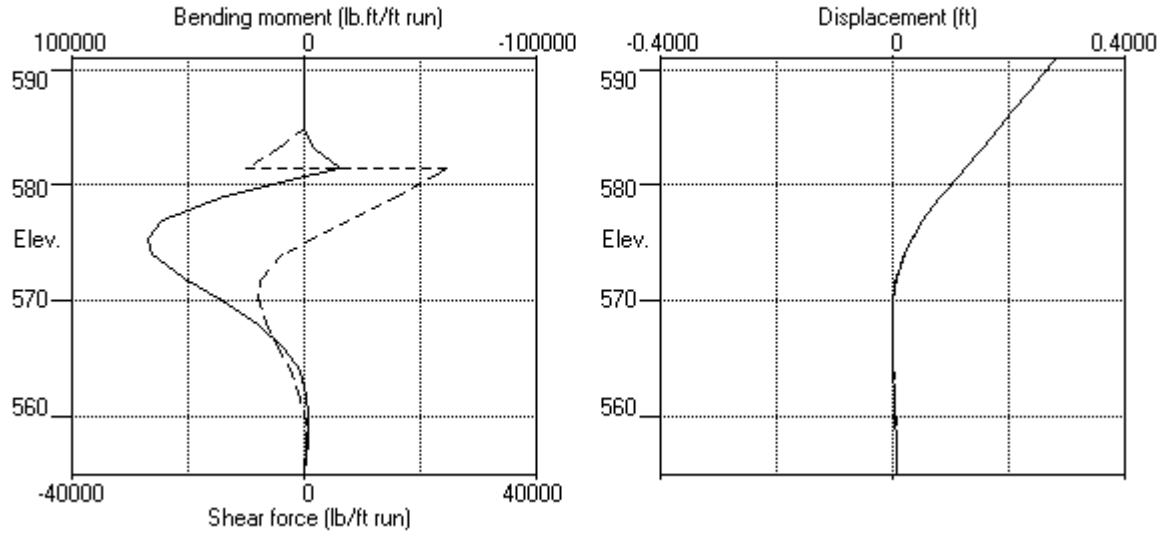
Stage No.5 Change properties of soil type 3 to soil type 4
Ko pressures will not be reset

		RIGHT side						
			Effective stresses				Total	Coeff. of
Node no.	Y coord	Water press.	Vertic -al	Active limit	Passive limit	Earth pressure	earth pressure	subgrade reaction
		lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft2	lb/ft3
21	556.50	1279.20	3155.80	1139.35	8741.02	2196.11	3475.31	315249
22	555.00	1372.80	3257.20	1175.96	9021.88	2479.14	3851.94	882551

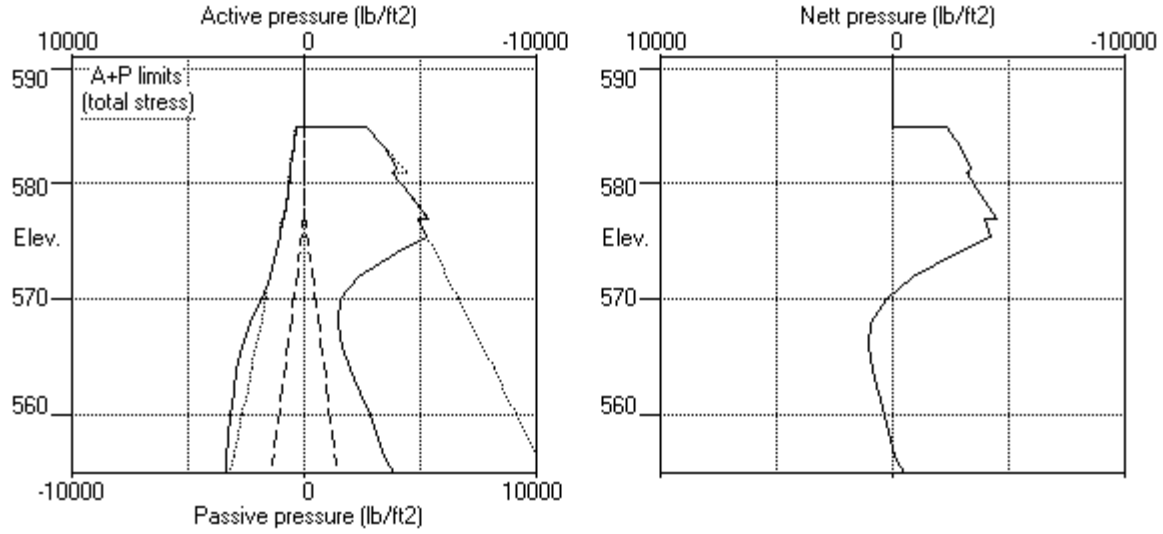
Note: 1420.28a Soil pressure at active limit
5277.05p Soil pressure at passive limit

Units: lb,ft

Stage No.5 Change soil type 3 to soil type 4



Stage No.5 Change soil type 3 to soil type 4



Units: lb,ft

Summary of results

STABILITY ANALYSIS of Fully Embedded Wall according to CP2 method
Factor of safety on gross pressure (excluding water pressure)

Stage No.	Ground level Act.	Ground level Pass.	Prop Elev.	**FoS for toe elev. = 555.00** Factor of Safety	Moment equilib. at elev.	**Toe elev. for FoS = 1.500** Toe elev.	Wall Penetr-ation	Direction of failure
1	591.00	591.00	Cant.	1.920	563.07	561.83	29.17	L to R
2	591.00	591.00		No analysis at this stage				
3	591.00	591.00	Cant.	2.015	561.99	562.82	28.18	L to R
4	591.00	591.00		No analysis at this stage				
5	591.00	591.00	Cant.	1.538	559.50	555.87	35.13	L to R

Units: lb,ft

Summary of results

BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

Analysis options

Length of wall perpendicular to section = 1000.00ft
Subgrade reaction model - Boussinesq Influence coefficients
Soil deformations are elastic until the active or passive limit is reached
Open Tension Crack analysis - No

Rigid boundaries: Left side 1000.00 from wall
Right side 1000.00 from wall

Bending moment, shear force and displacement envelopes

Node no.	Y coord	Displacement maximum	Displacement minimum	Bending moment maximum	Bending moment minimum	Shear force maximum	Shear force minimum
		ft	ft	lb.ft/ft	lb.ft/ft	lb/ft	lb/ft
1	591.00	0.282	0.000	0.0	0.0	0.0	0.0
2	589.50	0.257	0.000	0.0	0.0	0.0	0.0
3	588.00	0.232	0.000	0.0	-0.0	0.0	0.0
4	586.50	0.208	0.000	0.0	-0.0	0.0	0.0
5	585.00	0.183	0.000	0.0	-0.0	0.0	0.0
6	583.25	0.154	0.000	0.0	-3824.5	0.0	-4590.5
7	581.50	0.125	0.000	0.0	-15689.5	25477.7	-10114.3
8	581.00	0.116	0.000	0.0	-3916.7	24167.8	0.0
9	579.00	0.082	0.000	34778.6	0.0	15786.2	0.0
10	577.00	0.052	0.000	61056.9	0.0	7529.3	0.0
11	575.50	0.033	0.000	67096.3	0.0	1397.3	-2560.6
12	574.00	0.019	0.000	65437.9	0.0	0.0	-6005.4
13	572.00	0.007	-0.001	51838.0	0.0	0.0	-7320.3
14	570.00	0.001	-0.003	35490.6	0.0	0.0	-7881.3
15	568.00	0.000	-0.003	20350.6	0.0	0.0	-6647.6
16	566.00	0.000	-0.002	9027.4	0.0	0.0	-4607.1
17	564.00	0.001	-0.001	2125.7	-1691.5	0.0	-2602.6
18	562.00	0.002	-0.001	0.0	-2252.7	0.0	-1057.1
19	560.00	0.004	-0.000	0.0	-1910.0	342.8	-70.3
20	558.00	0.005	0.000	0.0	-1276.9	418.0	0.0
21	556.50	0.005	0.000	0.0	-546.7	404.8	0.0
22	555.00	0.006	0.000	0.0	-0.0	0.0	-0.0

Maximum and minimum bending moment and shear force at each stage

Stage no.	Bending moment maximum	Bending moment elev.	Bending moment minimum	Bending moment elev.	Shear force maximum	Shear force elev.	Shear force minimum	Shear force elev.
	lb.ft/ft		lb.ft/ft		lb/ft		lb/ft	
1	53427.8	577.00	-15520.7	581.50	25477.7	581.50	-9022.3	581.50
2	No calculation at this stage							
3	53050.4	577.00	-15679.0	581.50	25213.7	581.50	-9286.3	581.50
4	No calculation at this stage							
5	67096.3	575.50	-15689.5	581.50	24385.7	581.50	-10114.3	581.50

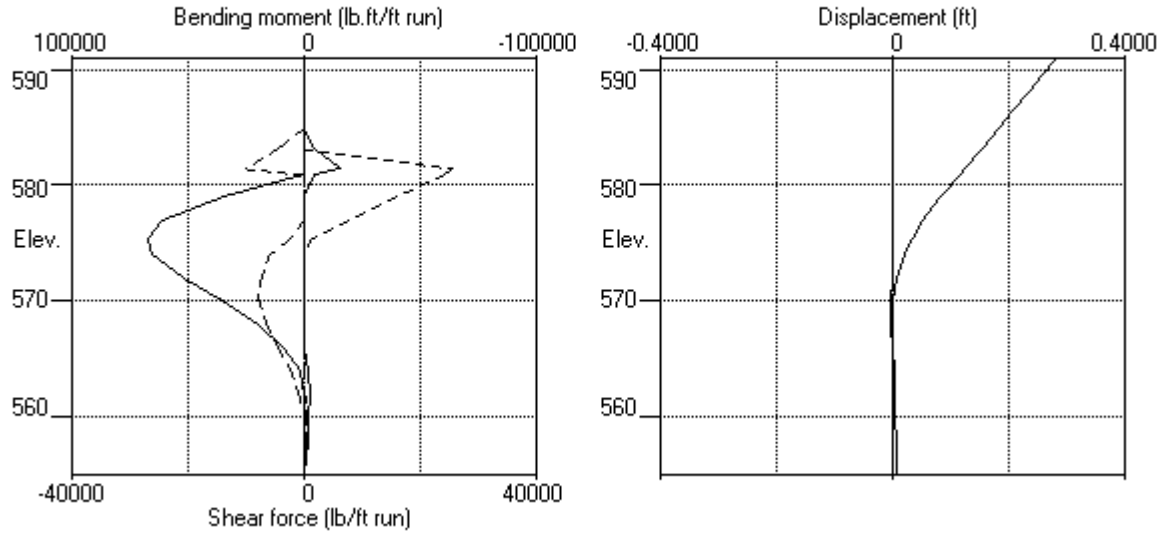
Maximum and minimum displacement at each stage

Stage no.	Displacement maximum	Displacement elev.	Displacement minimum	Displacement elev.	Stage description
	ft		ft		
1	0.180	591.00	-0.003	568.00	Apply load no.1 at elev. 581.50
2	No calculation at this stage				Apply surcharge no.1 at elev. 591.00
3	0.189	591.00	-0.001	568.00	Apply surcharge no.2 at elev. 591.00
4	No calculation at this stage				Change soil type 2 to soil type 7
5	0.282	591.00	-0.002	568.00	Change soil type 3 to soil type 4

Summary of results (continued)

Units: lb,ft

Bending moment, shear force, displacement envelopes



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TIEROD AND DEADMAN DESIGN

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TIEROD DESIGN

Brown County Anchored Bulkhead - Tierod and Deadman System

References:

- Federal Highway Administration - Geotechnical Circular No. 4, 1999
- Federal Highyway Administration - Geotechnical Circular No. 7 2015
- Nucor Skyline Material Cutsheet
- North American Steel Sheet Piling Association (NASSPA), Guidance on Corrosion
- USS Steel Sheet Piling Manual (1984)

INPUT PARAMETERS

Bar diameter: $D_b := 3.5in$

Min. net area: $A_b := 9.6in^2$

Min. Yield Strength: $f_y := \frac{768.8kip}{A_b} = 80 \cdot ksi$

Min. Ultimate Strength: $f_u := \frac{961kip}{A_b} = 100 \cdot ksi$

Design life: $t := 50yr$

Yield Tensile Load of Bar: $P_{b.max} := A_b \cdot f_y = 768.80 \cdot kip$

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Structural Capacity of Tierod

Tierod Line Load: $w_{tie} := 34.5 \cdot \frac{kip}{ft}$ From WALLAP dockwall analyses

Load Amplification Factor (USS, 1984): $LF_{tie} := 1.3$

Design Line Load: $w_{LF} := w_{tie} \cdot LF_{tie} = 44.85 \cdot \frac{kip}{ft}$

Tierod spacing: $s_{tie} := 9.3ft$

Design load: $P_{tie.DL} := w_{LF} \cdot s_{tie} = 417.11 \cdot kip$

Allowable Yield Load: $P_{b.allow} := 0.56 \cdot P_{b.max} = 430.53 \cdot kip$
FHWA GEC No. 7

$Check := if\left(P_{tie.DL} < P_{b.allow}, \text{"Bar and Spacing OK"}, \text{"Reduce spacing or change bar size"}\right)$

$Check = \text{"Bar and Spacing OK"}$

Use No. 28, 3.5" nominal diameter Bar, Grade 75/80 thread bar with ultimate strength of 961 kips.

Elongation of Tierod due to Design Tensile Load

Tierod Line Load: $P_{LL} := w_{tie} \cdot s_{tie} = 320.85 \cdot kip$

Length of Tierod: $L := 75ft$

Minimum Net Area: $A := A_b = 9.60 \cdot in^2$

Young's Modulus of Steel: $E := 29000ksi$

Elastic Deformation Due to Tension Load: $D := \frac{P_{LL} \cdot L}{A \cdot E} = 1.04 \cdot in$

This elastic deformation, considering that the tierod will be pre-stressed, will be removed from the overall deflection of the deadman wall.

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Elongation of Tierod due to Testing Conditions

Performance Test
Tierod Line Load: $P_{test} := P_{LL} \cdot 1.33 = 426.73 \cdot kip$

Allowable Yield Load:
FHWA GEC No. 4 $P_{test.allow} := 0.9 \cdot P_{b.max} = 691.92 \cdot kip$

Length of Tierod: $L := 75ft$

Minimum Net Area: $A := A_b = 9.60 \cdot in^2$

Young's Modulus of Steel: $E := 29000ksi$

Elastic Deformation Due to Performance Test Load: $D_{test} := \frac{P_{test} \cdot L}{A \cdot E} = 1.38 \cdot in$

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Subject	Deadman Sheeting Design						

Sheet Pile Anchor Wall Design

References

- USS Steel Sheet Piling Design Manual
- AISC Steel Construction Manual 14th Edition
- North American Steel Sheet Piling Association (NASSPA), Guidance on Corrosion

Input Data

Max Moment: $M := 65kip \cdot \frac{ft}{ft}$ *Output from Wallap*

Sheet Pile: NZ19

Elastic Section Modulus: $S_x := 35.08 \frac{in^3}{ft}$

Yield Stress: $F_y := 60ksi$

Flange Thickness: $t_f := 0.375 \cdot in$

Corroded Section Properties

Design Life: $t := 50yr$

Recommended Value for Loss of Thickness due to Corrosion: $c_t := 0.0005 \frac{in}{yr}$ *(undisturbed nat'l soils)*

Estimated Corrosion Thickness: $t_c := t \cdot c_t = 0.03 \cdot in$

Corroded Elastic Section Elastic Modulus: $S_{cr} := \frac{S_x \cdot (t_f - 2 \cdot t_c)}{t_f}$ $S_{cr} = 30.40 \cdot \frac{in^3}{ft}$

Approximate Section Loss: $S_{loss} := (S_x - S_{cr})$ $S_{loss} = 4.68 \cdot \frac{in^3}{ft}$

Percent Remaining Section Modulus after 50 years: $S_{per} := \frac{(S_{cr} - S_{loss})}{S_{cr}} = 85 \cdot \%$

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Strength Check

Allowable Bending Stress: $F_a := 0.60 \cdot F_y = 36.0 \cdot ksi$

Allowable Bending Capacity: $M_a := S_{cr} \cdot F_a = 91.2 \cdot kip \cdot \frac{ft}{ft}$

$$Check := \begin{cases} \text{"Okay"} & \text{if } M \le M_a \\ \text{"Not Okay"} & \text{otherwise} \end{cases}$$

Check = "Okay"

Minimum Elastic Section Modulus (No Corrosion): $S_{min} := 1.67 \cdot M \div F_y = 21.7 \cdot \frac{in^3}{ft}$

$Utilization := \frac{M}{M_a} = 71\%$ is less than $S_{per} = 85\%$ OK

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Subject	Tierod Wales and Connections Design					

Tieback System Design - Wales and Connections

References

- AISC360-22 Specification for Structural Steel Buildings
- USS Steel Sheet Piling Design Manual, July 1984
- PTI Anchorage Zone Design, 6tht Edition
- ACI 318-19, Building Code Requirements for Structural Concrete

Input Data

Yield Stress of Steel: $F_y := 50ksi$

Ultimate Stress of Steel: $F_u := 65ksi$

Modulus of Elasticity of Steel: $E := 29000ksi$

Weld Electrodes: $F_{EXX} := 70ksi$

Safety Factor for Tension/Flexure/Shear: $\Omega := 1.67$

Safety Factor for Welds: $\Omega_w := 2.00$

Spacing of King Piles: $s_{kp} := 9.3ft$

Wale Load from Wall Analysis: $\omega := 31.8klf$ *Max From GEI Wallap Analyses*

Design Loads:

Working loads for the wall analysis will be factored to included effects such as load uncertainty and eccentricities at the connections. The following load factors have been selected for design and are from the USS Steel Pile Design Manual:

Wale Load Amplification Factor: $LF_{wale} := 1.3$

Tieback Load Amplification Factor: $LF_{tbck} := 1.3$

Connection Load Amplification Factor: $LF_{conn} := 1.3$

Wale Design Load: $\omega_{wale} := LF_{wale} \cdot \omega = 41.3 \cdot klf$

Tieback Design Load: $\omega_{tbck} := LF_{tbck} \cdot \omega = 41.3 \cdot klf$

Connection Design Load: $\omega_{conn} := LF_{conn} \cdot \omega = 41.3 \cdot klf$

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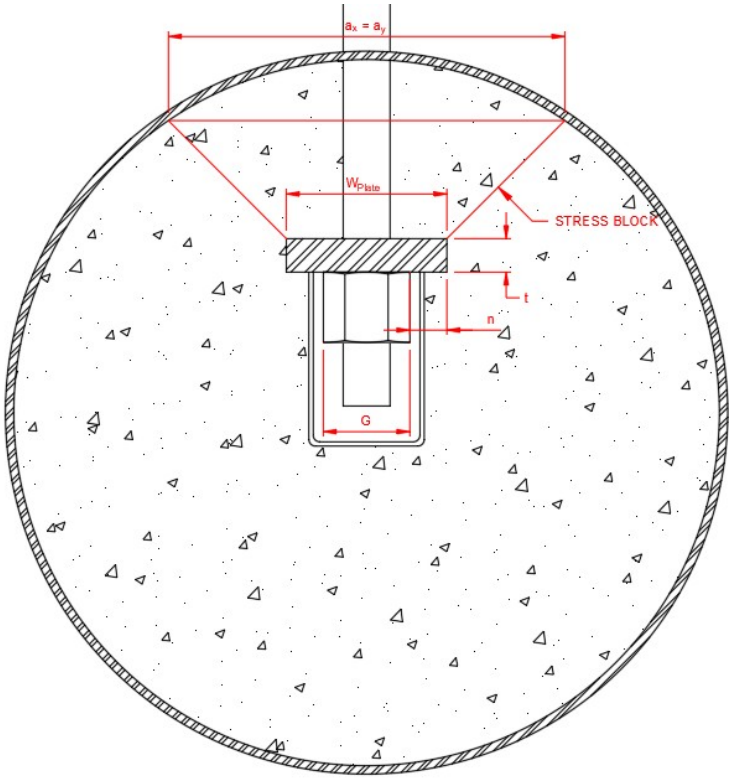
COMPRESSION BEARING STRESSES PTI Anchorage Zone Design, 6th Edition

Bearing Plate Check



Bearing Plate Load: $P := \omega_{conn} \cdot s_{kp} = 384.5 \cdot kip$

Bearing Plate Width: $W_{plate} := 14in$

Bearing Plate Hole: $ID_{plate} := 3.75in + \frac{1}{8}in$

Plate Hole Area: $A_{plate\_h} := 0.25 \cdot \pi \cdot ID_{plate}^{2} = 11.79 \cdot in^2$

Bearing Plate Area: $A_{plate} := W_{plate}^{2} = 196.00 \cdot in^2$

Bearing Area: $A_b := A_{plate} - A_{plate\_h} = 184.21 \cdot in^2$

Embedment of plate: $emb := 30in$

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Concrete Compressive Strength: $fc := 5000psi$

Design Bearing Capacity: $\sigma_{nom} := fc = 5000\ psi$

Diam. of the Dome/Nut $G := 5.0in$

Modulus of elasticity $E := 29000ksi$

Steel yield stress $f_y := 50ksi$

Bearing Stress: $q := \frac{P}{A_b} = 2087\ psi$

Check_Bearing_Stress := "OK" if $\sigma_{nom} \geq q$ = "OK"; "Not Good" otherwise

Cantilevered Length: $n := \frac{W_{plate} - G}{2} = 4.50 \cdot in$

from PTI - Chapter VIII pg.5 $f_{bi} := q$

Min Plate Thickness (1): $t_1 := \left(\frac{3 \cdot \frac{P \cdot n^2}{2}}{A_b \cdot f_y} \right)^{0.5} = 1.13 \cdot in$ *PTI Eq. 3.4 (rewritten solving for t)*

Min Plate Thickness (2): $t_2 := \frac{n}{0.08 \cdot \left(\frac{E \cdot A_b}{P} \right)^{0.333}} = 2.35 \cdot in$ *PTI Eq. 3.5 (rewritten solving for t)*

Min Plate Thickness: $t_{req} := \max(t_1, t_2) = 2.35 \cdot in$

Plate Thickness: $t := 2.5in$

Check_Plate_Thickness := "OK" if $t \geq t_{req}$ = "OK"; "Not Good" otherwise

Use 2.5" thick plate

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$$f_s := \frac{4P}{\pi \cdot \left(G^2 - ID_{plate}^{\ 2}\right)} = 49.0 \cdot ksi \qquad \textit{PTI Eq. 3.4} \qquad < \qquad 1.5 \cdot f_y = 75.0 \cdot ksi \quad \textbf{\textit{OKAY}}$$

Check_Plate_Stress := "OK" if $1.5 \cdot f_y \geq f_s$ = "OK"
"Not Good" otherwise

Punching Shear Check- ACI 318-19:

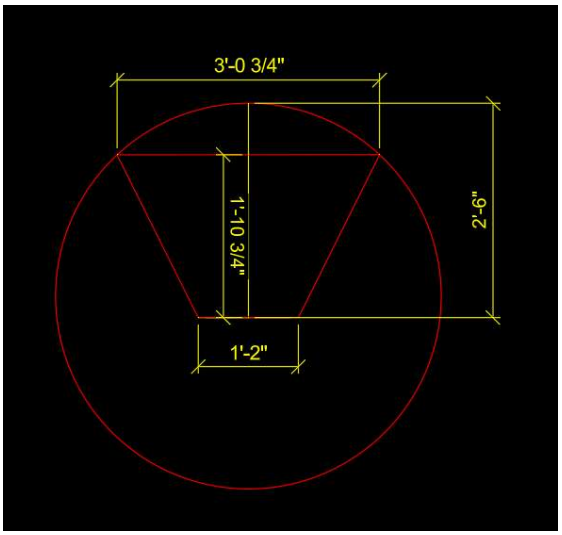
$d_{eff} := 22.75in$ compression plate embeddment- perpendicular to the plate

$$b_o := 4\left(\frac{36.75in + 14in}{2}\right) = 101.50 \cdot in$$

$\lambda := 1$ Normal Weight Concrete

$\alpha_s := 40$ Internal Pile

$\beta := 1$ Ratio of long and short length of plate



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Shear Strength in Concrete: (Tow-Way members without shear reinforcement, ACI 318.19 table 22.6.5.2)

$$V_{c1} := \left(2 + \frac{4}{\beta}\right)\cdot\lambda\cdot\sqrt{\frac{fc}{psi}}\cdot b_o\cdot d_{eff}\,psi \qquad V_{c1} = 979.68\cdot kip$$

$$V_{c2} := \left(\frac{\alpha_s\cdot emb}{b_o} + 2\right)\cdot\lambda\cdot\left(\sqrt{\frac{fc}{psi}}\cdot b_o\cdot d_{eff}\,psi\right) \qquad V_{c2} = 2256.96\cdot kip$$

$$V_{c3} := 4\cdot\lambda\cdot\left(\sqrt{\frac{fc}{psi}}\cdot b_o\cdot d_{eff}\cdot psi\right) \qquad V_{c3} = 653.12\cdot kip$$

$$V_c := \min\left(V_{c1}, V_{c2}, V_{c3}\right) \qquad V_c = 653.12\cdot kip$$

Resistance factor: $\phi_s := 0.75$

$$V_{c\_nom} := \phi_s\cdot V_c \qquad V_{c\_nom} = 489.84\cdot kip$$

Pipe pile thickness: $t_{w\_pipe} := \frac{5}{8}in$

Pipe pile cross sectional area contributing in shear strength: $A_{p\_pile} := 36.75in\cdot t_{w\_pipe}\cdot 2 = 45.94\cdot in^2$

Resistance factor: $\phi_{pipe} := 0.75$

Steel Shear strength: $V_s := \phi_v\cdot F_y\cdot A_{p\_pile} = 2067.19\cdot kip$

Load Factor: $LF := 1.6$

$$V_{c\_check} := \begin{cases} \text{"OK, Factored Shear < Nominal Punching Shear"} & \text{if } LF\cdot P < V_{c\_nom} + V_s \\ \text{"NG"} & \text{otherwise} \end{cases}$$

$V_{c\_check} = \text{"OK, Factored Shear < Nominal Punching Shear"}$ $\qquad LF\cdot P = 615.14\cdot kip$

$$DCR := \frac{P}{V_{c\_nom} + V_s} = 0.15$$

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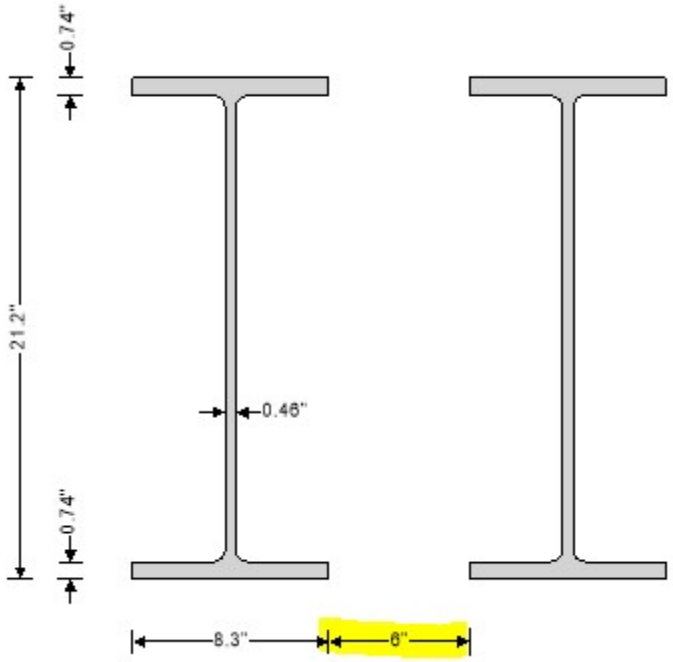
Design Wale at Deadman Wall

Wale Load: $\omega_{wale} = 41.3 \cdot klf$

Wale Shear: $V_{wale} := 0.6 \cdot \omega_{wale} \cdot s_{kp} = 230.7 \cdot kip$

Wale Moment: $M_{wale} := 0.10 \cdot \omega_{wale} \cdot {s_{kp}}^2 = 357.5 \cdot kip \cdot ft$

See attached Tedds analysis for the wale design



W 21x73 (AISC 15th Edn (v15.0))
Section depth, d, 21.2 in
Section breadth, b_f, 8.3 in
Weight of section, Weight, 73 lbf/ft
Flange thickness, t_f, 0.74 in
Web thickness, t_w, 0.455 in
Root radius, k - t_f, 0.5 in
Area of section, A, 21.5 in^2
Radius of gyration about x-axis, r_x, 8.64 in
Radius of gyration about y-axis, r_y, 1.81 in
Elastic section modulus about x-axis, S_x, 151 in^3
Elastic section modulus about y-axis, S_y, 17 in^3
Plastic section modulus about x-axis, Z_x, 172 in^3
Plastic section modulus about y-axis, Z_y, 26.6 in^3
Second moment of area about x-axis, I_x, 1600 in^4
Second moment of area about y-axis, I_y, 70.6 in^4

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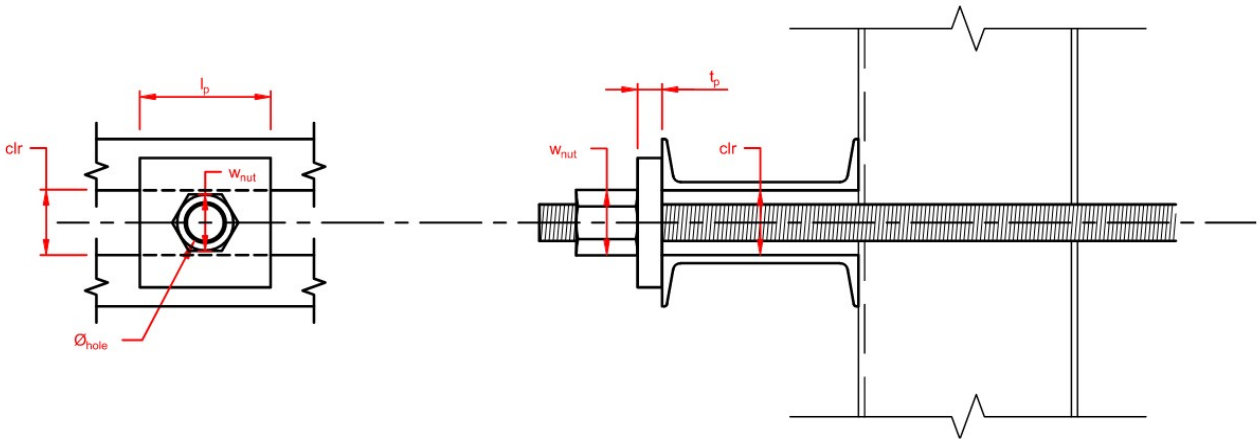
Design Bearing Plate at Deadman Wall- AISC 360



Steel ASD Design Factors of Safety

Plate Thickness: $t_p := 3.5in$

Plate Length: $l_p := 20in$ Plate width: $w_p := 12in$

Hole Size: $\phi_{hole} := 3.75in + \frac{1}{8}in$

Bar Nut Width (across flats): $w_{nut} := 5.0in$

Clear Space Between Channels $clr := 6in$

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Flexure $\Omega_f := 1.67$

Shear $\Omega_s := 1.5$

Max shear: $V_{max} := 0.5 \cdot P = 192.23 \cdot kip$

Max moment: $M_{max} := 0.5 \cdot P \cdot \left(\frac{clr}{4} + \frac{l_p}{4} - \frac{w_{nut} - \phi_{hole}}{4} \right) = 1195.44 \cdot kip \cdot in$

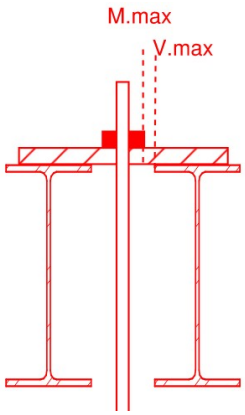

Plate Mid Span Elastic Section Modulus: $S_p := \frac{t_p^2 \cdot (l_p - \phi_{hole})}{6} = 32.92 \cdot in^3$

Plate Mid Span Plastic Section Modulus: $Z_p := \frac{t_p^2 \cdot (l_p - \phi_{hole})}{4} = 49.38 \cdot in^3$

Nominal Shear Capacity: $V_n := 0.6 \cdot F_y \cdot t_p \cdot l_p = 2100.00 \cdot kip$

Allowable Shear Capacity: $V_a := V_n \div \Omega_s = 1400.0 \cdot kip > V_{max} = 192.2 \cdot kip$

Check_shear := "OK" if $V_a \geq V_{max}$ = "OK"; "Not Good" otherwise

Nominal Moment Capacity (AISC Eq. F11-1): $M_n := \min(F_y \cdot Z_p, 1.6 \cdot F_y \cdot S_p) = 2469.1 \cdot kip \cdot in$

Allowable Moment Capacity: $M_a := M_n \div \Omega_f = 1478.5 \cdot kip \cdot i >$

$M_{max} = 1195.4 \cdot kip \cdot ir$

Check_shear := "OK" if $M_a \geq M_{max}$ = "OK"; "Not Good" otherwise

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Flanges & Webs with Concentrated Forces (AISC §J10)

References

- AISC Steel Construction Manual, 13th Ed.

Discussion

This Mathcad sheet presents the calculation of the allowable concentrated loads on the flanges of wide-flange sections and similar built-up shapes for the following limit states:

1. Flange Local Bending
2. Web Local Yielding
3. Web Crippling
4. Web Sidesway Buckling
5. Web Compression Buckling

Where the applied load will exceed the allowable load, stiffeners or doubler plates must be provided, sized for the difference between the applied load and the allowable load.

Material Properties

Specified Minimum Yield Stress of Steel: $F_y := 50ksi$

Note: The AISC Specification is written to account for the situation in which the flanges and the web have different yield strengths, as may be the case for a built-up section. For rolled sections, the web and flanges will have the same yield strength. Assuming a rolled section:

Specified Minimum Yield Stress of Flange: $F_{yf} := F_y = 50 \cdot ksi$

Specified Minimum Yield Stress of Web: $F_{yw} := F_y = 50 \cdot ksi$

Modulus of Elasticity of Steel: $E := 29000ksi$

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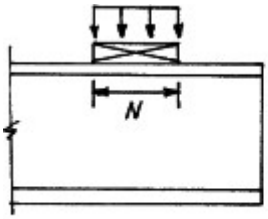
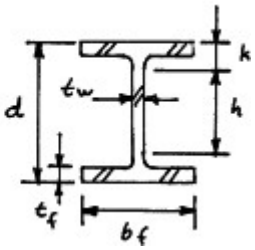
Input Dimensions





Member Size:	**W21x73**	
Overall Depth of Member:	$d := 21.2in$	
Thickness of Loaded Flange:	$t_f := 0.74in$	
Flange Width:	$b_f := 8.3in$	
Web Thickness:	$t_w := 0.455in$	
k-Distance:	$k := 1.24in$	*k_{des} from AISC Table 1-1*
Laterally Unbraced Length:	$L := 40in = 3.33\,ft$	*Largest of either flange at point of load. (SSP belly width)*
Length of Bearing:	$N := w_p = 12.00 \cdot in$	
Concentrated Load: (per W section)	$P := 0.5\omega_{conn} \cdot s_{kp} = 192.2 \cdot kip$	

Flange Local Bending (AISC §J10.1)

Safety Factor: $\Omega := 1.67$

Nominal Strength: $R_n := 6.25 \cdot F_{yw} \cdot (t_f)^2 = 171.13 \cdot kip$

Allowable Load: $R_n \div \Omega = 102.47 \cdot kip$

Check_Flange_Local_Bending := "OK" if $\frac{(R_n)}{\Omega} \geq P$ = "Not Good"

"Not Good" otherwise

Add two pairs of transverse stiffener (PL 18.72" x 3.5" x 7/8") on each W section at tierod location.

Width of stiffener:	$w_{p\_sti} := 3.5in$
Thickness of stiffener:	$t_{p\_sti} := \frac{7}{8}in$
Length of stiffener:	$L_{p\_sti} := 18.72in$
Number of stiffeners per W section:	$n_{sti} := 4$

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Gyration radius of plate:

$$r := \sqrt{\frac{\frac{w_{p\_sti} \cdot t_{p\_sti}^{3}}{12}}{w_{p\_sti} \cdot t_{p\_sti}}} = 0.25 \cdot in$$

Elastic Buckling stress:

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{L_{p\_sti}}{r}\right)^2} = 52.11 \cdot ksi$$

Critical Stress:

$$F_{cr} := \begin{cases} \left[\left(0.658^{\frac{F_y}{F_e}}\right) \cdot F_y\right] & \text{if } 4.71 \cdot \sqrt{\frac{E}{F_y}} \geq \frac{L_{p\_sti}}{r} \\ \left(0.8777 F_e\right) & \text{otherwise} \end{cases} = 33.46 \cdot ksi$$

AISC §E3

Added strength from stiffeners:

$$P_{n\_sti} := n_{sti} \cdot F_{cr} \cdot t_{p\_sti} \cdot w_{p\_sti} = 409.91 \cdot kip$$

Check_Flange_Local_Bending :=

$$\begin{cases} \text{"OK"} & \text{if } \frac{\left(R_n\right) + P_{n\_sti}}{\Omega} \geq P \\ \text{"Not Good"} & \text{otherwise} \end{cases} = \text{"OK"}$$

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Web Local Yielding (AISC §J10.2)

Applies to single-concentrated forces and both components of double-concentrated forces.

Safety Factor: $\Omega := 1.50$

When the force is applied at a distance from the end of the member that is greater than the depth, d:

Nominal Strength: $R_{n1} := (5k + N) \cdot F_{yw} \cdot t_w + P_{n\_sti} = 823.96 \cdot kip$ Allowable Load: $R_{n1} \div \Omega = 549.31 \cdot kip$

When the force is applied at a distance from the end of the member that is less than or equal to the depth, d:

Nominal Strength: $R_{n2} := (2.5k + N) \cdot F_{yw} \cdot t_w + P_{n\_sti} = 753.44 \cdot kip$ Allowable Load: $R_{n2} \div \Omega = 502.29 \cdot kip$

Check_Web_Local_Yield := "OK" if $\frac{\min(R_{n1}, R_{n2})}{\Omega} \geq P$ = "OK"

"Not Good" otherwise

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Web Crippling (AISC §J10.3)

When the force is applied at a distance from the end of the member that is greater than or equal to d/2:

Nominal Strength: $R_{n1} := 0.80\left(t_w\right)^2 \cdot \left[1 + 3 \cdot \left(\frac{N}{d}\right) \cdot \left(\frac{t_w}{t_f}\right)^{1.5}\right] \cdot \sqrt{\frac{E \cdot F_{yw} \cdot t_f}{t_w}}$

$R_{n1} = 462.57 \cdot kip$ Allowable Load: $R_{n1} \div \Omega = 308.38 \cdot kip$

When the force is applied at a distance from the end of the member that is less than d/2:

Nominal Strength: $R_{n2} := \begin{cases} 0.40\left(t_w\right)^2 \cdot \left[1 + 3 \cdot \left(\frac{N}{d}\right) \cdot \left(\frac{t_w}{t_f}\right)^{1.5}\right] \cdot \sqrt{\frac{E \cdot F_{yw} \cdot t_f}{t_w}} & \text{if } \frac{N}{d} \le 0.2 \\ 0.40\left(t_w\right)^2 \cdot \left[1 + \left(\frac{4N}{d} - 0.2\right) \cdot \left(\frac{t_w}{t_f}\right)^{1.5}\right] \cdot \sqrt{\frac{E \cdot F_{yw} \cdot t_f}{t_w}} & \text{otherwise} \end{cases}$

$R_{n2} = 253.73 \cdot kip$ Allowable Load: $R_{n2} \div \Omega = 169.15 \cdot kip$

Check_Web_Crippling := "OK" if $\frac{\min\left(R_{n1}, R_{n2}\right) + P_{n\_sti}}{\Omega} \ge P$ = "OK"

"Not Good" otherwise

$\frac{\min\left(R_{n1}, R_{n2}\right) + P_{n\_sti}}{\Omega} = 442.43 \cdot kip$

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Web Sidesway Buckling (AISC §J10.4)

Applies only to single-concentrated forces applied to members where relative lateral movement between the loaded compression flange the tension flange is not restrained at the point of application of the force.

Safety Factor: $\Omega := 1.76$

Distance between Flanges, less Fillets: $h := d - 2k$ $h = 18.72 \cdot in$ *See AISC manual for built-up sections.*

Assume: $C_r := 960000 ksi$ *Valid as long as conventional AISC elastic design provisions are used.*

Note: $\frac{h}{t_w} \div \frac{L}{b_f} = 8.54$ *If this ratio is greater than 2.3 with the compression flange restrained against rotation, or 1.7 with the compression flange not restrained against rotation, the limit state of web sidesway buckling does not apply.*

If the compression flange is restrained against rotation:

Nominal Strength: $R_n := \frac{C_r \cdot {t_w}^3 \cdot t_f}{h^2} \cdot \left[1 + 0.4 \cdot \left(\frac{h}{t_w} \div \frac{L}{b_f}\right)^3\right]$

$R_n = 47716.06 \cdot kip$ Allowable Load: $R_n \div \Omega = 27111.40 \cdot kip$

If the compression flange is <u>not</u> restrained against rotation:

Nominal Strength: $R_n := \frac{C_r \cdot {t_w}^3 \cdot t_f}{h^2} \cdot \left[0.4 \cdot \left(\frac{h}{t_w} \div \frac{L}{b_f}\right)^3\right]$

$R_n = 47525.11 \cdot kip$ Allowable Load: $R_n \div \Omega = 27002.90 \cdot kip$

$P = 192.2 \cdot kip$ ***OKAY***

Web Compression Buckling (AISC §J10.5)

Applies to a pair of compressive single-concentrated forces or the compressive components in a pair of double-concentrated forces, applied to both flanges of a member at the same location.

Safety Factor: $\Omega := 1.67$

Nominal Strength: $R_n := \frac{24 \left(t_w\right)^3 \cdot \sqrt{E \cdot F_{yw}}}{h} + P_{n\_sti} = 555.33 \cdot kip$

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Allowable Load: $R_n \div \Omega = 332.53 \cdot kip$

Check_Web_compression := "OK" if $\frac{R_n}{\Omega} \geq P$ = "OK"

"Not Good" otherwise

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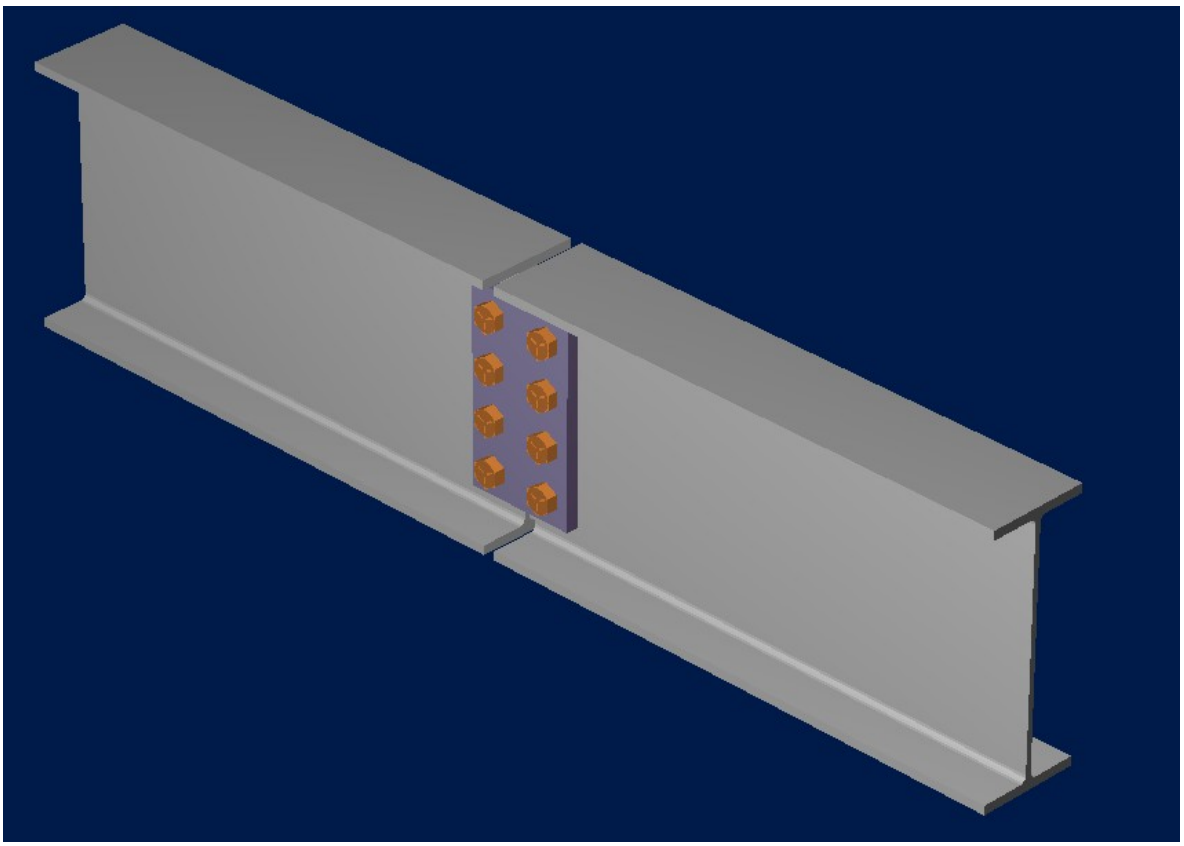
Design Wale Splice

The wale splice will be located within an area of negligible moment, therefore design for shear only. The maximum shear will be used. See attached analysis for the splice design.

Design Shear Load on each splice: $V_{splice} := 0.5V_{wale} = 115.3 \cdot kip$



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Lacing Design- AISC 360 - Section E6

In accordance with AISC Chapter E6 for built-up members, individual component shall be connected to one another at intervals "a" such that the senderness ratio"a/r" of each component does not exceed 3/4 of the governing slenderness ratio of the built-up member.

Radius of gyration of individual component- Y axis: $r_y := 1.81in$

Radius of gyration of individual component- x axis: $r_x := 8.64in$

minimum radius of gyration of individual component $r_i := \min(r_x, r_y) = 1.81 \cdot in$

Distance between lacings: $a_{lacing} := 6ft$

$$\frac{a_{lacing}}{r_i} = 39.78$$

Effective length: $L_c := 9.25ft$ tierod spacing

Modified slenderness ratio of built-up member: $Lr_m := \frac{L_c}{r_x} = 12.85$

Maximum connector spacing: $a := \frac{3 \cdot \max(r_x, r_y) \cdot Lr_m}{4} = 6.94\,ft$

Check := "OK, Connector spacing is adequate" if $a_{lacing} \le a$ = "OK, Connector spacing is adequate"
"Reduce spacing"" otherwise

Width of the lacing plate: $W_p := b_f + clr = 14.30 \cdot in$ Say $W_{pl} := 16in$

Use 16"x6"x0.5" plates welded to the top and bottom flanges every 6 ft.

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Design Wale at Return Wall

The return wall will have diagonal tiebacks. As a result the wall needs to be checked for the following:

1. Wall Stability to overturning and sliding
2. A wale will be designed to resist compressive loads that develop in the wall as a result of the diagonal tie force.
3. The wall interlocks will be welded to make the wall act as a diaphragm and prevent racking of the system.

1. Wall Stability

The wall is checked for stability assuming a rigid structure. We computed the overturning moment resulting from the wale load at Elev. 582 relative to the toe of the wall. Restoring moments included the weight of the wall, weight of the fill inside the pipes (assumed to be a loose sand), and frictional forces on the wall due to the active and passive pressures.

We conservatively assumed an interface friction angle between the soil and wall of 14 degrees or approximately 1/2 the friction angle for the soils modeled. We also conservatively idealized the wall as a planar structure ignoring the additional surface area gained from the radius of the pipe and bent shape of the sheet piles. Additionally, the friction angle is considered conservative for a sliding limit state since the areas betweent the pipe piles would plug with soil and the interface friction angle would be equal to the soil friction angle. The wall pressures during the critical stage were used and are presented below. The wall forces were graphically integrated in CAD based on the Wallap pressure diagram

A minimum factor of safety of 1.5 was assumed for the overturning and sliding limit states.

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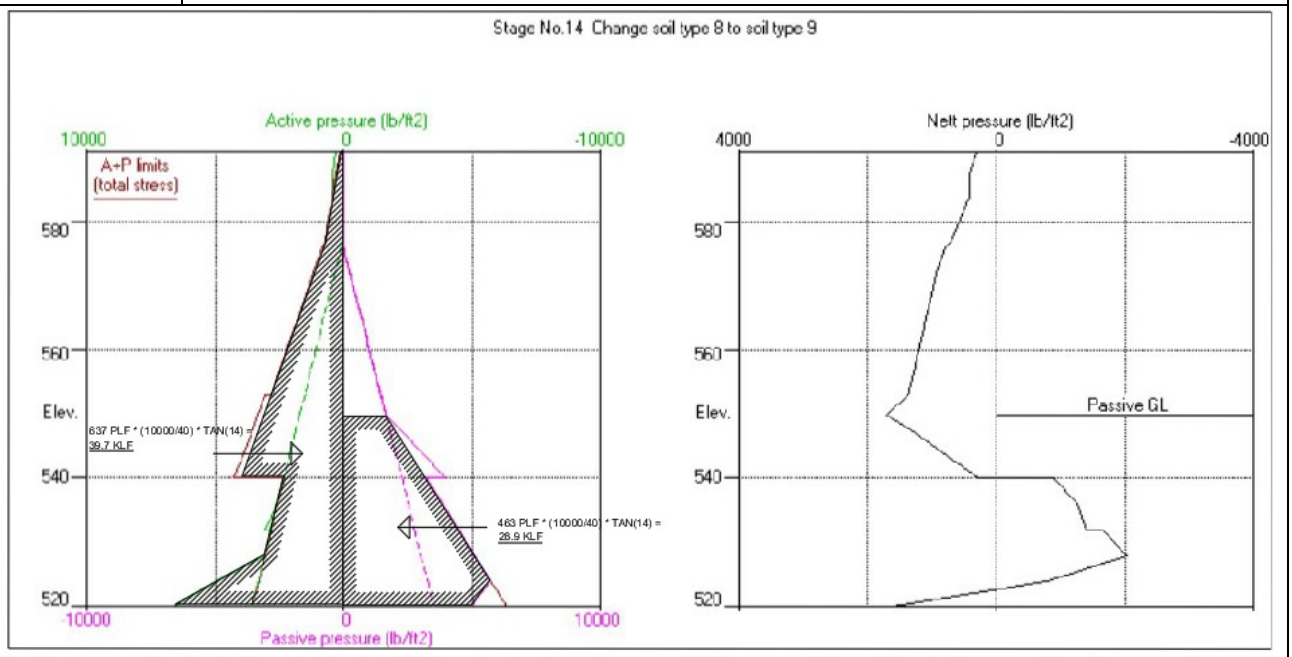

VERTICAL SCALE: 1:1
HORIZONTAL SCALE: 40:10,000

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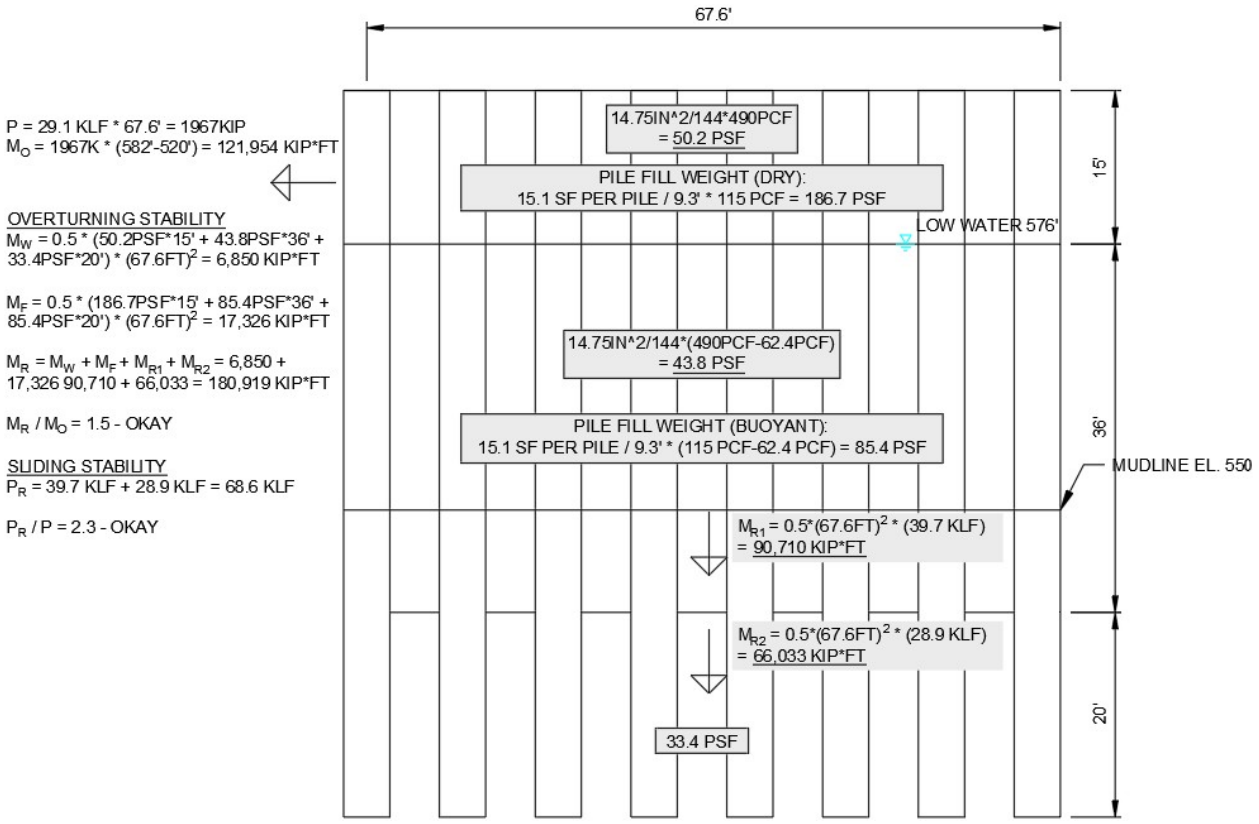

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Wale Design

The wale will be designed for the compressive load resulting from the diagonal component of the tierods. Additionally, this connection will be eccentric and therefore also needs to be designed for benidng moment resulting from this eccentiaty. To analyze the load demand of the wale, a STAAD model was built. The load inputs are computed below. The STAAD report is provided at the end of this calculation.

Point Load (Typ Pile): $P_1 := \omega_{wale} \div LF_{wale} \cdot s_{kp} = 295.7 \cdot kip$

Point Load (Corner Pile): $P_2 := 0.5 \cdot P_1 = 147.9 \cdot kip$

Connection Eccentricity: (CL Wale to Ctr Br PL) $e := 24in$

Moment (Typ Pile): $M_1 := P_1 \cdot e = 591.5 \cdot kip \cdot ft$

Moment (Corner Pile): $M_2 := P_2 \cdot e = 295.7 \cdot kip \cdot ft$

STAAD Results

Max Axial Compression: $P_{max} := 2024kip$

Max Moment: $M_{max} := 321.2kip \cdot ft$

Member Capacity Check

Tekla Tedds is used to check the capacity of the wale for combined axial load and bending. The calculation is provided on the following pages. The wale consists of (3) HSS 16"x16"x3/4" spaced vertically at 24-inch on-center. The design input loads are therefore as follows:

Number of Wales: $No_{wale} := 3$

Design Axial Compression: $P_{dsgn\_HSS} := P_{max} \cdot LF_{wale} \div No_{wale} = 877 \cdot kip$

Design Moment: $M_{dsgn\_HSS} := M_{max} \cdot LF_{wale} \div No_{wale} = 139\,ft \cdot kip$

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Tekla Tedds GEI Consultants, Inc 124 Grove Street, Suite 300 Franklin, MA, 02038	Project				Job Ref.	
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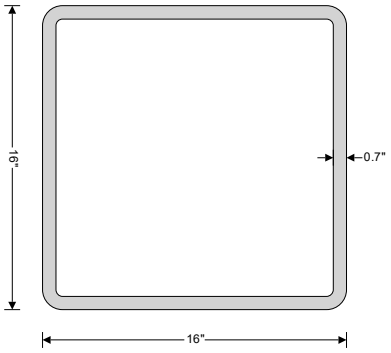
STEEL COLUMN DESIGN

In accordance with AISC360-10 and the ASD method

Tedds calculation version 1.0.10



Column and loading details

Column details

Column section	**HSS 16x16x3/4**

Design loading

Required axial strength	P_r = **877** kips (Compression)
Moment about x axis at end 1	M_{x1} = **139.2** kips_ft
Moment about x axis at end 2	M_{x2} = **139.2** kips_ft
	Single curvature bending about x axis
Maximum moment about x axis	M_x = max(abs(M_{x1}), abs(M_{x2})) = **139.2** kips_ft
Moment about y axis at end 1	M_{y1} = **0.0** kips_ft
Moment about y axis at end 2	M_{y2} = **0.0** kips_ft
Maximum moment about y axis	M_y = max(abs(M_{y1}), abs(M_{y2})) = **0.0** kips_ft
Maximum shear force parallel to y axis	V_{ry} = **26.8** kips
Maximum shear force parallel to x axis	V_{rx} = **0.0** kips

Material details

Steel grade	**A500 Gr. C**
Yield strength	F_y = **50** ksi
Ultimate strength	F_u = **62** ksi
Modulus of elasticity	E = **29000** ksi
Shear modulus of elasticity	G = **11200** ksi

Unbraced lengths

For buckling about x axis	L_x = **112** in
For buckling about y axis	L_y = **112** in
For torsional buckling	L_z = **112** in

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Tekla Tedds
GEI Consultants, Inc
124 Grove Street, Suite 300
Franklin, MA, 02038

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Effective length factors

For buckling about x axis	K_x = **0.65**
For buckling about y axis	K_y = **0.65**
For torsional buckling	K_z = **0.50**

Section classification

Section classification for local buckling (cl. B4)

Critical flange width	$b = b_f - 3 \times t$ = **13.906** in
Critical web width	$h = d - 3 \times t$ = **13.906** in
Width to thickness ratio of flange (compression)	$\lambda_{f\_c} = b / t$ = **19.923**
Width to thickness ratio of web (compression)	$\lambda_{w\_c} = h / t$ = **19.923**
Width to thickness ratio of flange (major flexure)	$\lambda_{f\_fx} = b / t$ = **19.923**
Width to thickness ratio of web (major flexure)	$\lambda_{w\_fx} = h / t$ = **19.923**
Width to thickness ratio of flange (minor flexure)	$\lambda_{f\_fy} = h / t$ = **19.923**
Width to thickness ratio of web (minor flexure)	$\lambda_{w\_fy} = b / t$ = **19.923**

Compression

Limit for nonslender section	$\lambda_{r\_c} = 1.40 \times \sqrt{(E / F_y)}$ = **33.716**

The section is nonslender in compression

Flexure

Limit for compact flange	$\lambda_{pf\_f} = 1.12 \times \sqrt{(E / F_y)}$ = **26.973**
Limit for noncompact flange	$\lambda_{rf\_f} = 1.40 \times \sqrt{(E / F_y)}$ = **33.716**
Limit for compact web	$\lambda_{pw\_f} = 2.42 \times \sqrt{(E / F_y)}$ = **58.281**
Limit for noncompact web	$\lambda_{rw\_f} = 5.70 \times \sqrt{(E / F_y)}$ = **137.274**

The section is compact in flexure about the major axis

Slenderness

Member slenderness

Slenderness ratio about x axis	$SR_x = K_x \times L_x / r_x$ = **11.7**
Slenderness ratio about y axis	$SR_y = K_y \times L_y / r_y$ = **11.7**

Second order effects

Second order effects for bending about y axis (cl. C2.1b)

Second order effects are already included or do not need to be considered therefore:-

P-δ amplifier	$B_{1x} = B_{1y}$ = **1.0**
Required flexural strength (x axis)	$M_{rx} = B_{1x} \times M_x$ = **139.2** kips_ft
Required flexural strength (y axis)	$M_{ry} = B_{1y} \times M_y$ = **0.0** kips_ft

Design of members for shear parallel to y axis - Chapter G

Required shear strength	V_{ry} = **26.800** kips
Web area	$A_w = 2 \times (d - 3 \times t) \times t$ = **19.413** in^2
Web plate buckling coefficient	k_v = **5**
Web shear coefficient - eq G2-3	C_v = **1**
Nominal shear strength – eq G2-1	$V_{ny} = 0.6 \times F_y \times A_w \times C_v$ = **582.383** kips

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Subject	Supplement to Wale and Connection Design					

Tekla Tedds
GEI Consultants, Inc
124 Grove Street, Suite 300
Franklin, MA, 02038

Project				Job Ref.	
Section				Sheet no./rev. 3	
Calc. by A	Date 10/22/2024	Chk'd by	Date	App'd by	Date

Safety factor for shear Ω_v = **1.67**

Allowable shear strength $V_{cy} = V_{ny} / \Omega_v$ = **348.733** kips

Reduction factor for slender elements

Reduction factor for slender elements (E7)

The section does not contain any slender elements therefore:-

Slender element reduction factor Q = **1.0**

Compressive strength

Flexural buckling about x axis (cl. E3)

Elastic critical buckling stress $F_{ex} = (\pi^2 \times E) / (SR_x)^2$ = **2084.1** ksi

Reduction factor $Q_x = Q$ = **1.000**

Flexural buckling stress about x axis $F_{crx} = Q_x \times (0.658^{Qx \times Fy/Fex}) \times F_y$ = **49.5** ksi

Nominal flexural buckling strength $P_{nx} = F_{crx} \times A_g$ = **2054.3** kips

Flexural buckling about y axis (cl. E3)

Elastic critical buckling stress $F_{ey} = (\pi^2 \times E) / (SR_y)^2$ = **2084.1** ksi

Reduction factor $Q_y = Q$ = **1.000**

Flexural buckling stress about y axis $F_{cry} = Q_y \times (0.658^{Qy \times Fy/Fey}) \times F_y$ = **49.5** ksi

Nominal flexural buckling strength $P_{ny} = F_{cry} \times A_g$ = **2054.3** kips

Allowable compressive strength (cl. E1)

Safety factor for compression Ω_c = **1.67**

Allowable compressive strength $P_c = \min(P_{nx}, P_{ny}) / \Omega_c$ = **1230.1** kips

PASS - The allowable compressive strength exceeds the required compressive strength

Flexural strength about the major axis

Yielding (cl. F7.1)

Nominal flexural strength $M_{nx\_yld} = M_{px} = F_y \times Z_x$ = **979.2** kips_ft

Allowable flexural strength about the major axis (cl. F1)

Safety factor for flexure Ω_b = **1.67**

Allowable flexural strength $M_{cx} = \min(M_{nx\_yld}) / \Omega_b$ = **586.327** kip_ft

PASS - The allowable flexural strength about the major axis exceeds the required flexural strength

Library item - Design flex str ASD x RHS**Combined forces**

Member utilization (cl. H1.1)

Equation H1-1a $UR = abs(P_r) / P_c + 8 / 9 \times (M_{rx} / M_{cx} + M_{ry} / M_{cy})$ = **0.924**

PASS - The member is adequate for the combined forces

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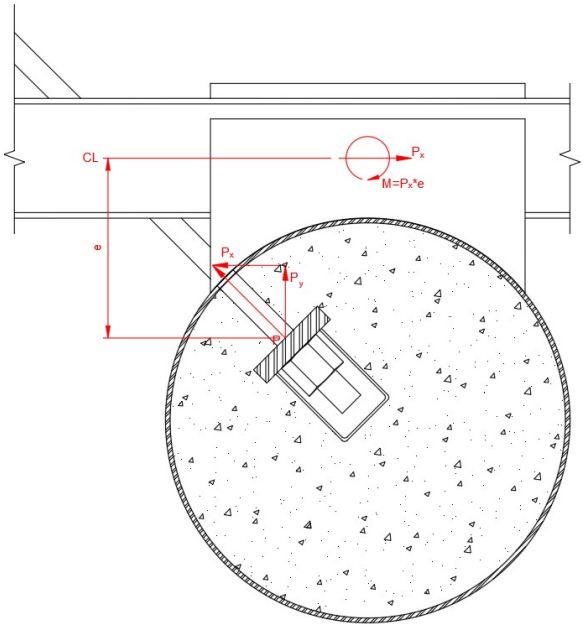
Wale / King Pile Connection Design



Total Connection Shear: $V_{conn} := P_1 \cdot LF_{conn} = 384.5 \cdot kip$

Total Connection Moment: $M_{conn} := P_1 \cdot e \cdot LF_{conn} = 768.9 \cdot kip \cdot ft$

Number of Connection Plates: (Per Wale) $No_{conn\_PL} := 2$

Design Shear: $V_{dsgn\_conn} := V_{conn} \div \left(No_{wale} \cdot No_{conn\_PL}\right) = 64.1 \cdot kip$

Design Moment: $M_{dsgn\_conn} := M_{conn} \div \left(No_{wale} \cdot No_{conn\_PL}\right) = 128.15 \cdot kip \cdot ft$

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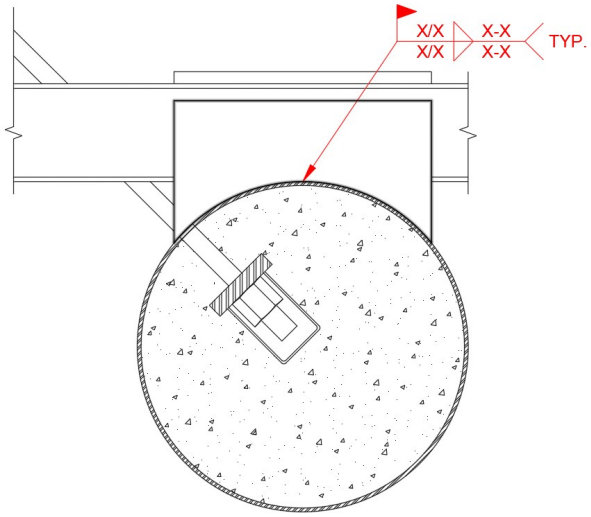
Size Connection Plate Between King Pile and Wale



Connection Plate Length: $L_{conn\_PL} := 42in$

Connection Plate Thickness: $t_{conn\_PL} := 0.75in$

Safety Factor for Flexure/Shear: $\Omega := 1.67$

Safety Factor for Welds: $\Omega_w = 2.00$

Elastic Section Modulus: $S_x := t_{conn\_PL} \cdot L_{conn\_PL}^2 \div 6 = 220.5 \cdot in^3$

Allowable Moment: $M_a := F_y \cdot S_x \div \Omega = 550.1 \cdot kip \cdot ft$

$> M_{dsgn\_conn} = 128.2 \cdot kip \cdot ft$

Allowable Shear: $V_a := 0.6 \cdot F_y \cdot L_{conn\_PL} \cdot t_{conn\_PL} \div \Omega = 565.9 \cdot kip$

$> V_{dsgn\_conn} = 64.1 \cdot kip$

Weld Length: $l_w := 2 \cdot L_{conn\_PL} = 84.0 \cdot in$

Weld Section Modulus: $S_w := L_{conn\_PL}^2 \div 3 = 588.0 \cdot in^2$

Weld Force: (Per inch) $r_w := \frac{V_{dsgn\_conn}}{l_w} + \frac{M_{dsgn\_conn}}{S_w} = 3.38 \cdot \frac{kip}{in}$

Weld Size: $t_{weld} := \frac{5}{16} in$

Nominal Weld Strength (per inch): $R_n := 0.60 \cdot F_{EXX} \cdot \left(\frac{\sqrt{2}}{2}\right) \cdot t_{weld} = 9.28 \cdot \frac{kip}{in}$

Allowable Weld Strength (per in): $R_a := R_n \div \Omega_w = 4.64 \cdot \frac{kip}{in}$

$> r_w = 3.38 \cdot \frac{kip}{in}$

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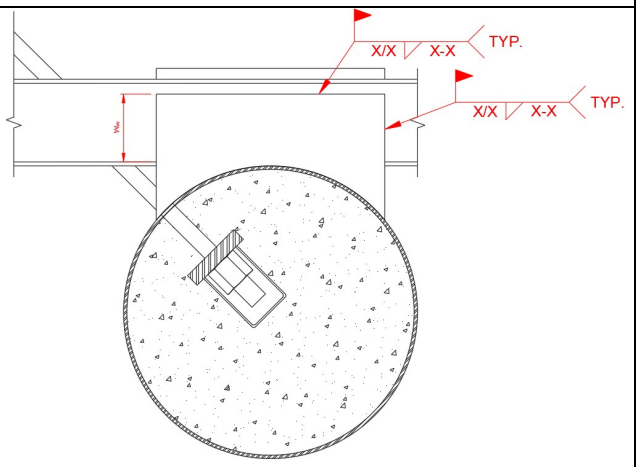
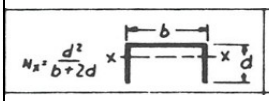
Size Weld Between Connection Plate and Wale



Minimum Weld Width: $w_w := 9in$

Design Torsion: $T_w := M_{dsgn\_conn}$

$T_w = 128.15 \cdot kip \cdot ft$



$S_w = \underset{top}{\frac{2bd + d^2}{3}} = \underset{bottom}{\frac{d^2(2b + d)}{3\,(b + d)}}$

$J_w = \frac{(b+2d)^3}{12} - \frac{d^2(b+d)^2}{(b + 2d)}$

Distance from top of weld to X-Axis: $N_{x1} := \frac{w_w^{\,2}}{\left(2 \cdot L_{conn\_PL} + w_w\right)} = 0.87 \cdot in$

Distance from bot of weld to X-Axis: $N_{x2} := w_w - N_{x1} = 8.13 \cdot in$

Max Distance from centroid to tip of weld: $c := \sqrt{\max\left(N_{x1}, N_{x2}\right)^2 + 0.5 \cdot L_{conn\_PL}^{\,2}} = 30.79 \cdot in$

Weld Length: $l_w := L_{conn\_PL} + 2 \cdot w_w = 60.0 \cdot in$

Weld Polar Moment of Inertia: $J_w := \frac{\left(L_{conn\_PL} + 2 \cdot w_w\right)^3}{12} - \frac{w_w^{\,2} \cdot \left(L_{conn\_PL} + w_w\right)^2}{\left(L_{conn\_PL} + 2 \cdot w_w\right)} = 14488.7 \cdot in^3$

Weld Force: (Per inch) $r_w := \frac{V_{dsgn\_conn}}{l_w} + \frac{T_w \cdot c}{J_w} = 4.34 \cdot \frac{kip}{in}$

Weld Size: $t_{weld} := \frac{5}{16} in$

Nominal Weld Strength (per inch): $R_n := 0.60 \cdot F_{EXX} \cdot \left(\frac{\sqrt{2}}{2}\right) \cdot t_{weld} = 9.28 \cdot \frac{kip}{in}$

Allowable Weld Strength (per in): $R_a := R_n \div \Omega_w = 4.64 \cdot \frac{kip}{in}$

$> r_w = 4.34 \cdot \frac{kip}{in}$

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Size Welds At Interlocks:

The analysis to assess the stability of the wall assumes the wall acts as a rigid structure (i.e. diaphragm). To prevet racking of the wall (slipage at the interlocks), the interlocks will be welded. This calculation determines the required weld lengths and sizes.

King Pile Diameter: $D_{kp} := 54in$

King Pile Wall Thickness: $t_{kp} := 0.625in$

NZ 19 SSP Iy: $I_{y\text{-}y\_NZ19} := 1186614in^4$

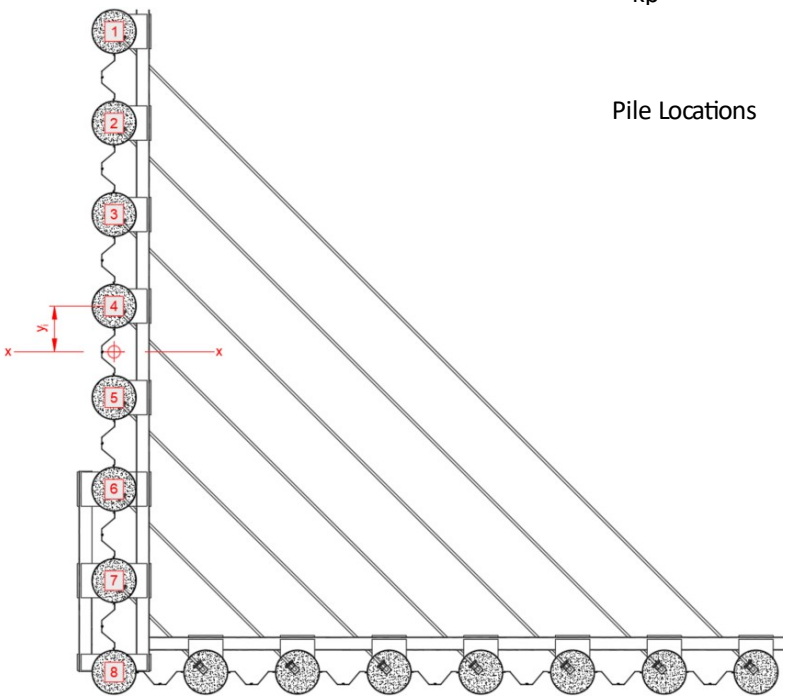
Computed in AutoCAD

Area of NZ19 SSP: $A_{NZ19} := 32.73in^2$

System Width: $w_{sys} := 9.3ft$

Moment of Inertia of King Pile: $I_{kp} := \pi \cdot \left[\frac{D_{kp}^4 - \left(D_{kp} - 2t_{kp}\right)^4}{64} \right] = 37326 \cdot in^4$

Cross Sectional Area of King Pile: $A_{kp} := 0.25 \cdot \pi \cdot \left[D_{kp}^2 - \left(D_{kp} - 2 \cdot t_{kp}\right)^2 \right] = 104.80 \cdot in^2$



Pile Locations

$y_{1\_KP} := 3.5 \cdot w_{sys} = 32.55\,ft$

$y_{1\_SSP} := 3.0 \cdot w_{sys} = 27.90\,ft$

$y_{2\_KP} := 2.5 \cdot w_{sys} = 23.25\,ft$

$y_{2\_SSP} := 2.0 \cdot w_{sys} = 18.60\,ft$

$y_{3\_KP} := 1.5 \cdot w_{sys} = 13.95\,ft$

$y_{3\_SSP} := 1.0 \cdot w_{sys} = 9.30\,ft$

$y_{4\_KP} := 0.5 \cdot w_{sys} = 4.65\,ft$

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Moment of Inertia of Wall:

Compute Moment of Inertia of Wall based on Parallel Axis Theorem

$$I_{wall} := 2\cdot\left[\begin{array}{l} 4\cdot I_{kp} + A_{kp}\cdot\left(y_{1\_KP}^{\ 2} + y_{2\_KP}^{\ 2} + y_{3\_KP}^{\ 2} + y_{4\_KP}^{\ 2}\right) \cdots \\ +\ 3\cdot I_{y\text{-}y\_NZ19} + A_{NZ19}\cdot\left(y_{1\_SSP}^{\ 2} + y_{2\_SSP}^{\ 2} + y_{3\_SSP}^{\ 2}\right) \end{array}\right]$$

$$I_{wall} = 73652961\cdot in^4$$

1st Moment of Inertia: $Q := A_{kp}\cdot\left(y_{1\_KP} - 0.5\cdot D_{kp}\right) = 38106\cdot in^3$

This is the outermost king pile relative to the wall centroid.

Shear Flow: $q := \dfrac{P_{max}\cdot Q}{I_{wall}} = 1.05\cdot\dfrac{kip}{in}$

Shear Flow is computed at the mostly highly stressed interlocks

Total Interlock Shear: $V_{lock} := q\cdot(584ft - 540ft) = 553\cdot kip$

Assume constant shear force from Tieback Elev. (584ft) to tip of sheet piles (El. 540ft)

Weld Length (Total - 2 sides): $l_w := 10ft$

Weld Force: (Per inch) $r_w := \dfrac{V_{lock}}{l_w} = 4.61\cdot\dfrac{kip}{in}$

Weld Size: $t_{weld} := \dfrac{5}{16}in$

Nominal Weld Strength (per inch): $R_n := 0.60\cdot F_{EXX}\cdot\left(\dfrac{\sqrt{2}}{2}\right)\cdot t_{weld} = 9.28\cdot\dfrac{kip}{in}$

Allowable Weld Strength (per in): $R_a := R_n \div \Omega_w = 4.64\cdot\dfrac{kip}{in}$

$> r_w = 4.61\cdot\dfrac{kip}{in}$

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APPENDIX B: BORINGS CONSIDERED FOR DOCK WALL ANALYSIS

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-2-22**

ARCHITECT-ENGINEER

LOCATION:

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³	UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5) / PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50) / STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)
					SURFACE ELEVATION (ft.) 584.7** EL. 580.3		
El. 580.3					Water from 0.0 to 5.5 feet		
580							
El. 574.8	1	SS			5.5 Dark gray silty fine sand (SP) - trace organics - wet - very loose		WoH
10	2	SS			9.0 Black organic silt (OL) - trace gravel - wet - very loose		WoH 117.9
570	3	SS			15.0 Gray fine silty sand (SM) - trace gravel - wet - very loose SEDIMENT		WoH
20	4	SS			20.0 Black clayey silt (ML) - wet - very loose **Vane Shear Test with vane tip at 28.0 feet** **Peak S_u = 2800 psf -- Remolded S_u = 425 psf**		1 75.3
560	5	SS					WoH 99.7
30							
El. 547.3	ST #1	ST			33.0 Brown silty clay (CL) - very stiff to stiff **Specific Gravity = 2.732** **Consolidation Test:** **P_c = 3.3 tsf** **C_c = 0.251** **C_{cr} = 0.064** CLAY I	100.5	3.25
550	6	SS					12 2

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **8/1/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **8/4/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,877.670** EASTING **102,285.623**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **1** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

** Based on the field logs; the "Surface Elevation" corresponds to the barge deck which is approximately 2' above the waterline; Reported elevations are incorrect. Mudline = 580.3' - 5.5' = 574.8'; See pages following boring for water level data during drilling

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-2-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

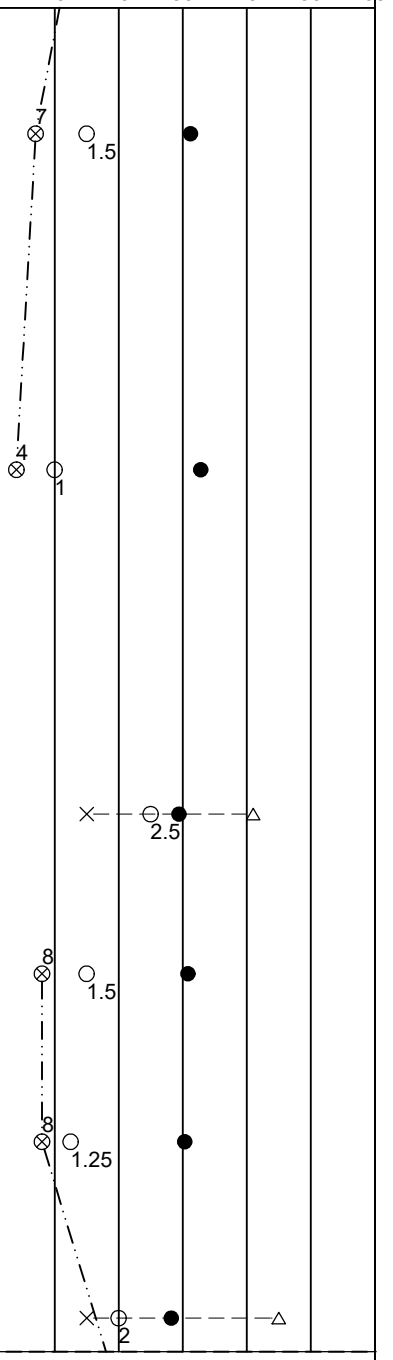
SURFACE ELEVATION (ft.) 584.7

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
	7	SS		CLAY I	
El. 532.3				Vane Shear Test with vane tip at 48.0 feet Peak S_u = 1175 psf -- Remolded S_u = 450 psf	
	8	SS		CLAY IIA	
				Vane Shear Test with vane tip at 58.0 feet Peak S_u = 1675 psf -- Remolded S_u = 550 psf	
El. 517.3	ST #2	ST		Specific Gravity = 2.738 Consolidation Test: P_c = 4.1 tsf C_c = 0.409 C_{cr} = 0.090	92.5
	9	SS		CLAY III	
	10	SS			
	ST#3	ST		78.0 Reddish brown clay (CH) - thin silt and sand seams noted - very stiff	76.6

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **8/1/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **8/4/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
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MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-2-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.7

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
					Consolidation Test: P_c = 6.7 tsf, C_c = 0.800, C_{cr} = 0.760 — CLAY III
El. 497.3	11	SS			83.0 Brown sandy silt (ML) - wet - medium dense
500					
	12	SS			88.0 Brown fine silty sand (SM) - wet - dense
490	13	SS			93.0 Gray coarse gravel (GP) with sand - wet - dense to very dense — HARDPAN
	14	SS			
480	15	SS			103.0 Gray clayey gravel (GC) - wet - very dense
	16	SS			
470	17	SS			
	18	SS			

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2 (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

UNIT DRY WT. LBS/FT^3

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)

24 34 44 50/0.1 93 38 48 52

2.5 2.5

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED 8/1/2022	GEI OFFICE Green Bay, WI	
	BORING COMPLETED 8/4/2022	ENTERED BY AKL	APPROVED BY SN
NORTHING 576,877.670 / EASTING 102,285.623	RIG/FOREMAN D-120 / DM	GEI PROJECT NO. 2201593	PAGE NO. 3 OF 4

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-2-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.7

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
El. 455	19	SS			HARDPAN	
460	Run 1	CORE			124.5 Gray fine grained dolomite (DO) - trace interbedded bluish gray shale - medium strong to strong - fresh to slightly weathered - moderately fractured - very thinly bedded - microcrystalline to fine grained Refusal at 125.5 feet, drilled one feet into rock Run # 1 — Depth ft. 126.0-131.0 — Recovery % 94 — RQD % 0 — Fracture Frequency 3-7 / ft. Run # 2 — Depth ft. 131.0-136.0 — Recovery % 99.6 — RQD % 36 — Fracture Frequency 3-5 / ft. Trace open vugs at 132.6 feet	
130	Run 2	CORE				
450						
					136.0 End of Boring Boring advanced from 5.5 to 126.0 feet with rock bit and drilling fluid HW casing to 13.0 feet Boring advanced from 126.0 to 136.0 feet with diamond bit Boring grouted with bentonite grout mix upon completion	
140						
440						
150						
430						

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² — 1 2 3 4 5

PLASTIC LIMIT (%) — WATER CONTENT (%) — LIQUID LIMIT (%) — 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT — 10 20 30 40 50 60

50/4

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **8/1/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **8/4/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,877.670** EASTING **102,285.623**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **4** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

Elevation Corrects Based on Water Level

Water Level Data from the NOAA Green Bay East, WI - Station ID: 9087077 was reviewed during the dates the Boring BW-2-22 was drilled. Water level data is presented in the IGLD85 vertical datum.

To Convert from IGLD85 to NAVD88 (project datum): IGLD85 + 0.44' = NAVD88

NOAA DATA (Green Bay East) FROM 8/1 TO 8/4 2022 (IGLD 85)
MIN: 578.88
MAX: 580.88

NAVD88
MIN: 579.32
MAX: 581.32
AVERAGE: 580.3

Approximate Mudline: 580.3' - 5.5' = 574.8' +/-1'

GEI Consultants	CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-3-22**
	PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 580.6

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT^3	○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2 (1 2 3 4 5) / PLASTIC LIMIT (%) × — WATER CONTENT (%) ● — LIQUID LIMIT (%) △ (10 20 30 40 50) / ⊗ STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)
	580					Water from 0.0 to 11.0 feet		
10	570	1	SS			11.0 Black organic silt (OL) - wet - very loose		WoH; 268.3
		2	SS			SEDIMENT		5
						14.0 Coarse sand and gravel (SP) - some organics - wet - loose		
		2a	SS			15.0 Brown silty clay (CL) - very stiff to stiff		9
20	560	3	SS			CLAY I		11; 3
		4	SS					9; 2
		ST #1	ST					2
30	550	5	SS			CLAY IIA		9; 1.5

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED 7/27/2022	GEI OFFICE Green Bay, WI	
	BORING COMPLETED 7/28/2022	ENTERED BY AKL	APPROVED BY SN
NORTHING 576,204.775 EASTING 102,016.225	RIG/FOREMAN D-120 / DM	GEI PROJECT NO. 2201593	PAGE NO. 1 OF 4

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-3-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 580.6

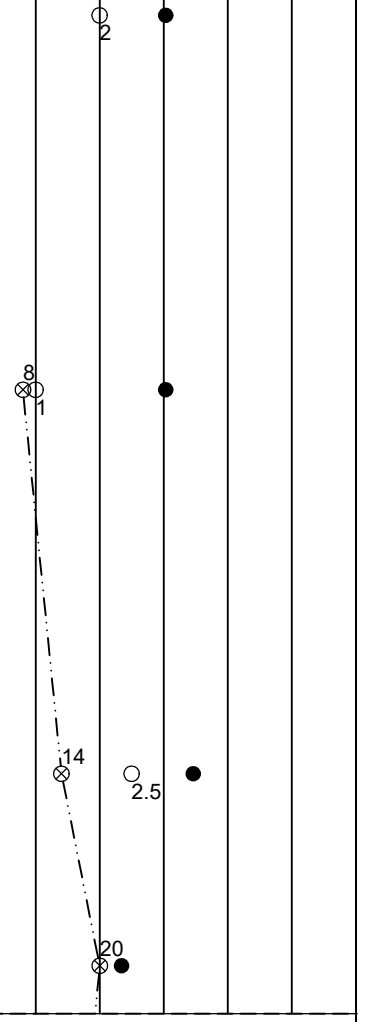
DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
40 / 540	ST #2	ST			Vane Shear Test with vane tip at 38.0 feet Peak S_u = 1,325 psf -- Remolded S_u = 525 psf
50 / 530	6	SS			Vane Shear Test with vane tip at 48.0 feet Peak S_u = 1,875 psf -- Remolded S_u = 575 psf CLAY IIA
60 / 520	7	SS			Vane Shear Test with vane tip at 58.0 feet Peak S_u = 1,575 psf -- Remolded S_u = 450 psf CLAY III
	8	SS			68.0 Brown silt (ML) - wet - medium dense

UNIT DRY WT. LBS/FT^3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2 (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/27/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/28/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,204.775** EASTING **102,016.225**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **2** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-3-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

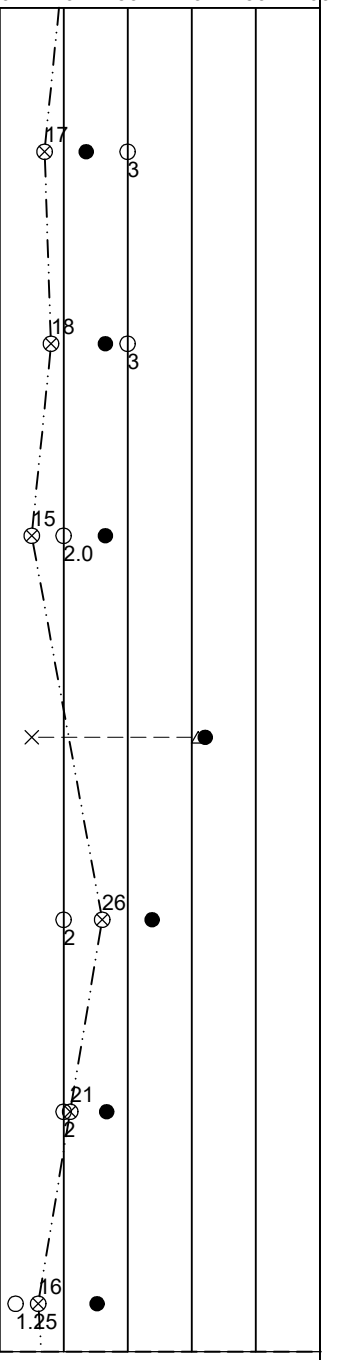
SURFACE ELEVATION (ft.) 580.6

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
510					69.5 Brown to reddish brown silty clay (CL) - trace gravel - moist - very stiff	
	9	SS				
	10	SS				
80 500						
	11	SS			CLAY III	
	ST #3	ST			**Consolidation Test:** **P_c = 4.5 tsf** **C_c = 0.465** **C_{cr} = 0.106**	80.1
90 490						
	12	SS				
	13	SS				
100 480						
	14	SS			103.0 Gray clay (CL) - trace sand - trace gravel - stiff to soft	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/27/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/28/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,204.775** EASTING **102,016.225**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **3** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-3-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

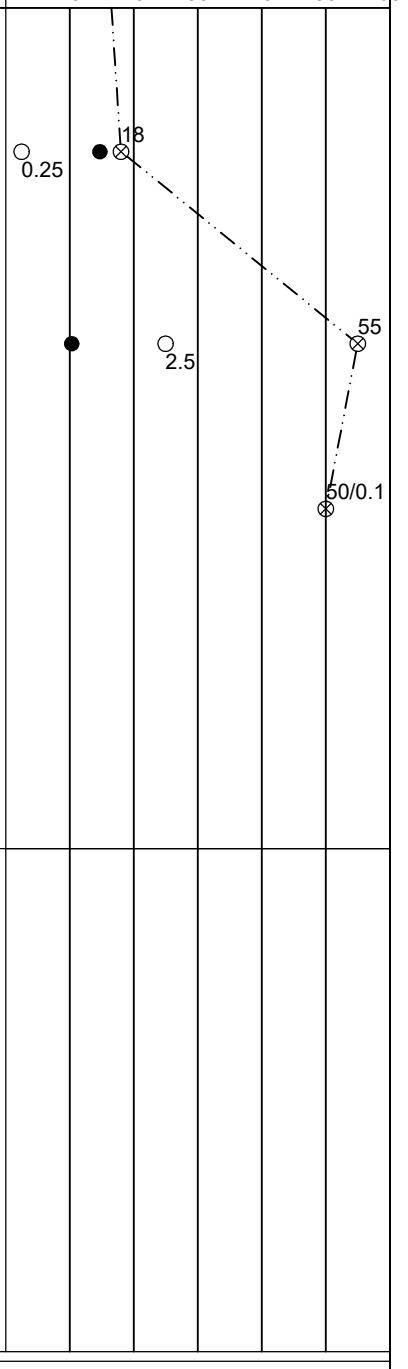
SURFACE ELEVATION (ft.) 580.6

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
		15	SS			CLAY III	
110	470					110.0 Clayey gravel (GC) - wet - very dense	
		16	SS			Note: Large gravel/cobbles while drilling HARDPAN	
		17	SS			Note: Misc. gravel/cobbles/hard drilling	
120	460					122.9 Refusal at 122.9 feet Drilled 2' into refusal, dolomite bedrock	
						124.9 End of Boring Boring advanced from 11.0 to 124.9 feet with rock bit and drilling fluid HW casing to 17.5 feet Boring grouted with bentonite grout mix upon completion	
130	450						

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) WATER CONTENT (%) LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/27/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/28/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,204.775** EASTING **102,016.225**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **4** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-4-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 580.2

DEPTH (FT) | ELEVATION (FT) | SAMPLE NO. | SAMPLE TYPE | SAMPLE DISTANCE | RECOVERY | DESCRIPTION OF MATERIAL | UNIT DRY WT. LBS/FT³

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) | WATER CONTENT (%) | LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)

580 / 570 / 560 / 550

Water from 0 to 27.5 feet

NOAA - GREEN BAY EAST,
WI BUOY
IGLD85 TO NAVD88
MAX: 580.8
MIN: 580.15
AVG: 580.5

El. 552.8
El. 551.8

1 SS

27.5 SEDIMENT

Dark brown organic silt (OL) - wet - very loose

28.0
Coarse sand (SP) - with gravel - wet - very loose

28.5
Brown silty clay (CL) - trace gravel - wet - stiff

CLAY IIA

2 SS

2 5 1

161.5

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/25/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/26/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **575,546.365** EASTING **101,809.521**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **1** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-4-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 580.2

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
40	540	ST #1	ST			CLAY IIA Vane Shear Test with vane tip at 43.0 feet Peak S_u = 1,100 psf -- Remolded S_u = 300 psf
		3	SS			
50	530					Vane Shear Test with vane tip at 53.0 feet Peak S_u = >2,525 psf CLAY III
		4	SS			58.0 Fine sand (SP) - some gravel - wet - very dense
60	520	ST #2	ST SS			
		5				
		6	SS			68.0 Brown silty clay (CL) - very stiff to stiff

El. 532.3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2: 1 2 3 4 5

PLASTIC LIMIT (%) WATER CONTENT (%) LIQUID LIMIT (%): 10 20 30 40 50

UNIT DRY WT. LBS/FT^3

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50 60

1.5 15 3.0 56 50/2" 9 2.5

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/25/2022**	GEI OFFICE **Green Bay, WI**
	BORING COMPLETED **7/26/2022**	ENTERED BY **AKL** / APPROVED BY **SN**
NORTHING **575,546.365** EASTING **101,809.521**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-4-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

DEPTH (FT) | ELEVATION (FT) | SAMPLE NO. | SAMPLE TYPE | SAMPLE DISTANCE | RECOVERY | DESCRIPTION OF MATERIAL | UNIT DRY WT. LBS/FT³

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) | WATER CONTENT (%) | LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)

SURFACE ELEVATION (ft.) 580.2

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³	UNCONFINED COMPRESSIVE STRENGTH TONS/FT²	PLASTIC LIMIT (%)	WATER CONTENT (%)	LIQUID LIMIT (%)	STANDARD PENETRATION BLOWS/FT
	510											
		7	SS									11
		8	SS									13
80	500											
		9	SS									10
		ST #3	ST			Specific Gravity = 2.759		2.5				
90	490											
El. 532.3		10	SS			93.0 Dark brown to gray silty clay (CL) - firm						8
		11	SS			CLAY IIA						6
100	480											
		12	SS									WoH

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/25/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/26/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **575,546.365** EASTING **101,809.521**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **3** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BW-4-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 580.2

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
		13	SS			CLAY IIA
110	470					Note: Gravel while drilling 111.5 to 113.0 feet
		14	SS			Fine gray sandy silt (ML) - wet - very dense
						114.0
						HARDPAN
		15	SS			Note: Very dense drilling from 119.0-122.3 feet Practical refusal at 124.3 feet
120	460					
130	450					124.3 End of Boring Boring advanced from 27.5 to 124.3 feet with rock bit and drilling fluid HW casing driven to 37.5 feet Boring grouted with bentonite grout mix upon completion

El. 471

El. 456

UNIT DRY WT. LBS/FT^3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2
1 2 3 4 5

PLASTIC LIMIT (%) WATER CONTENT (%) LIQUID LIMIT (%)
10 20 30 40 50

STANDARD PENETRATION BLOWS/FT
10 20 30 40 50 60

WoH
1
67/6"
66/6"

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/25/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **7/26/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **575,546.365** EASTING **101,809.521**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**	PAGE NO. **4** OF **4**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BW-5-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.7

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
					Water from 0.0 to 15.0 feet	
El. 569.7	1	SS			15.0 Black organic s SEDIMENT ose	
El. 567.7	2	SS			17.0 Brown silty clay (CL) - stiff to very stiff CLAY I	
	3	SS				
	4	SS				
	5	SS				
El. 559.7					25.0 End of Boring Boring advanced from 15.0 to 25 feet with rock bit and drilling fluid HW casing driven to 22.5 feet Boring grouted with bentonite grout mix upon completion	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)

WoH, 4, 8, 10, 18

1.5, 2.5, 4

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **7/29/2022**	GEI OFFICE **Green Bay, WI**
	BORING COMPLETED **7/29/2022**	ENTERED BY **AKL** / APPROVED BY **SN**
NORTHING **576,345.745** EASTING **102,237.710**	RIG/FOREMAN **D-120 / DM**	GEI PROJECT NO. **2201593**
		PAGE NO. **1** OF **1**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

Port Property Developement
(Green Bay,WI)
Project Number :2201593

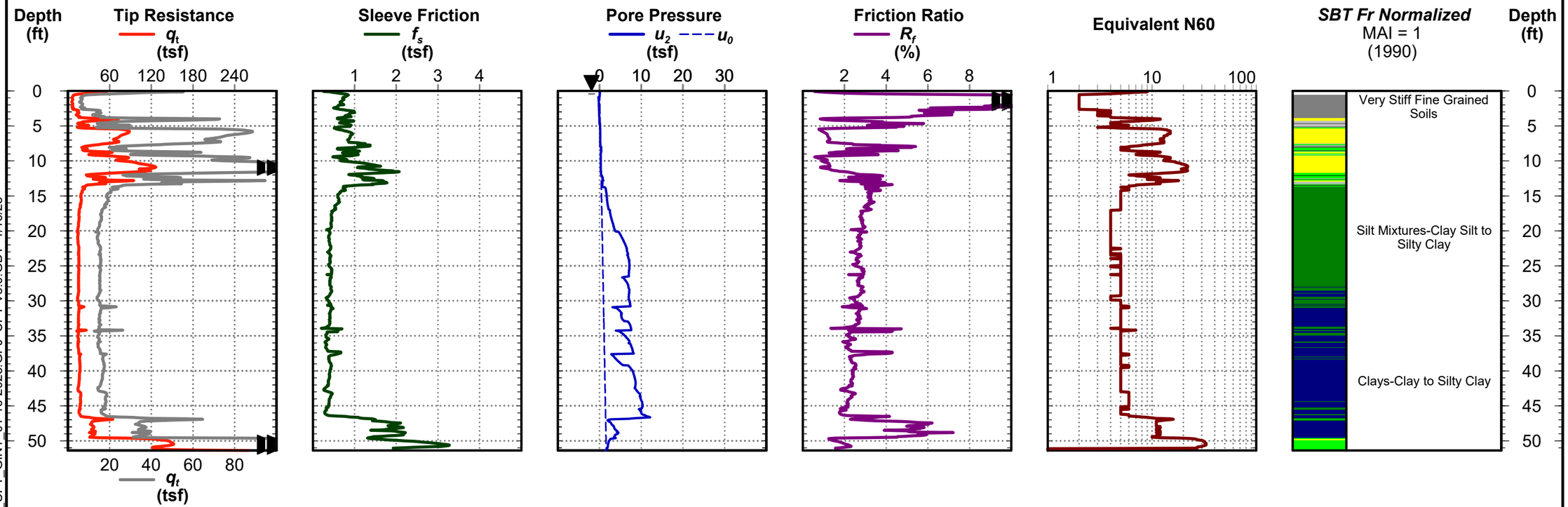
Cone Penetration Test

CPT 12-22

Date: Jan. 10, 2023
Estimated Water Depth: 0 ft
Rig/Operator: CAP

Northing: 263578.7
Easting: 2488155.8
Elevation:

Total Depth: 51.4 ft
Termination Criteria: Target



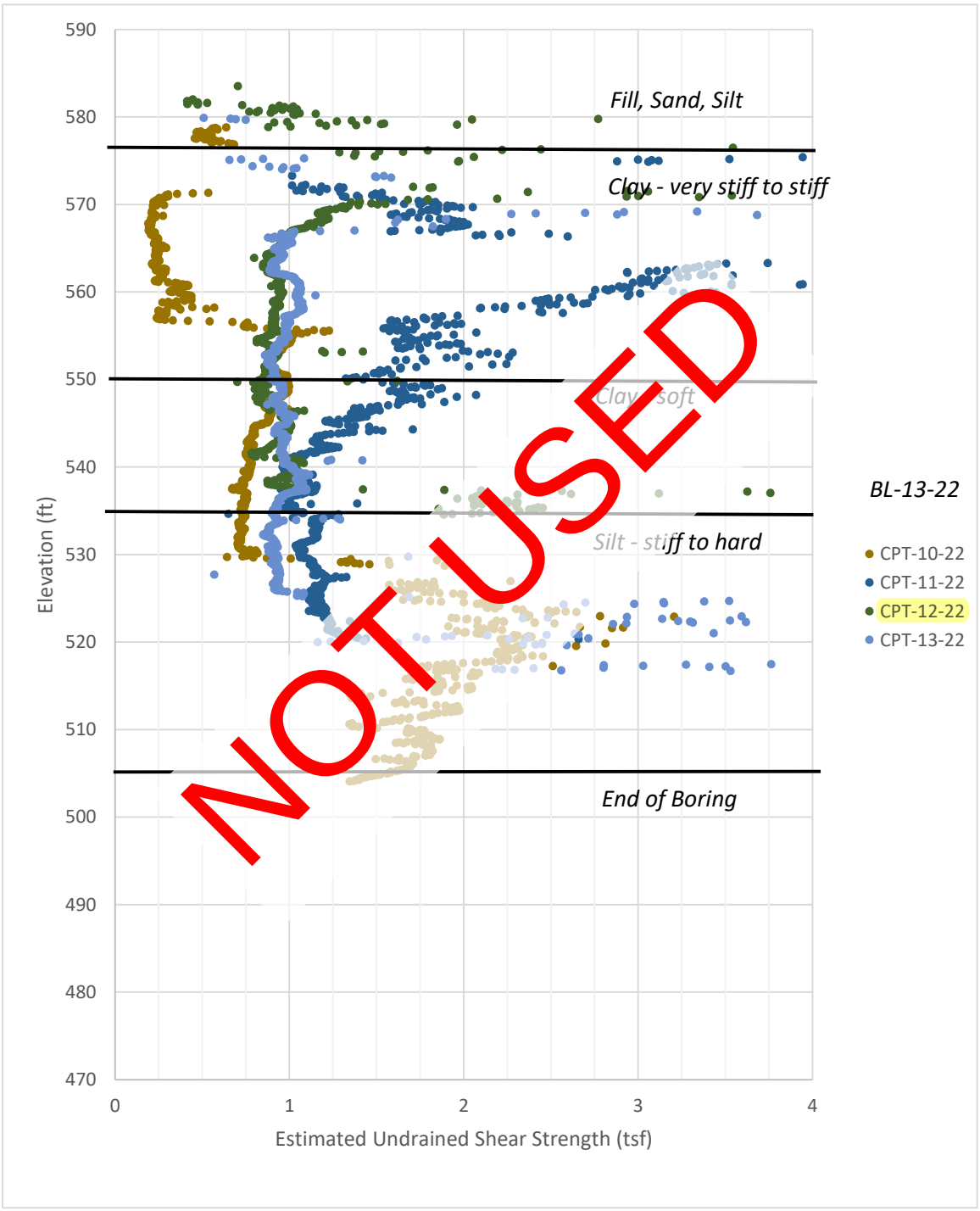
1 - Sensitive, Fine Grained Soils
2 - Organic Soils, Peats
3 - Clays-Clay to Silty Clay
4 - Silt Mixtures-Clay Silt to Silty Clay
5 - Sand Mixtures-Silty Sand to Sandy Silt
6 - Sands-Clean Sand to Silty Sand
7 - Gravelly Sand to Sand
8 - Very Stiff Clay to Clayey Sand
9 - Very Stiff Fine Grained Soils

CPT 12-22

Electronic File Name: CPT 12-22.cpt

CPT REPORT - DYNAMIC GEI_2201593_PORT PROPERTY DEVELOPEMENT_CPT_GINT_01-16-2023.GPJ CPT V3.0.GDT 1/16/23

GEI Consultants	**Client**	Brown County				**Page**	16 of 16
	Project	Port Property Redevelopment				**Pg. Rev.**	
	By		**Chk.**			**App.**	
	Date		**Date**			**Date**	
GEI Project No.	2201593	**Document No.**	Geotechnical Data Report - Appendix A.3				
Subject	CPTu Undrained Shear Strength Profile Estimations						



GEI Consultants

CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BL-14-22**
PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

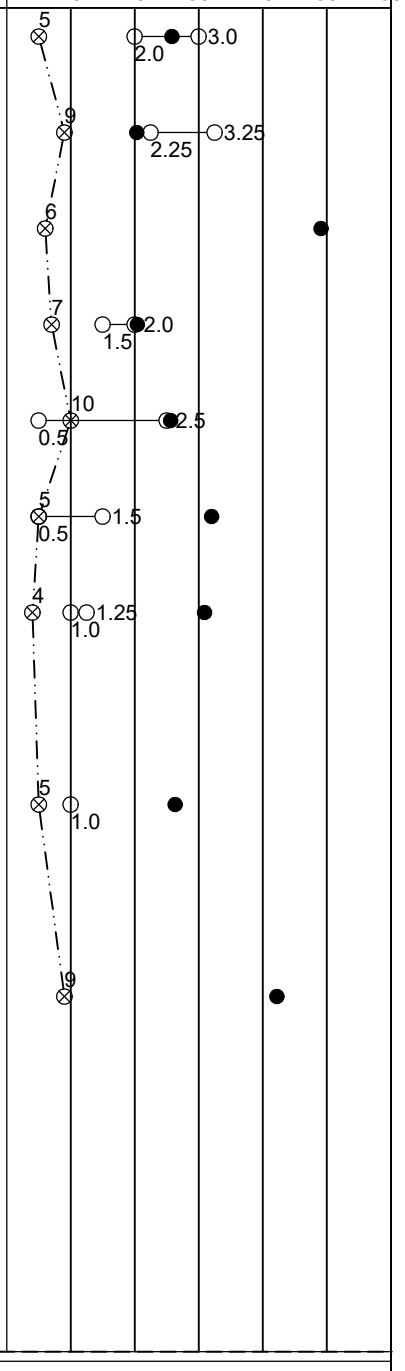
LOCATION:

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
					SURFACE ELEVATION (ft.) 584.0	
580	1	SS			Fill: Brown silty clay (CL) - some coal - little gravel - very stiff EXISTING FILL	
579.0 ▼	2	SS				
	3	SS			5.0 Gray silty fine sand (SM) - little organics - wet - loose	
	4	SS			7.0 Reddish brown silty clay (CL) - trace gravel - very stiff to stiff CLAY I	
10	5	SS				
570	6	SS				
	7	SS				
20	8	SS			20.0 Reddish brown silty clay (CL) - trace gravel - firm to soft CLAY II	
560	9	SS				
30	10	ST				
550						

UNCONFINED COMPRESSIVE STRENGTH TONS/FT² (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

⊗ STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 5.0 ft BCI Avg Lake Level during drilling = 579.4' (12/31/2022 & 1/13/2023) ~ 0.4' lower than lake level	BORING STARTED **12/30/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **1/13/2023**	ENTERED BY **CAH**	APPROVED BY **SN**
NORTHING **575,843.210** EASTING **101,759.370**	RIG/FOREMAN **D-120 / DJM**	GEI PROJECT NO. **2201593**	PAGE NO. **1** OF **3**

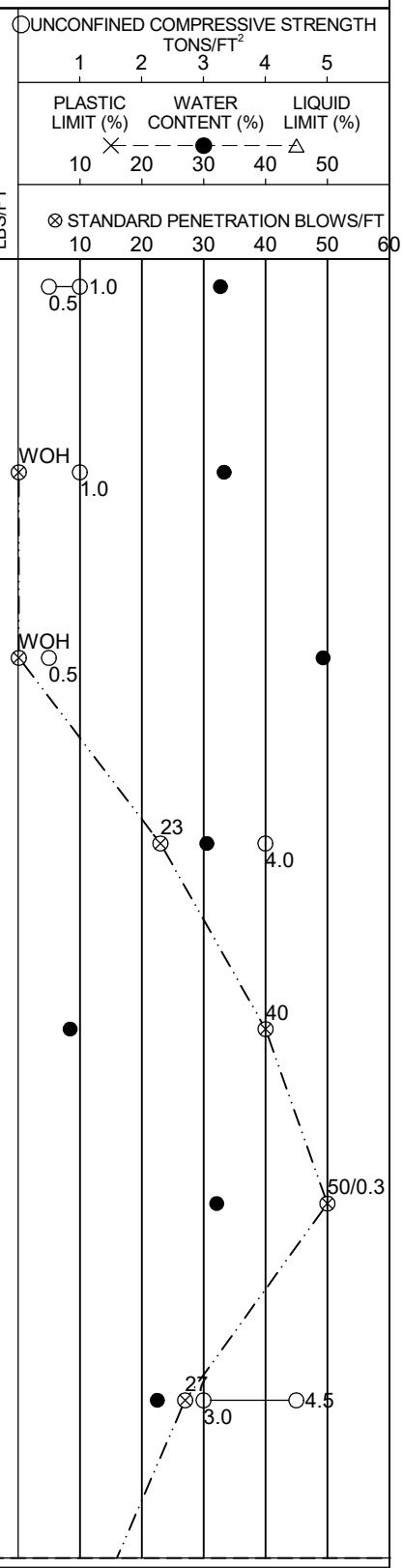
MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants	CLIENT: **Brown County Purchasing**	LOG OF BORING NUMBER **BL-14-22**
	PROJECT NAME: **Port Property Developments**	ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.0

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
		11	SS			CLAY II	
40		12	SS				
	540	13	SS				
50		14	SS			49.0 Reddish brown silty clay (CL) - silt varves - some gravel - very stiff to hard	
	530	15	SS			CLAY III	
60		16	SS				
	520	17	SS				



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 5.0 ft BCI	BORING STARTED 12/30/2022	GEI OFFICE Green Bay, WI	
	BORING COMPLETED 1/13/2023	ENTERED BY CAH	APPROVED BY SN
NORTHING 575,843.210 EASTING 101,759.370	RIG/FOREMAN D-120 / DJM	GEI PROJECT NO. 2201593	PAGE NO. 2 OF 3

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

LOG OF BORING NUMBER **BL-14-22**

PROJECT NAME: **Port Property Developments**

ARCHITECT-ENGINEER

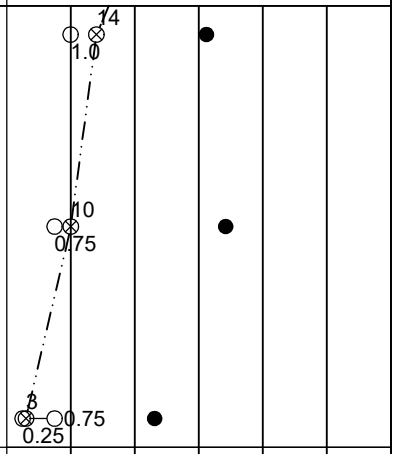
LOCATION:

DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³
SURFACE ELEVATION (ft.) 584.0						
	18	SS			70.0 Reddish brown silty clay (CL) - trace gravel - stiff to firm	
510						
	19	SS				
80	20	SS			80.0 End of Boring at 80.0 feet Boring advanced 0-7.5 feet with solid stem auger Boring advanced 7.5-80.0 feet with roller bit and drilling fluid HW casing driven to 9.0 feet Boring abandoned with bentonite grout and bentonite chips	
500						
90						
490						
100						
480						

UNCONFINED COMPRESSIVE STRENGTH TONS/FT²: 1 2 3 4 5

PLASTIC LIMIT (%) WATER CONTENT (%) LIQUID LIMIT (%): 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50 60



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 5.0 ft BCI	BORING STARTED **12/30/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **1/13/2023**	ENTERED BY **CAH**	APPROVED BY **SN**
NORTHING **575,843.210** EASTING **101,759.370**	RIG/FOREMAN **D-120 / DJM**	GEI PROJECT NO. **2201593**	PAGE NO. **3** OF **3**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BL-15-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.8

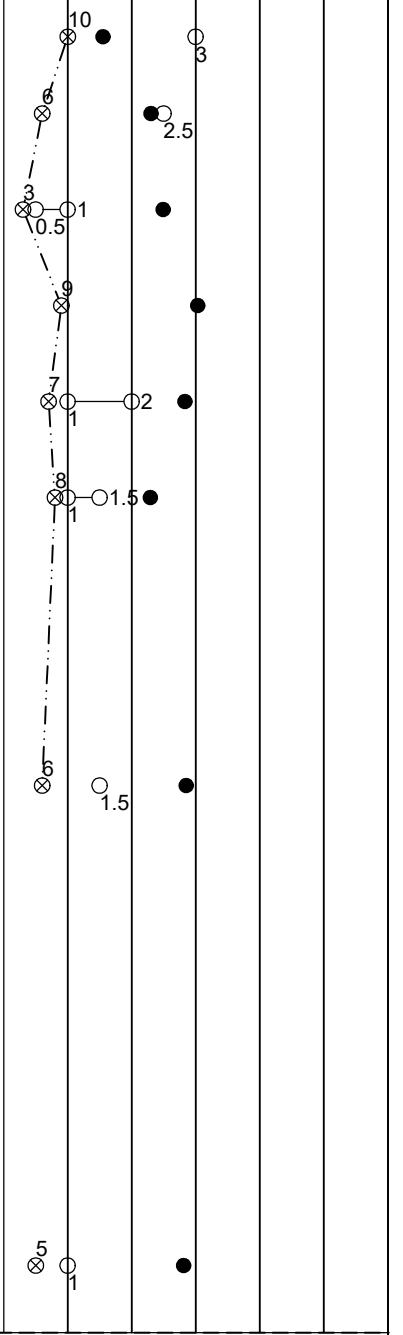
DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
0	1	SS			Brown silty sandy clay (CL) - little to trace gravel - trace organics - very stiff to firm
					EXISTING FILL
580	2	SS			
	3	SS			
578.6 ▼					
	4	SS			7.5 Brown silty fine sand (SM) - wet - loose
10	5	SS			10.0 Brown silty clay (CL) - trace gravel - stiff
	6	SS			
570	VST-1	VANE			**Vane Shear Test with vane tip at 15.5 feet Peak S_u = >2,075 psf**
20	7	SS			
					CLAY I
560	VST-2	VANE			**Vane Shear Test with vane tip at 25.5 feet Peak S_u = >2,050 psf**
30	VST-3	VANE			**Vane Shear Test with vane tip at 30.5 feet Peak S_u = >2,025 psf**
	8	SS			CLAY IIA
550					

UNIT DRY WT. LBS/FT^3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2 (1 2 3 4 5)

PLASTIC LIMIT (%) / WATER CONTENT (%) / LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 6.2 ft BCl
Avg Lake Level during drilling = 579.5'
~ 0.9' lower than lake level

NORTHING **576,372.821** EASTING **101,967.695**

BORING STARTED **11/16/2022**

BORING COMPLETED **11/17/2022**

RIG/FOREMAN **D-50 / JW**

GEI OFFICE **Green Bay, WI**

ENTERED BY **AKL** APPROVED BY **SN**

GEI PROJECT NO. **2201593**

PAGE NO. **1** OF **3**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BL-15-22**

ARCHITECT-ENGINEER

LOCATION:

DESCRIPTION OF MATERIAL

SURFACE ELEVATION (ft.) 584.8

DEPTH (FT) / ELEVATION (FT) | SAMPLE NO. | SAMPLE TYPE | SAMPLE DISTANCE | RECOVERY | UNIT DRY WT. LBS/FT^3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2 (1 2 3 4 5)

PLASTIC LIMIT (%) | WATER CONTENT (%) | LIQUID LIMIT (%) (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT (10 20 30 40 50 60)

VST-4 VANE

Vane Shear Test with vane tip at 35.0 feet
Peak S_u = 1,550 psf -- Remolded S_u = 650 psf

CLAY IIA

9 ST

1.5

540

VST-5 VANE

Vane Shear Test with vane tip at 45.5 feet
Peak S_u = 2,050 psf -- Remolded S_u = 800 psf

50

10 ST

CLAY III

1.5

530

VST-6 VANE

Vane Shear Test with vane tip at 55.5 feet
Peak S_u = 1,625 psf -- Remolded S_u = 550 psf

60

11 SS

6

0.75

64.3

61.0
Brown silt (ML) - wet - medium dense

520

VST-7 VANE

Vane Shear Test with vane tip at 65.5 feet
Peak S_u = >2,100 psf

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 6.2 ft BCI	BORING STARTED **11/16/2022**	GEI OFFICE **Green Bay, WI**	
	BORING COMPLETED **11/17/2022**	ENTERED BY **AKL**	APPROVED BY **SN**
NORTHING **576,372.821** EASTING **101,967.695**	RIG/FOREMAN **D-50 / JW**	GEI PROJECT NO. **2201593**	PAGE NO. **2** OF **3**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

CLIENT: **Brown County Purchasing**

PROJECT NAME: **Port Property Developments**

LOG OF BORING NUMBER **BL-15-22**

ARCHITECT-ENGINEER

LOCATION:

SURFACE ELEVATION (ft.) 584.8

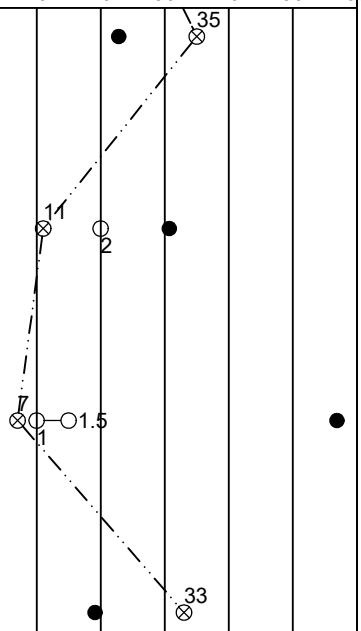
DEPTH (FT) / ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
	12	SS			
510	13	SS			75.0 Brown silty clay (CL) - very stiff to stiff
80	14	SS			
	VST-8	VANE			**Vane Shear Test with vane tip at 82.5 feet** **Peak S_u = >2,100 psf**
500	15	SS			85.0 Brown silt (ML) - wet - medium dense
90					86.5 End of Boring Boring advanced to 10 feet with solid-stem auger Boring advanced from 10.0 to 86.5 feet with rock bit and drilling fluid HW casing driven to 10.0 feet Boring backfilled with bentonite chips and bentonite group mix
490					
100					
480					

UNIT DRY WT. LBS/FT^3

UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2
1 2 3 4 5

PLASTIC LIMIT (%) WATER CONTENT (%) LIQUID LIMIT (%)
10 20 30 40 50

STANDARD PENETRATION BLOWS/FT
10 20 30 40 50 60



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: Groundwater observed at 6.2 ft BCl

BORING STARTED **11/16/2022**

BORING COMPLETED **11/17/2022**

GEI OFFICE **Green Bay, WI**

ENTERED BY **AKL**

APPROVED BY **SN**

NORTHING **576,372.821**

EASTING **101,967.695**

RIG/FOREMAN **D-50 / JW**

GEI PROJECT NO. **2201593**

MIDWEST BORING LOG 2201593_PORT PROPERTY DEVELOPMENT_PK.GPJ GEI DATA TEMPLATE.GDT 3/21/23

GEI Consultants

Port Property Developement
(Green Bay,WI)
Project Number :2201593

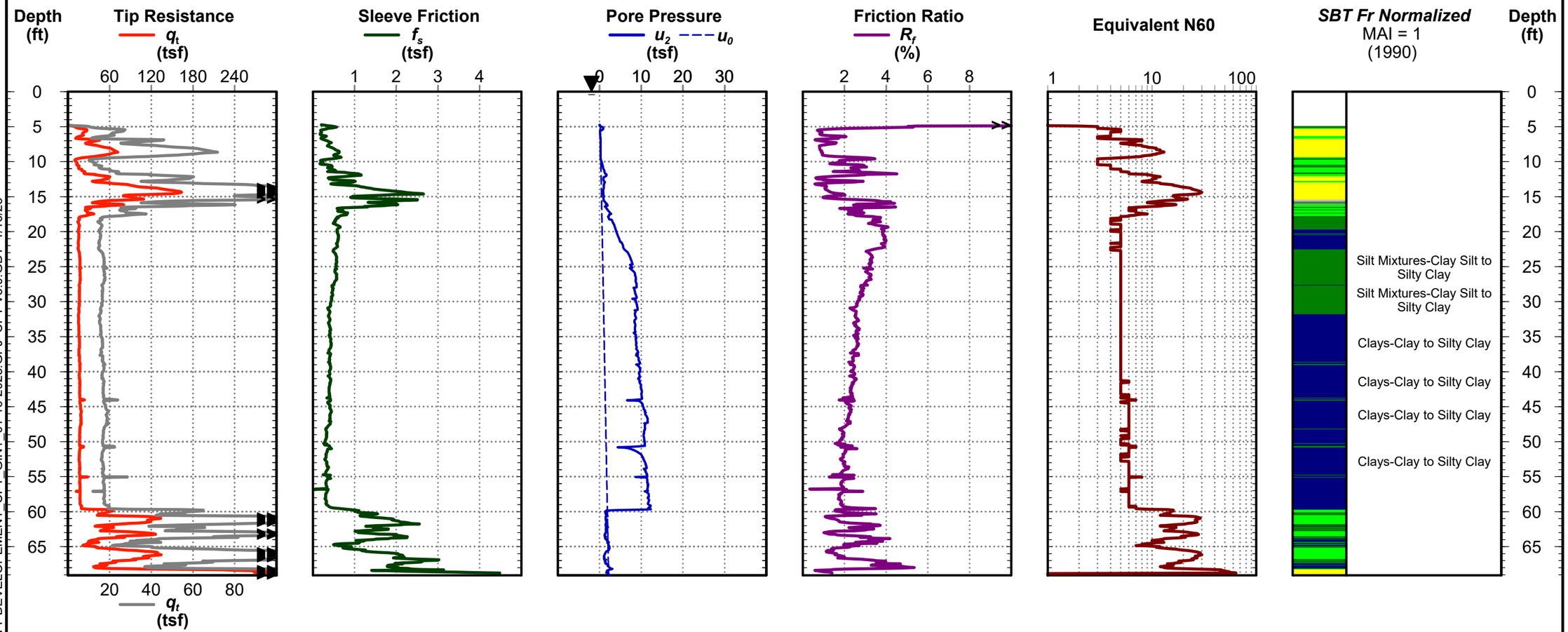
Cone Penetration Test

CPT 13-22

Date: Jan. 4, 2023
Estimated Water Depth: 0 ft
Rig/Operator: CAP

Northing: 263915.0
Easting: 2488216.7
Elevation:

Total Depth: 69.1 ft
Termination Criteria: Target



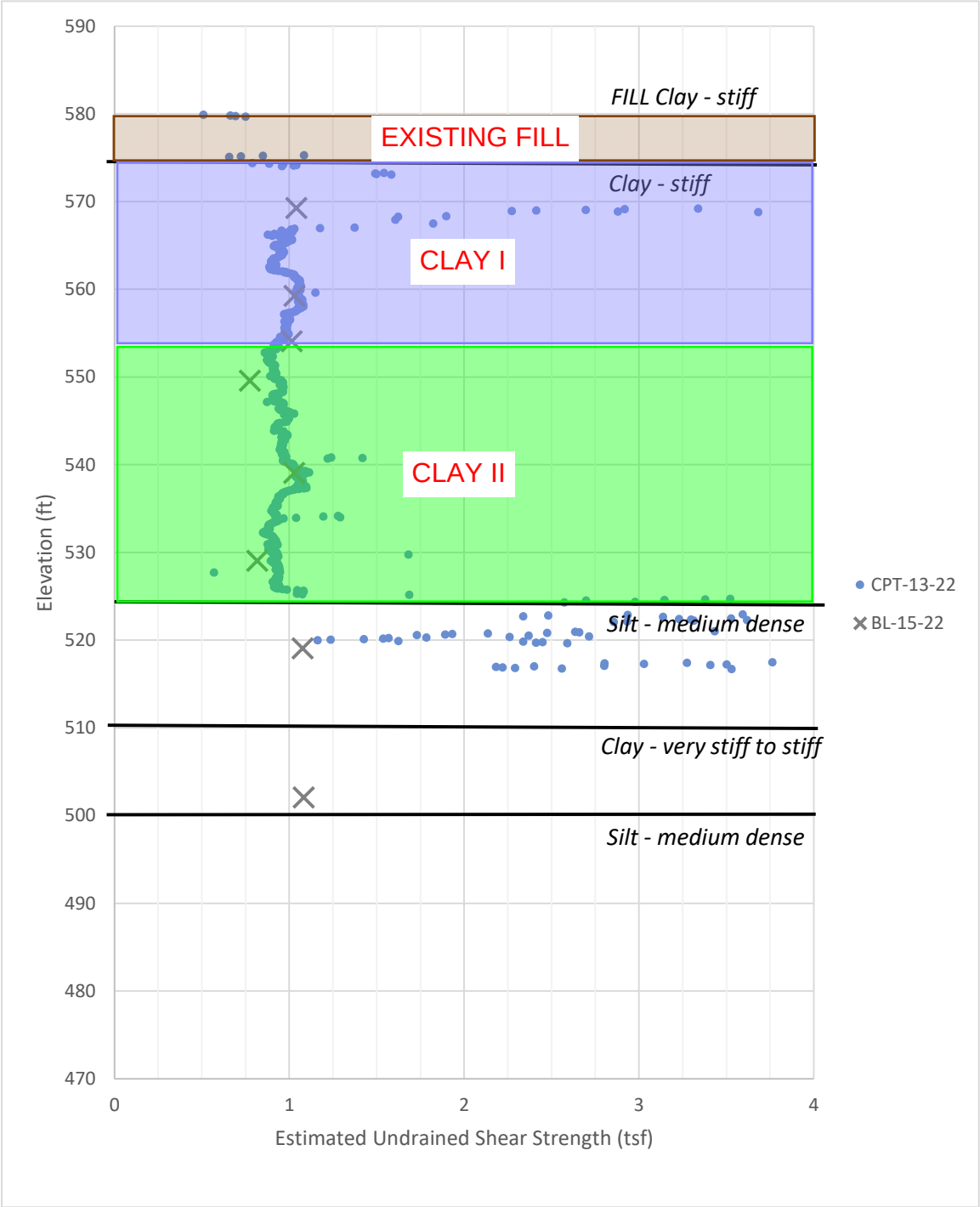
1 - Sensitive, Fine Grained Soils
2 - Organic Soils, Peats
3 - Clays-Clay to Silty Clay
4 - Silt Mixtures-Clay Silt to Silty Clay
5 - Sand Mixtures-Silty Sand to Sandy Silt
6 - Sands-Clean Sand to Silty Sand
7 - Gravelly Sand to Sand
8 - Very Stiff Clay to Clayey Sand
9 - Very Stiff Fine Grained Soils

CPT 13-22

Electronic File Name: CPT 13-22.cpt

CPT REPORT - DYNAMIC GEI_2201593_PORT PROPERTY DEVELOPEMENT_CPT_GINT_01-16-2023.GPJ CPT V3.0.GDT 1/16/23

GEI Consultants	**Client**	Brown County				**Page**	13 of 16
	Project	Port Property Redevelopment				**Pg. Rev.**	
	By			**Chk.**		**App.**	
	Date			**Date**		**Date**	
GEI Project No.	2201593	**Document No.**	Geotechnical Data Report - Appendix A.3				
Subject	CPTu Undrained Shear Strength Profile Estimations						



GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	
Project No.	2201593	Document No.	N/A			
Subject	Port Property Development – Dock Wall Design					

APPENDIX C: BROWN COUNTY PORT PROPERTY

GEOTECHNICAL DATA REPORT

(PROVIDED UNDER SEPARATE COVER)

GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

APPENDIX D: BROWN COUNTY DOCK WALL

GLOBAL STABILITY ANALYSIS

GEI Consultants	Client	Brown County WI			Page	1 of 5
	Project	Port Property Redevelopment			Pg. Rev.	Rev.0
	By	KMK	Chk.		App.	
	Date	06/15/2023	Date		Date	

GEI Project No.	2201593	Document No.	
Subject	Bulkhead Wall Preliminary Design – Global Stability Analysis		

Purpose

The purpose of this calculation is to present the global stability of the proposed bulkhead wall with respect to the maximum allowable stockpile offset and height behind the bulkhead wall.

References

1. GEI Preliminary Drawings for Pulliam Redevelopment, dated April 19, 2023.
2. Port Property Redevelopment - Geotechnical Data Report, prepared by GEI, dated March 2023.
3. Duncan and Wright, Soil Strength and Slope Stability, John Wiley & Sons Inc. 2005.

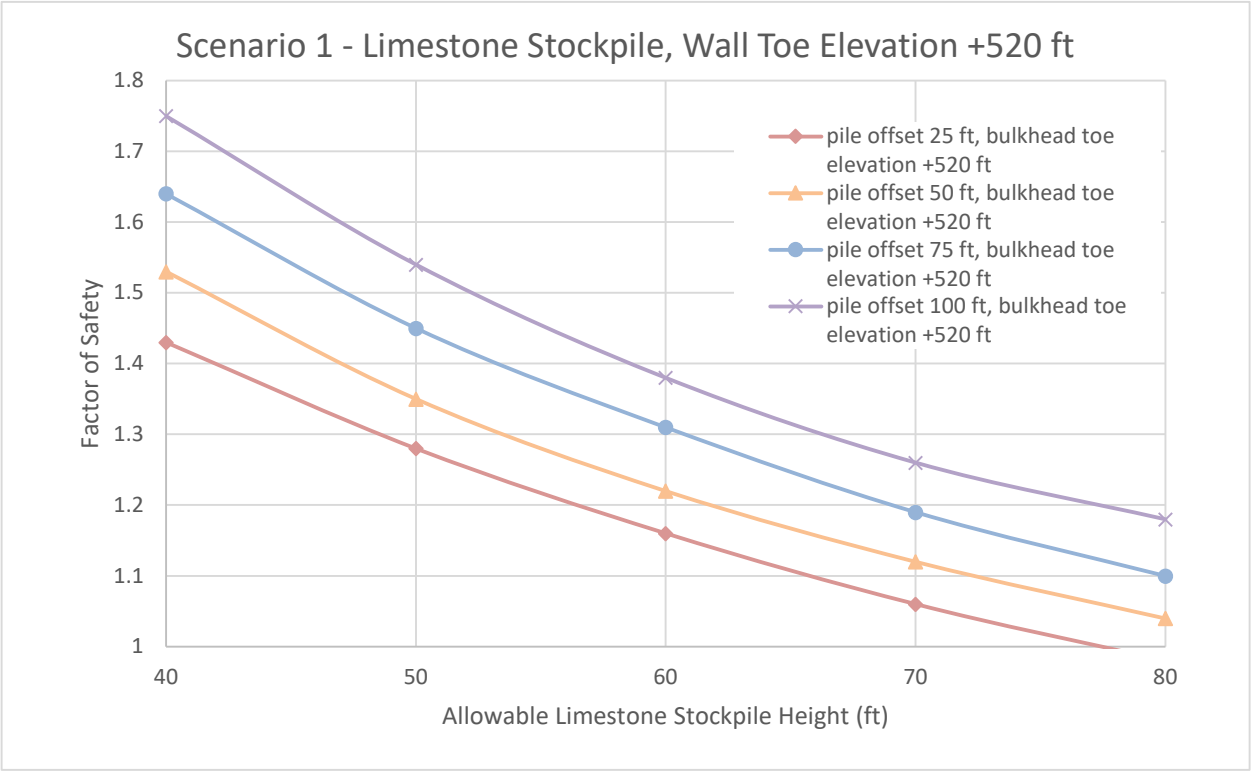
Assumptions

1. The design site grade is +592 ft. The design dredge grade is +550 feet. The design water level is +578 feet.
2. The water level varies at the site, generally between +575 feet and +582 feet. The design water level is +578 feet. The low-water datum and a high-water datum should be established and checked for the final design.
3. Soil layer and strength properties are identified in the Geotechnical Data report, Section 4.7.
4. For the short-term undrained strength analysis, a nominal surcharge of 500 psf was assumed from the edge of the wall to the edge of the stockpile.
5. The maximum stockpile width extends from the face of the wall to approximately 400 feet behind the wall based on site dimensions. The assumed stockpile slopes were 1.4H:1V. Two stockpile unit weights were considered. For a limestone or gravel stockpile, the total unit weight of the stockpile material was assumed to be 100 pcf. For a coal stockpile, the total unit weight of the stockpile was assumed to be 60 pcf.
6. The stockpile height was assumed to vary between 40 feet and 80 feet. Stockpiles greater than 80 feet in height were not analyzed. The maximum allowable stockpile height was calculated for various assumed toe setbacks from the wall for coal or limestone materials.
7. The stockpile toe setback was varied from the face of the wall in 25-foot increments, from 25 feet to 100 feet offset. Based on the preliminary internal stability calculations, offsets on the order of 25 to 75 feet provide workable solutions for the required sheeting section modulus.
8. The recommended minimum factors of safety for the various scenarios are based on standard geotechnical engineering practice [Duncan and Wright 2005]. For undrained strength analyses, the required minimum factor of safety is 1.30. However, for this analysis, the required minimum factor of safety of 1.50 was also considered due to difficulty in controlling the stockpile geometry.

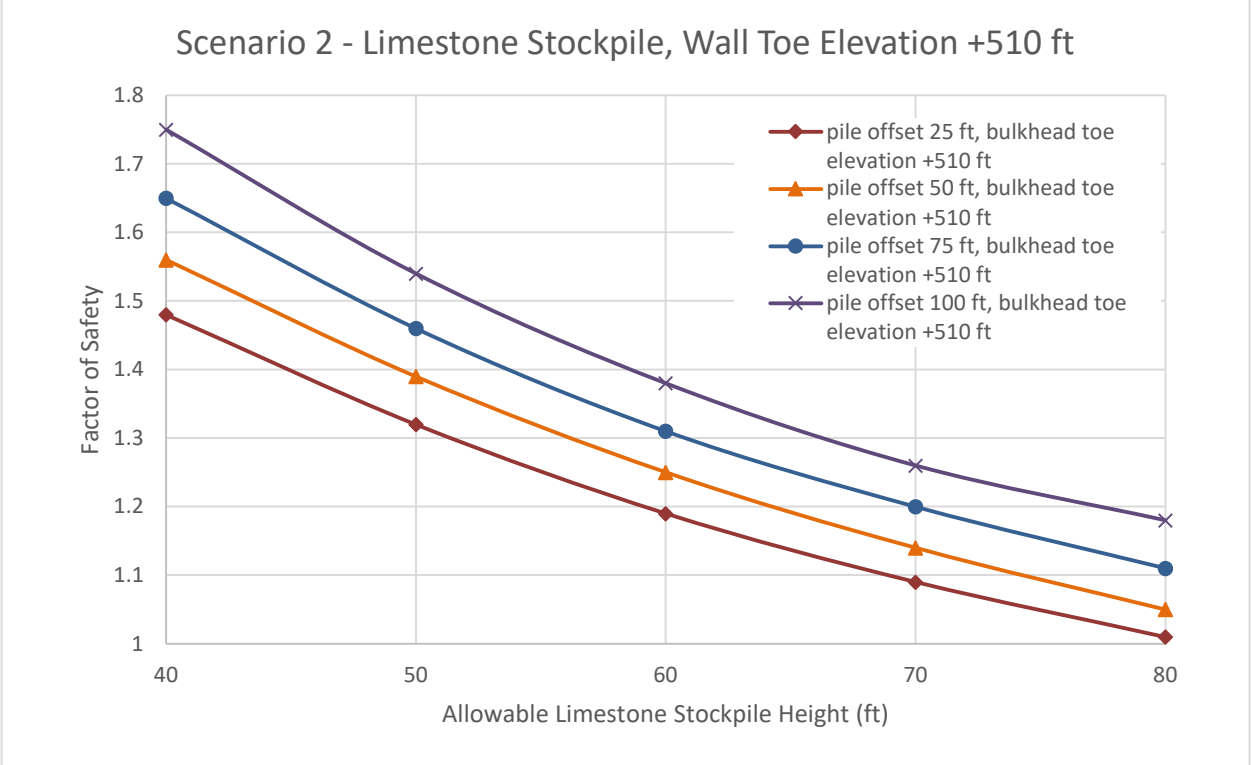
9. The embedment length of the wall was varied for each stockpile condition in order to achieve a minimum factor of safety of 1.50. Global stability failures were assumed to pass below the toe of the wall.
10. Based on the internal stress analysis for the dockwall, the required toe elevation of the wall is +527 if a limestone stockpile is beyond 50 feet from the wall. The required toe elevation of the wall is +519 if a limestone stockpile is set at 15 feet from the wall. For the purpose of this analysis, it was assumed that the toe of the wall cannot practically be installed deeper than +510.

Undrained Strength Analysis

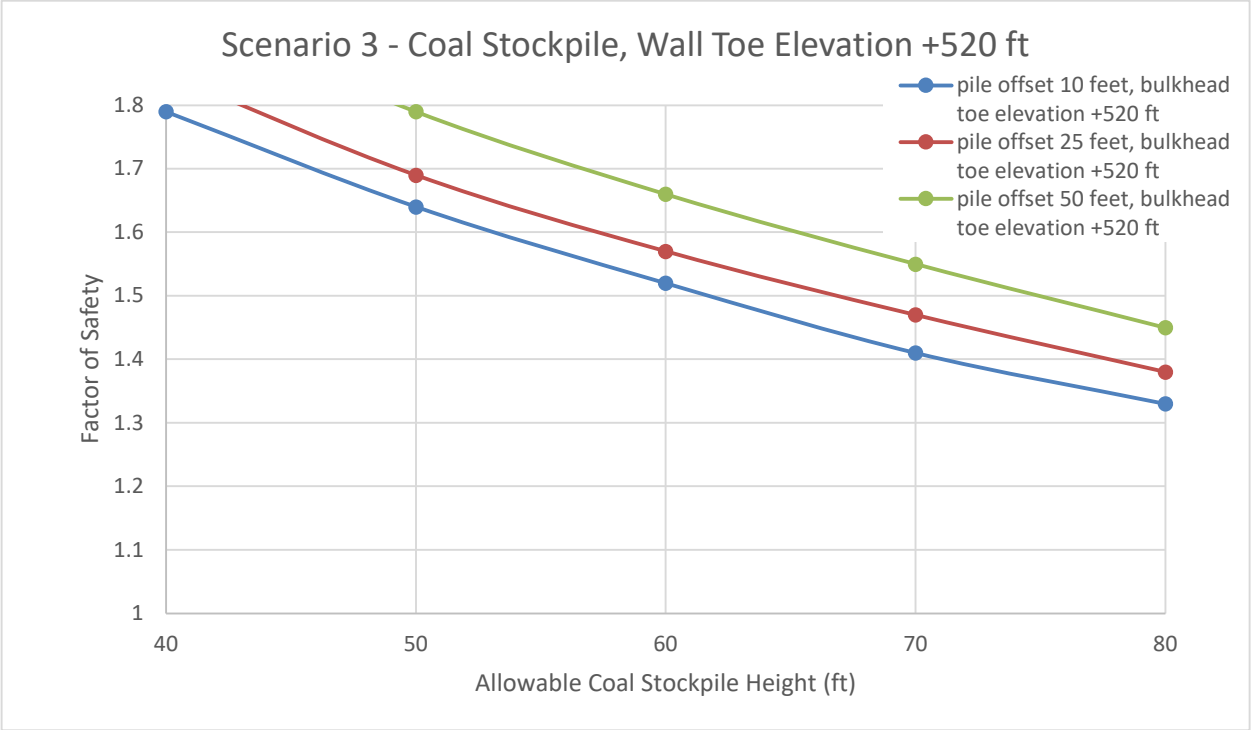
The results of the undrained strength analysis are presented as figures below. Scenario 1 assumes that the wall is installed to elevation +520 feet and a limestone material is stockpiled behind the wall. In this scenario, the stockpile would need to be offset a minimum of 50 feet and the maximum allowable height of the stockpile would be 40 feet in order to maintain a factor of safety of 1.5. If a factor of safety of 1.3 is allowed, the limestone stockpile could be offset a minimum of 25 feet and the maximum allowable height would be approximately 48 feet.



Scenario 2 below assumes that the wall is extended to elevation +510 feet and a limestone material is stockpiled behind the wall. In this scenario, the stockpile would still need to be offset a minimum of 50 feet and the maximum allowable height of the stockpile would be 40 feet in order to maintain a factor of safety of 1.5. If a factor of safety of 1.3 is allowed, the limestone stockpile could be offset a minimum of 25 feet and the maximum allowable height would be approximately 52 feet. There is minimal improvement of the factor of safety and minimal gains in the allowable stockpile size by extending the wall length.



Scenario 3 below assumes that the wall installed to elevation +520 feet and the stockpile material is coal instead of limestone. In this scenario, the stockpile could be as close as 10 feet from the wall with a maximum height of 60 feet in order to maintain a factor of safety of 1.5. If a factor of safety of 1.3 is allowed, the coal stockpile could be 10 feet from the wall and 80 feet in height. There is minimal improvement of the factor of safety and minimal gains in the allowable stockpile size by extending the wall length below elevation +520.



Long-Term Steady State Analysis

The results of the long-term drained strength analyses are presented in the following table. The minimum acceptable factor of safety for long-term conditions is 1.5. The long-term steady state conditions were checked for the maximum acceptable scenarios identified in the short-term undrained strength analyses.

The analysis shows that the toe of the wall would need to be extended to elevation +510 feet to meet the long-term factor of safety requirements for the scenario of a limestone stockpile within 25 feet of the wall. The wall designed with a toe elevation of +520 feet would meet long-term factor of safety requirements for the coal stockpile within 10 feet of the wall or the limestone stockpile within 50 feet of the wall.

Stockpile Material	Stockpile Offset (ft)	Stockpile Height (ft)	Sheetpile Toe Elevation (ft)	Short-Term Factor of Safety	Long-Term Factor of Safety
Limestone	50 ft	40 ft	+520	1.53	1.50
Limestone	25 ft	48 ft	+520	1.30	**1.38**
Limestone	25 ft	40 ft	+520	1.43	**1.43**
Limestone	25 ft	48 ft	+510	1.33	1.55
Coal	10 ft	60 ft	+520	1.52	1.67
Coal	10 ft	80 ft	+520	1.33	1.59

Conclusion

Based on the analyses discussed above, the design sheetpile toe elevation should be +520 feet. A limestone material stockpile may have a maximum height of 40 feet and must be offset a minimum of 50 feet from the wall. A coal stockpile may have a maximum height of 60 feet and be offset a minimum of 10 feet from the wall.

Design Sheetpile Toe Elevation (ft)	Stockpile Material	Max Stockpile Height (ft)	Minimum Stockpile Offset (ft)
+520 feet	Limestone	40 ft	50 ft
	Coal	60 ft	10 ft

Stockpile heights and offsets beyond what is described above would have a marginal factor of safety and may result in creep movement and overstressing of the wall. Excessive creep movement could lead to softening of the clay soils and a major global stability failure taking out the entire wall and failing into the river.

APPENDIX E: SETTLEMENT ANALYSIS

GEI Consultants							
		Client	Brown County, WI			**Page**	
		Project	Brown County Redevelopment			**Pg. Rev.**	
		By	E. Burton	**Chk.**		**App.**	
		Date	02/10/2025	**Date**		**Date**	
Project No.	2201593	**Document No.**	N/A				
Subject	Settlement and Time Rate of Consolidation Analysis						

Settlement Resulting from Proposed Dock Wall Construction

We used primary consolidation and time rate of consolidation equations, provided by UFC 3-220-10 Soil Mechanics (February 2022), to calculate primary consolidation and the time rate of consolidation in the clay layers associated with constructing the proposed dock wall along Section A on the Fox River in Green Bay, WI particularly as it pertains to clay layers beneath the proposed tierod and deadman system. Section A was considered the most critical section for settlement analysis due to the thickness of the soft Clay II layer compared to Sections B-D.

We considered the subsurface profile for Section A, provided in the appendix, to determine the elevations of the top and bottom of each layer. The soil parameters considered were based on the Geotechnical Data Report produced by GEI in March 2023 as well as Boring BW-2-22 which was considered most representative of the soil strata at Section A.

The settlement analysis considers the following stages of construction:

1. Immediately after dredging of existing Sediment.
2. Immediately after placement of proposed Granular Fill (Time Rate Consideration: 60 days)
3. Immediately after placement of stockpile surcharge (Time Rate Consideration: 60 days + ½ Year)

Because the uniform live load is not anticipated to be a constant load, the effect of the surcharge on the underlying soil was ignored for this analysis. Immediate settlement in the granular fill layer due to surcharge loading was not in the scope of this analysis and was also not considered for the clay layers. The time rates selected for analysis are based on our best estimate of the duration of time between stages or the expected length of time for a stockpile to retained. The change in vertical effective stress due to the placement of the material stockpile was evaluated at three locations as a function of distance from the water-side face of the proposed limestone stockpile in the considered clay layers beneath the tierod and deadman system: 10', 35' and 60'. This distances from the water-side face of the proposed limestone stockpile correspond to a distance of 25', 50' and 75' from the water-side face of the proposed dock wall.

Cases 1 and 2 were conducted to estimate the overconsolidation raio (OCR) at the midpoint of each considered clay layer for the primary consolidation calculations performed for Case 3. Therefore, the estimated primary consolidation due to the placement of the Granular Fill was considered equal at each considered distance in the analysis.

The following pages present a detailed account of our calculations. Estimated settlements are presented in the attached summary tables.

GEI Consultants						
	Client	Brown County, WI			**Page**	
	Project	Brown County Redevelopment			**Pg. Rev.**	
	By	E. Burton	**Chk.**		**App.**	
	Date	02/10/2025	**Date**		**Date**	
Project No.	2201593	**Document No.**	N/A			
Subject	Settlement and Time Rate of Consolidation Analysis					

Soil Parameters

The following soil parameters from the GEI Geotechnical Data Report were considered for analysis:

Table 1: Summary of Design Soil Parameters

Name	Elevation (ft)	Total Unit Weight (pcf)	Consolidation Parameters					
			e_0	P_c (psf)	C_c	C_{cr}	Su (psf)	*E_s (ksf)
Sediment	575 to 542	80	-	-	-	-	-	-
Granular Fill	591 to 542	130	-	-	-	-	-	-
Clay I	542 to 532	130	0.9	6600	0.251	0.064	2000	1200
Clay II	532 to 517	130	1	6000	0.44	0.07	1000	600
Clay III	517 to 492	130	1.2	8200	0.409	0.09	2500	1500

*where $E_s = 600 \times S_u$

Primary Settlement Equations:

1. For overconsolidated soil layers in which the final stress is less than or equal to the preconsolidation stress:

$$S = \left(C_{\varepsilon r} log \left(\frac{\sigma'_{v0} + \Delta\sigma_v}{\sigma'_{vo}} \right) \right) H_0$$

where $C_{\varepsilon r}$ is the modified recompression index (recompression ratio), σ'_{vo} is the in-situ vertical effective stress, $\Delta\sigma_v$ is the change in vertical stress, H_0 is the soil layer thickness, and S is the primary consolidation for the soil layer under evaluation.

2. For overconsolidated soil layers in which the final stress is greater than the preconsolidation stress:

$$S = \left(C_{\varepsilon r} log \left(\frac{\sigma'_p}{\sigma'_{vo}} \right) + C_{\varepsilon c} log \left(\frac{\sigma'_{v0} + \Delta\sigma_v}{\sigma'_p} \right) \right) H_0$$

where σ'_p is the maximum past pressure and $C_{\varepsilon c}$ is the modified compression index (compression ratio).

$C_{\varepsilon c}$ and $C_{\varepsilon r}$, the compression index and recompression index, are void ratio – log stress-based parameters. The modified compression index (compression ratio) and the modified recompression index (recompression ratio) are strain – log stress-based parameters.

C_C = compression index

$$C_{C\varepsilon} = \frac{C_C}{1 + e_0}$$

Cr = recompression index

$$C_{\varepsilon r} = \frac{C_r}{1 + e_0}$$

Primary Time Rate of Consolidation Equations:

1. Time Factor Equation

$$T_v = \frac{c_v t}{{H_{dr}}^2}$$

where T_v = time factor for vertical drainage, c_v = coefficient of consolidation for the soil layer in the vertical direction, and H_{dr} = drainage path length.

2. Average Degree of Consolidation Equation

$$\text{For } T_v \leq 0.2: \overline{U_z} \approx \frac{2}{\sqrt{\pi}}\sqrt{T_v}$$

$$\text{For } T_v > 0.2: \overline{U_z} \approx 1 - \frac{8}{\pi} exp\left(\frac{-\pi^2}{4} T_v\right)$$

where $\overline{U_z}$ = degree of compression.

Summary of Results:

Table 2: Primary Consolidation Results

Distance, X from Dock Wall (ft)	Estimated Total Primary Consolidation (in)
10	9.0
35	10.4
60	10.9

GEI Consultants						
	Client	Brown County, WI			**Page**	
	Project	Brown County Redevelopment			**Pg. Rev.**	
	By	E. Burton	**Chk.**		**App.**	
	Date	02/10/2025	**Date**		**Date**	
Project No.	2201593	**Document No.**	N/A			
Subject	Settlement and Time Rate of Consolidation Analysis					

Table 3: Time Rate of Consolidation Results

Clay Layer	Case (II or III)	Time (Days)	Distance, X from Dock Wall (ft)	Vertical Effective Stress (tsf)	Coeff of Consol, C_v (ft^2/sec)	H_{dr} (ft)	T_v (-)	Avg. Degree of Consol, U_z (%)	Settlement at time considered (in)	T.v @ U.z = 75% (-)	Time for 75% of Consol to occur (days)
Clay I	II	60	-	2.3	3.36E-06	4.97	0.71	95%	2.1	0.44	38
Clay III	II	60	-	3.4	2.65E-06	12.46	0.09	34%	0.9	0.44	299
Clay I	III	242.5	10	9	7.21E-07	4.86	0.64	90%	0.3	0.44	168
Clay III	III	242.5	10	8	9.59E-07	12.37	0.13	41%	0.4	0.44	816
Clay I	III	242.5	35	23.5	1.18E-06	4.64	1.15	100%	0.6	0.44	93
Clay III	III	242.5	35	17.6	7.00E-07	12.17	0.10	36%	0.6	0.44	1081
Clay I	III	242.5	60	33.1	1.12E-06	4.48	1.17	100%	0.6	0.44	92
Clay III	III	242.5	60	25.8	8.00E-07	12.00	0.12	39%	0.8	0.44	920

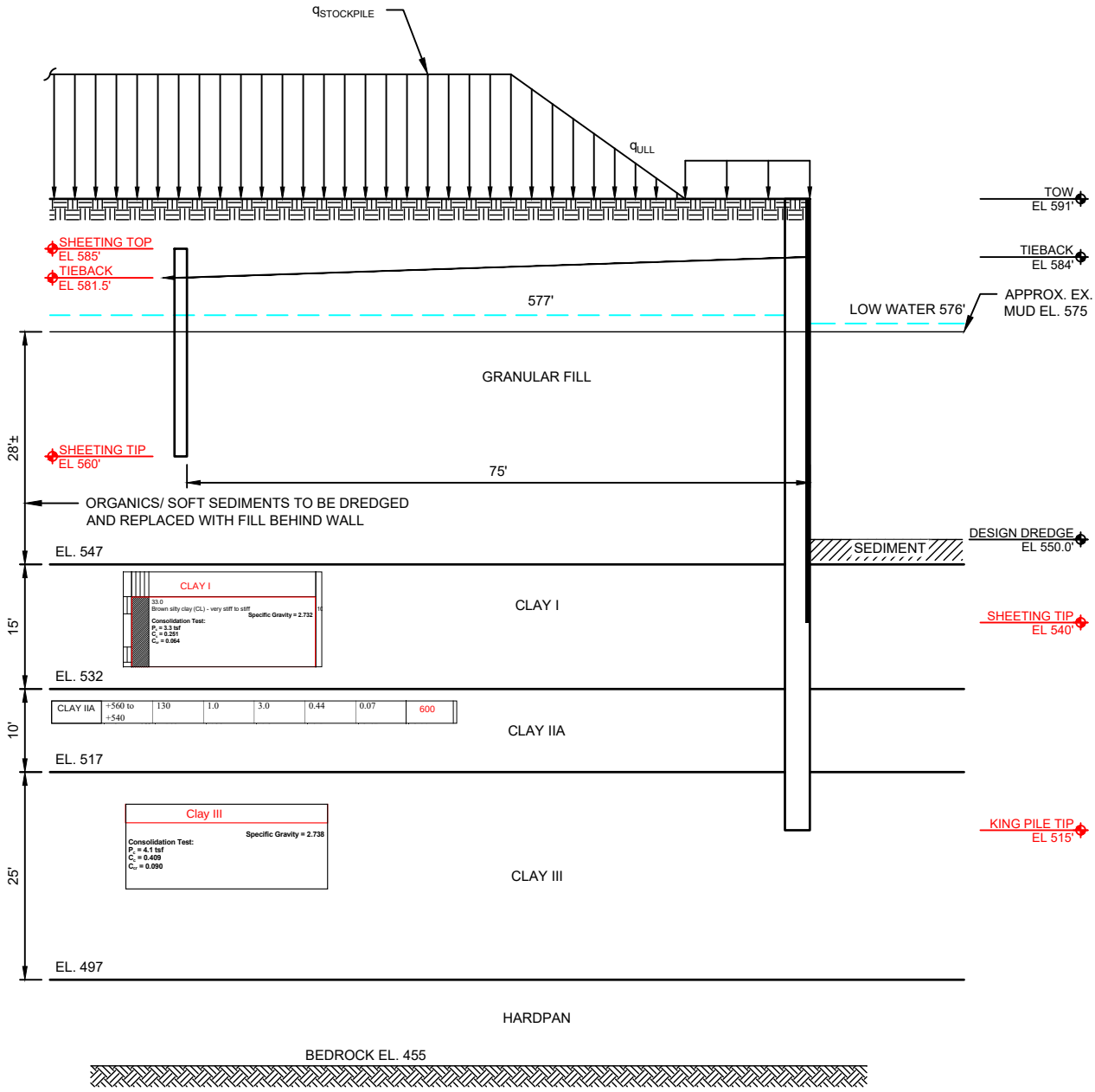
Notes:

1. Coefficients of Consolidation for Clay I and Clay III are selected based on results from Consolidation Test Data from Boring BW-2-22 at similar vertical effective stresses from the primary consolidation analysis.
2. Average Degree of Consolidations, U_z, are based upon the estimated time frame between Case II and Case III (60 days) and the duration of limestone stockpile retention once applied, Case III: (60 days + 6 months).

GEI Consultants	Client	Brown County, WI			Page	
	Project	Brown County Redevelopment			Pg. Rev.	0
	By	E. Burton	Chk.		App.	
	Date	02/10/2025	Date		Date	
Project No.	2201593	**Document No.**	N/A			
Subject	Settlement and Time Rate of Consolidation Analysis					

Settlement Analysis Cases

SECTION A

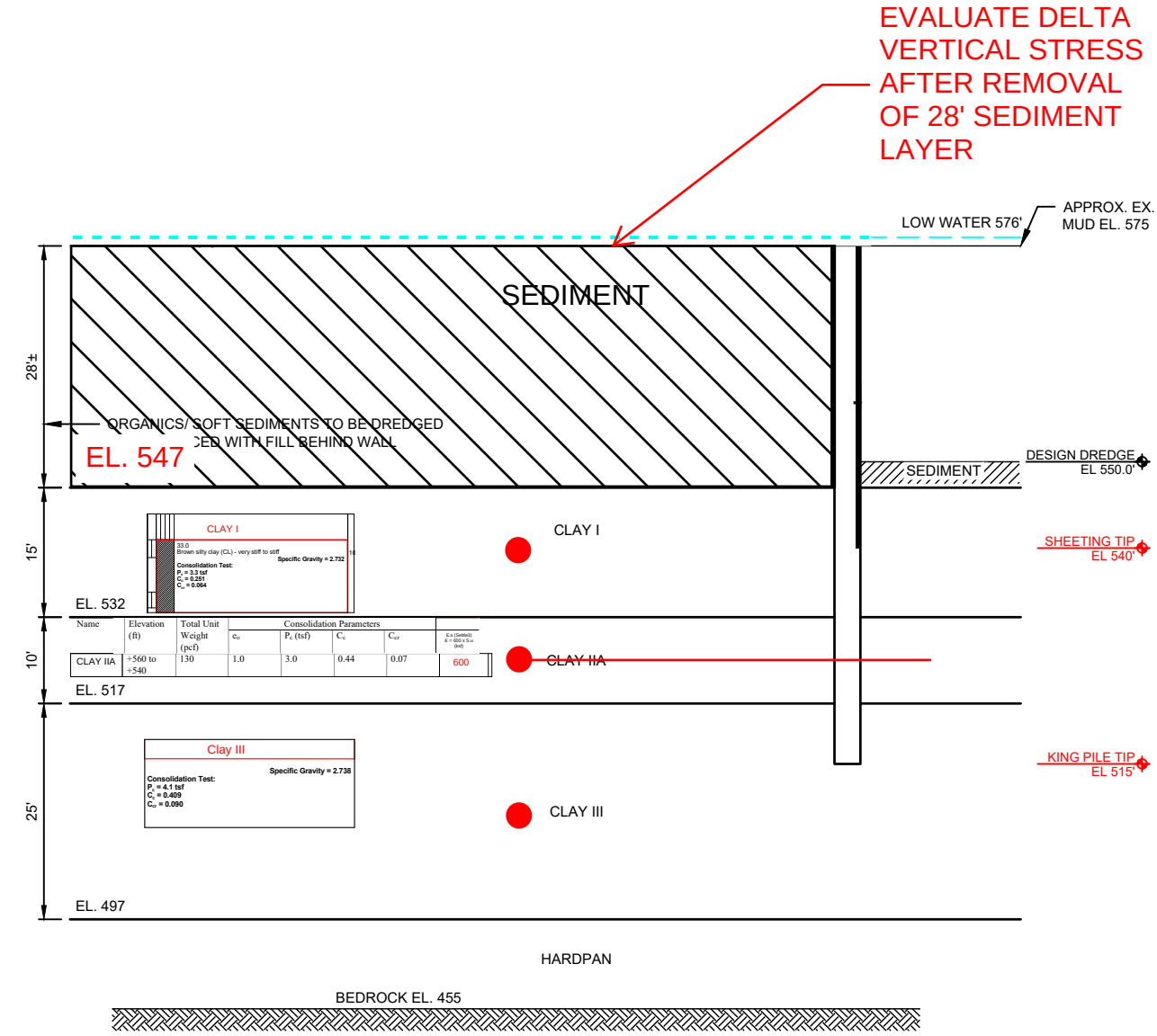


ASSUMPTIONS:

1. ANALYSIS BASED ON FOLLOWING BORING LOGS: BW-2-22
2. NOTE BASED ON WATER LEVELS DURING DRILLING AND FIELD LOGS, THE REPORTED "SURFACE ELEVATION" APPEARS TO BE INCORRECTLY REPORTED. THE "SURFACE ELEVATION" CORRESPONDS TO THE BARGE DECK. THE BARGE HAS AN APPROXIMATE FREEBOARD OF 2'. WATER LEVELS DURING DRILLING AT NOAA STATION "GREEN BAY EAST" RANGED FROM EL 579.3 NAVD88 (EL. 578.9 IGLD85) TO EL 581.3 NAVD88 (580.9 IGLD85). ASSUMING AN AVERAGE WATER ELEVATION OF 580.3 THE MUDLINE WOULD APPROXIMATELY BE EL 574.8. THIS IS ASSUMED FOR DEVELOPING THE SOIL PROFILE
3. LOW LAKE LEVEL ASSUMED FOR DESIGN OF THE DOCKWALL IS EL. 576.

SETTLEMENT CASE I:
Immediately after dredging of existing fill material

SECTION A



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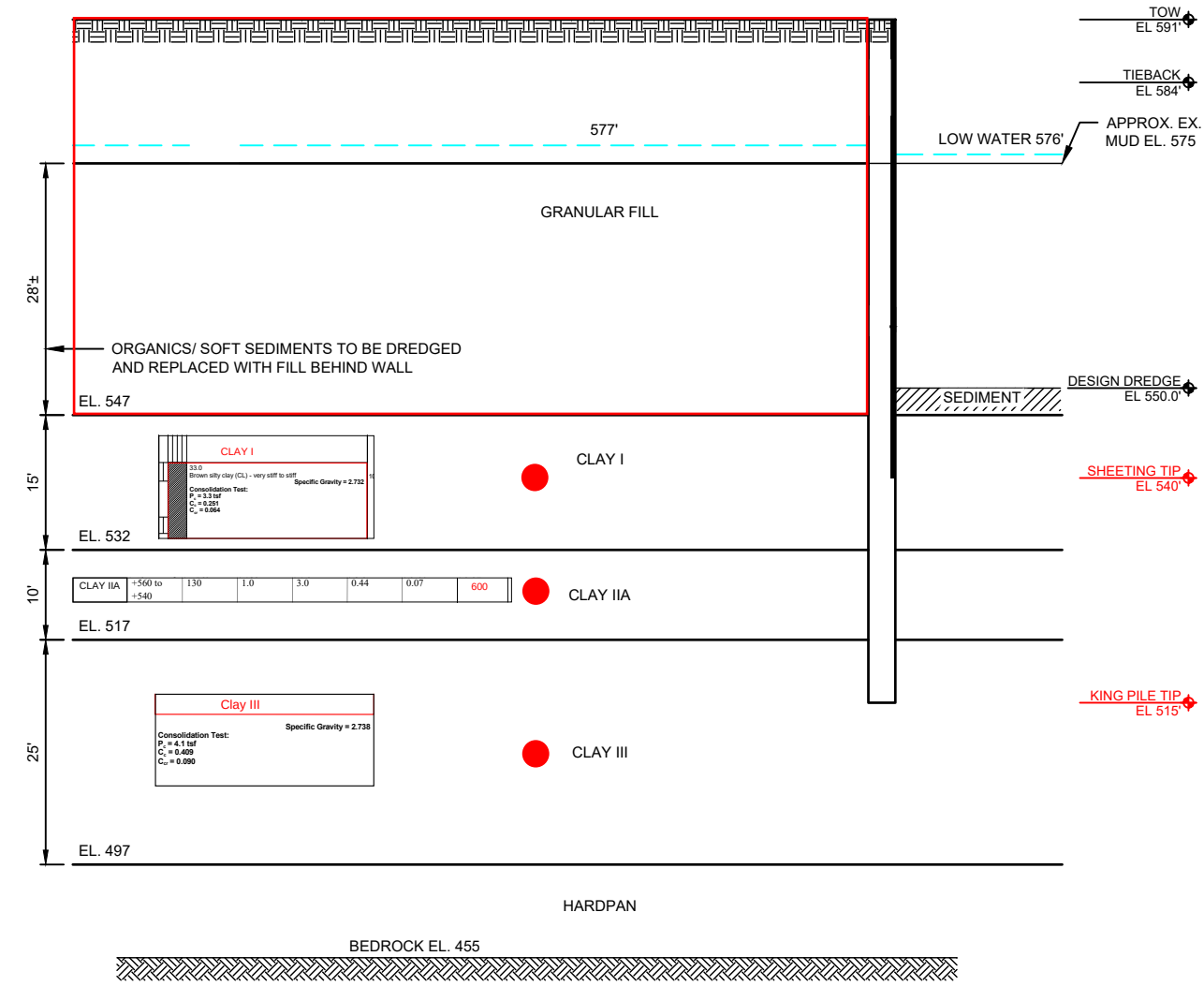
3. LOW LAKE LEVEL ASSUMED FOR DESIGN OF THE DOCKWALL IS EL. 576.

SETTLEMENT CASE II:
Immediately after placement of proposed Granular Fill
- Calc immediate settlement using an initial vertical effective stress from the final vertical effective stress of Case I
- Calc consolidation using cv and permeability
- Report time for completion of primary consolidation

SECTION A



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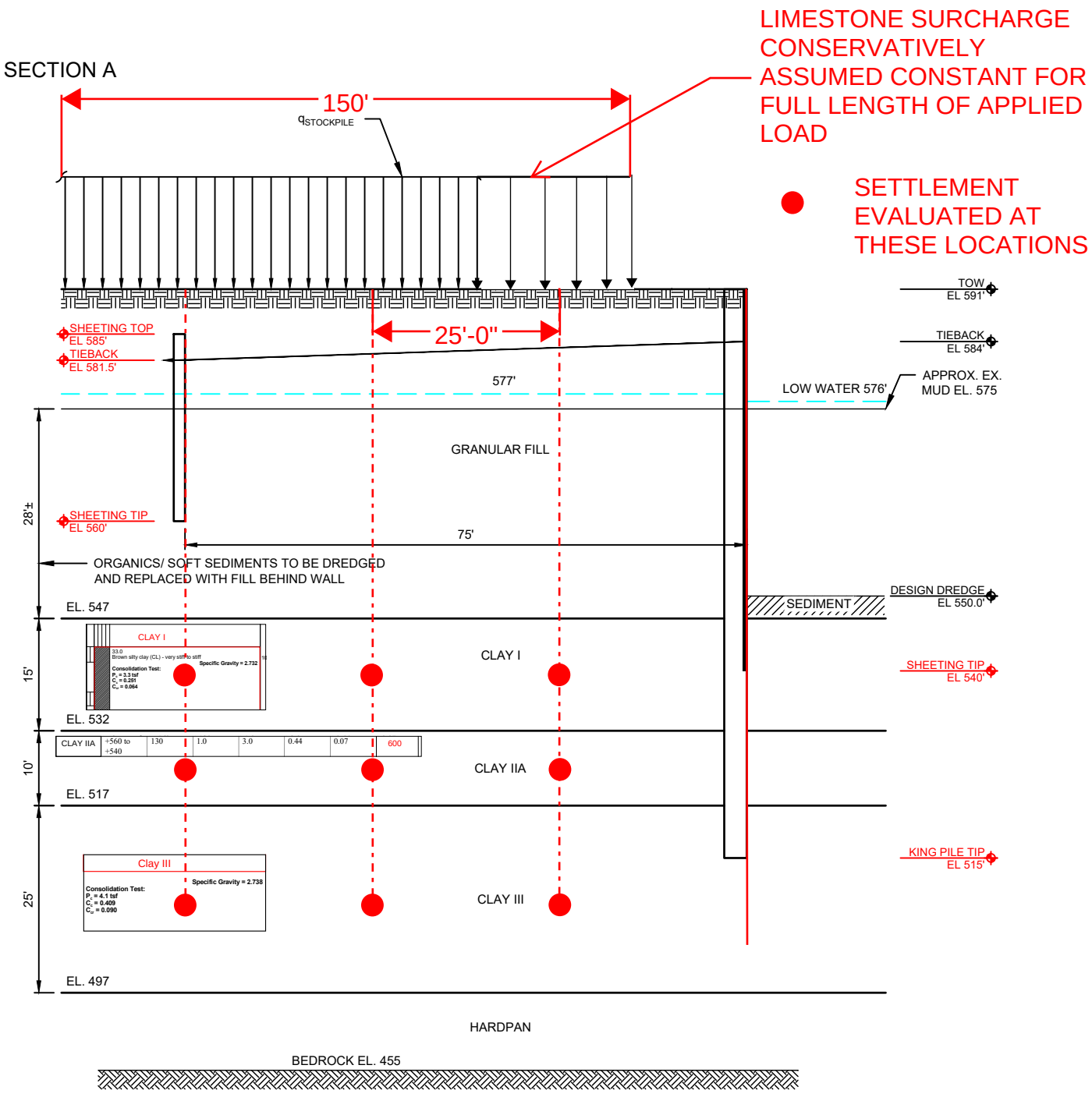
3. LOW LAKE LEVEL ASSUMED FOR DESIGN OF THE DOCKWALL IS EL. 576.

SETTLEMENT CASE III:
Immediately after placement of stockpile surcharge
- Assume 6 months from placement of fill to placement of stockpile; using primary consolidation calculation from Case II, what is S at t = 6 months
- Calculate immediate settlement, starting from t = 6 months, for placement of surcharge
- Calculate time rate of consolidation for primary consolidation



ASSUMPTIONS:
1. ANALYSIS BASED ON FOLLOWING BORING LOGS: BW-2-22
2. NOTE BASED ON WATER LEVELS DURING DRILLING AND FIELD LOGS, THE REPORTED "SURFACE ELEVATION" APPEARS TO BE INCORRECTLY REPORTED. THE "SURFACE ELEVATION" CORRESPONDS TO THE BARGE DECK. THE BARGE HAS AN APPROXIMATE FREEBOARD OF 2'. WATER LEVELS DURING DRILLING AT NOAA STATION "GREEN BAY EAST" RANGED FROM EL 579.3 NAVD88 (EL. 578.9 IGLD85) TO EL 581.3 NAVD88 (580.9 IGLD85). ASSUMING AN AVERAGE WATER ELEVATION OF 580.3 THE MUDLINE WOULD APPROXIMATELY BE EL 574.8. THIS IS ASSUMED FOR DEVELOPING THE SOIL PROFILE
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GEI Consultants	Client	Brown County, WI			Page	
	Project	Brown County Redevelopment			Pg. Rev.	0
	By	E. Burton	Chk.		App.	
	Date	02/10/2025	Date		Date	

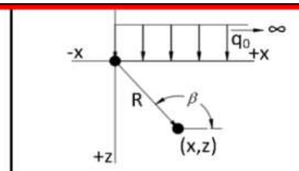
Project No.	2201593	Document No.	N/A
Subject	Settlement and Time Rate of Consolidation Analysis		

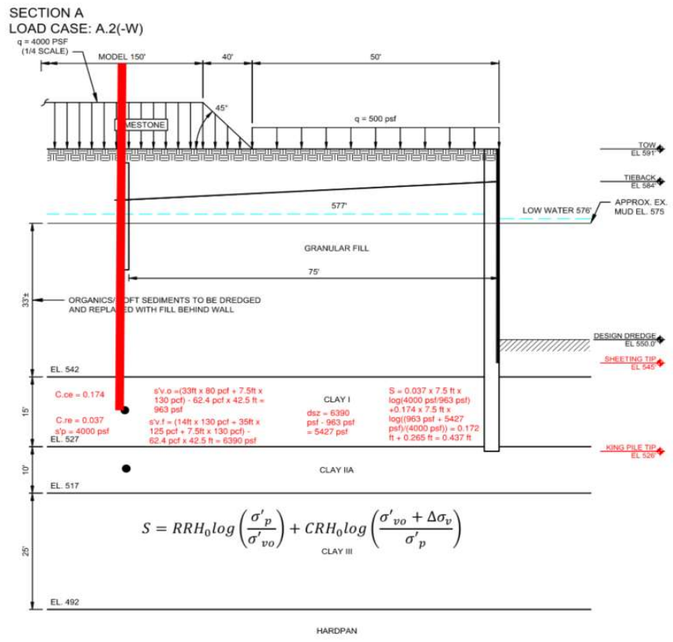
Analysis Results

$$\sigma_z = \frac{q_0}{\pi}\left[\beta + \frac{xz}{R^2}\right]$$

q0	4000	psf
pi	3.141593	
Z	56.5	FT

X	B	R^2	s.z
0	0	3192.25	0
1	0.017697	3192.25	45.06807
5	0.088266	3192.258	225.0591
10	0.175177	3192.28	448.3923
15	0.2595	3192.315	668.4275
20	0.340218	3192.363	883.8675
25	0.416581	3192.419	1093.758
30	0.488118	3192.482	1297.499
35	0.554612	3192.549	1494.813
40	0.616051	3192.619	1685.685
45	0.672579	3192.69	1870.299
50	0.724441	3192.76	2048.967
55	0.771946	3192.83	2222.084
60	0.815432	3192.897	2390.079
65	0.855243	3192.961	2553.392
70	0.891715	3193.023	2712.45
75	0.925165	3193.082	2867.657
80	0.955888	3193.139	3019.39
85	0.984152	3193.192	3167.99
90	1.010202	3193.243	3313.768
95	1.034256	3193.29	3457.003
100	1.05651	3193.336	3597.945
105	1.077139	3193.378	3736.817
110	1.096299	3193.419	3873.818
115	1.114129	3193.457	4009.123
120	1.130753	3193.494	4142.892

Semi-infinite Uniform Load		a location under the $\sigma_z = \frac{q_0}{\pi}\left[\beta + \frac{xz}{R^2}\right]$



Case I

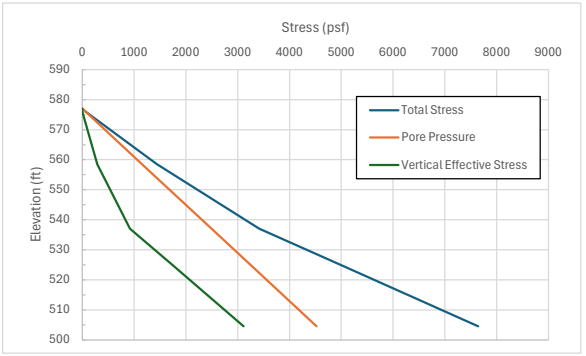
Evaluate vertical effective stress immediately after dredging of existing fill material.

L.stone: 4000 psf

Layer Elevations			Unit Weights			Initial Void Ratio		P'c (psf)			C.c		C.r	
GWT:	577	ft	y.w	62.4	pcf									
Clay I:	542	ft	y.c1	130	pcf	e.0	0.9	s'p.1	6600	psf	C.c.1	0.251	C.r.1	0.064
Clay II:	532	ft	y.c2	130	pcf	e.0	1	s'p.2	6000	psf	C.c.2	0.44	C.r.2	0.07
Clay III:	517	ft	y.c3	130	pcf	e.0	1.2	s'p.3	8200	psf	C.c.3	0.409	C.r.3	0.09
Bot. Clay III:	492	ft	y.gr.f	130	pcf									
Sediment:	575	ft	y.sed	80	pcf									
Top of Wall	591	ft												

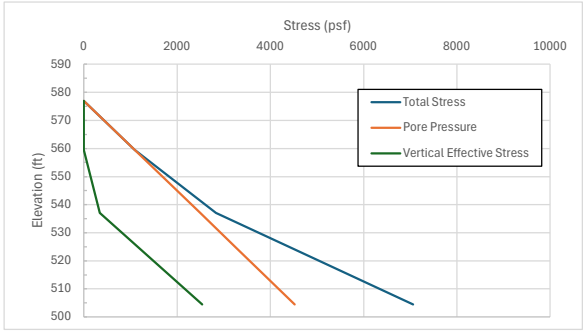
Prior to Dredging on Active Side

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
576	Water	577	575	2	1	1	62.4	62.4	0	-
558.5	Sediment	575	542	33	16.5	18.5	1444.8	1154.4	290.4	-
537	Clay I	542	532	10	5	40	3414.8	2496	918.8	7.2
524.5	Clay II	532	517	15	7.5	52.5	5039.8	3276	1763.8	3.4
504.5	Clay III	517	492	25	12.5	72.5	7639.8	4524	3115.8	2.6



Immediately after Dredging on Active Side

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
559.5	Water	577	542	35	17.5	17.5	1092	1092	0	-
537	Clay I	542	532	10	5	40	2834	2496	338	19.5
524.5	Clay II	532	517	15	7.5	52.5	4459	3276	1183	5.1
504.5	Clay III	517	492	25	12.5	72.5	7059	4524	2535	3.2



Case II

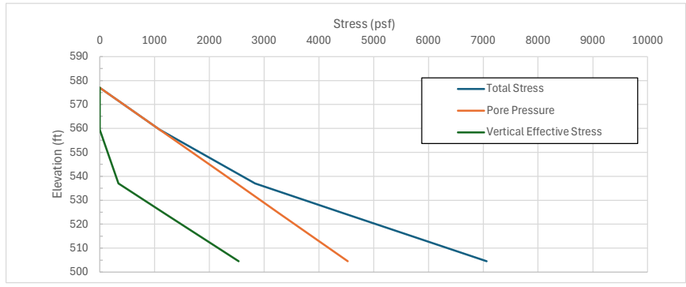
Evaluate vertical effective stress immediately after placing Granular Fill

L.stone: 4000 psf Poisson's Ratio: 0.49 Width, B (ft): 75

Layer Elevations			Unit Weights			Initial Void Ratio		u1	u0	P'c (psf)			C.c	Cec	C.r	Cer	E.s (ksf)	E.s (psf)
Granular Fill:	591	ft									6600							
GWT:	577	ft	y.w	62.4	pcf													
Clay I:	542	ft	y.c1	130	pcf	e.0	0.9	0.25	1	s'p.1	6000	psf	C.c.1	0.251	0.13	C.r.1	0.064	0.034	1200	1200000
Clay II:	532	ft	y.c2	130	pcf	e.0	1	0.32	1	s'p.2	8200	psf	C.c.2	0.44	0.22	C.r.2	0.07	0.035	600	600000
Clay III:	517	ft	y.c3	130	pcf	e.0	1.2	0.41	1	s'p.3	8200	psf	C.c.3	0.409	0.19	C.r.3	0.09	0.041	1500	1500000
Bot. Clay III:	492	ft	y.gr.f	130	pcf													
Sediment:	575	ft	y.sed	80	pcf													
Top of Wall	591	ft																

Immediately after Dredging on Active Side

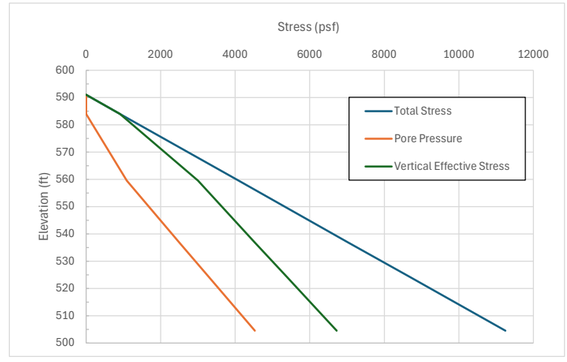
Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
559.5	Water	577	542	35	17.5	17.5	1092	1092	0	-
537	Clay I	542	532	10	5	40	2834	2496	338	17.8
524.5	Clay II	532	517	15	7.5	52.5	4459	3276	1183	6.9
504.5	Clay III	517	492	25	12.5	72.5	7059	4524	2535	3.2



Calc:
- Immediate Settlement
- Consolidation of Clay Layers

Immediately after placement of Full Height of Granular Fill

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	Delta Vertical Stress (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	910	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	3003	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40	7020	2496	4524	4186	1.3	54	2.3
524.5	Clay II	532	517	15	7.5	14.83	7.42	52.5	8645	3276	5369	4186	1.5	66.5	2.0
504.5	Clay III	517	492	25	12.5	24.91	12.46	72.5	11245	4524	6721	4186	1.2	86.5	2.6
														Σ (in)	**6.9**



Case III - X =10FT

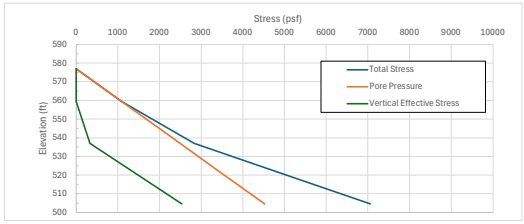
Evaluate vertical effective stress immediately after placement of Limestone Stockpile

L.stone: 4000 psf Poisson's Ratio: 0.49 Width, B (ft): 75

Layer Elevations			Unit Weights			Initial Void Ratio		u1	u0	P'c (psf)			C.c		Cec	C.r		Cer	E.s (ksf)	E.s (psf)
Granular Fill:	591	ft									6600									
GWT:	577	ft	y.w	62.4	pcf															
Clay I:	542	ft	y.c1	130	pcf	e.0	0.9	0.25	1	s'p.1	6000	psf	C.c.1	0.251	0.13	C.r.1	0.064	0.034	1200	1200000
Clay II:	532	ft	y.c2	130	pcf	e.0	1	0.32	1	s'p.2	8200	psf	C.c.2	0.44	0.22	C.r.2	0.07	0.035	600	600000
Clay III:	517	ft	y.c3	130	pcf	e.0	1.2	0.41	1	s'p.3	8200	psf	C.c.3	0.409	0.19	C.r.3	0.09	0.041	1500	1500000
Bot. Clay III:	492	ft	y.gr.f	130	pcf															
Sediment:	575	ft	y.sed	80	pcf															
Top of Wall	591	ft																		

Immediately after Dredging on Active Side

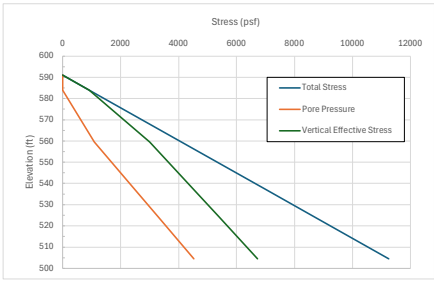
Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
559.5	Water	577	542	35	17.5	17.5	1092	1092	0	-
537	Clay I	542	532	10	5	40	2834	2496	338	17.8
524.5	Clay II	532	517	15	7.5	52.5	4459	3276	1183	6.9
504.5	Clay III	517	492	25	12.5	72.5	7059	4524	2535	3.2



Calc:
- Immediate Settlement
- Consolidation of Clay Layers

Immediately after placement of Full Height of Granular Fill

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	Delta Vertical Stress (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	910	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	3003	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40	7020	2496	4524	4186	1.3	54	2.3
524.5	Clay II	532	517	15	7.5	14.83	7.42	52.5	8645	3276	5369	4186	1.5	66.5	2.0
504.5	Clay III	517	492	25	12.5	24.91	12.46	72.5	11245	4524	6721	4186	1.2	86.5	2.6
														Σ (in)	**6.9**



Immediately after placement of Limestone Stockpile Surcharge (X = 10FT)

Semi-Infinite Uniform Load

	Clay I	Clay II	Clay III
X	10	10	10
Z	54	66.5	86.5
R	54.92	66.9	87
B	10.49	8.6	6.6

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Delta Vertical Stress (psf)	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	-	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	-	-	-	-	-
537	Clay I	542	532	9.93	4.97	9.72	4.86	40.0	7020	2496	13584	18108	0.33		0.4
524.5	Clay II	532	517	14.83	7.42	14.39	7.19	52.4	8645	3276	11139	16508	0.50		0.8
504.5	Clay III	517	492	24.91	12.46	24.74	12.37	72.2	11245	4524	8549	15270	0.54		0.9
														Σ (in)	**2.1**

Case III - X =35FT

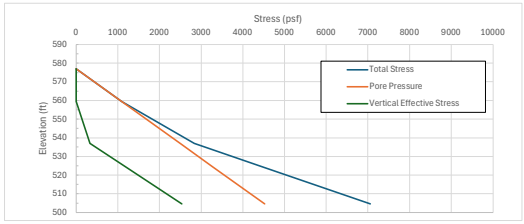
Evaluate vertical effective stress immediately after placement of Limestone Stockpile

L.stone: 4000 psf Poisson's Ratio: 0.49 Width, B (ft): 75

Layer Elevations			Unit Weights			Initial Void Ratio		u1	u0	P'c (psf)			C.c	Cec	C.r	Cer	E.s (ksf)	E.s (psf)
Granular Fill:	591	ft									6600							
GWT:	577	ft	y.w	62.4	pcf													
Clay I:	542	ft	y.c1	130	pcf	e.0	0.9	0.25	1	s'p.1	6000	psf	C.c.1	0.251	0.13	C.r.1	0.064	0.034	1200	1200000
Clay II:	532	ft	y.c2	130	pcf	e.0	1	0.32	1	s'p.2	8200	psf	C.c.2	0.44	0.22	C.r.2	0.07	0.035	600	600000
Clay III:	517	ft	y.c3	130	pcf	e.0	1.2	0.41	1	s'p.3	8200	psf	C.c.3	0.409	0.19	C.r.3	0.09	0.041	1500	1500000
Bot. Clay III:	492	ft	y.gr.f	130	pcf															
Sediment:	575	ft	y.sed	80	pcf															
Top of Wall	591	ft																		

Immediately after Dredging on Active Side

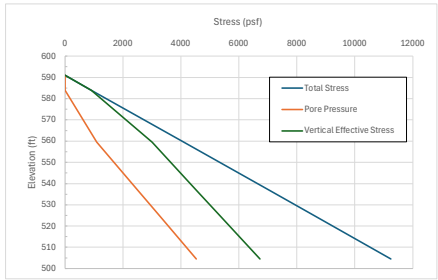
Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
559.5	Water	577	542	35	17.5	17.5	1092	1092	0	-
537	Clay I	542	532	10	5	40	2834	2496	338	17.8
524.5	Clay II	532	517	15	7.5	52.5	4459	3276	1183	6.9
504.5	Clay III	517	492	25	12.5	72.5	7059	4524	2535	3.2



Calc:
- Immediate Settlement
- Consolidation of Clay Layers

Immediately after placement of Full Height of Granular Fill

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	Delta Vertical Stress (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	910	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	3003	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40	7020	2496	4524	4186	1.326	54	2.3
524.5	Clay II	532	517	15	7.5	14.83	7.42	52.5	8645	3276	5369	4186	1.527	66.5	2.0
504.5	Clay III	517	492	25	12.5	24.91	12.46	72.5	11245	4524	6721	4186	1.220	86.5	2.6
														Σ (in)	**6.9**



Immediately after placement of Limestone Stockpile Surcharge (X = 35FT)

Semi-Infinite Uniform Load

	Clay I	Clay II	Clay III
X	35	35	35
Z	54	66.5	86.5
R	64.4	75.2	93.3
B	32.9	27.8	22

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Delta Vertical Stress (psf)	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	-	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	-	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40.0	7020	2496	42470	46994	0.128		0.6
524.5	Clay II	532	517	14.83	7.42	13.40	6.70	52.4	8645	3276	35920	41289	0.199		1.3
504.5	Clay III	517	492	24.91	12.46	24.33	12.17	72.2	11245	4524	28454	35175	0.233		1.7
														Σ (in)	**3.5**

Case III - X =60FT

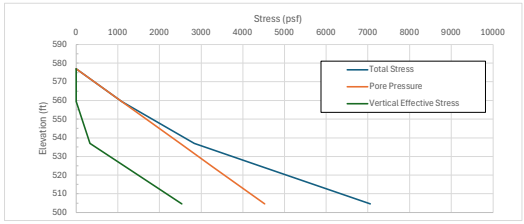
Evaluate vertical effective stress immediately after placement of Limestone Stockpile

L.stone: 4000 psf Poisson's Ratio: 0.49 Width, B (ft): 75

Layer Elevations			Unit Weights			Initial Void Ratio		u1	u0	P'c (psf)			C.c		Cec		C.r		Cer	E.s (ksf)	E.s (psf)
Granular Fill:	591	ft									6600										
GWT:	577	ft	y.w	62.4	pcf																
Clay I:	542	ft	y.c1	130	pcf	e.0	0.9	0.25	1	s'p.1	6000	psf	C.c.1	0.251	0.13		C.r.1	0.064	0.034	1200	1200000
Clay II:	532	ft	y.c2	130	pcf	e.0	1	0.32	1	s'p.2	8200	psf	C.c.2	0.44	0.22		C.r.2	0.07	0.035	600	600000
Clay III:	517	ft	y.c3	130	pcf	e.0	1.2	0.41	1	s'p.3	8200	psf	C.c.3	0.409	0.19		C.r.3	0.09	0.041	1500	1500000
Bot. Clay III:	492	ft	y.gr.f	130	pcf																
Sediment:	575	ft	y.sed	80	pcf																
Top of Wall	591	ft																			

Immediately after Dredging on Active Side

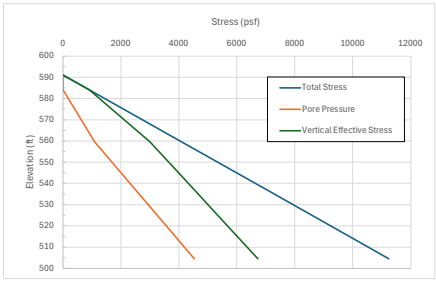
Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)
577	Water	-	-	-	-	0	0	0	0	-
559.5	Water	577	542	35	17.5	17.5	1092	1092	0	-
537	Clay I	542	532	10	5	40	2834	2496	338	17.8
524.5	Clay II	532	517	15	7.5	52.5	4459	3276	1183	6.9
504.5	Clay III	517	492	25	12.5	72.5	7059	4524	2535	3.2



Calc:
- Immediate Settlement
- Consolidation of Clay Layers

Immediately after placement of Full Height of Granular Fill

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Vertical Effective Stress @ Midpoint (psf)	Delta Vertical Stress (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	910	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	3003	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40	7020	2496	4524	4186	1.326	54	2.3
524.5	Clay II	532	517	15	7.5	14.83	7.42	52.5	8645	3276	5369	4186	1.527	66.5	2.0
504.5	Clay III	517	492	25	12.5	24.91	12.46	72.5	11245	4524	6721	4186	1.220	86.5	2.6
														Σ (in)	**6.9**



Immediately after placement of Limestone Stockpile Surcharge (X = 60FT)

Semi-Infinite Uniform Load

	Clay I	Clay II	Clay III
X	60	60	60
Z	54	66.5	86.5
R	80.7	89.6	105.3
B	48	42.1	34.8

Elevation @ Midpoint (ft)	Layer	Top of Layer (El - ft)	Bottom of Layer (El - ft)	Full Ht (ft)	H.0 (ft)	Full Ht after Immediate Settlement (ft)	H0 after Immediate Settlement (ft)	Ht of Pore Water @ Midpoint (ft)	Total Vertical Stress @ Midpoint (psf)	Pore Pressure @ Midpoint	Delta Vertical Stress (psf)	Vertical Effective Stress @ Midpoint (psf)	**in situ** OCR (-)	Depth from Base of Applied Load to Midpoint (ft)	Primary Consolidation (in)
591	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
584	Gr. Fill (unsat.)	591	577	14	7	-	-	0	910	0	-	-	-	-	-
559.5	Gr. Fill (sat.)	577	542	35	17.5	-	-	17.5	4095	1092	-	-	-	-	-
537	Clay I	542	532	10	5	9.93	4.97	40.0	7020	2496	61749	66273	0.091		0.6
524.5	Clay II	532	517	14.83	7.42	12.66	6.33	52.4	8645	3276	54236	59605	0.138		1.4
504.5	Clay III	517	492	24.91	12.46	23.99	12.00	72.2	11245	4524	44905	51626	0.159		2.0
														Σ (in)	**4.0**

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	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
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APPENDIX F: SEISMIC EVALUATION

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				Rev. No.	
	Client	BROWN COUNTY WI			
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Seismic Evaluation

The purpose of this analysis was to perform a comparative analysis of the lateral loads imparted on the dockwall due to surcharge live loads and seismic activity. The Green Bay area is a low seismicity zone with mapped ground accelerations of less than 5%g. Our evaluation was based on guidance from UFC 4-152-01 Design of Piers and Wharves which provides a more appropriate means to evaluate marine terminal facilities.

Ground accelerations were based on the mapped values in ASCE7-10 and amplified for Site Class E soils (soft clay). We assumed 100% of this design acceleration for this evaluation (ASCE7-10 permits the design acceleration to be 2/3 of the modified ground acceleration).

Lateral earth pressures during a seismic event were based on the theory developed by Mononobe-Okabe. These equations were modified for partial submergence of the fill materials behind the wall.

Based on UFC 4-152-01 Design of Piers and Wharves ASD load combinations, static load cases will govern the total lateral load on the dockwall. Therefore, only static load conditions have been included as part of the dockwall analyses.

Signature Block & Record of Revisions

Rev.	Description	Code	Pages/Sections	Signature	Date
0	For Internal Review	P	All	A. Gradeski	10/18/24
		C	All		
		A	All		

Codes: P = Prepared; C = Checked; A = Approved

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Seismic Loading

References

- GEI Memo - Seismic Design for Gravity Retaining Walls
- UFC 4-152-01: Design Piers and Wharves
- ASCE7-10 Minimum Design Loads for Buildings and Other Structures

Input Data

Top of Wall Elevation:	$TOW := 591.0ft$	
Bottom of Wall Elevation:	$BOW := 540ft$	*Tip of sheet piles assumed*
Average Angle of Internal Friction:	$\phi := 24°$	*Minimum value for all clay layers assumed*
Dry Soil Thickness:	$h_{dry} := TOW - 576.0ft = 15.00 \cdot ft$	
Submerged Soil Thickness:	$h_{sub} := 576.0ft - BOW = 36.00 \cdot ft$	
Height of Backfill:	$H := h_{dry} + h_{sub} = 51.00 \cdot ft$	
Interface Friction Angle:	$\delta := 0deg$	
Unit Weight of Water:	$\gamma_w := 62.4pcf \cdot g$	
Unit Weight of Soil - Dry:	$\gamma_{rf,dry} := 130pcf \cdot g$	
Unit Weight of Soil - Submerged:	$\gamma_{rf,sub} := 130pcf \cdot g$	
Unit Weight of Soil - Bouyant:	$\gamma_{rf,buy} := \gamma_{rf,sub} - \gamma_w = 67.60 \cdot pcf \cdot g$	
Peak Ground Acceleration:	$PGA_{Des} := 0.061$	*ASCE7-10 Site Class E*
Horizontal Seismic Coefficient:	$k_h := PGA_{Des} = 0.061$	*Conservatively use 100%g*
Vertical Seismic Coefficient:	$k_v := 0$	
Back Face Batter:	$\theta := 0°$	
Backslope Angle:	$\beta := 0deg$	

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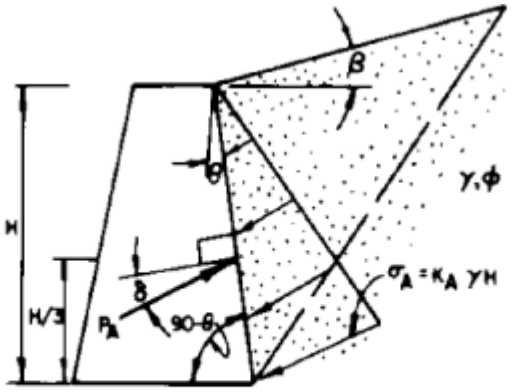
Weighted Average of Effective Unit Weight: $\gamma'_{avg} := \gamma_{rf,dry} \cdot \left(1 - \frac{h_{sub}^2}{H^2}\right) + \gamma_{rf,buy} \cdot \left(\frac{h_{sub}^2}{H^2}\right)$

Refer to GEI Memo "Seismic Design for Gravity Retaining Walls"

$\gamma'_{avg} = 98.91 \cdot pcf \cdot g$

Design Horizontal Seismic Coefficient: $k_{h,des} := \frac{\gamma_{rf,dry}}{\gamma'_{avg}} \cdot k_h = 0.080$



$$K_A = \frac{\cos^2(\phi-\theta)}{\cos^2\theta\cos(\theta+\delta)\left[1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\cos(\theta+\delta)\cos(\theta-\beta)}}\right]^2}$$

Calculation of Active Earth Pressure using Coulomb Theory

Earth Pressure Coefficient:

$$K_a := \frac{(\cos(\phi-\theta))^2}{(\cos(\theta))^2 \cdot \cos(\theta+\delta) \cdot \left(1+\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi-\beta)}{\cos(\theta+\delta)\cdot\cos(\theta-\beta)}}\right)^2}$$

$K_a = 0.422$

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Static Soil Pressures:

Effective Vertical Earth Pressues...

At Grade: $\sigma'_{v1} := 0psf$

At Waterline: $\sigma'_{v2} := h_{dry} \cdot \gamma_{rf,dry} = 1950.0 \cdot psf$

At Wall Base: $\sigma'_{v3} := \sigma'_{v2} + h_{sub} \cdot \gamma_{rf,buy} = 4383.6 \cdot psf$

Lateral Earth Pressures...

At Grade: $\sigma'_{h1} := \sigma'_{v1} \cdot K_a = 0.0$

At Waterline: $\sigma'_{h2} := \sigma'_{v2} \cdot K_a = 822.4 \cdot psf$

At Wall Base: $\sigma'_{h3} := \sigma'_{v3} \cdot K_a = 1848.7 \cdot psf$

Static Dry Soil Resultant Load: $P_1 := 0.5 \cdot \sigma'_{h2} \cdot h_{dry}$ $P_1 = 6.2 \cdot klf$

Static Submerged Resultant Load: $P_2 := 0.5 \cdot \left(\sigma'_{h2} + \sigma'_{h3}\right) \cdot h_{sub}$ $P_2 = 48.1 \cdot klf$

Active Force (inclined at an angle of δ from the face): $P_a := P_1 + P_2$ $P_a = 54.2 \cdot klf$

Normal Force (normal to back face of wall): $P_{a\_n} := P_a \cdot \cos(\delta)$ $P_{a\_n} = 54.2 \cdot klf$

Tangential Force (tangential to back face of wall): $P_{a\_t} := P_a \cdot \sin(\delta)$ $P_{a\_t} = 0.0 \cdot klf$

Horizontal Component: $P_{a\_h} := P_a \cdot \cos(\theta + \delta)$ $P_{a\_h} = 54.2 \cdot klf$

Vertical Component: $P_{a\_v} := P_a \cdot \sin(\theta + \delta)$ $P_{a\_v} = 0.0 \cdot klf$

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Calculation of Seismic Earth Pressure using Mononobe-Okabe Equation

Angle of Resultant Acceleration (from vertical): $\Psi := \operatorname{atan}\left(\frac{k_{h,des}}{1 - k_v}\right)$ $\Psi = 4.58 \cdot °$

Earth Pressure Coefficient:

$$K_{ae} := \frac{(\cos(\phi - \Psi - \theta))^2}{\cos(\Psi)\cdot(\cos(\theta))^2 \cdot \cos(\theta + \delta + \Psi)\cdot\left(1 + \sqrt{\frac{\sin(\phi + \delta)\cdot\sin(\phi - \Psi - \beta)}{\cos(\theta + \delta + \Psi)\cdot\cos(\beta - \theta)}}\right)^2}$$

$K_{ae} = 0.478$

Total Force (Active + Earthquake)

Total Force (inclined at an angle of δ from the face): $P_{ae} := \frac{1}{2} K_{ae} \cdot \gamma'_{avg} \cdot H^2 \cdot (1 - k_v)$ $P_{ae} = 61.5 \cdot klf$

Normal Force (normal to back face of wall): $P_{ae\_n} := P_{ae} \cdot \cos(\delta)$ $P_{ae\_n} = 61.5 \cdot klf$

Tangential Force (tangential to back face of wall): $P_{ae\_t} := P_{ae} \cdot \sin(\delta)$ $P_{ae\_t} = 0.0 \cdot klf$

Horizontal Component: $P_{ae\_h} := P_{ae} \cdot \cos(\theta + \delta)$ $P_{ae\_h} = 61.5 \cdot klf$

Vertical Component: $P_{ae\_v} := P_{ae} \cdot \sin(\theta + \delta)$ $P_{ae\_v} = 0.0 \cdot klf$

Seismic Increment

Seismic Force (inclined at an angle of δ from the face): $P_e := P_{ae} - P_a$ $P_e = 7.3 \cdot klf$

Normal Force (normal to back face of wall): $P_{e\_n} := P_{ae\_n} - P_{a\_n}$ $P_{e\_n} = 7.3 \cdot klf$

Tangential Force (tangential to back face of wall): $P_{e\_t} := P_{ae\_t} - P_{a\_t}$ $P_{e\_t} = 0.0 \cdot klf$

Horizontal Component: $P_{e\_h} := P_{ae\_h} - P_{a\_h}$ $P_{e\_h} = 7.3 \cdot klf$

Vertical Component: $P_{e\_v} := P_{ae\_v} - P_{a\_v}$ $P_{e\_v} = 0.0 \cdot klf$

Resultant Location: $y := 0.6 \cdot H$ $y = 30.60 \cdot ft$

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Calculation of Active Load due to 500 psf surcharge load

$$P_q := K_a \cdot 500\,psf \cdot H = 10.75 \cdot klf$$

Load Combination Analysis

THe load combinations provided in UFC 4-152-01 are used for this analysis in leiue of those presented in ASCE7-10. This load combinations are considered more appropriate for a marine facility and recognize all the loads which could be expected at a marine terminal (whereas ASCE7 does not)

Table 3-8 Load Combinations - Allowable Stress Design (ASD)

Load	S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
D [a]	1.0	1.0	1.0	1.0	1.0	1.0	1+k'	1-k'	1.0	1.0
$(L_c+l)\|L_u$	-	1.0	-	1.0	-	1.0	0.1	-	1.0	0.75
B	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	1.0	1.0
Be	-	-	1.0	-	-	-	-	-	-	-
C	-	-	1.0	1.0	1.0	1.0	-	-	1.0	1.0
H [d]	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Eq	-	-	-	-	-	-	0.7	0.7	-	-
W	-	-	-	-	0.6	-	-	-	-	0.6
M	-	-	-	-	-	1.0	-	-	-	-
R+S+T	-	-	-	1.0	-	-	-	-	-	-
Ice	-	-	-	0.2	-	-	-	-	0.7	0.7

Notes:

[a] 0.9 (0.6 ASD) for checking members for minimum axial load and maximum moment.
[b] 1.3 for the maximum outrigger float load from a truck crane.
[c] Accidental Berthing: 1.2 support structure, 1.0 fender system components.
[d] Where the effect of H resists the primary variable load effect, a load factor of 0.9 (0.6 for ASD) shall be included with H where H is permanent and H shall be set to zero for all other conditions.

Combination S1: $S_1 := 1.0 \cdot P_{a\_h} = 54.2\,klf$

Combination S3: $S_3 := 1.0 \cdot P_{a\_h} + 1.0 P_q = 65.0\,klf$

Combination S6: $S_6 := 1.0 \cdot P_{a\_h} + 0.1 P_q + 0.7 \cdot P_{e\_h} = 60.4\,klf$

Combination S7: $S_6 := 1.0 \cdot P_{a\_h} + 0.7 \cdot P_{e\_h} = 59.3\,klf$

Lateral load on the dockwall is governed by the static load combinations (S1 and S3). Additionally note that the lateral load due the 500 PSF surcharge load is nearly 50% greater than lateral seismic load. Only static load cases/combinations will be considered for design of the dockwall.

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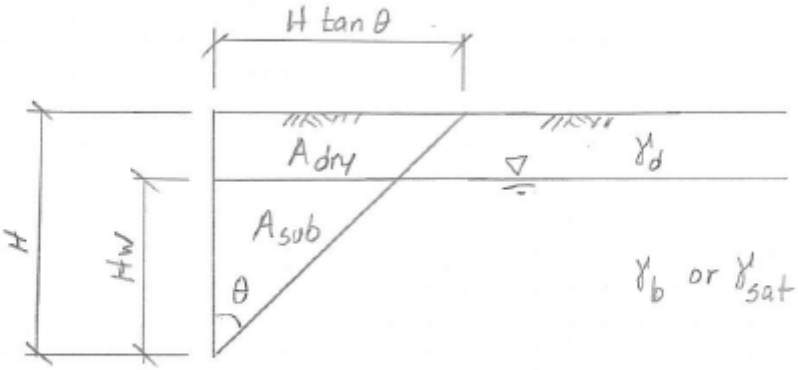
Calculation of weighted average γ for partial submergence:



$$A_{tot} = \frac{1}{2}(H)(H\tan\theta) = \frac{1}{2}H^2\tan\theta$$

$$A_{sub} = \frac{1}{2}(H_w)(H_w\tan\theta) = \frac{1}{2}H_w^2\tan\theta$$

$$A_{dry} = \frac{1}{2}H^2\tan\theta - \frac{1}{2}H_w^2\tan\theta = \frac{1}{2}(H^2-H_w^2)\tan\theta$$

$$\frac{A_{dry}}{A_{tot}} = \frac{\frac{1}{2}(H^2-H_w^2)\tan\theta}{\frac{1}{2}H^2\tan\theta} = 1-\frac{H_w^2}{H^2}$$

$$\frac{A_{sub}}{A_{tot}} = \frac{\frac{1}{2}H_w^2\tan\theta}{\frac{1}{2}H^2\tan\theta} = \frac{H_w^2}{H^2}$$

$$\gamma_{b\text{-}av} = \gamma_d\left(1-\frac{H_w^2}{H^2}\right)+\gamma_b\left(\frac{H_w^2}{H^2}\right) = \gamma_d\left(1-\frac{12.5^2}{16^2}\right)+\gamma_b\left(\frac{12.5^2}{16^2}\right)$$

$$= 0.390\,\gamma_d + 0.610\,\gamma_b$$

$$= 0.39(18.0)+0.61(10.5)$$

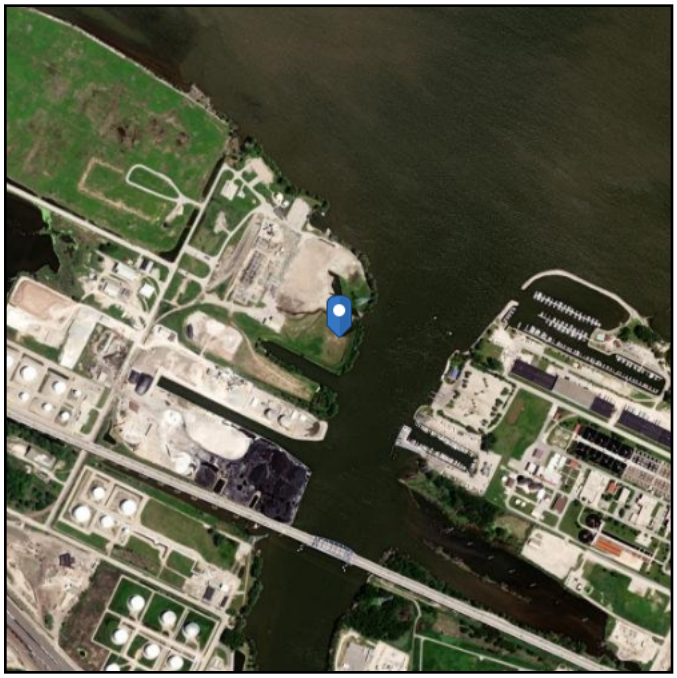
$$= 13.43$$

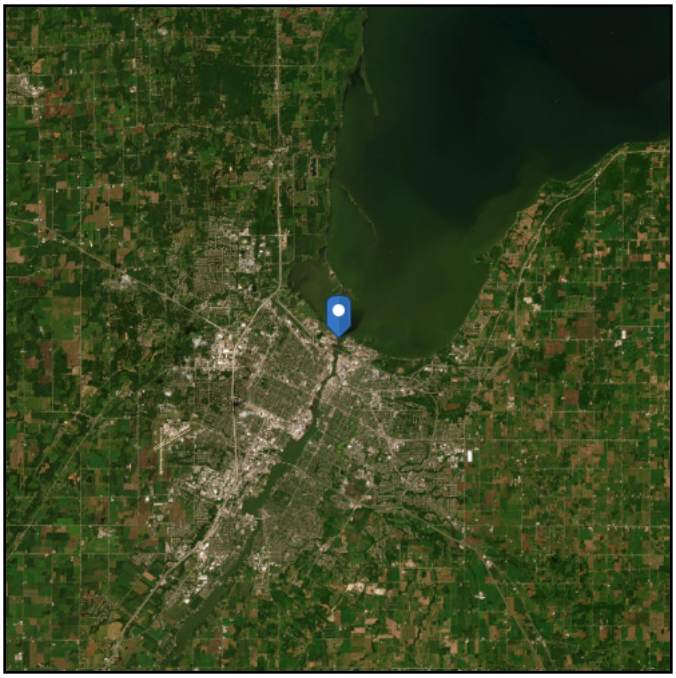
$$\gamma_{t\text{-}av} = 0.39(\gamma_d)+0.61(\gamma_{sat}) = 0.39(18.0)+0.61(20.5) = 19.53$$

ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-10	**Latitude:**	44.53877
Risk Category:	II	**Longitude:**	-88.007404
Soil Class:	E - Soft Clay Soil	**Elevation:**	583.9394583546972 ft (NAVD 88)





Wind

Results:

Wind Speed	115 Vmph
10-year MRI	75 Vmph
25-year MRI	84 Vmph
50-year MRI	90 Vmph
100-year MRI	96 Vmph

Data Source: ASCE/SEI 7-10, Fig. 26.5-1A and Figs. CC-1–CC-4, and Section 26.5.2, incorporating errata of March 12, 2014

Date Accessed: Fri Dec 13 2024

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-10 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2.

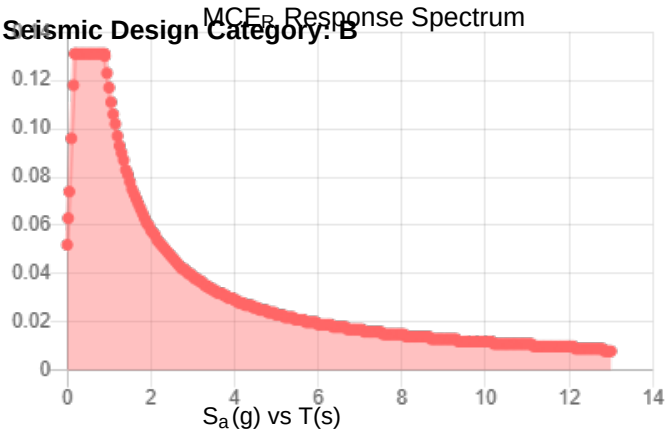
Seismic

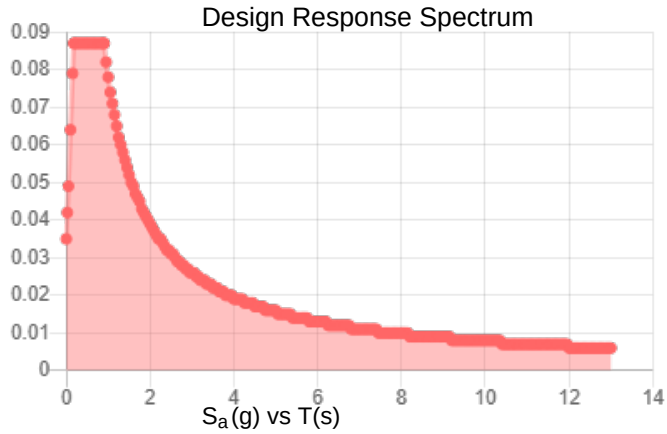
Site Soil Class: E - Soft Clay Soil

Results:

S_S :	0.052	S_{D1} :	0.078
S_1 :	0.033	T_L :	12
F_a :	2.5	PGA :	0.024
F_v :	3.5	PGA_M :	0.061
S_{MS} :	0.131	F_{PGA} :	2.5
S_{M1} :	0.117	I_e :	1
S_{DS} :	0.087		

Seismic Design Category: B





Data Accessed: **Fri Dec 13 2024**

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-10, incorporating Supplement 1 and errata of March 31, 2013, and ASCE/SEI 7-10 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-10 Ch. 21 are available from USGS.

Ice

Results:

Ice Thickness:	0.50 in.
Concurrent Temperature:	-5 F
Gust Speed	50 mph
Data Source:	Standard ASCE/SEI 7-10, Figs. 10-2 through 10-8
Date Accessed:	Fri Dec 13 2024

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 50-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Snow

Results:

Ground Snow Load, p_g:	40 lb/ft^2
Mapped Elevation:	583.9 ft
Data Source:	ASCE/SEI 7-10, Fig. 7-1.
Date Accessed:	Fri Dec 13 2024

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported ‘elevation’ and ‘mapped elevation’ differ significantly from each other.

Flood

Results:

Flood Zone Categorization:	X (unshaded)
Base Flood Elevation:	Refer to map for local elevations and interpolate according to the Authority Having Jurisdiction.
Data Source:	FEMA National Flood Hazard Layer - Effective Flood Hazard Layer for US, where modernized (https://msc.fema.gov/portal/search)
Date Accessed:	Fri Dec 13 2024
FIRM Panel:	If available, download FIRM panel here
Insurance Study Note:	Download FEMA Flood Insurance Study for this area here

The ASCE Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	

Project No.	2201593	Document No.	N/A
Subject	Port Property Development – Dock Wall Design		

ATTACHMENT 1: NUCOR SKYLINE STEEL CUTSHEET

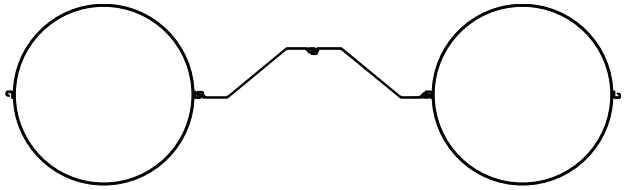
TECHNICAL PRODUCT MANUAL

2024 EDITION

NUCOR®

SKYLINE

Pipe-Z with E22 Connector System*



Pipe Diameter	Wall Thickness	Intermediary Sheet Pile	Sheet Pile Connector	System Width	Moment of Inertia	Section Modulus	Weight (NZ Length / Pipe Length)			Cross Sectional Area
							100%	80%	60%	
in mm	in mm			in mm	in⁴/ft cm⁴/m	in³/ft cm³/m	lb/ft² kg/m²	lb/ft² kg/m²	lb/ft² kg/m²	in²/ft cm²/m
36 914	0.375 9.5	NZ 14	E22	99.19 2519.4	911 124341	50.6 2720	32.2 157.5	29.3 142.8	26.3 128.2	8.99 190.3
36 914	0.438 11.1	NZ 19	E22	93.68 2379.4	1158 158082	64.3 3458	37.2 181.5	34.0 166.1	30.8 150.6	10.43 220.7
42 1067	0.500 12.7	NZ 14	E22	105.19 2671.8	1700 232167	81.0 4353	39.4 192.5	36.6 178.7	33.8 164.9	11.13 235.5
42 1067	0.563 14.3	NZ 19	E22	99.68 2531.8	2051 280023	97.6 5250	44.9 219.3	41.9 204.8	39.0 190.2	12.73 269.5
48 1219	0.563 14.3	NZ 14	E22	111.19 2824.2	2641 360648	110.0 5916	44.2 215.7	41.5 202.6	38.8 189.6	12.54 265.5
48 1219	0.625 15.875	NZ 19	E22	105.68 2684.2	3112 424898	129.6 6970	50.0 244.1	47.2 230.4	44.4 216.7	14.25 301.6
54 1372	0.625 15.9	NZ 19	E22	111.68 2836.6	4150 566773	153.7 8265	51.6 252.0	49.0 239.0	46.3 226.1	14.75 312.2
54 1372	0.688 17.5	NZ 26	E22	111.68 2836.6	4607 629086	170.6 9173	58.9 287.4	55.5 271.1	52.2 254.7	16.86 356.9
60 1524	0.688 17.5	NZ 19	E22	117.68 2989.0	5882 803218	196.1 10541	57.1 278.8	54.6 266.5	52.1 254.2	16.38 346.8
60 1524	0.750 19.1	NZ 26	E22	117.68 2989.0	6445 880060	214.8 11550	64.3 314.1	61.1 298.6	58.0 283.1	18.49 391.3
66 1676	0.750 19.1	NZ 19	E22	123.68 3141.4	8066 1101454	244.4 13141	62.8 306.5	60.4 294.7	58.0 283.0	18.07 382.4
66 1676	0.813 20.7	NZ 26	E22	123.68 3141.4	8769 1197480	265.7 14287	70.1 342.2	67.1 327.4	64.0 312.7	20.20 427.6
72 1829	0.813 20.7	NZ 26	E22	129.68 3293.8	10838 1479947	301.0 16185	71.7 349.9	68.8 335.8	65.9 321.8	20.68 437.8
72 1829	0.875 22.2	NZ 26	E22	129.68 3293.8	11621 1586893	322.8 17355	76.0 371.0	73.1 356.9	70.2 342.8	21.95 464.6
78 1981	0.875 22.2	NZ 26	E22	135.68 3446.2	14114 1927403	361.9 19457	77.6 378.8	74.8 365.4	72.1 351.9	22.44 475.0
78 1981	0.938 23.8	NZ 26	E22	135.68 3446.2	15082 2059540	386.7 20791	82.1 401.0	79.4 387.5	76.6 374.1	23.77 503.2
84 2134	0.938 23.8	NZ 26	E22	141.68 3598.6	18045 2464133	429.6 23099	83.7 408.9	81.1 396.0	78.5 383.1	24.26 513.6
84 2134	1.000 25.4	NZ 26	E22	141.68 3598.6	19184 2619754	456.8 24558	88.3 431.4	85.7 418.5	83.1 405.6	25.62 542.2

* Additional combinations are available upon request.

PIPE COMBINED WALLS

SPECIFICATIONS

Manufacturing Specifications	Yield Strength		PIPE	NZ, PZ, & WF
	ksi	MPa		
A252 Grade 3 (50 ksi)	50	345	✔	
A252 Grade 3 (60 ksi)	60	415	✔	

Steel Specifications	Yield Strength		PIPE	NZ, PZ, & WF
	ksi	MPa		
A572 Grade 60	60	415	✔	✔
A690	50	345	✔	✔

For a complete list of steel grades see page 46. For availability of other yield strengths please, contact Nucor Skyline.

DELIVERY CONDITIONS & TOLERANCES

SHEET PILE	ASTM A6	EN10248
Mass	± 2.5%	± 5%
Length	+ 5 in.	± 200 mm
Height		± 7 mm
Thickness		≤ 8.5 mm > 8.5 mm
Width		± 2%
Double Pile Width		± 3%
Straightness		0.2% of the length
Ends out of Square		2% of the width

PIPE	A139	A252	A500	A1085	AWWA C200
Outside Diameter	± 1%	± 1%	± 0.75%	± 0.75%	+1/8" / -1/16"
Thickness	- 12.5%	- 12.5%	±10%	+10% / -5%	+10%[§]
Weight	+10% / -5%	+10% / -5%	±10%	+10% / -3.5%	+10% / -5%
Length	± ½"	± 1"	+¾" / -¼"	+¾" / -¼"	± 2"

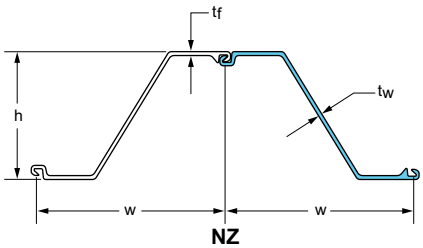
**Different conditions and tolerances vary based on diameter, length, and project requirements. Please inquire for additional information.
§ Lowest of value of applicable ASTM tolerance, 0.01 inch, or 6% percent of the nominal thickness.

MAXIMUM ROLLED LENGTHS†

E22	59 ft.	18.0 m
NZ & PZ	105 ft.	32.0 m

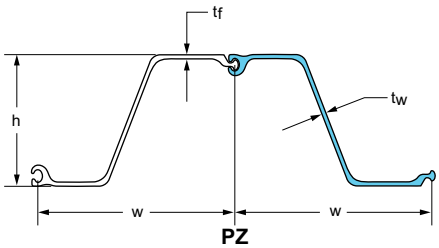
	12" OD and Under		12.75" OD and Over	
Spiralweld / Rolled & Welded	90 ft.	27.4 m	115 ft.	31.1 m

† All sections are readily spliced for longer lengths.



NZ

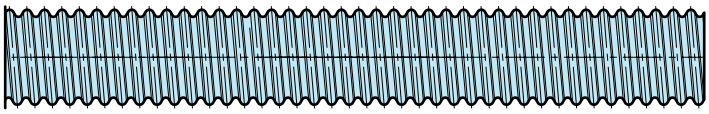
SECTION	Width (w) in mm	Height (h) in mm	THICKNESS Flange (t_f) in mm	THICKNESS Web (t_w) in mm	Cross Sectional Area in²/ft cm²/m	WEIGHT Single Pile lb/ft kg/m	WEIGHT Wall Area lb/ft² kg/m²	SECTION MODULUS Elastic in³/ft cm³/m	SECTION MODULUS Plastic in³/ft cm³/m	Moment of Inertia in⁴/ft cm⁴/m	COATING AREA Both Sides ft²/ft of single m²/m	COATING AREA Wall Surface ft²/ft² m²/m²
NZ 14	30.31 770	13.39 340	0.375 9.5	0.375 9.5	6.40 135.4	55 81.26	21.77 106.30	25.65 1379	30.50 1640	171.7 23447	6.10 1.86	1.20 1.20
NZ 19	27.56 700	16.14 410	0.375 9.5	0.375 9.5	7.07 149.6	55 81.85	24.05 117.40	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 411	0.394 10.0	0.394 10.0	7.34 155.4	57 85.37	24.82 122.00	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 412	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.70	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 22	27.56 700.0	16.25 413.0	0.480 12.20	0.480 12.20	8.57 181.4	67 99.71	29.20 142.44	41.47 2230	49.34 2653	336.9 46006	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440	0.500 12.7	0.500 12.7	9.08 192.2	71 105.66	30.99 151.30	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41
NZ 28	27.56 700	17.38 441	0.560 14.2	0.560 14.2	9.98 211.2	78 116.08	33.96 165.82	52.62 2829	62.16 3342	457.4 62461	6.49 1.98	1.41 1.41
NZ 38	27.56 700	19.69 500	0.689 17.5	0.500 12.7	11.00 232.9	86 127.99	37.45 182.83	70.84 3809	81.57 4386	697.3 95214	6.58 2.01	1.43 1.43
NZ 40	27.56 700.0	19.73 501.0	0.735 18.70	0.551 14.00	11.77 249.1	92 136.91	40.06 195.59	74.97 4031	86.75 4664	739.6 100997	6.58 2.01	1.43 1.43
NZ 42	27.56 700.0	19.77 502.0	0.769 19.50	0.589 15.0	12.41 262.7	97 144.36	42.24 206.23	78.17 4203	90.80 4881	772.5 105490	6.58 2.01	1.43 1.43

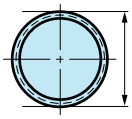


PZ

SECTION	Width (w) in mm	Height (h) in mm	THICKNESS Flange (t_f) in mm	THICKNESS Web (t_w) in mm	Cross Sectional Area in²/ft cm²/m	WEIGHT Single Pile lb/ft kg/m	WEIGHT Wall Area lb/ft² kg/m²	SECTION MODULUS Elastic in³/ft cm³/m	SECTION MODULUS Plastic in³/ft cm³/m	Moment of Inertia in⁴/ft cm⁴/m	COATING AREA Both Sides ft²/ft of single m²/m	COATING AREA Wall Surface ft²/ft² m²/m²
PZ 22	22.00 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.00 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.64 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.69 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

FULLY THREADED BAR





Grade 80 ksi Yield Strength / 100 ksi Ultimate Strength									
Bar Designation	**Nominal Diameter** in mm	**Grade**	**Min. Net Area Thru Threads** in^2 mm^2	**Min. Ultimate Strength** kips kN	**Min. Yield Strength** kips kN	**Nominal Weight** lbs/ft kg/m	**Approx. Major Thread Diameter** in mm	**Thread Orientation**	**Max. Length** ft m
#18	2 ¼ 55	80	4.000 2581.0	400.0 1779	320.0 1423	13.60 20.2	2.438 62.0	Right Hand	60 18.3
#20	2 ½ 64	80	4.910 3168.0	491.0 2184	392.8 1747	16.69 24.8	2.750 70.0	Right Hand	60 18.3
#24	3 76	80	7.070 4561.0	707.0 3145	565.6 2516	24.10 35.9	3.250 82.6	Right Hand	60 18.3
#28	3 ½ 89	80	9.610 6200.0	961.0 4275	768.8 3420	32.70 48.7	3.750 95.3	Right Hand	60 18.3
#32	4 102	80	12.57 8107.0	1257.0 5590	1005.3 4472	42.75 63.6	4.125 104.8	Right Hand	40 12.2

Cold rolled threaded bars conform to the physical and chemical requirements of ASTM A615 Grade 80 ksi "Standard Specification for Deformed Carbon Steel Bars for Concrete Reinforcement".

Contact your sales representative for information on hot dip galvanized and epoxy coated bars.

Please note: As we continuously improve the design of our products, product details are subject to change.

GEI Consultants	Client	BROWN COUNTY WI			Page	
	Project	Port Property Development			Pg. Rev.	0
	By	E. Burton	Chk.	C. Englert	App.	A. Pepin
	Date	08/19/2025	Date		Date	
Project No.	2201593	Document No.	N/A			
Subject	Port Property Development – Dock Wall Design					

ATTACHMENT 2: AISC, 14TH EDITION

DENSITIES OF COMMON MATERIALS

STEEL CONSTRUCTION

MANUAL

AMERICAN INSTITUTE
OF
STEEL CONSTRUCTION

FOURTEENTH EDITION

Table 17-12
Densities of Common Materials

Substance	Weight lb per ft^3
ASHLAR, MASONRY	
Granite, syenite, gneiss	143 – 187
Limestone, marble	143 – 174
Sandstone, bluestone	131 – 150
MORTAR RUBBLE MASONRY	
Granite, syenite, gneiss	137 – 174
Limestone, marble	137 – 162
Sandstone, bluestone	125 – 137
DRY RUBBLE MASONRY	
Granite, syenite, gneiss	118 – 143
Limestone, marble	118 – 131
Sandstone, bluestone	112 – 118
BRICK MASONRY	
Pressed brick	137 – 143
Common brick	112 – 125
Soft brick	93.5 – 106
CONCRETE MASONRY	
Cement, stone, sand	137 – 150
Cement, slag, etc.	118 – 143
Cement, cinder, etc.	93.5 – 106
VARIOUS BUILDING MATERIALS	
Ashes, cinders	40.0 – 45.0
Cement, portland, loose	90.0
Cement, portland, set	168 – 199
Lime, gypsum, loose	53.0 – 64.0
Mortar, set	87.2 – 118
Slags, bank slag	67.0 – 72.0
Slags, bank screenings	98 – 117
Slags, machine slag	96.0
Slag, slag sand	49.0 – 55.0
EARTH, ETC., EXCAVATED	
Clay, dry	63.0
Clay, damp, plastic	110
Clay and gravel, dry	100
Earth, dry, loose	76.0
Earth, dry, packed	95.0
Earth, moist, loose	78.0
Earth, moist, packed	96.0
Earth, mud, flowing	108
Earth, mud, packed	115
Riprap, limestone	80.0 – 85.0
Riprap, sandstone	90.0
Riprap, shale	105
Sand, gravel, dry, loose	90.0 – 105
Sand, gravel, dry, packed	100 – 120
Sand, gravel, wet	118 – 120
EXCAVATIONS IN WATER	
Sand or gravel	60.0
Sand or gravel and clay	65.0
Clay	80.0
River mud	90.0
Soil	70.0
Stone riprap	65.0
MINERALS	
Asbestos	131 – 174
Barytes	280
Basalt	168 – 199
Bauxite	159
Borax	106 – 112
Chalk	112 – 162
Clay, marl	112 – 162
Dolomite	181
Feldspar, orthoclase	156 – 162
Gneiss, serpentine	150 – 168
Granite, syenite	156 – 193
Greenstone, trap	174 – 199
Gypsum, alabaster	143 – 174
Hornblende	187
Limestone, marble	156 – 174
Magnesite	187
Phosphate rock, apatite	199
Porphyry	162 – 181
Pumice, natural	23.1 – 56.1
Quartz, flint	156 – 174
Sandstone, bluestone	137 – 156
Shale, slate	168 – 181
Soapstone, talc	162 – 174
STONE, QUARRIED, PILED	
Basalt, granite, gneiss	96.0
Limestone, marble, quartz	95.0
Sandstone	82.0
Shale	92.0
Greenstone, hornblende	107
BITUMINOUS SUBSTANCES	
Asphaltum	68.5 – 93.5
Coal, anthracite	87.2 – 106
Coal, bituminous	74.8 – 93.5
Coal, lignite	68.5 – 87.2
Coal, peat, turf, dry	40.5 – 53
Coal, charcoal, pine	17.4 – 27.4
Coal, charcoal, oak	29.3 – 35.5
Coal, coke	62.3 – 87.2
Graphite	118 – 143
Paraffine	54.2 – 56.7
Petroleum	54.2
Petroleum, refined	49.2 – 51.1
Petroleum, benzine	45.5 – 46.7
Petroleum, gasoline	41.1 – 43
Pitch	66.7 – 71.6
Tar, bituminous	74.8
COAL AND COKE, PILED	
Coal, anthracite	47.0 – 58.0
Coal, bituminous, lignite	40.0 – 54.0

Table 17-12 (continued)
Densities of Common Materials

Substance	Weight lb per ft^3
Coal, peat, turf	20.0 – 26.0
Coal charcoal	10.0 – 14.0
Coal coke	23.0 – 32.0
METALS, ALLOYS, ORES	
Aluminum, cast, hammered	159 – 171
Brass, cast, rolled	523 – 542
Bronze, 7.9 to 14% Sn	461 – 554
Bronze, aluminum	480
Copper, cast, rolled	548 – 561
Copper ore, pyrites	255 – 268
Gold, cast, hammered	1200–1210
Iron, cast, pig	449
Iron, wrought	473 – 492
Iron, speigel–eisen	467
Iron, ferro–silicon	417 – 455
Iron ore, hematite	324
Iron ore, hematite in bank	160 – 180
Iron ore, hematite loose	130 – 160
Iron ore, limonite	224 – 249
Iron ore, magnetite	305 – 324
Iron slag	156 – 187
Lead	710
Lead ore, galena	455 – 473
Magnesium, alloys	108 – 114
Manganese	449 – 498
Manganese, ore, pyrolusite	231 – 287
Mercury	847
Monel Metal	548 – 561
Nickel	554 – 573
Platinum, cast, hammered	1310 – 1340
Silver, cast, hammered	648 – 668
Steel, rolled	490
Tin, cast, hammered	449 – 467
Tin ore, cassiterite	399 – 436
Zinc, cast, rolled	430 – 449
Zinc, ore, blende	243 – 262
VARIOUS SOLIDS	
Cereals, oats, bulk	32.0
Cereals, barley, bulk	39.0
Cereals, corn, rye, bulk	48.0
Cereals, wheat, bulk	48.0
Hay and Straw, bales	20.0
Cotton, Flax, Hemp	91.6 – 93.5
Fats	56.1 – 60.4
Flour, loose	24.9 – 31.2
Flour, pressed	43.6 – 49.8
Glass, common	150 – 162
Glass, plate or crown	153 – 169
Glass, crystal	181 – 187
Leather	53.6 – 63.5
Paper	43.6 – 71.6
Potatoes, piled	42.0
Rubber, caoutchouc	57.3 – 59.8
Rubber goods	62.3 – 125
Salt, granulated, piled	48.0
Saltpeter	67.0
Starch	95.3
Sulphur	120 – 129
Wool	82.2
TIMBER, U.S. SEASONED	
Moisture content by weight:	
Seasoned timber 15 to 20%	
Green timber up to 50%	
Ash, white, red	38.6 – 40.5
Cedar, white, red	19.9 – 23.7
Chestnut	41.1
Cypress	29.9
Fir, Douglas spruce	31.8
Fir, eastern	24.9
Elm, white	44.9
Hemlock	26.2 – 32.4
Hickory	46.1 – 52.3
Locust	45.5
Maple, hard	42.4
Maple, white	33.0
Oak, chestnut	53.6
Oak, live	59.2
Oak, red, black	40.5
Oak, white	46.1
Pine, Oregon	31.8
Pine, red	29.9
Pine, white	25.5
Pine, yellow, long–leaf	43.6
Pine, yellow, short–leaf	38.0
Poplar	29.9
Redwood, California	26.2
Spruce, white, black	24.9 – 28.7
Walnut, black	38.0
Walnut, white	25.5
VARIOUS LIQUIDS	
Alcohol, 100%	49.2
Acids, muriatic 40%	74.8
Acids, nitric 91%	93.5
Acids, sulphuric 87%	112
Lye, soda 66%	106
Oils, vegetable	56.7 – 58.6
Oils, mineral, lubricants	56.1 – 57.9
Water, 4°C max. density	62.3
Water, 100°C	59.7
Water, ice	54.8 – 57.3
Water, sea water	63.5 – 64.2
GASES	
Air, 0°C 760 mm	0.0871
Ammonia	0.0478
Carbon dioxide	0.123
Carbon monoxide	0.078
Gas, illuminating	0.028–0.036
Gas, natural	0.038–0.039
Hydrogen	0.00559
Nitrogen	0.0784
Oxygen	0.0892

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ATTACHMENT 3: WALLAP ANALYSIS INPUT PARAMETERS

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WALLAP ANALYSIS - INPUT PARAMETERS

References adfad
- Nucor Skyline Technical Product Manual (2024)
- Waterfront Facilities Inspection and Assessment (ASCE, 2nd Edition)

Structural Wall Inputs

Yield Stress of Steel: $F_y := 60ksi$

Modulus of Elasticity of Steel: $E_s := 29000ksi$ $\quad E_s = 4176000000 \frac{lb}{ft^2}$

Dockwall: 54"x11/16" Pipes w/ NZ26 Steel Sheet Piles

King Pile:

King Pile Outside Diameter: $OD := 54in$

King Pile Wall Thickness: $t_w := 0.688in$

King Pile Inside Diameter: $ID := OD - 2. \cdot t_w = 52.62 \cdot in$

King Pile Spacing: $S_{KP} := 111.68in = 9.31 \cdot ft$

Elastic Section Modulus: $S_{x\_KP} := \frac{\pi \cdot \left(OD^4 - ID^4\right)}{32 \cdot OD} = 1516.5 \cdot in^3$

Moment of Inertia: $I_x := \frac{\pi \cdot \left(OD^4 - ID^4\right)}{64} = 40945 \cdot in^4$

Per Foot Moment of Inertia $I_{KP} := I_x \div S_{KP}$ $\quad I_{KP} = 0.21217 \cdot \frac{ft^4}{ft}$

$I_{KP} \cdot E_s = 8.86 \times 10^8 lb \cdot \frac{ft^2}{ft}$

Composite Wall Section:

Elastic Section Modulus: $S_{x\_comb} := 170.6 \frac{in^3}{ft}$

Moment of Inertia: $I_{comb} := 4607 \frac{in^4}{ft}$ $\quad I_{comb} = 0.22217 \cdot \frac{ft^4}{ft}$

Note: Composite wall section properties are based on the composite wall properties provided in the 2024 Nucor Technical Product Manual (shown below).

$I_{comb} \cdot E_s = 927798611 lb \cdot \frac{ft^2}{ft}$

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Capacities:

$$M_{a\_comb} := 0.6 \cdot S_{x\_comb} \cdot F_y = 511.8 \cdot kip \cdot \frac{ft}{ft}$$

$$M_{a\_KP} := 0.6 \cdot S_{x\_KP} \cdot F_y \div S_{KP} = 488.8 \cdot kip \cdot \frac{ft}{ft}$$

Allowable Utility Considering Corrosion (ASCE Reports on Engineering Practice No. 130)

Design Life: $Des_l := 50yr$

Frontside Corrosion: $C_{fs} := 0.0006 \frac{in}{yr} \cdot Des_l = 0.03\,in$ *Common Fresh Water*

Frontside Corrosion: $C_{is} := \frac{1}{2} \cdot 0.0005 \frac{in}{yr} \cdot Des_l = 0.0125\,in$ *Undisturbed Nat'l Soils*

$$OD_{corr} := OD - 2\left(C_{fs}\right) = 53.94\,in$$

$$ID_{corr} := ID + 2\left(C_{is}\right) = 52.65\,in$$

Corroded Elastic Section Modulus

$$S_{x\_corr} := \frac{\pi\left(OD_{corr}^{\ 4} - ID_{corr}^{\ 4}\right)}{32 \cdot OD_{corr}} = 1422.94\,in^3$$

Allowable Utilization Considering Corrosion

$$Util_{all} := \frac{S_{x\_corr}}{S_{x\_KP}} = 0.94$$

Tierod Wallap Input

Diameter: $d_{tie} := 3.5in$

Area: $A_{tie} := 9.61in^2$ *(Mininum net area thru threads)*

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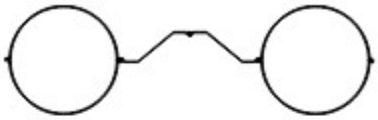
PIPE COMBINED WALLS

Pipe-Z with E22 Connector System*



Pipe Diameter	Wall Thickness	Intermediary Sheet Pile	Sheet Pile Connector	System Width	Moment of Inertia	Section Modulus	Weight (NZ Length / Pipe Length)			Cross Sectional Area
							100%	80%	60%	
in mm	in mm			in mm	in⁴/ft cm⁴/m	in³/ft cm³/m	lb/ft² kg/m²	lb/ft² kg/m²	lb/ft² kg/m²	in²/ft cm²/m
36 914	0.375 9.5	NZ 14	E22	99.19 2519.4	911 124341	50.6 2720	32.2 157.5	29.3 143.8	26.3 128.2	8.99 190.3
36 914	0.438 11.1	NZ 19	E22	93.68 2379.4	1158 158082	64.3 3458	37.2 181.5	34.0 166.1	30.8 150.6	10.43 220.7
42 1067	0.500 12.7	NZ 14	E22	105.19 2671.8	1700 232167	81.0 4353	39.4 192.5	36.6 178.7	33.8 164.9	11.93 252.5
42 1067	0.563 14.3	NZ 19	E22	99.68 2531.8	2351 2911003	97.6 5250	44.9 219.3	41.9 204.8	39.0 190.2	12.73 269.5
48 1219	0.563 14.3	NZ 14	E22	111.19 2824.2	2641 360648	110.0 5916	44.2 215.7	41.5 202.6	38.8 189.6	12.54 265.5
48 1219	0.625 15.875	NZ 19	E22	105.68 2684.2	3112 424998	129.6 6970	50.0 244.1	47.2 230.4	44.4 216.7	14.25 301.6
54 1372	0.625 15.9	NZ 19	E22	111.68 2836.6	4150 566772	153.7 8265	51.6 252.0	49.0 239.0	46.3 226.1	14.75 312.2
54 1372	0.688 17.5	NZ 26	E22	111.68 2836.6	4607 629038	170.6 9173	58.9 287.4	55.5 271.1	52.2 254.7	16.86 356.9
60 1524	0.688 17.5	NZ 19	E22	117.68 2989.0	5882 803278	196.1 10541	57.1 278.8	54.6 266.5	52.1 254.2	16.38 346.8
60 1524	0.750 19.1	NZ 26	E22	117.68 2989.0	6445 880060	214.8 11550	64.3 314.1	61.3 299.4	58.0 283.1	18.49 391.2
66 1676	0.750 19.1	NZ 19	E22	123.68 3141.4	8066 1101454	244.4 13141	62.8 306.5	60.4 294.7	58.0 283.0	18.07 382.4
66 1676	0.813 20.7	NZ 26	E22	123.68 3141.4	8769 1197480	265.7 14287	70.1 342.2	67.1 327.4	64.0 312.7	20.20 427.6
72 1829	0.813 20.7	NZ 26	E22	129.68 3293.6	10838 1479947	301.0 16185	71.7 349.9	68.8 335.8	65.9 321.8	20.68 437.8
72 1829	0.875 22.2	NZ 26	E22	129.68 3293.6	11621 1586893	322.8 17355	76.0 371.0	73.1 356.9	70.2 342.8	21.95 464.6
78 1981	0.875 22.2	NZ 26	E22	135.68 3446.2	14114 1927403	361.9 19457	77.6 378.8	74.8 365.4	72.1 351.9	22.44 475.0
78 1981	0.938 23.8	NZ 26	E22	135.68 3446.2	15082 2059540	386.7 20791	82.1 401.0	79.4 387.5	76.6 374.1	23.77 503.2
84 2134	0.938 23.8	NZ 26	E22	141.68 3598.6	18045 2464133	429.6 23094	83.7 408.8	81.1 396.0	78.5 383.1	24.26 513.6
84 2134	1.000 25.4	NZ 26	E22	141.68 3598.6	19184 2619754	456.8 24558	88.3 431.4	85.7 418.5	83.1 405.6	25.62 542.2

* Additional combinations are available upon request.

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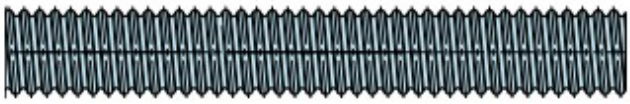
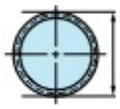
REINFORCING STEEL GRADE / COLD ROLLED

FULLY THREADED BAR





Grade 80 ksi Yield Strength / 100 ksi Ultimate Strength

Bar Designation	Nominal Diameter in mm	Grade	Min. Net Area Thru Threads in² mm²	Min. Ultimate Strength kips kN	Min. Yield Strength kips kN	Nominal Weight lbs/ft kg/m	Approx. Major Thread Diameter in mm	Thread Orientation	Max. Length ft in
#18	2 ¼ 55	80	4.000 2581.0	400.0 1779	320.0 1423	13.60 20.2	2.438 62.0	Right Hand	60 18.3
#20	2 ½ 64	80	4.910 3168.0	491.0 2184	392.8 1747	16.69 24.8	2.750 70.0	Right Hand	60 18.3
#24	3 76	80	7.070 4561.0	707.0 3145	565.6 2516	24.10 35.9	3.250 82.6	Right Hand	60 18.3
#28	3 ½ 89	80	9.610 6200.0	961.0 4275	768.8 3420	32.70 48.7	3.750 95.3	Right Hand	60 18.3
#32	4 102	80	12.57 8107.0	1257.0 5590	1005.3 4472	42.75 63.6	4.125 104.8	Right Hand	40 12.2

Cold rolled threaded bars conform to the physical and chemical requirements of ASTM A615 Grade 80 ksi "Standard Specification for Deformed Carbon Steel Bars for Concrete Reinforcement".

Contact your sales representative for information on hot dip galvanized and epoxy coated bars.

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ATTACHMENT 4: UNDRAINED AND DRAINED ELASTIC MODULI

Soil Mechanics

T. William Lambe • *Robert V. Whitman*

Massachusetts Institute of Technology

1969

JOHN WILEY & SONS, New York • Chichester • Brisbane • Toronto • Singapore

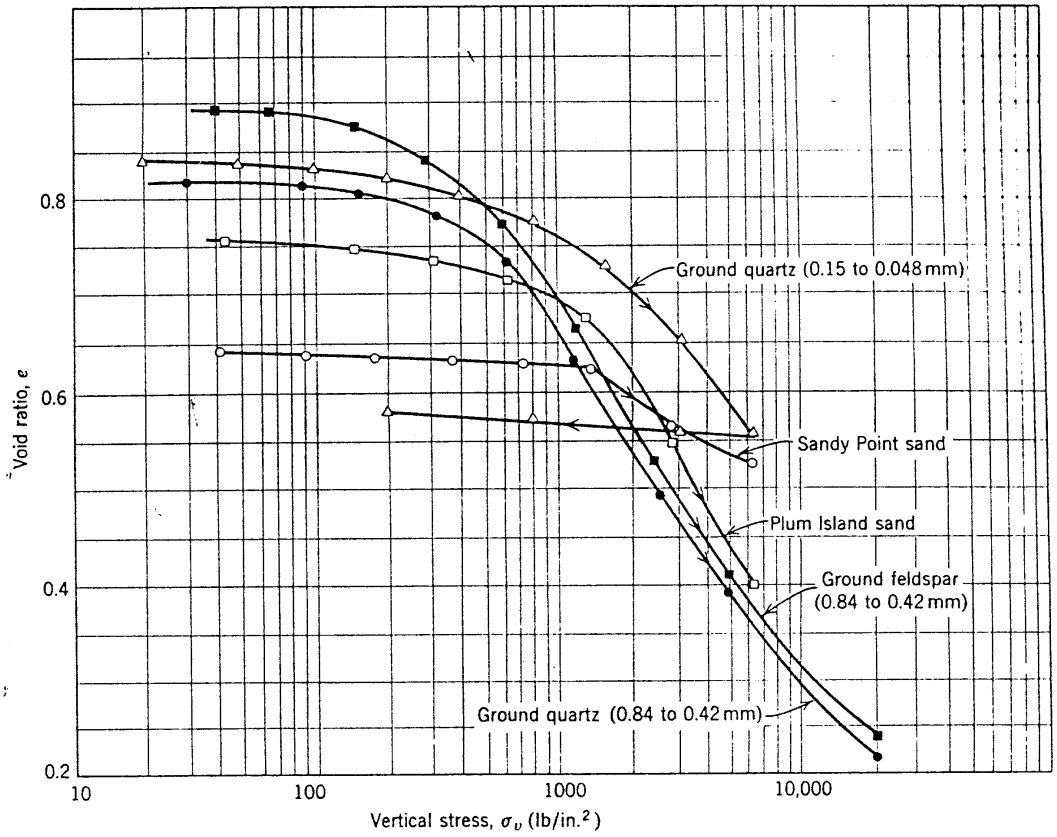


Fig. 12.7 Results of high-stress, confined compression tests on several sands (data from Roberts, 1964).

The stress-strain curve for an initial loading generally resembles a parabola. Hence the stress-strain relationship may be expressed as

$$\sigma_v = C(\epsilon_v)^n \tag{12.13}$$

The coefficient C varies with the type of soil and its initial void ratio. For a wide variety of soils, however, the exponent n has been found to be very close to 2. For a perfect packing of elastic spheres, this exponent would be 3. The difference between the theoretical and actual values for the exponent is the result of sliding among and rearrangement of the particles within an actual soil. Equation 12.13 implies that both secant modulus from zero stress and the tangent modulus should increase as $\sqrt{\sigma_v}$.

Table 12.2 Relations Between Various Stress-Strain Parameters for Confined Compression

	Constrained Modulus	Coefficient of Volume Change	Coefficient of Compressibility	Compression Index
Constrained modulus	$D = \dfrac{\Delta\sigma_v}{\Delta\epsilon_v}$	$D = \dfrac{1}{m_v}$	$D = \dfrac{1 + e_0}{a_v}$	$D = \dfrac{(1 + e_0)\sigma_{va}}{0.435C_c}$
Coefficient of volume change	$m_v = \dfrac{1}{D}$	$m_v = \dfrac{\Delta\epsilon_v}{\Delta\sigma_v}$	$m_v = \dfrac{a_v}{1 + e_0}$	$m_v = \dfrac{0.435C_c}{(1 + e_0)\sigma_{va}}$
Coefficient of compressibility	$a_v = \dfrac{1 + e_0}{D}$	$a_v = (1 + e_0)m_v$	$a_v = -\dfrac{\Delta e}{\Delta\sigma_v}$	$a_v = \dfrac{0.435C_c}{\sigma_{va}}$
Compression index	$C_c = \dfrac{(1 + e_0)\sigma_{va}}{0.435D}$	$C_c = \dfrac{(1 + e_0)\sigma_{va}m_v}{0.435}$	$C_c = \dfrac{a_v\sigma_{va}}{0.435}$	$C_c = -\dfrac{\Delta e}{\Delta \log \sigma_v}$

Note. e_0 denotes the initial void ratio. σ_{va} denotes the average of the initial and final stresses.

DRAINED ELASTIC MODULUS BASED ON CONSOL TESTS -- Cc

Virginia Polytechnic Institute
And State University

The Charles E. Via, Jr.
Department of Civil Engineering

CENTER FOR
GEOTECHNICAL PRACTICE AND RESEARCH

Engineering Manual for Settlement Studies

by

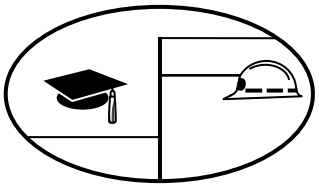
J. Michael Duncan

and

A. L. Buchignani

Report of a study performed by the Virginia Tech Center for
Geotechnical Practice and Research

Revised October 1987
CGPR #2



Center for
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200 Patton Hall
Blacksburg, VA 24061

Virginia Tech

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June, 1976

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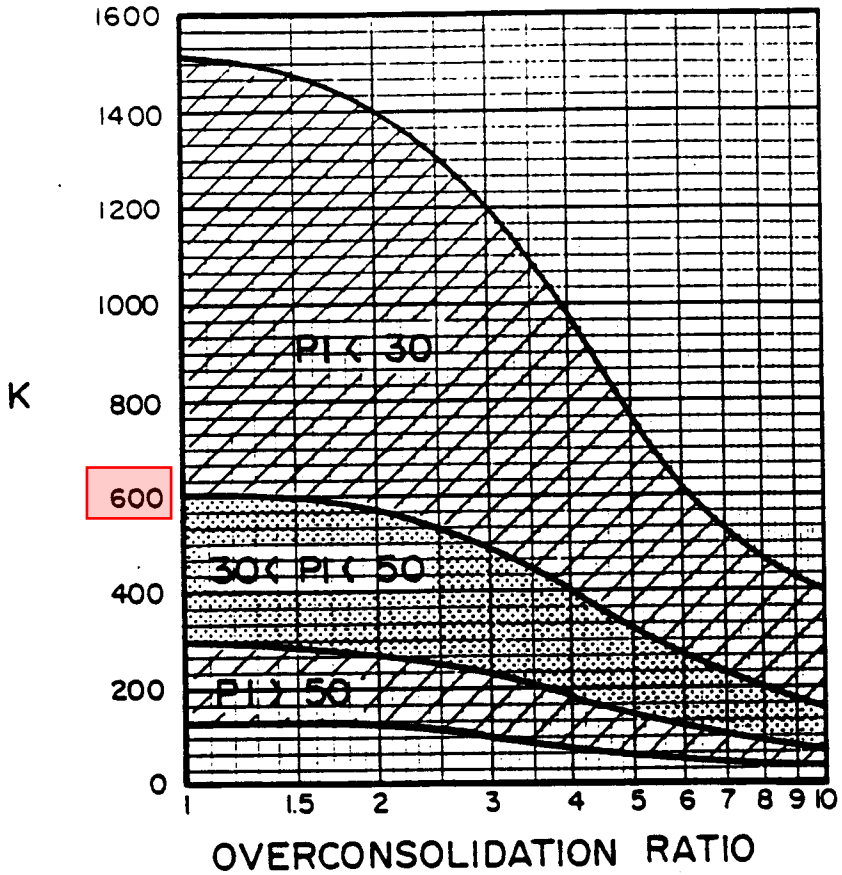

UNDRAINED ELASTIC MODULUS
E = 600 * Su

$E_u = KS_u$

E_u = UNDRAINED MODULUS OF CLAY

K = FACTOR FROM CHART ABOVE

S_u = UNDRAINED SHEAR STRENGTH OF CLAY

Fig. 5 CHART FOR ESTIMATING UNDRAINED MODULUS OF CLAY