PRCNC20240013

VISSER ENGINEERING

# STRUCTURAL CALCULATIONS
## (Permit Submittal)

Project: Arco ampm Puyallup
Stormwater Detention Vault
1042 South Meridian Ave.
Puyallup, WA

Project No.: 23-045

Client: Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032

By: Andy Derrick, P.E.,S.E.
Mike Visser, P.E., S.E.

Date: October 6, 2023

City of Puyallup
Building
ACCEPTED
JMontgomery
01/23/2024
12:27:54 PM

REPORT IS REQUIRED TO BE PROVIDED BY THE PERMITTEE ON SITE FOR ALL INSPECTIONS.

ELECTRONICALLY SIGNED
10/06/23
MIKE VISSER
STATE OF WASHINGTON
22263
REGISTERED
PROFESSIONAL ENGINEER

VISSER ENGINEERING

CALCULATION SHEET

Title:

Project: AMPM VAULT (23-045)

Client: BARGHAUSEN

Date:

Page:

# DETENTION VAULT

## SOIL PARAMETERS

$q_A$ = 1500 psf

AT REST EARTH PRESSURE (SATURATED) = 80 pcf

PEP = 350 pcf

$\gamma$ = 125 pcf

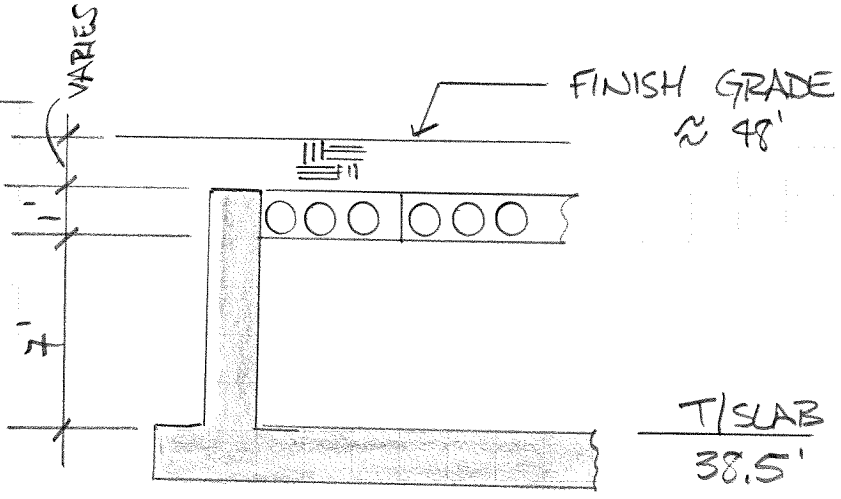
$\mu$ = 0.35

## SURCHARGE LOADING

LIVE (TRAFFIC) = 250 pcf OR 45$^k$ (FIRETRUCK)

SEISMIC = 25H

## TYP. GEOMETRY



VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23

Page:

## Stormwater Vault Design - 250 psf LL

| Soil Information | | |
|---|---|---|
| At-Rest Soil Pressure, AEFP = | 80 | pcf |
| Seismic Surcharge, E_= | 25 | *H psf |
| Soil Density, ws = | 125 | pcf |
| Allowable Soil Bearing Pressure, q\|allow = | 2000 | psf |

| Concrete Information | | |
|---|---|---|
| Concrete Weight, wc = | 145 | pcf |
| Concrete Strength, fc' = | 4500 | psi |
| Reinforcement, fy = | 60000 | psi |

| Applied Loads | | |
|---|---|---|
| Live Load, wll = | 250 | psf |
| Concentrated Live Load = | 0 | kips |
| Panel Weight, wp = | 84 | psf |
| Topping Slap, wts = | 0 | psf |

Vault Wall Geometry

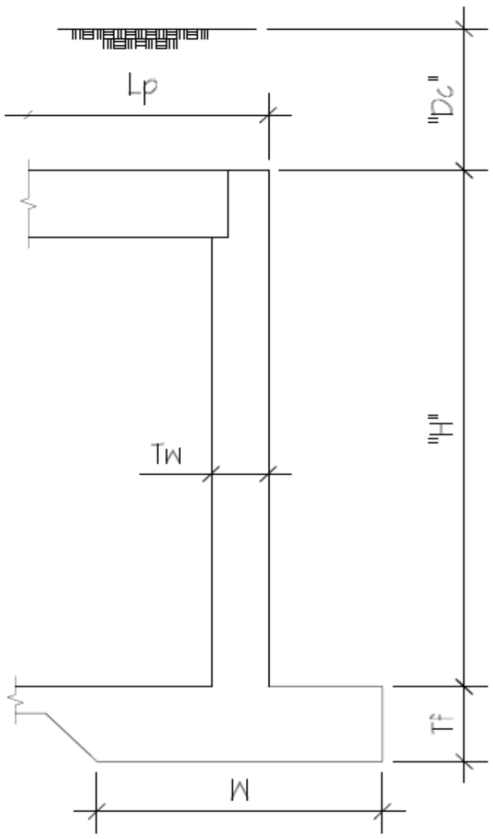
| Mark | H (feet) | Dcp (feet) | Dcw (feet) | Dll (feet) | Tw (ext) (in) | Tw (int) (in) | Lp (feet) | Tf (in) | W (ext) (ft) | W (int) (ft) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 2 | 3 | 2.00 | 10 | 8 | 14 | 15 | 6.5 | 6.5 |

| Terms | |
|---|---|
| Dcp = | Depth of Cover over Planks |
| Dcw = | Depth of Cover over Walls |
| Dll = | Theoretical Live Load Depth (wll/ws) |
| H = | Height of Wall |
| Lp = | Span of Panel |
| Tw = | Thickness of Wall (exterior / interior) |
| W = | Total Footing Width (exterior / interior) |
| wll = | Live Load tributary to Wall |
| wp = | Weight of Panel |
| ws = | Weight of Soil tributary to Wall |
| wts = | Weight of Topping Slab |

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

## Exterior Bearing Wall Design - 250 psf LL



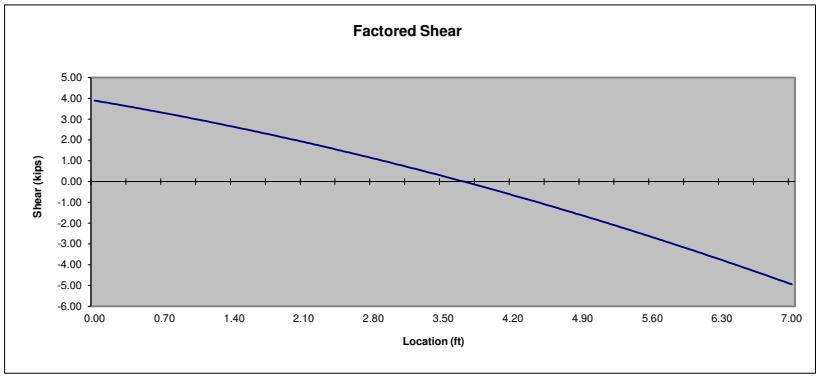

Wall Design:

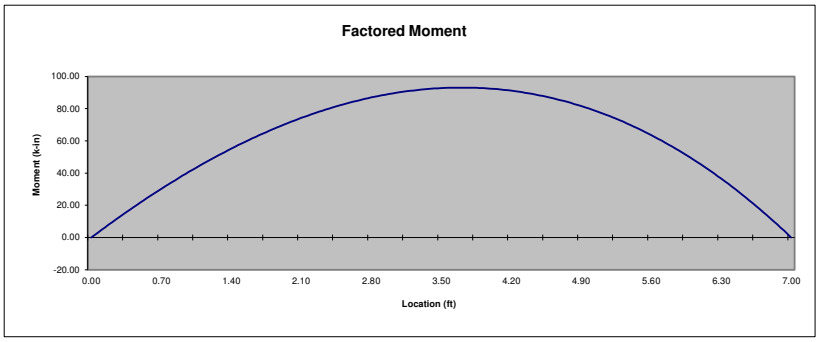
Mu(max): 93.33 k-in/ft  Pu: 6.62 k/ft

| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Mn (k-in/ft) | |
|---|---|---|---|---|---|---|---|
| 6 | 7.625 | 0.44 | 15 | 21.21 | 0.46 | 141.12 | ok |

Dowels: Vu: 4.94 klf

| bar size | As | spacing | AsFy | Vu (psi) | nu | phi Vn (klf) | |
|---|---|---|---|---|---|---|---|
| 5 | 0.31 | 15 | 14.73 | 41.19 | 0.6 | 6.63 | ok |




Footing Reactions:

| | | |
|---|---|---|
| Dead Load of Panels: | 588 | plf |
| Dead Load of Topping Slab: | 0 | plf |
| Dead Load of Soil: | 1750 | plf |
| Dead Load of Wall: | 846 | plf |
| Dead Load of Footing: | 1178 | plf |
| Live Load on Panels: | 1750 | plf |
| Total Load on Footing: | 6112 | plf |
| Required Footing Width: | 3.06 | feet |

Footing Design:

fp(ASD): 940 psf
Pu: 8594.35 plf
fu: 1322.208 psf
Vu: 3.75 kips/ft
Mu: 63.69 kip-in/ft

| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Vn (k/ft) | Phi Mn (k-in/ft) | |
|---|---|---|---|---|---|---|---|---|
| 5 | 11.688 | 0.31 | 12 | 18.41 | 0.40 | 14.11 | 190.30 | ok |

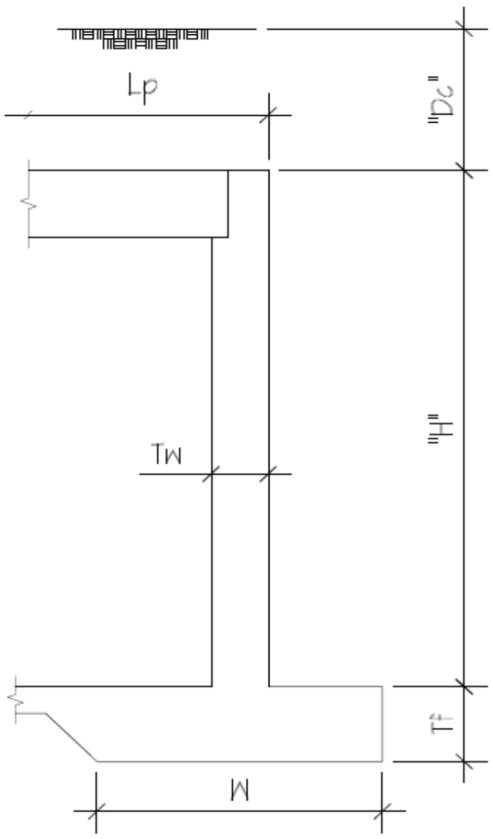
## Summary

Wall: Provide 10" Thick Wall w/ #6 Bars @ 15"oc Vert. and #5 Bars @ 15"oc Horiz.
Dowels: Provide #5 Dowels @ 15"oc - Embed 8" into Footing
Footing: Provide 6.5' Wide x 15" Deep Footing w/ #5 Bars @ 12"oc - Transverse

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

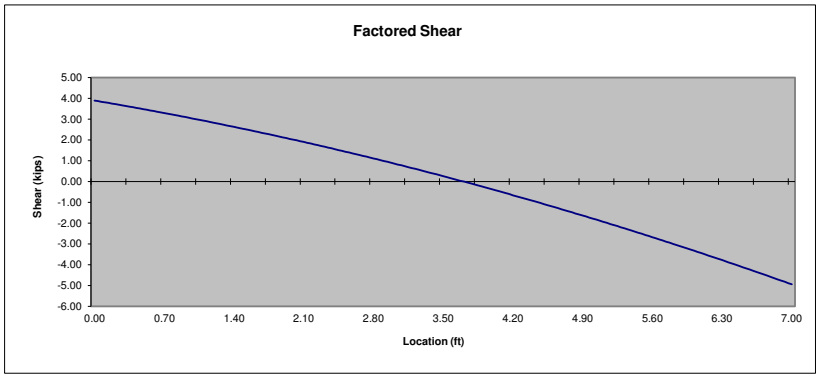
## Exterior Non-Bearing Wall Design

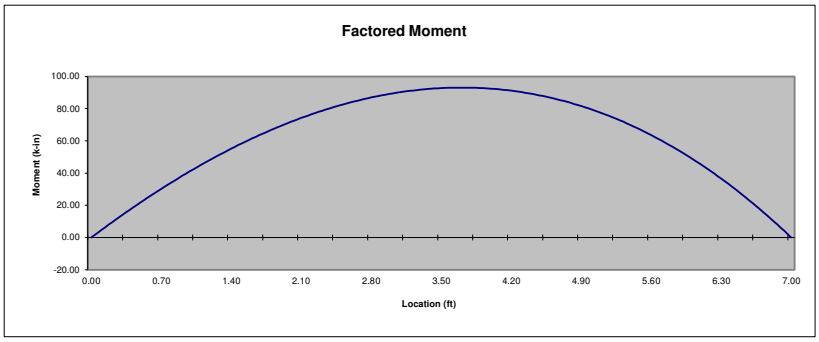



Wall Design:

| Mu(max): | 93.24 | k-in/ft | | | Pu: | 2.62 | k/ft | |
|---|---|---|---|---|---|---|---|---|
| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Mn (k-in/ft) | | |
| 6 | 7.625 | 0.44 | 15 | 21.21 | 0.46 | 141.12 | ok | |

| Dowels: | Vu: | 4.94 | klf | | | | |
|---|---|---|---|---|---|---|---|
| bar size | As | spacing | AsFy | Vu (psi) | nu | phi Vn (klf) | |
| 5 | 0.31 | 15 | 14.73 | 41.19 | 0.6 | 6.63 | ok |




| Footing Reactions: | | |
|---|---|---|
| Dead Load of Panels: | 168 | plf |
| Dead Load of Topping Slab: | 0 | plf |
| Dead Load of Soil: | 500 | plf |
| Dead Load of Wall: | 846 | plf |
| Dead Load of Footing: | 1178 | plf |
| Live Load on Panels: | 500 | plf |
| Total Load on Footing: | 3192 | plf |
| Required Footing Width: | 1.60 | feet |

Footing Design:

| fp(ASD): | 491 | psf |
|---|---|---|
| Pu: | 4190.35 | plf |
| fu: | 644.6692 | psf |
| Vu: | 1.83 | kips/ft |
| Mu: | 31.05 | kip-in/ft |

| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Vn (k/ft) | Phi Mn (k-in/ft) | |
|---|---|---|---|---|---|---|---|---|
| 5 | 11.688 | 0.31 | 12 | 18.41 | 0.40 | 14.11 | 190.30 | ok |

## Summary

Wall: Provide 10" Thick Wall w/ #6 Bars @ 15"oc Vert. and #5 Bars @ 15"oc Horiz.
Dowels: Provide #5 Dowels @ 15"oc - Embed 8" into Footing
Footing: Provide 6.5' Wide x 15" Deep Footing w/ #5 Bars @ 12"oc - Transverse

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23

Page:

**Interior Bearing Wall Design - 250 psf LL**

| Seismic Forces: | | |
|---|---|---|
| Ss: | 1.5 | g |
| Sds: | 1 | g |
| Wall weight: | 0.10 | ksf |
| E: | 0.04 | ksf |
| Mu: | 2.84 | k-in/ft |
| Vu: | 0.14 | klf |

| Gravity Loads: | | |
|---|---|---|
| Dead Load of Panels: | 1176 | plf |
| Dead Load of Topping Slab: | 0 | |
| Dead Load of Soil: | 3500 | plf |
| Dead Load of Wall: | 677 | plf |
| Dead Load of Footing: | 1178 | plf |
| Live Load on Panels: | 3500 | plf |
| Total Load on Footing: | 10031 | plf |
| Required Footing Width: | 5.02 | feet |

Wall Design:

Mu(max): 3.05 k-in/ft  Pu: 13.44 k/ft

| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Mn (in-k/ft) | |
|---|---|---|---|---|---|---|---|
| 5 | 4 | 0.31 | 15 | 14.73 | 0.61 | 93.61 | ok |

Dowels: Vu: 0.14 klf

| bar size | As | spacing | AsFy | Vu (psi) | nu | phi Vn (klf) | |
|---|---|---|---|---|---|---|---|
| 4 | 0.20 | 18 | 7.85 | 1.41 | 0.6 | 3.53 | ok |

Footing Design:

| | | |
|---|---|---|
| fp(ASD): | 1543 | psf |
| Pu: | 14557 | plf |
| fu: | 2240 | psf |
| Vu: | 6.53 | kips/ft |
| Mu: | 114.31 | k-in/ft |

| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Vn (k/ft) | Phi Mn (in-k/ft) | |
|---|---|---|---|---|---|---|---|---|
| 5 | 11.688 | 0.31 | 12 | 18.41 | 0.40 | 14.11 | 190.30 | ok |

## Summary

Wall: Provide 8" Thick Wall w/ #5 Bars @ 15"oc Vert. and #4 Bars @ 12"oc Horiz.

Dowels: Provide #4 Dowels @ 18"oc - Embed 7" into Footing

Footing: Provide 6.5' Wide x 15" Deep Footing w/ #5 Bars 12"oc - Transverse

Lateral Pressures from Point Loads - Boussinesq Equations

| | | | |
|---|---|---|---|
| P = | 45.00 | kips | (unfactored point load) |
| H = | 9.00 | ft | (height from finish grade to base of wall) |
| X = | 2.00 | ft | (distance from face of wall to point load - must be <= H) |
| ν = | 0.50 | | (Poisson's Ratio) |

Y(0)

| α = | 0.0000 |
|---|---|
| Y = | 0.00 |
| r = | 2.00 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 2.00 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 2.05 | 1.3495 | 1.06821 | 1.06821 |
| 0.90 | 2.19 | 1.1479 | 1.52438 | 1.52438 |
| 1.35 | 2.41 | 0.9770 | 1.41832 | 1.41832 |
| 1.80 | 2.69 | 0.8380 | 1.09683 | 1.09683 |
| 2.25 | 3.01 | 0.7266 | 0.78213 | 0.78213 |
| 2.70 | 3.36 | 0.6375 | 0.54180 | 0.54180 |
| 3.15 | 3.73 | 0.5657 | 0.37431 | 0.37431 |
| 3.60 | 4.12 | 0.5071 | 0.26119 | 0.26119 |
| 4.05 | 4.52 | 0.4587 | 0.18512 | 0.18512 |
| 4.50 | 4.92 | 0.4182 | 0.13355 | 0.13355 |
| 4.95 | 5.34 | 0.3840 | 0.09809 | 0.09809 |
| 5.40 | 5.76 | 0.3547 | 0.07329 | 0.07329 |
| 5.85 | 6.18 | 0.3294 | 0.05566 | 0.05566 |
| 6.30 | 6.61 | 0.3074 | 0.04291 | 0.04291 |
| 6.75 | 7.04 | 0.2881 | 0.03355 | 0.03355 |
| 7.20 | 7.47 | 0.2709 | 0.02656 | 0.02656 |
| 7.65 | 7.91 | 0.2557 | 0.02127 | 0.02127 |
| 8.10 | 8.34 | 0.2421 | 0.01722 | 0.01722 |
| 8.55 | 8.78 | 0.2298 | 0.01408 | 0.01408 |
| 9.00 | 9.22 | 0.2187 | 0.01161 | 0.01161 |

Y(0.45)

| α = | 0.2213 |
|---|---|
| Y = | 0.45 |
| r = | 2.05 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 2.05 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 2.10 | 1.3547 | 0.99772 | 0.97339 |
| 0.90 | 2.24 | 1.1571 | 1.44467 | 1.40943 |
| 1.35 | 2.45 | 0.9884 | 1.36805 | 1.33469 |
| 1.80 | 2.73 | 0.8502 | 1.07557 | 1.04933 |
| 2.25 | 3.04 | 0.7389 | 0.77755 | 0.75859 |
| 2.70 | 3.39 | 0.6494 | 0.54449 | 0.53121 |
| 3.15 | 3.76 | 0.5769 | 0.37932 | 0.37006 |
| 3.60 | 4.14 | 0.5176 | 0.26639 | 0.25989 |
| 4.05 | 4.54 | 0.4686 | 0.18975 | 0.18512 |
| 4.50 | 4.94 | 0.4275 | 0.13743 | 0.13407 |
| 4.95 | 5.36 | 0.3926 | 0.10124 | 0.09878 |
| 5.40 | 5.78 | 0.3628 | 0.07584 | 0.07399 |
| 5.85 | 6.20 | 0.3371 | 0.05771 | 0.05631 |
| 6.30 | 6.63 | 0.3146 | 0.04457 | 0.04348 |
| 6.75 | 7.05 | 0.2949 | 0.03489 | 0.03404 |
| 7.20 | 7.49 | 0.2774 | 0.02765 | 0.02698 |
| 7.65 | 7.92 | 0.2618 | 0.02217 | 0.02163 |
| 8.10 | 8.36 | 0.2479 | 0.01796 | 0.01752 |
| 8.55 | 8.79 | 0.2353 | 0.01469 | 0.01433 |
| 9.00 | 9.23 | 0.2240 | 0.01213 | 0.01183 |

Y(0.9)

| α = | 0.4229 |
|---|---|
| Y = | 0.90 |
| r = | 2.19 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 2.19 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 2.24 | 1.3684 | 0.82675 | 0.75393 |
| 0.90 | 2.37 | 1.1814 | 1.24223 | 1.13281 |
| 1.35 | 2.58 | 1.0190 | 1.23151 | 1.12304 |
| 1.80 | 2.84 | 0.8835 | 1.01177 | 0.92265 |
| 2.25 | 3.14 | 0.7726 | 0.75930 | 0.69242 |
| 2.70 | 3.48 | 0.6822 | 0.54790 | 0.49964 |
| 3.15 | 3.84 | 0.6082 | 0.39077 | 0.35635 |
| 3.60 | 4.22 | 0.5472 | 0.27950 | 0.25488 |
| 4.05 | 4.61 | 0.4963 | 0.20196 | 0.18418 |
| 4.50 | 5.01 | 0.4535 | 0.14793 | 0.13490 |
| 4.95 | 5.41 | 0.4171 | 0.10997 | 0.10028 |
| 5.40 | 5.83 | 0.3858 | 0.08298 | 0.07567 |
| 5.85 | 6.25 | 0.3587 | 0.06352 | 0.05792 |
| 6.30 | 6.67 | 0.3350 | 0.04929 | 0.04495 |
| 6.75 | 7.10 | 0.3142 | 0.03874 | 0.03532 |
| 7.20 | 7.53 | 0.2957 | 0.03081 | 0.02809 |
| 7.65 | 7.96 | 0.2792 | 0.02477 | 0.02259 |
| 8.10 | 8.39 | 0.2644 | 0.02012 | 0.01834 |
| 8.55 | 8.83 | 0.2511 | 0.01649 | 0.01504 |
| 9.00 | 9.26 | 0.2390 | 0.01364 | 0.01244 |

Y(1.35)

| α = | 0.5937 |
|---|---|
| Y = | 1.35 |
| r = | 2.41 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 2.41 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 2.45 | 1.3864 | 0.63181 | 0.52367 |
| 0.90 | 2.58 | 1.2138 | 0.99383 | 0.82374 |
| 1.35 | 2.76 | 1.0607 | 1.04509 | 0.86622 |
| 1.80 | 3.01 | 0.9299 | 0.91078 | 0.75490 |
| 2.25 | 3.30 | 0.8203 | 0.72007 | 0.59683 |
| 2.70 | 3.62 | 0.7293 | 0.54252 | 0.44966 |
| 3.15 | 3.97 | 0.6537 | 0.40061 | 0.33204 |
| 3.60 | 4.33 | 0.5905 | 0.29457 | 0.24415 |
| 4.05 | 4.71 | 0.5373 | 0.21758 | 0.18034 |
| 4.50 | 5.11 | 0.4922 | 0.16219 | 0.13443 |
| 4.95 | 5.51 | 0.4536 | 0.12228 | 0.10135 |
| 5.40 | 5.91 | 0.4202 | 0.09333 | 0.07736 |
| 5.85 | 6.33 | 0.3912 | 0.07212 | 0.05978 |
| 6.30 | 6.75 | 0.3658 | 0.05640 | 0.04675 |
| 6.75 | 7.17 | 0.3433 | 0.04461 | 0.03698 |
| 7.20 | 7.59 | 0.3234 | 0.03567 | 0.02957 |
| 7.65 | 8.02 | 0.3055 | 0.02882 | 0.02388 |
| 8.10 | 8.45 | 0.2895 | 0.02350 | 0.01948 |
| 8.55 | 8.88 | 0.2751 | 0.01933 | 0.01602 |
| 9.00 | 9.32 | 0.2619 | 0.01603 | 0.01329 |

Y(1.8)

| | |
|---|---|
| α = | 0.7328 |
| Y = | 1.80 |
| r = | 2.69 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 2.69 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 2.73 | 1.4051 | 0.46324 | 0.34433 |
| 0.90 | 2.84 | 1.2480 | 0.76146 | 0.56599 |
| 1.35 | 3.01 | 1.1058 | 0.84939 | 0.63135 |
| 1.80 | 3.24 | 0.9812 | 0.78752 | 0.58536 |
| 2.25 | 3.51 | 0.8744 | 0.65931 | 0.49006 |
| 2.70 | 3.81 | 0.7837 | 0.52191 | 0.38793 |
| 3.15 | 4.14 | 0.7069 | 0.40156 | 0.29848 |
| 3.60 | 4.49 | 0.6419 | 0.30536 | 0.22697 |
| 4.05 | 4.86 | 0.5864 | 0.23180 | 0.17230 |
| 4.50 | 5.24 | 0.5389 | 0.17667 | 0.13132 |
| 4.95 | 5.63 | 0.4979 | 0.13564 | 0.10082 |
| 5.40 | 6.03 | 0.4623 | 0.10508 | 0.07811 |
| 5.85 | 6.44 | 0.4311 | 0.08221 | 0.06110 |
| 6.30 | 6.85 | 0.4036 | 0.06495 | 0.04828 |
| 6.75 | 7.27 | 0.3793 | 0.05183 | 0.03852 |
| 7.20 | 7.69 | 0.3576 | 0.04175 | 0.03103 |
| 7.65 | 8.11 | 0.3382 | 0.03393 | 0.02522 |
| 8.10 | 8.54 | 0.3207 | 0.02782 | 0.02068 |
| 8.55 | 8.96 | 0.3049 | 0.02299 | 0.01709 |
| 9.00 | 9.39 | 0.2905 | 0.01914 | 0.01423 |

Y(2.25)

| | |
|---|---|
| α = | 0.8442 |
| Y = | 2.25 |
| r = | 3.01 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 3.01 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 3.04 | 1.4224 | 0.33535 | 0.22280 |
| 0.90 | 3.14 | 1.2803 | 0.57224 | 0.38017 |
| 1.35 | 3.30 | 1.1492 | 0.67246 | 0.44676 |
| 1.80 | 3.51 | 1.0319 | 0.66022 | 0.43863 |
| 2.25 | 3.76 | 0.9290 | 0.58427 | 0.38817 |
| 2.70 | 4.04 | 0.8397 | 0.48619 | 0.32301 |
| 3.15 | 4.36 | 0.7627 | 0.39056 | 0.25947 |
| 3.60 | 4.69 | 0.6964 | 0.30799 | 0.20462 |
| 4.05 | 5.05 | 0.6392 | 0.24099 | 0.16010 |
| 4.50 | 5.41 | 0.5896 | 0.18836 | 0.12514 |
| 4.95 | 5.79 | 0.5464 | 0.14767 | 0.09811 |
| 5.40 | 6.18 | 0.5086 | 0.11641 | 0.07734 |
| 5.85 | 6.58 | 0.4753 | 0.09241 | 0.06139 |
| 6.30 | 6.98 | 0.4458 | 0.07392 | 0.04911 |
| 6.75 | 7.39 | 0.4195 | 0.05960 | 0.03959 |
| 7.20 | 7.80 | 0.3960 | 0.04843 | 0.03218 |
| 7.65 | 8.22 | 0.3749 | 0.03967 | 0.02635 |
| 8.10 | 8.64 | 0.3558 | 0.03273 | 0.02175 |
| 8.55 | 9.06 | 0.3385 | 0.02721 | 0.01807 |
| 9.00 | 9.49 | 0.3228 | 0.02277 | 0.01512 |

Y(2.7)

| | |
|---|---|
| α = | 0.9332 |
| Y = | 2.70 |
| r = | 3.36 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 3.36 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 3.39 | 1.4377 | 0.24379 | 0.14511 |
| 0.90 | 3.48 | 1.3091 | 0.42867 | 0.25516 |
| 1.35 | 3.62 | 1.1888 | 0.52598 | 0.31308 |
| 1.80 | 3.81 | 1.0790 | 0.54257 | 0.32295 |
| 2.25 | 4.04 | 0.9807 | 0.50474 | 0.30044 |
| 2.70 | 4.31 | 0.8939 | 0.44015 | 0.26199 |
| 3.15 | 4.61 | 0.8177 | 0.36870 | 0.21946 |
| 3.60 | 4.92 | 0.7509 | 0.30156 | 0.17950 |
| 4.05 | 5.26 | 0.6926 | 0.24344 | 0.14490 |
| 4.50 | 5.62 | 0.6414 | 0.19539 | 0.11630 |
| 4.95 | 5.98 | 0.5964 | 0.15667 | 0.09325 |
| 5.40 | 6.36 | 0.5566 | 0.12588 | 0.07493 |
| 5.85 | 6.75 | 0.5214 | 0.10155 | 0.06044 |
| 6.30 | 7.14 | 0.4900 | 0.08235 | 0.04902 |
| 6.75 | 7.54 | 0.4619 | 0.06719 | 0.03999 |
| 7.20 | 7.95 | 0.4366 | 0.05516 | 0.03283 |
| 7.65 | 8.36 | 0.4139 | 0.04557 | 0.02712 |
| 8.10 | 8.77 | 0.3932 | 0.03789 | 0.02255 |
| 8.55 | 9.19 | 0.3744 | 0.03170 | 0.01887 |
| 9.00 | 9.61 | 0.3573 | 0.02668 | 0.01588 |

Y(3.15)

| | |
|---|---|
| α = | 1.0051 |
| Y = | 3.15 |
| r = | 3.73 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 3.73 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 3.76 | 1.4508 | 0.17952 | 0.09622 |
| 0.90 | 3.84 | 1.3341 | 0.32316 | 0.17322 |
| 1.35 | 3.97 | 1.2236 | 0.41053 | 0.22005 |
| 1.80 | 4.14 | 1.1213 | 0.44126 | 0.23652 |
| 2.25 | 4.36 | 1.0282 | 0.42858 | 0.22972 |
| 2.70 | 4.61 | 0.9444 | 0.38972 | 0.20889 |
| 3.15 | 4.88 | 0.8697 | 0.33938 | 0.18191 |
| 3.60 | 5.18 | 0.8033 | 0.28741 | 0.15405 |
| 4.05 | 5.51 | 0.7445 | 0.23923 | 0.12823 |
| 4.50 | 5.85 | 0.6923 | 0.19719 | 0.10570 |
| 4.95 | 6.20 | 0.6459 | 0.16179 | 0.08672 |
| 5.40 | 6.56 | 0.6046 | 0.13259 | 0.07107 |
| 5.85 | 6.94 | 0.5678 | 0.10881 | 0.05832 |
| 6.30 | 7.32 | 0.5347 | 0.08955 | 0.04800 |
| 6.75 | 7.71 | 0.5050 | 0.07399 | 0.03966 |
| 7.20 | 8.11 | 0.4781 | 0.06141 | 0.03292 |
| 7.65 | 8.51 | 0.4538 | 0.05123 | 0.02746 |
| 8.10 | 8.92 | 0.4317 | 0.04295 | 0.02302 |
| 8.55 | 9.33 | 0.4115 | 0.03620 | 0.01940 |
| 9.00 | 9.74 | 0.3930 | 0.03067 | 0.01644 |

Y(3.6)

| α = | 1.0637 |
|---|---|
| Y = | 3.60 |
| r = | 4.12 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 4.12 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 4.14 | 1.4620 | 0.13438 | 0.06526 |
| 0.90 | 4.22 | 1.3556 | 0.24638 | 0.11965 |
| 1.35 | 4.33 | 1.2540 | 0.32176 | 0.15626 |
| 1.80 | 4.49 | 1.1587 | 0.35766 | 0.17370 |
| 2.25 | 4.69 | 1.0708 | 0.36024 | 0.17495 |
| 2.70 | 4.92 | 0.9905 | 0.33975 | 0.16500 |
| 3.15 | 5.18 | 0.9178 | 0.30635 | 0.14878 |
| 3.60 | 5.47 | 0.8524 | 0.26790 | 0.13011 |
| 4.05 | 5.78 | 0.7938 | 0.22956 | 0.11148 |
| 4.50 | 6.10 | 0.7411 | 0.19415 | 0.09429 |
| 4.95 | 6.44 | 0.6939 | 0.16295 | 0.07913 |
| 5.40 | 6.79 | 0.6515 | 0.13622 | 0.06616 |
| 5.85 | 7.15 | 0.6134 | 0.11374 | 0.05524 |
| 6.30 | 7.53 | 0.5790 | 0.09504 | 0.04616 |
| 6.75 | 7.91 | 0.5478 | 0.07958 | 0.03865 |
| 7.20 | 8.29 | 0.5196 | 0.06683 | 0.03245 |
| 7.65 | 8.69 | 0.4938 | 0.05632 | 0.02735 |
| 8.10 | 9.09 | 0.4704 | 0.04764 | 0.02314 |
| 8.55 | 9.49 | 0.4489 | 0.04047 | 0.01966 |
| 9.00 | 9.90 | 0.4291 | 0.03453 | 0.01677 |

Y(4.05)

| α = | 1.1121 |
|---|---|
| Y = | 4.05 |
| r = | 4.52 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 4.52 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 4.54 | 1.4715 | 0.10236 | 0.04532 |
| 0.90 | 4.61 | 1.3741 | 0.19037 | 0.08429 |
| 1.35 | 4.71 | 1.2804 | 0.25414 | 0.11253 |
| 1.80 | 4.86 | 1.1916 | 0.29032 | 0.12855 |
| 2.25 | 5.05 | 1.1086 | 0.30141 | 0.13346 |
| 2.70 | 5.26 | 1.0320 | 0.29329 | 0.12986 |
| 3.15 | 5.51 | 0.9618 | 0.27268 | 0.12074 |
| 3.60 | 5.78 | 0.8979 | 0.24547 | 0.10869 |
| 4.05 | 6.07 | 0.8398 | 0.21604 | 0.09566 |
| 4.50 | 6.38 | 0.7873 | 0.18721 | 0.08289 |
| 4.95 | 6.70 | 0.7397 | 0.16059 | 0.07110 |
| 5.40 | 7.04 | 0.6966 | 0.13688 | 0.06061 |
| 5.85 | 7.39 | 0.6575 | 0.11628 | 0.05149 |
| 6.30 | 7.75 | 0.6220 | 0.09866 | 0.04368 |
| 6.75 | 8.12 | 0.5897 | 0.08373 | 0.03707 |
| 7.20 | 8.50 | 0.5603 | 0.07115 | 0.03150 |
| 7.65 | 8.88 | 0.5334 | 0.06060 | 0.02683 |
| 8.10 | 9.27 | 0.5087 | 0.05175 | 0.02291 |
| 8.55 | 9.67 | 0.4860 | 0.04433 | 0.01963 |
| 9.00 | 10.07 | 0.4651 | 0.03810 | 0.01687 |

Y(4.5)

| α = | 1.1526 |
|---|---|
| Y = | 4.50 |
| r = | 4.92 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 4.92 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 4.94 | 1.4797 | 0.07930 | 0.03221 |
| 0.90 | 5.01 | 1.3900 | 0.14916 | 0.06058 |
| 1.35 | 5.11 | 1.3032 | 0.20265 | 0.08230 |
| 1.80 | 5.24 | 1.2204 | 0.23670 | 0.09613 |
| 2.25 | 5.41 | 1.1422 | 0.25201 | 0.10235 |
| 2.70 | 5.62 | 1.0693 | 0.25181 | 0.10227 |
| 3.15 | 5.85 | 1.0017 | 0.24043 | 0.09765 |
| 3.60 | 6.10 | 0.9395 | 0.22208 | 0.09020 |
| 4.05 | 6.38 | 0.8825 | 0.20026 | 0.08133 |
| 4.50 | 6.67 | 0.8304 | 0.17749 | 0.07209 |
| 4.95 | 6.98 | 0.7828 | 0.15541 | 0.06312 |
| 5.40 | 7.31 | 0.7394 | 0.13496 | 0.05481 |
| 5.85 | 7.65 | 0.6997 | 0.11658 | 0.04735 |
| 6.30 | 8.00 | 0.6635 | 0.10041 | 0.04078 |
| 6.75 | 8.36 | 0.6303 | 0.08636 | 0.03508 |
| 7.20 | 8.72 | 0.5999 | 0.07428 | 0.03017 |
| 7.65 | 9.10 | 0.5719 | 0.06395 | 0.02597 |
| 8.10 | 9.48 | 0.5462 | 0.05514 | 0.02239 |
| 8.55 | 9.87 | 0.5226 | 0.04764 | 0.01935 |
| 9.00 | 10.26 | 0.5007 | 0.04126 | 0.01676 |

Y(4.95)

| α = | 1.1868 |
|---|---|
| Y = | 4.95 |
| r = | 5.34 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 5.34 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 5.36 | 1.4867 | 0.06242 | 0.02339 |
| 0.90 | 5.41 | 1.4038 | 0.11848 | 0.04438 |
| 1.35 | 5.51 | 1.3231 | 0.16326 | 0.06116 |
| 1.80 | 5.63 | 1.2456 | 0.19418 | 0.07274 |
| 2.25 | 5.79 | 1.1719 | 0.21111 | 0.07908 |
| 2.70 | 5.98 | 1.1026 | 0.21573 | 0.08082 |
| 3.15 | 6.20 | 1.0377 | 0.21077 | 0.07896 |
| 3.60 | 6.44 | 0.9775 | 0.19916 | 0.07461 |
| 4.05 | 6.70 | 0.9218 | 0.18355 | 0.06876 |
| 4.50 | 6.98 | 0.8704 | 0.16606 | 0.06221 |
| 4.95 | 7.28 | 0.8232 | 0.14820 | 0.05552 |
| 5.40 | 7.59 | 0.7797 | 0.13098 | 0.04907 |
| 5.85 | 7.92 | 0.7397 | 0.11497 | 0.04307 |
| 6.30 | 8.26 | 0.7030 | 0.10047 | 0.03764 |
| 6.75 | 8.61 | 0.6692 | 0.08756 | 0.03280 |
| 7.20 | 8.96 | 0.6380 | 0.07621 | 0.02855 |
| 7.65 | 9.33 | 0.6093 | 0.06631 | 0.02484 |
| 8.10 | 9.70 | 0.5828 | 0.05773 | 0.02163 |
| 8.55 | 10.08 | 0.5582 | 0.05032 | 0.01885 |
| 9.00 | 10.46 | 0.5354 | 0.04393 | 0.01646 |

| Y(5.4) | | | | |
|---|---|---|---|---|
| α = | 1.2161 | | | |
| Y = | 5.40 | | | |
| r = | 5.76 | | | |
| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
| 0.00 | 5.76 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 5.78 | 1.4928 | 0.04987 | 0.01732 |
| 0.90 | 5.83 | 1.4158 | 0.09534 | 0.03311 |
| 1.35 | 5.91 | 1.3405 | 0.13288 | 0.04615 |
| 1.80 | 6.03 | 1.2678 | 0.16043 | 0.05572 |
| 2.25 | 6.18 | 1.1983 | 0.17748 | 0.06164 |
| 2.70 | 6.36 | 1.1324 | 0.18486 | 0.06420 |
| 3.15 | 6.56 | 1.0702 | 0.18422 | 0.06398 |
| 3.60 | 6.79 | 1.0121 | 0.17756 | 0.06167 |
| 4.05 | 7.04 | 0.9579 | 0.16686 | 0.05795 |
| 4.50 | 7.31 | 0.9075 | 0.15379 | 0.05341 |
| 4.95 | 7.59 | 0.8608 | 0.13968 | 0.04851 |
| 5.40 | 7.89 | 0.8175 | 0.12549 | 0.04358 |
| 5.85 | 8.21 | 0.7775 | 0.11183 | 0.03884 |
| 6.30 | 8.54 | 0.7405 | 0.09909 | 0.03442 |
| 6.75 | 8.87 | 0.7063 | 0.08746 | 0.03038 |
| 7.20 | 9.22 | 0.6746 | 0.07701 | 0.02675 |
| 7.65 | 9.58 | 0.6453 | 0.06772 | 0.02352 |
| 8.10 | 9.94 | 0.6180 | 0.05952 | 0.02067 |
| 8.55 | 10.31 | 0.5927 | 0.05233 | 0.01818 |
| 9.00 | 10.68 | 0.5692 | 0.04605 | 0.01599 |

| Y(5.85) | | | | |
|---|---|---|---|---|
| α = | 1.2414 | | | |
| Y = | 5.85 | | | |
| r = | 6.18 | | | |
| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
| 0.00 | 6.18 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 6.20 | 1.4981 | 0.04038 | 0.01306 |
| 0.90 | 6.25 | 1.4262 | 0.07765 | 0.02512 |
| 1.35 | 6.33 | 1.3558 | 0.10925 | 0.03534 |
| 1.80 | 6.44 | 1.2875 | 0.13354 | 0.04320 |
| 2.25 | 6.58 | 1.2218 | 0.14990 | 0.04849 |
| 2.70 | 6.75 | 1.1590 | 0.15868 | 0.05133 |
| 3.15 | 6.94 | 1.0996 | 0.16084 | 0.05203 |
| 3.60 | 7.15 | 1.0435 | 0.15775 | 0.05103 |
| 4.05 | 7.39 | 0.9909 | 0.15082 | 0.04879 |
| 4.50 | 7.65 | 0.9416 | 0.14135 | 0.04573 |
| 4.95 | 7.92 | 0.8957 | 0.13046 | 0.04220 |
| 5.40 | 8.21 | 0.8528 | 0.11899 | 0.03849 |
| 5.85 | 8.51 | 0.8130 | 0.10755 | 0.03479 |
| 6.30 | 8.83 | 0.7760 | 0.09656 | 0.03124 |
| 6.75 | 9.15 | 0.7415 | 0.08627 | 0.02791 |
| 7.20 | 9.49 | 0.7095 | 0.07681 | 0.02485 |
| 7.65 | 9.84 | 0.6797 | 0.06824 | 0.02208 |
| 8.10 | 10.19 | 0.6519 | 0.06055 | 0.01959 |
| 8.55 | 10.55 | 0.6261 | 0.05370 | 0.01737 |
| 9.00 | 10.92 | 0.6019 | 0.04762 | 0.01541 |

| Y(6.3) | | | | |
|---|---|---|---|---|
| α = | 1.2634 | | | |
| Y = | 6.30 | | | |
| r = | 6.61 | | | |
| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
| 0.00 | 6.61 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 6.63 | 1.5028 | 0.03310 | 0.01001 |
| 0.90 | 6.67 | 1.4355 | 0.06396 | 0.01935 |
| 1.35 | 6.75 | 1.3693 | 0.09069 | 0.02744 |
| 1.80 | 6.85 | 1.3049 | 0.11199 | 0.03389 |
| 2.25 | 6.98 | 1.2427 | 0.12727 | 0.03851 |
| 2.70 | 7.14 | 1.1830 | 0.13658 | 0.04133 |
| 3.15 | 7.32 | 1.1261 | 0.14050 | 0.04251 |
| 3.60 | 7.53 | 1.0721 | 0.13991 | 0.04233 |
| 4.05 | 7.75 | 1.0211 | 0.13581 | 0.04109 |
| 4.50 | 8.00 | 0.9731 | 0.12922 | 0.03910 |
| 4.95 | 8.26 | 0.9280 | 0.12100 | 0.03661 |
| 5.40 | 8.54 | 0.8858 | 0.11191 | 0.03386 |
| 5.85 | 8.83 | 0.8463 | 0.10249 | 0.03101 |
| 6.30 | 9.13 | 0.8094 | 0.09316 | 0.02819 |
| 6.75 | 9.45 | 0.7749 | 0.08420 | 0.02548 |
| 7.20 | 9.77 | 0.7427 | 0.07577 | 0.02293 |
| 7.65 | 10.11 | 0.7126 | 0.06799 | 0.02057 |
| 8.10 | 10.45 | 0.6844 | 0.06088 | 0.01842 |
| 8.55 | 10.81 | 0.6581 | 0.05445 | 0.01647 |
| 9.00 | 11.17 | 0.6335 | 0.04866 | 0.01472 |

| Y(6.75) | | | | |
|---|---|---|---|---|
| α = | 1.2827 | | | |
| Y = | 6.75 | | | |
| r = | 7.04 | | | |
| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
| 0.00 | 7.04 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 7.05 | 1.5070 | 0.02743 | 0.00779 |
| 0.90 | 7.10 | 1.4436 | 0.05322 | 0.01512 |
| 1.35 | 7.17 | 1.3813 | 0.07595 | 0.02158 |
| 1.80 | 7.27 | 1.3205 | 0.09461 | 0.02688 |
| 2.25 | 7.39 | 1.2615 | 0.10865 | 0.03086 |
| 2.70 | 7.54 | 1.2046 | 0.11798 | 0.03352 |
| 3.15 | 7.71 | 1.1501 | 0.12291 | 0.03492 |
| 3.60 | 7.91 | 1.0981 | 0.12403 | 0.03523 |
| 4.05 | 8.12 | 1.0488 | 0.12203 | 0.03467 |
| 4.50 | 8.36 | 1.0021 | 0.11768 | 0.03343 |
| 4.95 | 8.61 | 0.9580 | 0.11166 | 0.03172 |
| 5.40 | 8.87 | 0.9165 | 0.10458 | 0.02971 |
| 5.85 | 9.15 | 0.8775 | 0.09695 | 0.02754 |
| 6.30 | 9.45 | 0.8408 | 0.08914 | 0.02533 |
| 6.75 | 9.75 | 0.8064 | 0.08145 | 0.02314 |
| 7.20 | 10.07 | 0.7742 | 0.07405 | 0.02104 |
| 7.65 | 10.40 | 0.7439 | 0.06707 | 0.01905 |
| 8.10 | 10.73 | 0.7155 | 0.06059 | 0.01721 |
| 8.55 | 11.08 | 0.6888 | 0.05464 | 0.01552 |
| 9.00 | 11.43 | 0.6638 | 0.04920 | 0.01398 |

Y(7.2)

| α = | 1.2998 |
|---|---|
| Y = | 7.20 |
| r = | 7.47 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 7.47 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 7.49 | 1.5106 | 0.02296 | 0.00615 |
| 0.90 | 7.53 | 1.4509 | 0.04470 | 0.01196 |
| 1.35 | 7.59 | 1.3921 | 0.06415 | 0.01717 |
| 1.80 | 7.69 | 1.3344 | 0.08050 | 0.02154 |
| 2.25 | 7.80 | 1.2783 | 0.09326 | 0.02496 |
| 2.70 | 7.95 | 1.2241 | 0.10230 | 0.02738 |
| 3.15 | 8.11 | 1.1719 | 0.10776 | 0.02884 |
| 3.60 | 8.29 | 1.1218 | 0.11001 | 0.02944 |
| 4.05 | 8.50 | 1.0741 | 0.10954 | 0.02932 |
| 4.50 | 8.72 | 1.0288 | 0.10690 | 0.02861 |
| 4.95 | 8.96 | 0.9857 | 0.10265 | 0.02747 |
| 5.40 | 9.22 | 0.9450 | 0.09726 | 0.02603 |
| 5.85 | 9.49 | 0.9066 | 0.09118 | 0.02440 |
| 6.30 | 9.77 | 0.8703 | 0.08474 | 0.02268 |
| 6.75 | 10.07 | 0.8362 | 0.07821 | 0.02093 |
| 7.20 | 10.38 | 0.8040 | 0.07179 | 0.01922 |
| 7.65 | 10.69 | 0.7737 | 0.06562 | 0.01756 |
| 8.10 | 11.02 | 0.7451 | 0.05978 | 0.01600 |
| 8.55 | 11.36 | 0.7183 | 0.05433 | 0.01454 |
| 9.00 | 11.70 | 0.6929 | 0.04930 | 0.01319 |

Y(7.65)

| α = | 1.3151 |
|---|---|
| Y = | 7.65 |
| r = | 7.91 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 7.91 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 7.92 | 1.5139 | 0.01940 | 0.00491 |
| 0.90 | 7.96 | 1.4575 | 0.03788 | 0.00958 |
| 1.35 | 8.02 | 1.4017 | 0.05461 | 0.01381 |
| 1.80 | 8.11 | 1.3470 | 0.06895 | 0.01744 |
| 2.25 | 8.22 | 1.2936 | 0.08049 | 0.02036 |
| 2.70 | 8.36 | 1.2417 | 0.08907 | 0.02253 |
| 3.15 | 8.51 | 1.1917 | 0.09473 | 0.02396 |
| 3.60 | 8.69 | 1.1436 | 0.09770 | 0.02471 |
| 4.05 | 8.88 | 1.0974 | 0.09831 | 0.02487 |
| 4.50 | 9.10 | 1.0534 | 0.09698 | 0.02453 |
| 4.95 | 9.33 | 1.0115 | 0.09412 | 0.02381 |
| 5.40 | 9.58 | 0.9716 | 0.09013 | 0.02280 |
| 5.85 | 9.84 | 0.9338 | 0.08536 | 0.02159 |
| 6.30 | 10.11 | 0.8980 | 0.08013 | 0.02027 |
| 6.75 | 10.40 | 0.8642 | 0.07466 | 0.01888 |
| 7.20 | 10.69 | 0.8322 | 0.06915 | 0.01749 |
| 7.65 | 11.00 | 0.8019 | 0.06375 | 0.01612 |
| 8.10 | 11.32 | 0.7733 | 0.05855 | 0.01481 |
| 8.55 | 11.65 | 0.7464 | 0.05362 | 0.01356 |
| 9.00 | 11.98 | 0.7208 | 0.04899 | 0.01239 |

Y(8.1)

| α = | 1.3287 |
|---|---|
| Y = | 8.10 |
| r = | 8.34 |

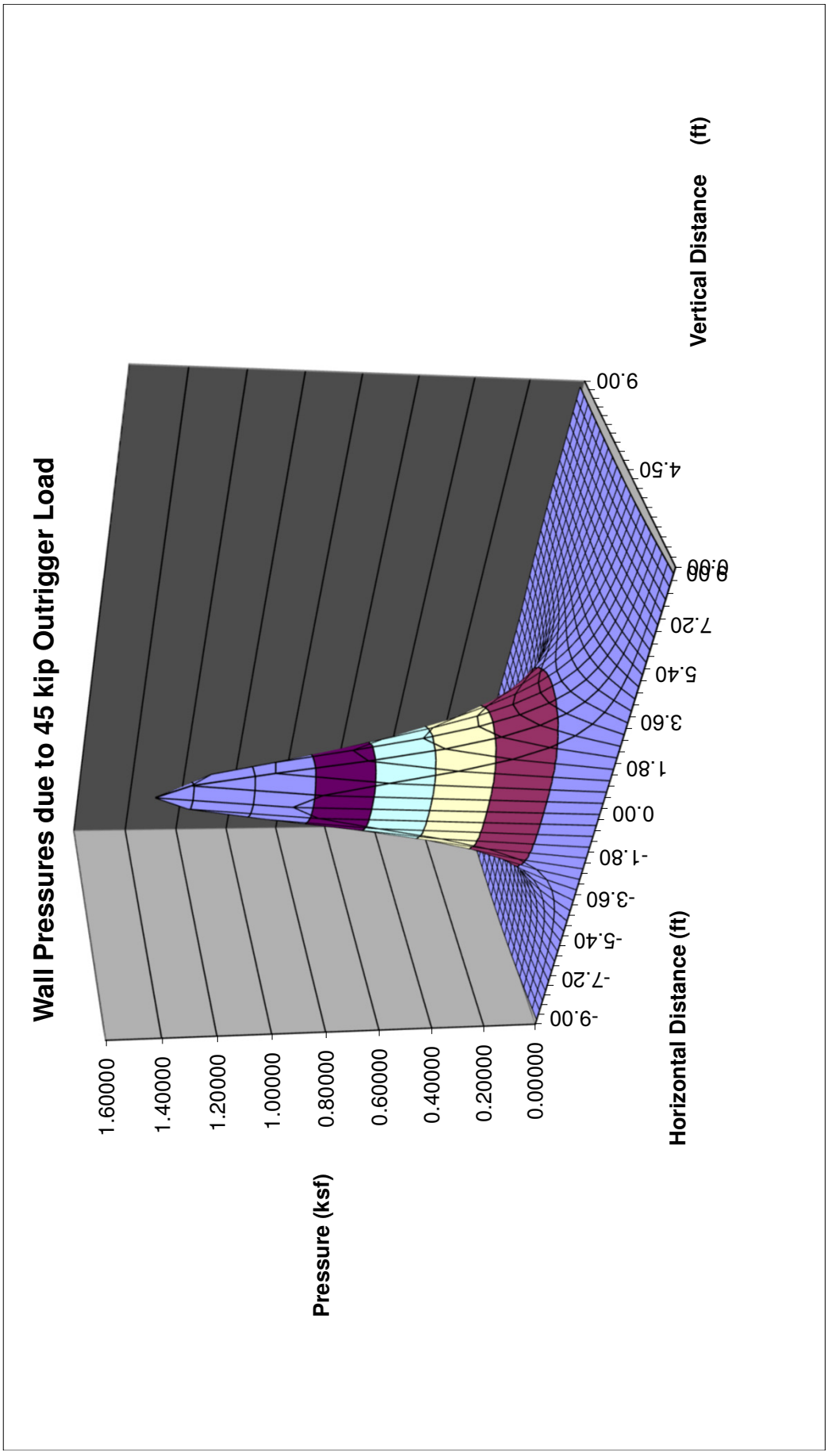
| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 8.34 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 8.36 | 1.5169 | 0.01653 | 0.00396 |
| 0.90 | 8.39 | 1.4633 | 0.03235 | 0.00775 |
| 1.35 | 8.45 | 1.4104 | 0.04682 | 0.01122 |
| 1.80 | 8.54 | 1.3583 | 0.05943 | 0.01425 |
| 2.25 | 8.64 | 1.3074 | 0.06984 | 0.01674 |
| 2.70 | 8.77 | 1.2578 | 0.07787 | 0.01867 |
| 3.15 | 8.92 | 1.2098 | 0.08352 | 0.02002 |
| 3.60 | 9.09 | 1.1634 | 0.08691 | 0.02083 |
| 4.05 | 9.27 | 1.1189 | 0.08828 | 0.02116 |
| 4.50 | 9.48 | 1.0762 | 0.08793 | 0.02108 |
| 4.95 | 9.70 | 1.0353 | 0.08616 | 0.02065 |
| 5.40 | 9.94 | 0.9964 | 0.08330 | 0.01997 |
| 5.85 | 10.19 | 0.9593 | 0.07964 | 0.01909 |
| 6.30 | 10.45 | 0.9240 | 0.07544 | 0.01808 |
| 6.75 | 10.73 | 0.8906 | 0.07092 | 0.01700 |
| 7.20 | 11.02 | 0.8588 | 0.06625 | 0.01588 |
| 7.65 | 11.32 | 0.8287 | 0.06157 | 0.01476 |
| 8.10 | 11.63 | 0.8002 | 0.05698 | 0.01366 |
| 8.55 | 11.95 | 0.7732 | 0.05256 | 0.01260 |
| 9.00 | 12.27 | 0.7475 | 0.04835 | 0.01159 |

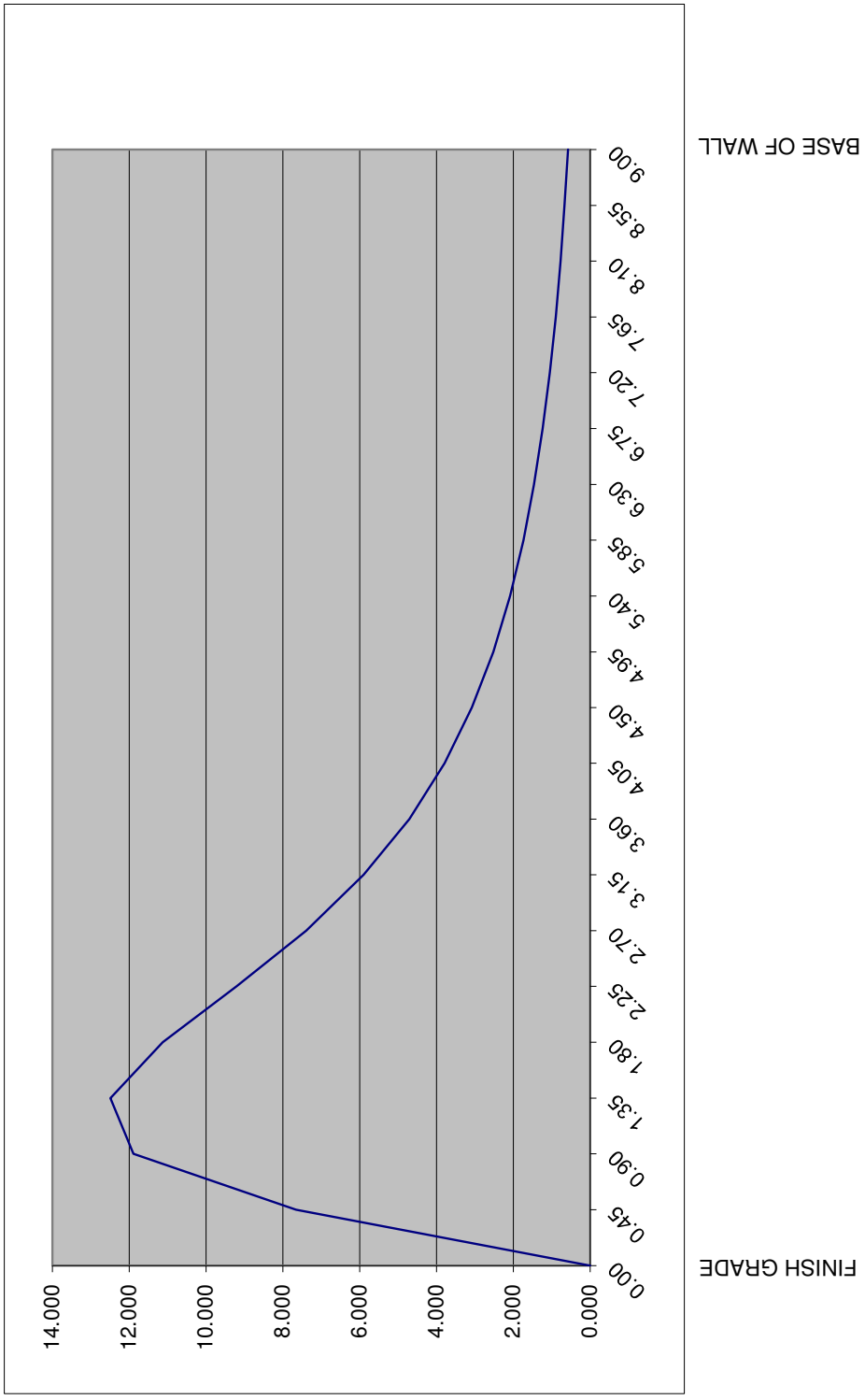
Y(8.55)

| α = | 1.3410 |
|---|---|
| Y = | 8.55 |
| r = | 8.78 |

| Z | R | θ | $\sigma_r$ | $\sigma_h$ |
|---|---|---|---|---|
| 0.00 | 8.78 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 8.79 | 1.5196 | 0.01419 | 0.00323 |
| 0.90 | 8.83 | 1.4687 | 0.02783 | 0.00634 |
| 1.35 | 8.88 | 1.4182 | 0.04041 | 0.00920 |
| 1.80 | 8.96 | 1.3686 | 0.05154 | 0.01174 |
| 2.25 | 9.06 | 1.3200 | 0.06091 | 0.01387 |
| 2.70 | 9.19 | 1.2725 | 0.06836 | 0.01557 |
| 3.15 | 9.33 | 1.2264 | 0.07386 | 0.01682 |
| 3.60 | 9.49 | 1.1817 | 0.07748 | 0.01765 |
| 4.05 | 9.67 | 1.1386 | 0.07936 | 0.01808 |
| 4.50 | 9.87 | 1.0972 | 0.07972 | 0.01816 |
| 4.95 | 10.08 | 1.0575 | 0.07880 | 0.01795 |
| 5.40 | 10.31 | 1.0194 | 0.07685 | 0.01750 |
| 5.85 | 10.55 | 0.9831 | 0.07411 | 0.01688 |
| 6.30 | 10.81 | 0.9484 | 0.07080 | 0.01613 |
| 6.75 | 11.08 | 0.9154 | 0.06710 | 0.01528 |
| 7.20 | 11.36 | 0.8840 | 0.06318 | 0.01439 |
| 7.65 | 11.65 | 0.8541 | 0.05916 | 0.01348 |
| 8.10 | 11.95 | 0.8257 | 0.05515 | 0.01256 |
| 8.55 | 12.26 | 0.7987 | 0.05122 | 0.01167 |
| 9.00 | 12.57 | 0.7731 | 0.04744 | 0.01080 |

| Y(9) | | | | |
|---|---|---|---|---|
| $\alpha$ = | 1.3521 | | | |
| Y = | 9.00 | | | |
| r = | 9.22 | | | |
| Z | R | $\theta$ | $\sigma_r$ | $\sigma_h$ |
| 0.00 | 9.22 | 1.5708 | 0.00000 | 0.00000 |
| 0.45 | 9.23 | 1.5220 | 0.01226 | 0.00266 |
| 0.90 | 9.26 | 1.4735 | 0.02410 | 0.00523 |
| 1.35 | 9.32 | 1.4254 | 0.03510 | 0.00761 |
| 1.80 | 9.39 | 1.3780 | 0.04495 | 0.00975 |
| 2.25 | 9.49 | 1.3314 | 0.05338 | 0.01158 |
| 2.70 | 9.61 | 1.2859 | 0.06026 | 0.01307 |
| 3.15 | 9.74 | 1.2416 | 0.06553 | 0.01422 |
| 3.60 | 9.90 | 1.1985 | 0.06922 | 0.01502 |
| 4.05 | 10.07 | 1.1569 | 0.07143 | 0.01550 |
| 4.50 | 10.26 | 1.1167 | 0.07232 | 0.01569 |
| 4.95 | 10.46 | 1.0781 | 0.07205 | 0.01563 |
| 5.40 | 10.68 | 1.0409 | 0.07082 | 0.01536 |
| 5.85 | 10.92 | 1.0054 | 0.06884 | 0.01493 |
| 6.30 | 11.17 | 0.9713 | 0.06627 | 0.01438 |
| 6.75 | 11.43 | 0.9388 | 0.06329 | 0.01373 |
| 7.20 | 11.70 | 0.9078 | 0.06003 | 0.01302 |
| 7.65 | 11.98 | 0.8782 | 0.05662 | 0.01228 |
| 8.10 | 12.27 | 0.8499 | 0.05314 | 0.01153 |
| 8.55 | 12.57 | 0.8231 | 0.04968 | 0.01078 |
| 9.00 | 12.88 | 0.7974 | 0.04630 | 0.01004 |


Wall Pressures due to 45 kip Outrigger Load
Pressure (ksf)
1.60000
1.40000
1.20000
1.00000
0.80000
0.60000
0.40000
0.20000
0.00000
Horizontal Distance (ft)
-9.00
-7.20
-5.40
-3.60
-1.80
0.00
1.80
3.60
5.40
7.20
9.00
Vertical Distance (ft)
0.00
4.50
9.00




| Wall Forces | |
|---|---|
| Z (ft) | F (klf) |
| 0.00 | 0.000 |
| 0.45 | 7.658 |
| 0.90 | 11.890 |
| 1.35 | 12.492 |
| 1.80 | 11.129 |
| 2.25 | 9.208 |
| 2.70 | 7.398 |
| 3.15 | 5.897 |
| 3.60 | 4.712 |
| 4.05 | 3.793 |
| 4.50 | 3.080 |
| 4.95 | 2.524 |
| 5.40 | 2.086 |
| 5.85 | 1.739 |
| 6.30 | 1.460 |
| 6.75 | 1.234 |
| 7.20 | 1.050 |
| 7.65 | 0.899 |
| 8.10 | 0.773 |
| 8.55 | 0.668 |
| 9.00 | 0.580 |

VISSER ENGINEERING

CALCULATION SHEET

Title:

Project: AMPM VAULT (23-045)

Client: BARGHAUSEN

Date:

Page:

## OUTRIGGER LOADING

FOR DESIGN PURPOSES - PLACE OUTRIGGER AWAY FROM WALL A DISTANCE = SOIL COVER ABOVE WALL

⇒ FULL OUTRIGGER LOAD OUTBOARD OF WALL

⇒ DISTANCE FROM WALL ≈ 2'

LATERAL LOADS FROM OUTRIGGER MAY BE DISTRIBUTED OVER A HORIZONTAL DISTANCE OF THE HEIGHT OF THE WALL OR 10', WHICHEVER IS LESS

⇒ 7' IN THIS CASE

WIDTH OF WALL SUPPORTING VERTICAL LOAD = 1.5 + 1.5 + 7

= 10'

⇒ LL ON WALL = $\frac{45000}{10}$ = 4500 plf

LATERAL PRESSURES ARE DETERMINED BY BOUSSINESQ EQUATIONS

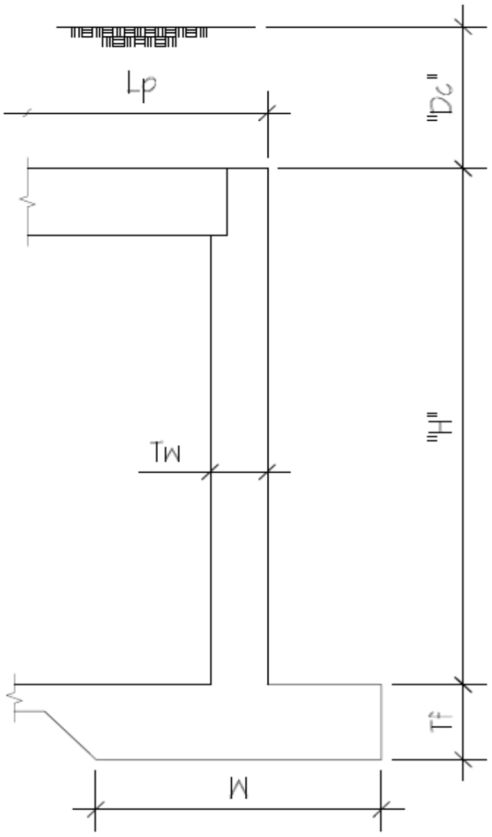
SEE PAGES
FOR WALL DESIGN

VISSER ENGINEERING

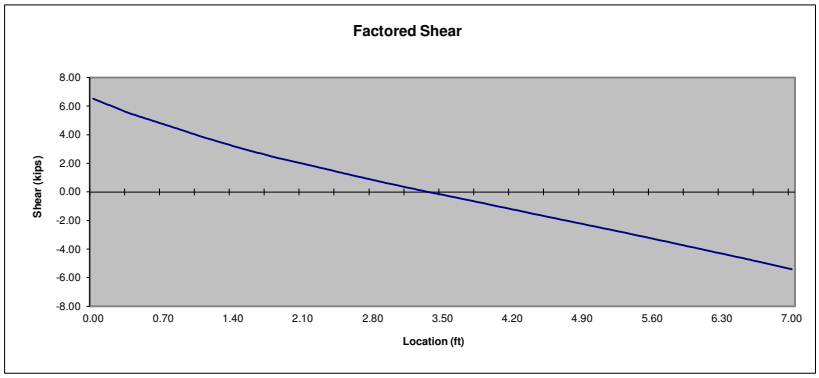
AMPM Vault (23-045)

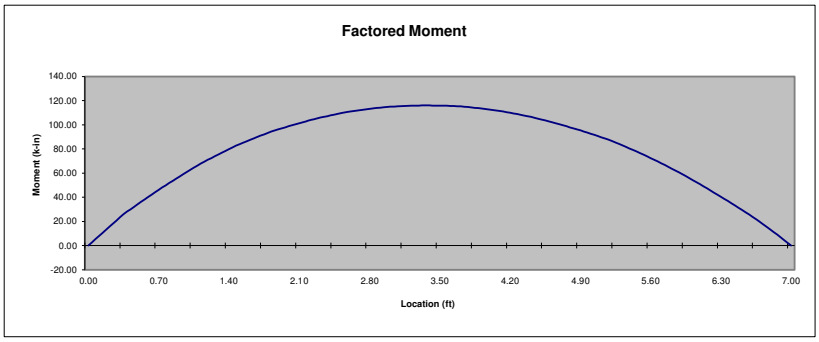
Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

**Exterior Bearing Wall Design - 45 kip Outrigger Load**




| Wall Design: | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mu(max): | 116.38 | k-in/ft | | | Pu: | 11.02 | k/ft |
| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Mn (k-in/ft) | |
| 6 | 7.625 | 0.44 | 15 | 21.21 | 0.46 | 141.12 | ok |
| Dowels: | | Vu: | 5.40 | klf | | | |
| bar size | As | spacing | AsFy | Vu (psi) | nu | phi Vn (klf) | |
| 5 | 0.31 | 15 | 14.73 | 70.86 | 0.6 | 6.63 | ok |




| Footing Reactions: | | |
|---|---|---|
| Dead Load of Panels: | 588 | plf |
| Dead Load of Topping Slab: | 0 | plf |
| Dead Load of Soil: | 1750 | plf |
| Dead Load of Wall: | 846 | plf |
| Dead Load of Footing: | 1178 | plf |
| Live Load on Panels: | 4500 | plf |
| Total Load on Footing: | 8862 | plf |
| Required Footing Width: | 4.43 | feet |

| Footing Design: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| fp(ASD): | 1363 | psf | | | | | | |
| Pu: | 13874.35 | plf | | | | | | |
| fu: | 2134.515 | psf | | | | | | |
| Vu: | 6.05 | kips/ft | | | | | | |
| Mu: | 102.81 | kip-in/ft | | | | | | |
| bar size | d (inches) | As (sq. in.) | spacing (inches) | AsFy (klf) | a (inches) | Phi Vn (k/ft) | Phi Mn (k-in/ft) | |
| 5 | 11.688 | 0.31 | 12 | 18.41 | 0.40 | 14.11 | 190.30 | ok |

**Summary**

Wall: Provide 10" Thick Wall w/ #6 Bars @ 15"oc Vert. and #5 Bars @ 15"oc Horiz.
Dowels: Provide #5 Dowels @ 15"oc - Embed 8" into Footing
Footing: Provide 6.5' Wide x 15" Deep Footing w/ #5 Bars @ 12"oc - Transverse

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23

Page:

## Vault Design - LL = 45 Kip Outrigger Load

| Soil Information | | |
|---|---|---|
| At-Rest Soil Pressure (Saturated), AEFP = | 80 | pcf |
| Seismic Surcharge, E_= | 25 | *H psf |
| Soil Density, ws = | 125 | pcf |
| Allowable Soil Bearing Pressure, q\|allow = | 2000 | psf |

| Concrete Information | | |
|---|---|---|
| Concrete Weight, wc = | 145 | pcf |
| Concrete Strength, fc' = | 4500 | psi |
| Reinforcement, fy = | 60000 | psi |

| Applied Loads | | |
|---|---|---|
| Live Load, wll = | 0 | psf |
| Concentrated Live Load = | 45 | kips |
| Panel Weight, wp = | 84 | psf |
| Topping Slap, wts = | 0 | psf |

Vault Wall Geometry

| Mark | H (feet) | Dcp (feet) | Dcw (feet) | Dll (feet) | Tw (ext) (in) | Tw (int) (in) | Lp (feet) | Tf (in) | W (ext) (ft) | W (int) (ft) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 2 | 3 | 0.00 | 10 | 8 | 14 | 15 | 6.50 | 3 |

| Terms | |
|---|---|
| Dcp = | Depth of Cover over Planks |
| Dcw = | Depth of Cover over Walls |
| Dll = | Theoretical Live Load Depth (wll/ws) |
| H = | Height of Wall |
| Lp = | Span of Panel |
| Tw = | Thickness of Wall (exterior / interior) |
| W = | Total Footing Width (exterior / interior) |
| wll = | Live Load tributary to Wall |
| wp = | Weight of Panel |
| ws = | Weight of Soil tributary to Wall |
| wts = | Weight of Topping Slab |

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

**Concrete Beam Design:** 5' Beam at Access Grate - Axle Load at Middle

| Materials | | |
|---|---|---|
| fc: | 4500 | psi |
| fy: | 60 | ksi |

| | | |
|---|---|---|
| Length: | 5 | feet |
| Width of Support: | 8 | inches |
| Percent of Total Moment to Fixed Ends: | 10% | Percent |
| Percent of Total Moment to Positive M: | 100% | Percent |

**Loads:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| wdl: | 0 | klf | Pdl_1: | 2.9 | kips | Pdl_2: | 0 | kips | Pdl_3: | 0 | kips |
| wll: | 0 | klf | Pll_1: | 20.8 | kips | Pll_2: | 0 | kips | Pll_3: | 0 | kips |
| wsl: | 0 | klf | Psl_1: | 0 | kips | Psl_2: | 0 | kips | Psl_3: | 0 | kips |
| wu: | 0.24 | klf | Pu_1: | 36.76 | kips | Pu_2: | 0 | kips | Pu_3: | 0 | kips |
| | | | x_1: | 2.50 | feet | x_2: | 0 | feet | x_3: | 0 | feet |

**Geometry**

| | | |
|---|---|---|
| b: | 8 | inches |
| h: | 24 | inches |
| bottom cover: | 1.5 | inches |
| top cover: | 1.5 | inches |
| Vertical Bar Spacing: | 2 | inches |

**Shear Reinforcing:**

Stirrup Size: 3
Minimum Spacing: 10.9 Maximum Spacing: 10.9

| | Number | @ | + | Number | @ | + | Number | @ |
|---|---|---|---|---|---|---|---|---|
| Provide: | 10 | 3 | | | | | | |
| x = | 2.50 | feet | | 2.50 | feet | | 2.50 | feet |

**Flexural Reinforcing:**

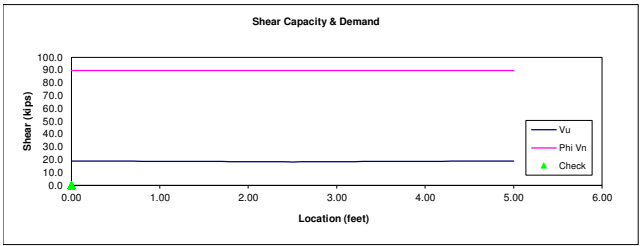
| | # | size | As_layer | d | As | d_eff | As Fy | a | phi Mn (kip-ft) | Bar Length (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| Top A Bars: | 2 | 4 | 0.4 | 21.88 | 0.4 | 21.88 | 24 | 0.78 | 38.7 | 4.5 |
| Top B Bars: | | | | | | | | | | |
| Top C Bars: | | | | | | | | | | |
| Bottom A Bars: | 2 | 7 | 1.2 | 21.69 | 1.2 | 21.69 | 72 | 2.35 | 110.8 | span |
| Bottom B Bars: | 2 | 7 | 1.2 | 19.69 | 2.4 | 20.69 | 144 | 4.71 | 198.0 | 6.5 |
| Bottom C Bars: | | | | | | | | | | |

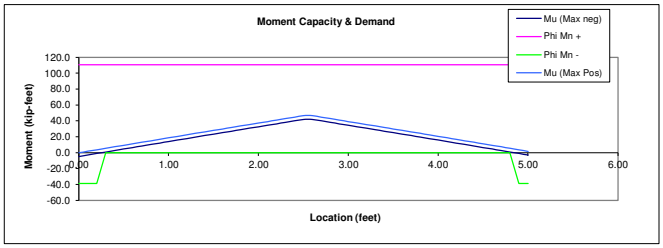
**Summary**

*Top Reinformcement*
( 2 ) # 4 x 4.5 feet

*Bottom Reinforcement*
( 2 ) # 7 x span feet
( 2 ) # 7 x 6.5 feet

*Stirrups*
( 10 ) # 3 @ 3.00 inches o.c.




*dx =* 1.2 *inches*

| X (ft) | wu (k / dx) | Pu (kips) | Vu (kips) | Phi Vc (kips) | Stirrups s(req'd) (inches) | s (inches) | Phi Vs (kips) | Phi Vn (kips) | Mu (Max neg) (kip-ft) | ɯ (Max Pc (kip-ft) | Negative Reinforcement A | B | C | Positive Reinforcement A | B | C | Phi Vs Req'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.02 | 0.0 | 19.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -4.7 | 0.0 | A | | | A | | | 8.8 |
| 0.10 | 0.02 | 0.0 | 19.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -2.8 | 1.9 | A | | | A | | | 8.8 |
| 0.20 | 0.02 | 0.0 | 18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -0.9 | 3.8 | A | | | A | | | 8.8 |
| 0.30 | 0.02 | 0.0 | 18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 1.0 | 5.7 | - | | | A | | | 8.8 |
| 0.40 | 0.02 | 0.0 | 18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 2.9 | 7.6 | - | | | A | | | 8.8 |
| 0.50 | 0.02 | 0.0 | 18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 4.8 | 9.5 | - | | | A | | | 8.8 |
| 0.60 | 0.02 | 0.0 | 18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 6.7 | 11.3 | - | | | A | | | 8.8 |
| 0.70 | 0.02 | 0.0 | 18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 8.6 | 13.2 | - | | | A | | | 8.8 |
| 0.80 | 0.02 | 0.0 | 18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 10.4 | 15.1 | - | | | A | | | 8.8 |
| 0.90 | 0.02 | 0.0 | 18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 12.3 | 17.0 | - | | | A | | | 8.8 |
| 1.00 | 0.02 | 0.0 | 18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 14.2 | 18.9 | - | | | A | | | 8.8 |
| 1.10 | 0.02 | 0.0 | 18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 16.1 | 20.7 | - | | | A | | | 8.8 |
| 1.20 | 0.02 | 0.0 | 18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 17.9 | 22.6 | - | | | A | | | 8.8 |
| 1.30 | 0.02 | 0.0 | 18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 19.8 | 24.5 | - | | | A | | | 8.8 |
| 1.40 | 0.02 | 0.0 | 18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 21.7 | 26.3 | - | | | A | | | 8.8 |
| 1.50 | 0.02 | 0.0 | 18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 23.5 | 28.2 | - | | | A | | | 8.8 |
| 1.60 | 0.02 | 0.0 | 18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 25.4 | 30.1 | - | | | A | | | 8.8 |
| 1.70 | 0.02 | 0.0 | 18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 27.2 | 31.9 | - | | | A | | | 8.8 |
| 1.80 | 0.02 | 0.0 | 18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 29.1 | 33.8 | - | | | A | | | 8.8 |
| 1.90 | 0.02 | 0.0 | 18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 31.0 | 35.6 | - | | | A | | | 8.8 |
| 2.00 | 0.02 | 0.0 | 18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 32.8 | 37.5 | - | | | A | | | 8.8 |
| 2.10 | 0.02 | 0.0 | 18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 34.7 | 39.3 | - | | | A | | | 8.8 |
| 2.20 | 0.02 | 0.0 | 18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 36.5 | 41.2 | - | | | A | | | 8.8 |
| 2.30 | 0.02 | 0.0 | 18.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 38.3 | 43.0 | - | | | A | | | 8.8 |
| 2.40 | 0.02 | 0.0 | 18.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 40.2 | 44.9 | - | | | A | | | 8.8 |
| 2.50 | 0.02 | 36.8 | 18.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 42.0 | 46.7 | - | | | A | | | 8.8 |
| 2.60 | 0.02 | 0.0 | -18.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 42.0 | 46.7 | - | | | A | | | 8.8 |
| 2.70 | 0.02 | 0.0 | -18.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 40.2 | 44.9 | - | | | A | | | 8.8 |
| 2.80 | 0.02 | 0.0 | -18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 38.3 | 43.0 | - | | | A | | | 8.8 |
| 2.90 | 0.02 | 0.0 | -18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 36.5 | 41.2 | - | | | A | | | 8.8 |
| 3.00 | 0.02 | 0.0 | -18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 34.6 | 39.3 | - | | | A | | | 8.8 |
| 3.10 | 0.02 | 0.0 | -18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 32.8 | 37.5 | - | | | A | | | 8.8 |
| 3.20 | 0.02 | 0.0 | -18.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 30.9 | 35.6 | - | | | A | | | 8.8 |
| 3.30 | 0.02 | 0.0 | -18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 29.1 | 33.8 | - | | | A | | | 8.8 |
| 3.40 | 0.02 | 0.0 | -18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 27.2 | 31.9 | - | | | A | | | 8.8 |
| 3.50 | 0.02 | 0.0 | -18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 25.4 | 30.0 | - | | | A | | | 8.8 |
| 3.60 | 0.02 | 0.0 | -18.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 23.5 | 28.2 | - | | | A | | | 8.8 |
| 3.70 | 0.02 | 0.0 | -18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 21.6 | 26.3 | - | | | A | | | 8.8 |
| 3.80 | 0.02 | 0.0 | -18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 19.8 | 24.4 | - | | | A | | | 8.8 |
| 3.90 | 0.02 | 0.0 | -18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 17.9 | 22.6 | - | | | A | | | 8.8 |
| 4.00 | 0.02 | 0.0 | -18.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 16.0 | 20.7 | - | | | A | | | 8.8 |
| 4.10 | 0.02 | 0.0 | -18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 14.2 | 18.8 | - | | | A | | | 8.8 |
| 4.20 | 0.02 | 0.0 | -18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 12.3 | 16.9 | - | | | A | | | 8.8 |
| 4.30 | 0.02 | 0.0 | -18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 10.4 | 15.1 | - | | | A | | | 8.8 |
| 4.40 | 0.02 | 0.0 | -18.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 8.5 | 13.2 | - | | | A | | | 8.8 |
| 4.50 | 0.02 | 0.0 | -18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 6.6 | 11.3 | - | | | A | | | 8.8 |
| 4.60 | 0.02 | 0.0 | -18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 4.7 | 9.4 | - | | | A | | | 8.8 |
| 4.70 | 0.02 | 0.0 | -18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 2.9 | 7.5 | - | | | A | | | 8.8 |
| 4.80 | 0.02 | 0.0 | -18.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 1.0 | 5.6 | - | | | A | | | 8.8 |
| 4.90 | 0.02 | 0.0 | -19.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -0.9 | 3.7 | A | | | A | | | 8.8 |
| 5.00 | 0.02 | 0.0 | -19.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -2.8 | 1.8 | A | | | A | | | 8.8 |

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

**Concrete Beam Design:** 5' Beam at Access Grate - Axle Load at End

| | | |
|---|---|---|
| Length: | 5 | feet |
| Width of Support: | 8 | inches |
| Percent of Total Moment to Fixed Ends: | 10% | Percent |
| Percent of Total Moment to Positive M: | 100% | Percent |

**Materials**

| | | |
|---|---|---|
| fc: | 4500 | psi |
| fy: | 60 | ksi |

**Loads:**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| wdl: | 0 | klf | Pdl_1: | 2.9 | kips | Pdl_2: | 0 | kips | Pdl_3: | 0 | kips |
| wll: | 0 | klf | Pll_1: | 20.8 | kips | Pll_2: | 0 | kips | Pll_3: | 0 | kips |
| wsl: | 0 | klf | Psl_1: | 0 | kips | Psl_2: | 0 | kips | Psl_3: | 0 | kips |
| wu: | 0.24 | klf | Pu_1: | 36.76 | kips | Pu_2: | 0 | kips | Pu_3: | 0 | kips |
| | | | x_1: | 3.19 | feet | x_2: | 0 | feet | x_3: | 0 | feet |

**Geometry**

| | | |
|---|---|---|
| b: | 8 | inches |
| h: | 24 | inches |
| bottom cover: | 1.5 | inches |
| top cover: | 1.5 | inches |
| Vertical Bar Spacing: | 2 | inches |

**Shear Reinforcing:**

Stirrup Size: 3
Minimum Spacing: 10.9 Maximum Spacing: 10.9

| | Number | @ | + | Number | @ | + | Number | @ |
|---|---|---|---|---|---|---|---|---|
| Provide: | 10 | 3 | | | | | | |
| x = | 2.50 | feet | | 2.50 | feet | | 2.50 | feet |

**Flexural Reinforcing:**

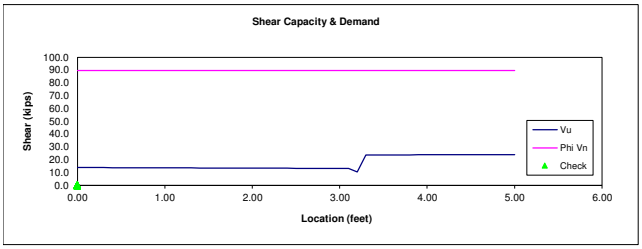
| | # | size | As_layer | d | As | d_eff | As Fy | a | phi Mn (kip-ft) | Bar Length (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| Top A Bars: | 2 | 4 | 0.4 | 21.88 | 0.4 | 21.88 | 24 | 0.78 | 38.7 | 4.5 |
| Top B Bars: | | | | | | | | | | |
| Top C Bars: | | | | | | | | | | |
| Bottom A Bars: | 2 | 7 | 1.2 | 21.69 | 1.2 | 21.69 | 72 | 2.35 | 110.8 | span |
| Bottom B Bars: | 2 | 7 | 1.2 | 19.69 | 2.4 | 20.69 | 144 | 4.71 | 198.0 | 6.5 |
| Bottom C Bars: | | | | | | | | | | |

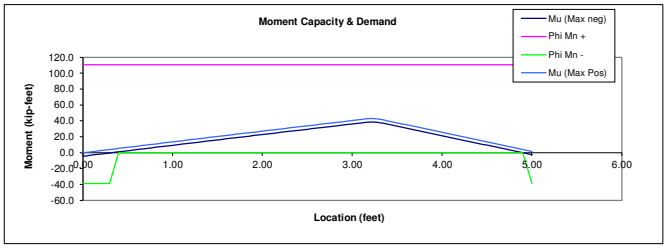
**Summary**

*Top Reinformcement*
( 2 ) # 4 x 4.5 feet

*Bottom Reinforcement*
( 2 ) # 7 x span feet
( 2 ) # 7 x 6.5 feet

*Stirrups*
( 10 ) # 3 @ 3.00 inches o.c.




*dx =* 1.2 *inches*

| X (ft) | wu (k / dx) | Pu (kips) | Vu (kips) | Phi Vc (kips) | Stirrups s(req'd) (inches) | s (inches) | Phi Vs (kips) | Phi Vn (kips) | Mu (Max neg) (kip-ft) | ɯ (Max Pc (kip-ft) | Negative Reinforcement A | B | C | Positive Reinforcement A | B | C | Phi Vs Req'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.02 | 0.0 | 13.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -4.3 | 0.0 | A | | | A | | | 8.8 |
| 0.10 | 0.02 | 0.0 | 13.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -2.9 | 1.4 | A | | | A | | | 8.8 |
| 0.20 | 0.02 | 0.0 | 13.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -1.5 | 2.8 | A | | | A | | | 8.8 |
| 0.30 | 0.02 | 0.0 | 13.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -0.2 | 4.2 | A | | | A | | | 8.8 |
| 0.40 | 0.02 | 0.0 | 13.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 1.2 | 5.5 | - | | | A | | | 8.8 |
| 0.50 | 0.02 | 0.0 | 13.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 2.6 | 6.9 | - | | | A | | | 8.8 |
| 0.60 | 0.02 | 0.0 | 13.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 4.0 | 8.3 | - | | | A | | | 8.8 |
| 0.70 | 0.02 | 0.0 | 13.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 5.4 | 9.7 | - | | | A | | | 8.8 |
| 0.80 | 0.02 | 0.0 | 13.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 6.7 | 11.0 | - | | | A | | | 8.8 |
| 0.90 | 0.02 | 0.0 | 13.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 8.1 | 12.4 | - | | | A | | | 8.8 |
| 1.00 | 0.02 | 0.0 | 13.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 9.5 | 13.8 | - | | | A | | | 8.8 |
| 1.10 | 0.02 | 0.0 | 13.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 10.8 | 15.1 | - | | | A | | | 8.8 |
| 1.20 | 0.02 | 0.0 | 13.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 12.2 | 16.5 | - | | | A | | | 8.8 |
| 1.30 | 0.02 | 0.0 | 13.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 13.5 | 17.9 | - | | | A | | | 8.8 |
| 1.40 | 0.02 | 0.0 | 13.6 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 14.9 | 19.2 | - | | | A | | | 8.8 |
| 1.50 | 0.02 | 0.0 | 13.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 16.3 | 20.6 | - | | | A | | | 8.8 |
| 1.60 | 0.02 | 0.0 | 13.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 17.6 | 21.9 | - | | | A | | | 8.8 |
| 1.70 | 0.02 | 0.0 | 13.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 19.0 | 23.3 | - | | | A | | | 8.8 |
| 1.80 | 0.02 | 0.0 | 13.5 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 20.3 | 24.6 | - | | | A | | | 8.8 |
| 1.90 | 0.02 | 0.0 | 13.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 21.6 | 26.0 | - | | | A | | | 8.8 |
| 2.00 | 0.02 | 0.0 | 13.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 23.0 | 27.3 | - | | | A | | | 8.8 |
| 2.10 | 0.02 | 0.0 | 13.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 24.3 | 28.6 | - | | | A | | | 8.8 |
| 2.20 | 0.02 | 0.0 | 13.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 25.7 | 30.0 | - | | | A | | | 8.8 |
| 2.30 | 0.02 | 0.0 | 13.3 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 27.0 | 31.3 | - | | | A | | | 8.8 |
| 2.40 | 0.02 | 0.0 | 13.3 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 28.3 | 32.6 | - | | | A | | | 8.8 |
| 2.50 | 0.02 | 0.0 | 13.3 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 29.7 | 34.0 | - | | | A | | | 8.8 |
| 2.60 | 0.02 | 0.0 | 13.3 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 31.0 | 35.3 | - | | | A | | | 8.8 |
| 2.70 | 0.02 | 0.0 | 13.2 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 32.3 | 36.6 | - | | | A | | | 8.8 |
| 2.80 | 0.02 | 0.0 | 13.2 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 33.6 | 37.9 | - | | | A | | | 8.8 |
| 2.90 | 0.02 | 0.0 | 13.2 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 35.0 | 39.3 | - | | | A | | | 8.8 |
| 3.00 | 0.02 | 0.0 | 13.2 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 36.3 | 40.6 | - | | | A | | | 8.8 |
| 3.10 | 0.02 | 2.7 | 13.1 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 37.6 | 41.9 | - | | | A | | | 8.8 |
| 3.20 | 0.02 | 34.1 | 10.4 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 38.8 | 43.1 | - | | | A | | | 8.8 |
| 3.30 | 0.02 | 0.0 | -23.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 38.1 | 42.4 | - | | | A | | | 8.8 |
| 3.40 | 0.02 | 0.0 | -23.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 35.7 | 40.0 | - | | | A | | | 8.8 |
| 3.50 | 0.02 | 0.0 | -23.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 33.4 | 37.7 | - | | | A | | | 8.8 |
| 3.60 | 0.02 | 0.0 | -23.7 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 31.0 | 35.3 | - | | | A | | | 8.8 |
| 3.70 | 0.02 | 0.0 | -23.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 28.6 | 32.9 | - | | | A | | | 8.8 |
| 3.80 | 0.02 | 0.0 | -23.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 26.2 | 30.6 | - | | | A | | | 8.8 |
| 3.90 | 0.02 | 0.0 | -23.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 23.9 | 28.2 | - | | | A | | | 8.8 |
| 4.00 | 0.02 | 0.0 | -23.8 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 21.5 | 25.8 | - | | | A | | | 8.8 |
| 4.10 | 0.02 | 0.0 | -23.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 19.1 | 23.4 | - | | | A | | | 8.8 |
| 4.20 | 0.02 | 0.0 | -23.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 16.7 | 21.0 | - | | | A | | | 8.8 |
| 4.30 | 0.02 | 0.0 | -23.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 14.3 | 18.6 | - | | | A | | | 8.8 |
| 4.40 | 0.02 | 0.0 | -23.9 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 11.9 | 16.2 | - | | | A | | | 8.8 |
| 4.50 | 0.02 | 0.0 | -24.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 9.5 | 13.8 | - | | | A | | | 8.8 |
| 4.60 | 0.02 | 0.0 | -24.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 7.1 | 11.4 | - | | | A | | | 8.8 |
| 4.70 | 0.02 | 0.0 | -24.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 4.7 | 9.0 | - | | | A | | | 8.8 |
| 4.80 | 0.02 | 0.0 | -24.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | 2.3 | 6.6 | - | | | A | | | 8.8 |
| 4.90 | 0.02 | 0.0 | -24.0 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -0.1 | 4.2 | - | | | A | | | 8.8 |
| 5.00 | 0.02 | 0.0 | -24.1 | 17.6 | 10.9 | 3.0 | 72.2 | 89.8 | -2.5 | 1.8 | A | | | A | | | 8.8 |

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

**Concrete Beam Design:** 5' Beam at Vault Wall - Axle Load at Middle

| | | |
|---|---|---|
| Length: | 4 | feet |
| Width of Support: | 8 | inches |
| Percent of Total Moment to Fixed Ends: | 10% | Percent |
| Percent of Total Moment to Positive M: | 100% | Percent |

**Materials**

| | | |
|---|---|---|
| fc: | 4500 | psi |
| fy: | 60 | ksi |

**Loads:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| wdl: | 0 | klf | Pdl_1: | 0 | kips | Pdl_2: | 0 | kips | Pdl_3: | 0 | kips |
| wll: | 0 | klf | Pll_1: | 20.8 | kips | Pll_2: | 0 | kips | Pll_3: | 0 | kips |
| wsl: | 0 | klf | Psl_1: | 0 | kips | Psl_2: | 0 | kips | Psl_3: | 0 | kips |
| wu: | 0.15 | klf | Pu_1: | 33.28 | kips | Pu_2: | 0 | kips | Pu_3: | 0 | kips |
| | | | x_1: | 2.00 | feet | x_2: | 0 | feet | x_3: | 0 | feet |

**Geometry**

| | | |
|---|---|---|
| b: | 8 | inches |
| h: | 15 | inches |
| bottom cover: | 1.5 | inches |
| top cover: | 1.5 | inches |
| Vertical Bar Spacing: | 2 | inches |

**Shear Reinforcing:**

Stirrup Size: 3
Minimum Spacing: 6.4 Maximum Spacing: 6.4

| | Number | @ | | Number | @ | | Number | @ |
|---|---|---|---|---|---|---|---|---|
| Provide: | 8 | 3 | +' | | | + | | |
| x = | 2.00 feet | | | 2.00 feet | | | 2.00 feet | |

**Summary**

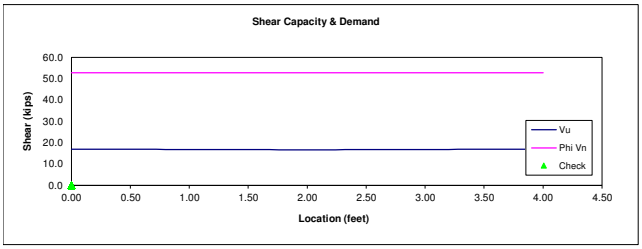
*Top Reinformcement*
( 2 ) # 4 x 4.5 feet

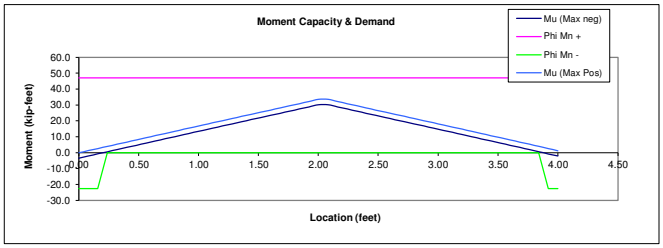
*Bottom Reinforcement*
( 2 ) # 6 x span feet
( 2 ) # 6 x 4.5 feet

*Stirrups*
( 8 ) # 3 @ 3.00 inches o.c.

**Flexural Reinforcing:**

| | # | size | As_layer | d | As | d_eff | As Fy | a | phi Mn (kip-ft) | Bar Length (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| Top A Bars: | 2 | 4 | 0.4 | 12.88 | 0.4 | 12.88 | 24 | 0.78 | 22.5 | 4.5 |
| Top B Bars: | | | | | | | | | | |
| Top C Bars: | | | | | | | | | | |
| Bottom A Bars: | 2 | 6 | 0.88 | 12.75 | 0.88 | 12.75 | 52.8 | 1.73 | 47.1 | span |
| Bottom B Bars: | 2 | 6 | 0.88 | 10.75 | 1.76 | 11.75 | 105.6 | 3.45 | 79.4 | 4.5 |
| Bottom C Bars: | | | | | | | | | | |




| dx = | 0.96 inches | | | | Stirrups | | | | | | Negative Reinforcement | | | Positive Reinforcement | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X (ft) | wu (k / dx) | Pu (kips) | Vu (kips) | Phi Vc (kips) | s(req'd) (inches) | s (inches) | Phi Vs (kips) | Phi Vn (kips) | Mu (Max neg) (kip-ft) | u (Max Pc (kip-ft) | A | B | C | A | B | C | Phi Vs Req'd |
| 0.00 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -3.4 | 0.0 | A | | | A | | | 6.6 |
| 0.08 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -2.0 | 1.4 | A | | | A | | | 6.6 |
| 0.16 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -0.6 | 2.7 | A | | | A | | | 6.6 |
| 0.24 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 0.7 | 4.1 | - | | | A | | | 6.5 |
| 0.32 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 2.1 | 5.4 | - | | | A | | | 6.5 |
| 0.40 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 3.4 | 6.8 | - | | | A | | | 6.5 |
| 0.48 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 4.8 | 8.1 | - | | | A | | | 6.5 |
| 0.56 | 0.01 | 0.0 | 16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 6.1 | 9.5 | - | | | A | | | 6.5 |
| 0.64 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 7.5 | 10.8 | - | | | A | | | 6.5 |
| 0.72 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 8.8 | 12.2 | - | | | A | | | 6.5 |
| 0.80 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 10.1 | 13.5 | - | | | A | | | 6.5 |
| 0.88 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 11.5 | 14.8 | - | | | A | | | 6.4 |
| 0.96 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 12.8 | 16.2 | - | | | A | | | 6.4 |
| 1.04 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 14.2 | 17.5 | - | | | A | | | 6.4 |
| 1.12 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 15.5 | 18.9 | - | | | A | | | 6.4 |
| 1.20 | 0.01 | 0.0 | 16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 16.9 | 20.2 | - | | | A | | | 6.4 |
| 1.28 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 18.2 | 21.6 | - | | | A | | | 6.4 |
| 1.36 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 19.5 | 22.9 | - | | | A | | | 6.4 |
| 1.44 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 20.9 | 24.2 | - | | | A | | | 6.4 |
| 1.52 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 22.2 | 25.6 | - | | | A | | | 6.3 |
| 1.60 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 23.6 | 26.9 | - | | | A | | | 6.3 |
| 1.68 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 24.9 | 28.2 | - | | | A | | | 6.3 |
| 1.76 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 26.2 | 29.6 | - | | | A | | | 6.3 |
| 1.84 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 27.6 | 30.9 | - | | | A | | | 6.3 |
| 1.92 | 0.01 | 0.0 | 16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 28.9 | 32.2 | - | | | A | | | 6.3 |
| 2.00 | 0.01 | 33.3 | 16.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 30.2 | 33.6 | - | | | A | | | 6.3 |
| 2.08 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 30.2 | 33.6 | - | | | A | | | 6.3 |
| 2.16 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 28.9 | 32.2 | - | | | A | | | 6.3 |
| 2.24 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 27.6 | 30.9 | - | | | A | | | 6.3 |
| 2.32 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 26.2 | 29.6 | - | | | A | | | 6.3 |
| 2.40 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 24.9 | 28.2 | - | | | A | | | 6.3 |
| 2.48 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 23.5 | 26.9 | - | | | A | | | 6.3 |
| 2.56 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 22.2 | 25.6 | - | | | A | | | 6.4 |
| 2.64 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 20.9 | 24.2 | - | | | A | | | 6.4 |
| 2.72 | 0.01 | 0.0 | -16.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 19.5 | 22.9 | - | | | A | | | 6.4 |
| 2.80 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 18.2 | 21.6 | - | | | A | | | 6.4 |
| 2.88 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 16.9 | 20.2 | - | | | A | | | 6.4 |
| 2.96 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 15.5 | 18.9 | - | | | A | | | 6.4 |
| 3.04 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 14.2 | 17.5 | - | | | A | | | 6.4 |
| 3.12 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 12.8 | 16.2 | - | | | A | | | 6.4 |
| 3.20 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 11.5 | 14.8 | - | | | A | | | 6.5 |
| 3.28 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 10.1 | 13.5 | - | | | A | | | 6.5 |
| 3.36 | 0.01 | 0.0 | -16.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 8.8 | 12.1 | - | | | A | | | 6.5 |
| 3.44 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 7.4 | 10.8 | - | | | A | | | 6.5 |
| 3.52 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 6.1 | 9.4 | - | | | A | | | 6.5 |
| 3.60 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 4.7 | 8.1 | - | | | A | | | 6.5 |
| 3.68 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 3.4 | 6.7 | - | | | A | | | 6.5 |
| 3.76 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 2.0 | 5.4 | - | | | A | | | 6.5 |
| 3.84 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 0.7 | 4.0 | - | | | A | | | 6.6 |
| 3.92 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -0.7 | 2.7 | A | | | A | | | 6.6 |
| 4.00 | 0.01 | 0.0 | -16.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -2.0 | 1.3 | A | | | A | | | 6.6 |

VISSER ENGINEERING

Project: AMPM Vault (23-045)
Client: Barghausen
Date: 10/05/23
Page:

**Concrete Beam Design:** 4' Beam at Vault Wall - Axle Load at End

| | | |
|---|---|---|
| Length: | 4 | feet |
| Width of Support: | 8 | inches |
| Percent of Total Moment to Fixed Ends: | 10% | Percent |
| Percent of Total Moment to Positive M: | 100% | Percent |

**Materials**

| | | |
|---|---|---|
| fc: | 4500 | psi |
| fy: | 60 | ksi |

**Loads:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| wdl: | 0 | klf | Pdl_1: | 0 | kips | Pdl_2: | 0 | kips | Pdl_3: | 0 | kips |
| wll: | 0 | klf | Pll_1: | 20.8 | kips | Pll_2: | 0 | kips | Pll_3: | 0 | kips |
| wsl: | 0 | klf | Psl_1: | 0 | kips | Psl_2: | 0 | kips | Psl_3: | 0 | kips |
| wu: | 0.15 | klf | Pu_1: | 33.28 | kips | Pu_2: | 0 | kips | Pu_3: | 0 | kips |
| | | | x_1: | 2.94 | feet | x_2: | 0 | feet | x_3: | 0 | feet |

**Geometry**

| | | |
|---|---|---|
| b: | 8 | inches |
| h: | 15 | inches |
| bottom cover: | 1.5 | inches |
| top cover: | 1.5 | inches |
| Vertical Bar Spacing: | 2 | inches |

**Shear Reinforcing:**

Stirrup Size: 3
Minimum Spacing: 6.4 Maximum Spacing: 6.4

| | Number | @ | + | Number | @ | + | Number | @ |
|---|---|---|---|---|---|---|---|---|
| Provide: | 8 | 3 | | | | | | |
| x = | 2.00 feet | | | 2.00 feet | | | 2.00 feet | |

**Flexural Reinforcing:**

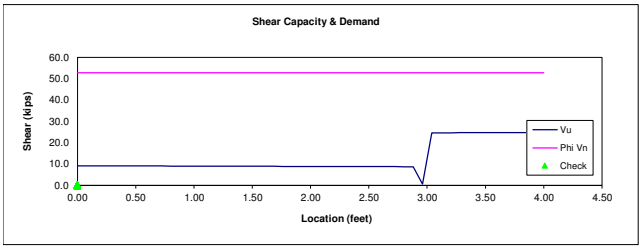
| | # | size | As_layer | d | As | d_eff | As Fy | a | phi Mn (kip-ft) | Bar Length (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| Top A Bars: | 2 | 4 | 0.4 | 12.88 | 0.4 | 12.88 | 24 | 0.78 | 22.5 | 4.5 |
| Top B Bars: | | | | | | | | | | |
| Top C Bars: | | | | | | | | | | |
| Bottom A Bars: | 2 | 6 | 0.88 | 12.75 | 0.88 | 12.75 | 52.8 | 1.73 | 47.1 | span |
| Bottom B Bars: | 2 | 6 | 0.88 | 10.75 | 1.76 | 11.75 | 105.6 | 3.45 | 79.4 | 4.5 |
| Bottom C Bars: | | | | | | | | | | |

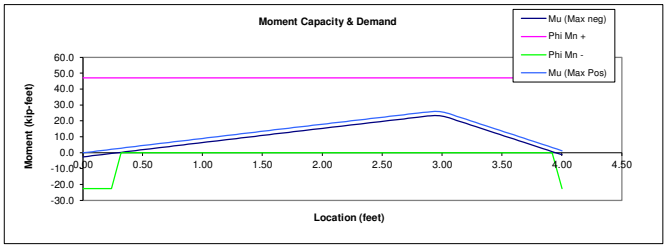
**Summary**

*Top Reinformcement*
( 2 ) # 4 x 4.5 feet

*Bottom Reinforcement*
( 2 ) # 6 x span feet
( 2 ) # 6 x 4.5 feet

*Stirrups*
( 8 ) # 3 @ 3.00 inches o.c.




dx = 0.96 inches

| X (ft) | wu (k / dx) | Pu (kips) | Vu (kips) | Phi Vc (kips) | Stirrups s(req'd) (inches) | s (inches) | Phi Vs (kips) | Phi Vn (kips) | Mu (Max neg) (kip-ft) | u (Max Pc (kip-ft) | Negative Reinforcement A | B | C | Positive Reinforcement A | B | C | Phi Vs Req'd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -2.6 | 0.0 | A | | | A | | | 5.2 |
| 0.08 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -1.9 | 0.7 | A | | | A | | | 5.2 |
| 0.16 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -1.1 | 1.5 | A | | | A | | | 5.2 |
| 0.24 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -0.4 | 2.2 | A | | | A | | | 5.2 |
| 0.32 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 0.3 | 2.9 | - | | | A | | | 5.2 |
| 0.40 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 1.0 | 3.6 | - | | | A | | | 5.2 |
| 0.48 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 1.8 | 4.4 | - | | | A | | | 5.2 |
| 0.56 | 0.01 | 0.0 | 9.1 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 2.5 | 5.1 | - | | | A | | | 5.2 |
| 0.64 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 3.2 | 5.8 | - | | | A | | | 5.2 |
| 0.72 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 3.9 | 6.5 | - | | | A | | | 5.2 |
| 0.80 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 4.7 | 7.3 | - | | | A | | | 5.2 |
| 0.88 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 5.4 | 8.0 | - | | | A | | | 5.2 |
| 0.96 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 6.1 | 8.7 | - | | | A | | | 5.2 |
| 1.04 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 6.8 | 9.4 | - | | | A | | | 5.2 |
| 1.12 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 7.5 | 10.1 | - | | | A | | | 5.2 |
| 1.20 | 0.01 | 0.0 | 9.0 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 8.3 | 10.9 | - | | | A | | | 5.2 |
| 1.28 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 9.0 | 11.6 | - | | | A | | | 5.2 |
| 1.36 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 9.7 | 12.3 | - | | | A | | | 5.2 |
| 1.44 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 10.4 | 13.0 | - | | | A | | | 5.2 |
| 1.52 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 11.1 | 13.7 | - | | | A | | | 5.2 |
| 1.60 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 11.8 | 14.4 | - | | | A | | | 5.2 |
| 1.68 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 12.5 | 15.1 | - | | | A | | | 5.2 |
| 1.76 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 13.3 | 15.9 | - | | | A | | | 5.2 |
| 1.84 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 14.0 | 16.6 | - | | | A | | | 5.2 |
| 1.92 | 0.01 | 0.0 | 8.9 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 14.7 | 17.3 | - | | | A | | | 5.2 |
| 2.00 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 15.4 | 18.0 | - | | | A | | | 5.2 |
| 2.08 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 16.1 | 18.7 | - | | | A | | | 5.2 |
| 2.16 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 16.8 | 19.4 | - | | | A | | | 5.2 |
| 2.24 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 17.5 | 20.1 | - | | | A | | | 5.2 |
| 2.32 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 18.2 | 20.8 | - | | | A | | | 5.2 |
| 2.40 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 18.9 | 21.5 | - | | | A | | | 5.2 |
| 2.48 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 19.6 | 22.2 | - | | | A | | | 5.2 |
| 2.56 | 0.01 | 0.0 | 8.8 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 20.3 | 22.9 | - | | | A | | | 5.2 |
| 2.64 | 0.01 | 0.0 | 8.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 21.0 | 23.6 | - | | | A | | | 5.2 |
| 2.72 | 0.01 | 0.0 | 8.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 21.7 | 24.3 | - | | | A | | | 5.2 |
| 2.80 | 0.01 | 0.0 | 8.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 22.4 | 25.0 | - | | | A | | | 5.2 |
| 2.88 | 0.01 | 9.4 | 8.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 23.1 | 25.7 | - | | | A | | | 5.2 |
| 2.96 | 0.01 | 23.9 | -0.7 | 10.4 | | 3.0 | 42.5 | 52.9 | 23.4 | 26.0 | - | | | A | | | 0.0 |
| 3.04 | 0.01 | 0.0 | -24.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 22.4 | 25.0 | - | | | A | | | 14.2 |
| 3.12 | 0.01 | 0.0 | -24.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 20.4 | 23.0 | - | | | A | | | 14.2 |
| 3.20 | 0.01 | 0.0 | -24.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 18.5 | 21.1 | - | | | A | | | 14.3 |
| 3.28 | 0.01 | 0.0 | -24.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 16.5 | 19.1 | - | | | A | | | 14.3 |
| 3.36 | 0.01 | 0.0 | -24.6 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 14.5 | 17.1 | - | | | A | | | 14.3 |
| 3.44 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 12.6 | 15.2 | - | | | A | | | 14.3 |
| 3.52 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 10.6 | 13.2 | - | | | A | | | 14.3 |
| 3.60 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 8.6 | 11.2 | - | | | A | | | 14.3 |
| 3.68 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 6.6 | 9.2 | - | | | A | | | 14.3 |
| 3.76 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 4.7 | 7.3 | - | | | A | | | 14.3 |
| 3.84 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 2.7 | 5.3 | - | | | A | | | 14.4 |
| 3.92 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | 0.7 | 3.3 | - | | | A | | | 14.4 |
| 4.00 | 0.01 | 0.0 | -24.7 | 10.4 | 6.4 | 3.0 | 42.5 | 52.9 | -1.3 | 1.3 | A | | | A | | | 14.4 |

VISSER ENGINEERING

CALCULATION SHEET

Title:

Project: AMPM VAULT (23-045)

Client: BARGHAUSEN

Date:

Page:

## HYDROSTATIC UPLIFT

ASSUME WATER TABLE IS @ TOP OF UD

$\Rightarrow$ 8' OF WATER TO T/SLAB + SLAB/FTG THICKNESS

## DEAD LOADS

AREA OF VAULT = 5760 FT$^2$

$\Rightarrow$ SOIL $= \frac{(125)(1)(5760)}{1000} = 720^k$

PLANK $= \frac{(84)(5760)}{1000} = 484^k$

10" CONC. WALLS $= \frac{(429')(10/12)(150)(7')}{1000} = 375^k$

8" CONC. WALLS $= \frac{(212')(8/12)(150)(7)}{1000} = 148^k$

30" SLAB $= \frac{(30/12)(150)(5760)}{1000} = 2160^k$

$\Rightarrow$ TOTAL DL $= 3887^k$

TOTAL UPLIFT $= \frac{(8 + 30/12)(64)(5760)}{1000} = 3870^k < 3887^k$

$\Rightarrow$ OK

VISSER ENGINEERING

CALCULATION SHEET

Title:

Project: AMPM VAULT (23-045)

Client: BARGHAUSEN

Date:

Page:

## LL ON VAULT WALLS

(2) CASES: a) 250 psf ON 1 OR 2 SPANS

b) 45 k OVER 1 WALL (4500 plf)

CASE a: i) LL = 250 psf ON BOTH SPANS

$\Rightarrow P_{EXT.} = (250)(14/2) = 1750$ plf

$P_{INT.} = (250)(14) = 3500$ plf

ii) LL = 250 ON 1 SPAN

$\Rightarrow P_{EXT} = P_{INT} = 1750$ plf

CASE b: P = 4500 plf ON ANY WALL

## DL ON VAULT WALLS

P @ EXT. WALLS $= ((125)(1) + 84)(14/2) + (10/12)(150)(7') = 2338$ plf

P @ INT. WALLS $= ((125)(1) + 84)(14) + (8/12)(150)(7) = 3626$ plf

**Location:** **Vault Slab**

$q_{allow}$ = 1.50 ksf

**Loading**

| | LL (k) | DL (k) | P(total) | Pu(total) | | | |
|---|---|---|---|---|---|---|---|
| $P_1$ = | 1.75 | 2.338 | 4.088 | 5.606 | at | 1.00 | ft |
| $P_2$ = | 3.5 | 3.626 | 7.126 | 9.951 | at | 15.00 | ft |
| $P_3$ = | 1.75 | 2.338 | 4.088 | 5.606 | at | 29.00 | ft |
| $P_4$ = | 0 | 0 | 0 | 0.000 | at | 0.00 | ft |

**Footing Geometry**

| | | |
|---|---|---|
| Footing Width (W) = | 1 | ft |
| Footing Length (L) = | 30 | ft |
| Footing Depth (d) = | 2.5 | ft |
| Footing Weight ($W_{ftg}$) = | 10.88 | k |

$P_{total}$ = 15 k

$P_{u\ total}$ = 21 k

**Check Soil Bearing Pressure (Ignoring Footing Weight)**

x-bar = 15.0000 ft

e = 0.0000 ft

$M_{soil}$ = 0.00 k-ft

$q_{max}$ = 0.510 ksf < 1.5 ksf **OK**

$q_{min}$ = 0.510 ksf

**Soil Pressure for Footing Design**

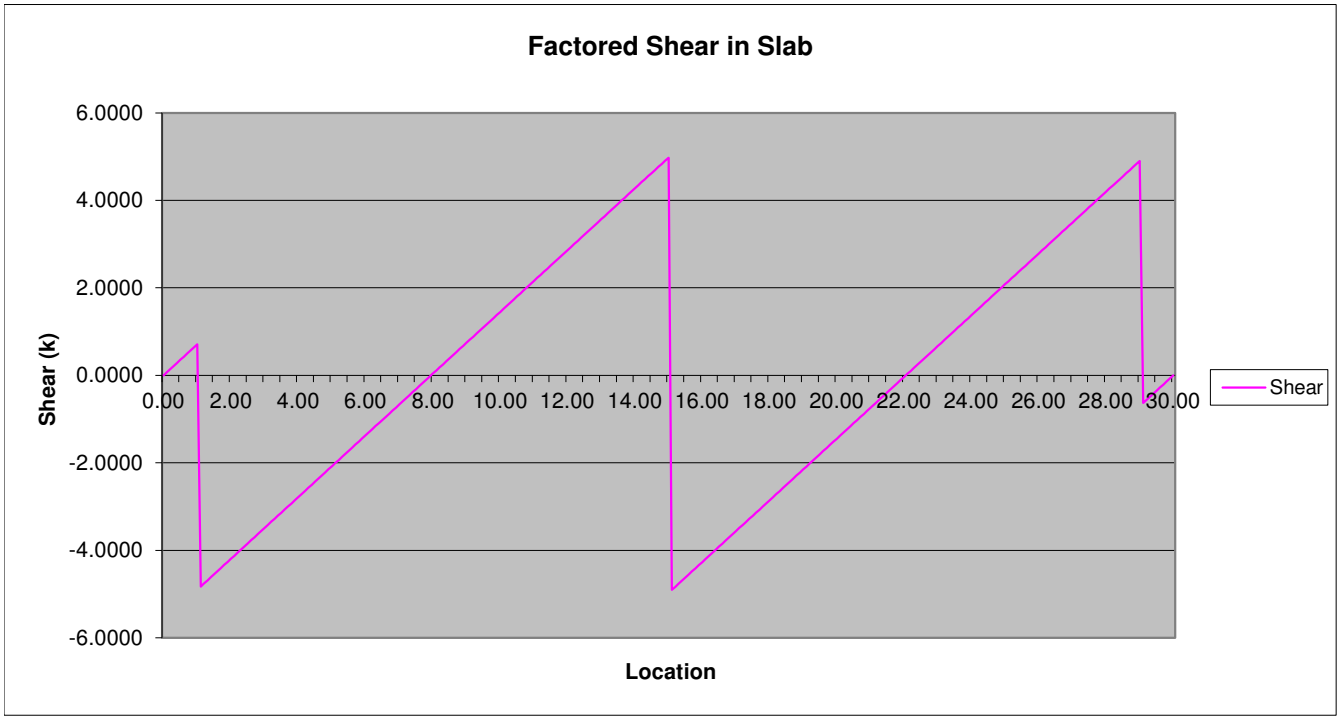
x-bar = 15.0000 ft

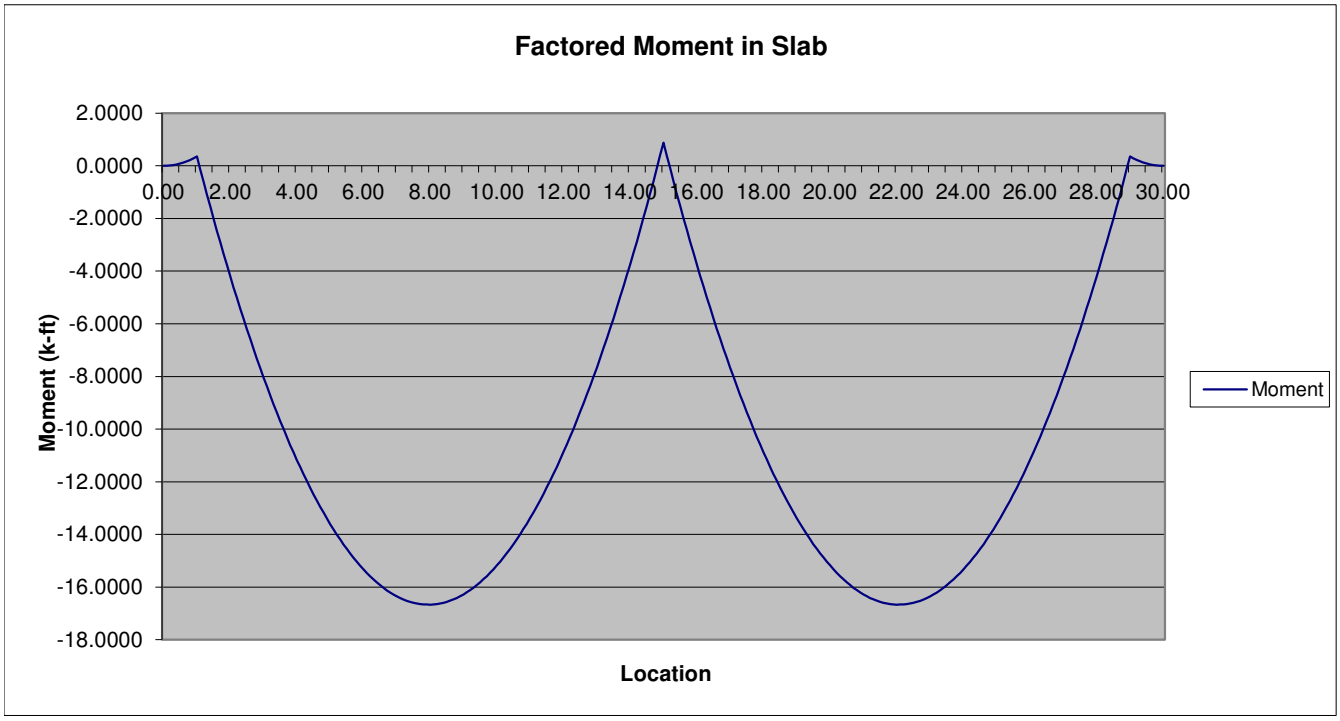
e = 0.0000 ft

Msoil = 0.00 k-ft

$q_{max}$ = 0.705 ksf

$q_{min}$ = 0.705 ksf


Factored Shear in Slab
6.0000
4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
Shear (k)
0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00 18.00 20.00 22.00 24.00 26.00 28.00 30.00
Location
Shear


Factored Moment in Slab
2.0000
0.0000
-2.0000
-4.0000
-6.0000
-8.0000
-10.0000
-12.0000
-14.0000
-16.0000
-18.0000
Moment (k-ft)
0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00 18.00 20.00 22.00 24.00 26.00 28.00 30.00
Location
Moment

**Location:** **Vault Slab**

$q_{allow}$ = 1.50 ksf

**Loading**

| | LL (k) | DL (k) | P(total) | Pu(total) | | | |
|---|---|---|---|---|---|---|---|
| $P_1$ = | 1.75 | 2.338 | 4.088 | 5.606 | at | 1.00 | ft |
| $P_2$ = | 1.75 | 3.626 | 5.376 | 7.151 | at | 15.00 | ft |
| $P_3$ = | 0 | 2.338 | 2.338 | 2.806 | at | 29.00 | ft |
| $P_4$ = | 0 | 0 | 0 | 0.000 | at | 0.00 | ft |

**Footing Geometry**

| | | |
|---|---|---|
| Footing Width (W) = | 1 | ft |
| Footing Length (L) = | 30 | ft |
| Footing Depth (d) = | 2.5 | ft |
| Footing Weight ($W_{ftg}$) = | 10.88 | k |

$P_{total}$ = 12 k

$P_{u\ total}$ = 16 k

**Check Soil Bearing Pressure (Ignoring Footing Weight)**

x-bar = 12.9241 ft

e = 2.0759 ft

$M_{soil}$ = 24.50 k-ft

$q_{max}$ = 0.557 ksf < 1.5 ksf **OK**

$q_{min}$ = 0.230 ksf

**Soil Pressure for Footing Design**

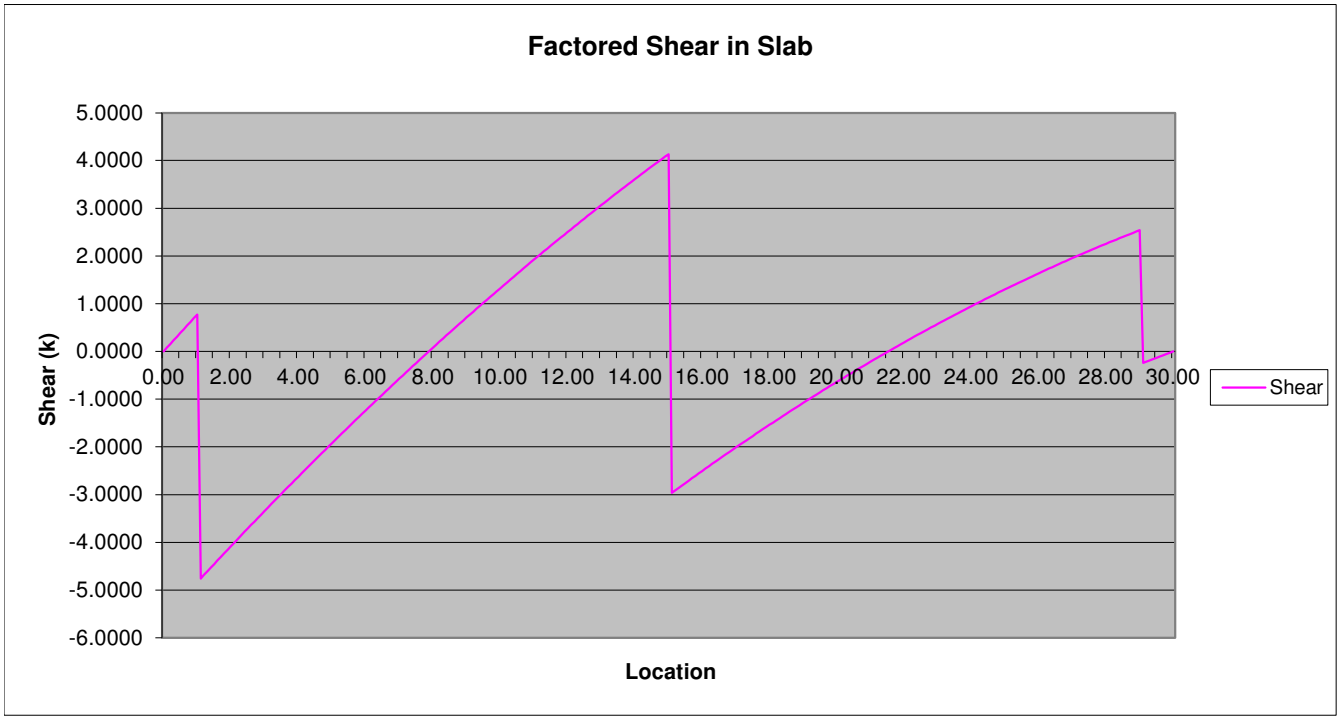
x-bar = 12.4811 ft

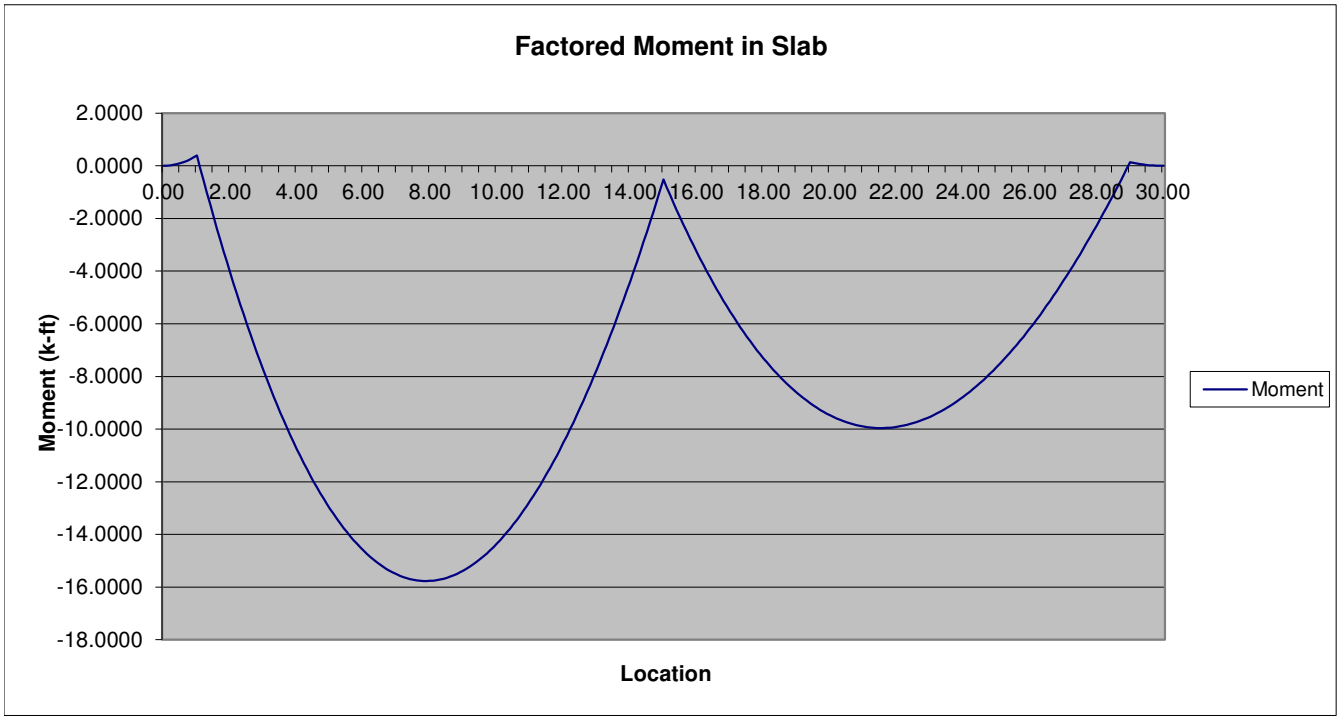
e = 2.5189 ft

Msoil = 39.20 k-ft

$q_{max}$ = 0.780 ksf

$q_{min}$ = 0.257 ksf


Factored Shear in Slab
5.0000
4.0000
3.0000
2.0000
1.0000
0.0000
-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
-6.0000
0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00 18.00 20.00 22.00 24.00 26.00 28.00 30.00
Shear (k)
Location
Shear


Factored Moment in Slab
2.0000
0.0000
-2.0000
-4.0000
-6.0000
-8.0000
-10.0000
-12.0000
-14.0000
-16.0000
-18.0000
0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00 18.00 20.00 22.00 24.00 26.00 28.00 30.00
Moment (k-ft)
Location
Moment

VISSER ENGINEERING

CALCULATION SHEET

Title:

Project: AMPM VAULT (23-045)

Client: BARGHAUSEN

Date:

Page:

FOR HYDROSTATIC UPLIFT ON SLAB

$W_u$ NET = (1.6)(672) - (.9)(375)

= 738 plf

⇒ FOR 2 SPAN CONDITION:

$V_{u\,MAX}$ = 6.41 k

$M_{u+\,MAX}$ = 10.05 k' = 120.6 k" (TOP BARS)

$M_{u-\,MAX}$ = 17.80 k' = 213.6 k" (BOTTOM BARS)

FOR 30" SLAB:

$d_{BOTTOM}$ = 30 - 3½ = 26.5", $d_{TOP}$ = 30 - 2 = 28"

#5 @ 15" oc: T = (.31)(12/15)(60) = 14.88 k/FT

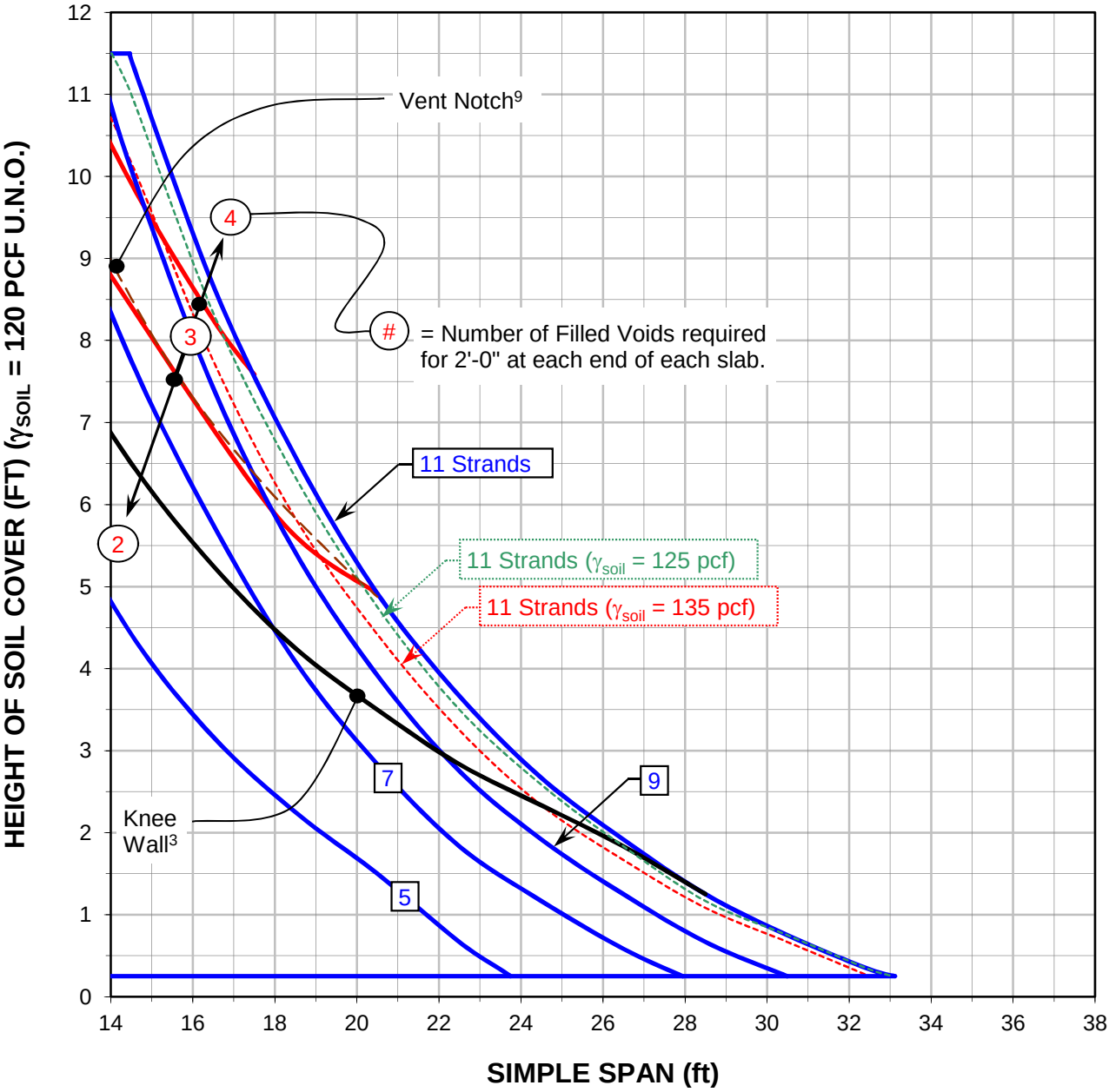
$$a = \frac{14.88}{(.85)(3)(12)} = .486"$$

$\phi M_N$ = (.9)(14.88)(26.5 - .486/2) = 351.6 k"/FT ⇒ Ok

(.0012)(30)(12) = .432 IN²/FT ⇒ #5 @ 18" oc T & B

# CONCRETE TECHNOLOGY CORPORATION

## 12½" HOLLOW CORE SLAB
## 250 PSF

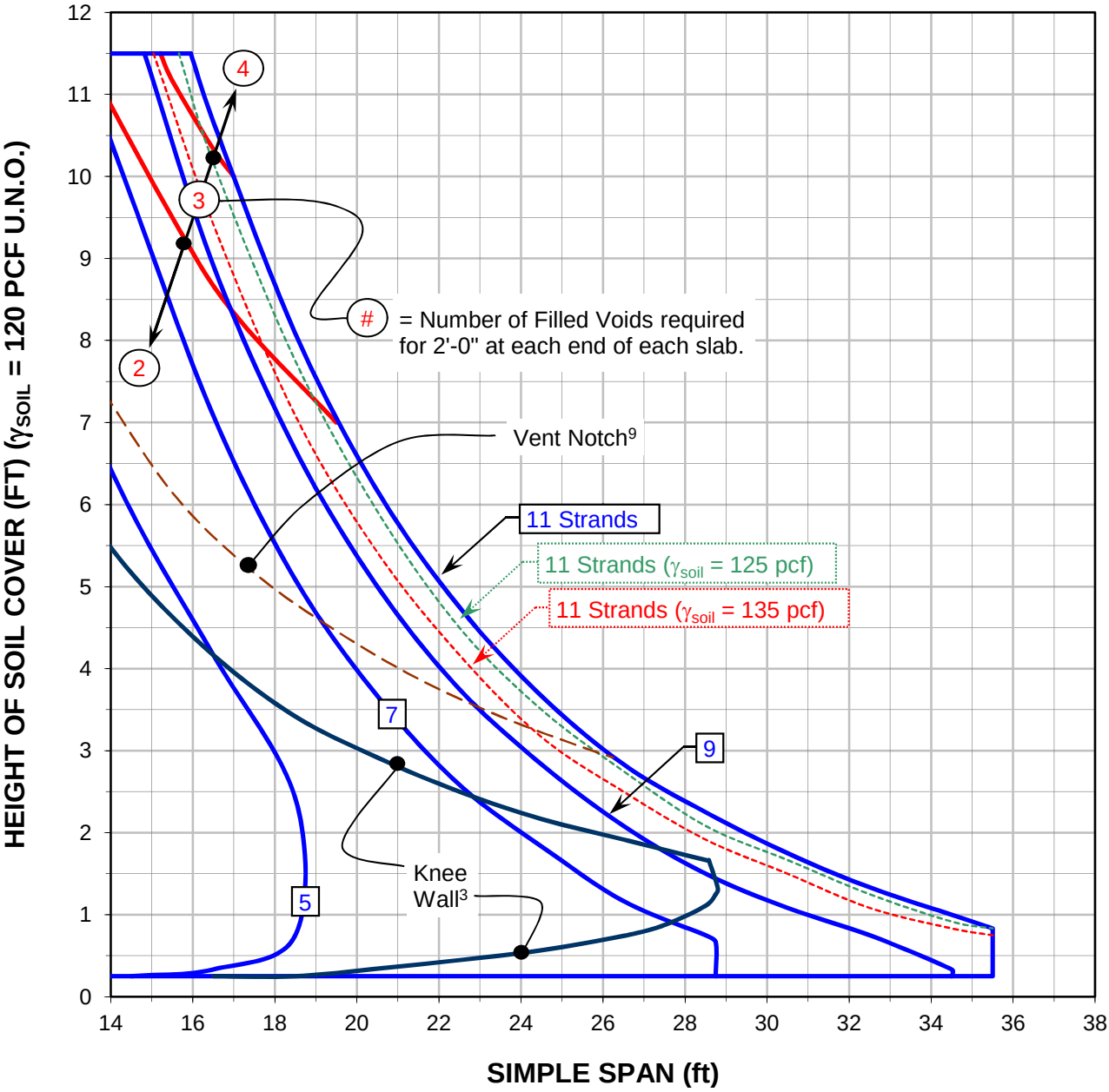



**GENERAL NOTES:**

1.) A minimum cover depth of six inches OR a three inch thick cast in place concrete topping slab is required.
2.) Simple Span is centerline of bearing to centerline of bearing.
3.) The Knee Wall envelope represents the maximum span and height of soil cover that can be supported by slabs with standard notches for manhole openings, assuming void fill concrete f'c = 3,000 psi. Points falling outside this envelope require knee walls to support the slabs at manhole openings.
4.) Interpolation between strand contours is acceptable. DO NOT extrapolate beyond the bounds of this chart.
5.) Soil cover is assumed to be uniform.
6.) Except as noted, soil cover unit weight is assumed to be 120 pcf.
7.) Minimum span length = 14'-0".
8.) The values shown on this chart are in compliance with IBC 2012 & ACI 318-11.
9.) The Vent Notch envelope represents the maximum span and height of soil cover that can be supported by slabs with 6½" standard notches in adjacent slabs to accommodate 12" diameter vents, assuming void fill concrete f'c = 3,000 psi. Refer to Detail 3 on page 13 of this brochure for vent notch details.

# CONCRETE TECHNOLOGY CORPORATION

## 12½" HOLLOW CORE SLAB
## HS20-44



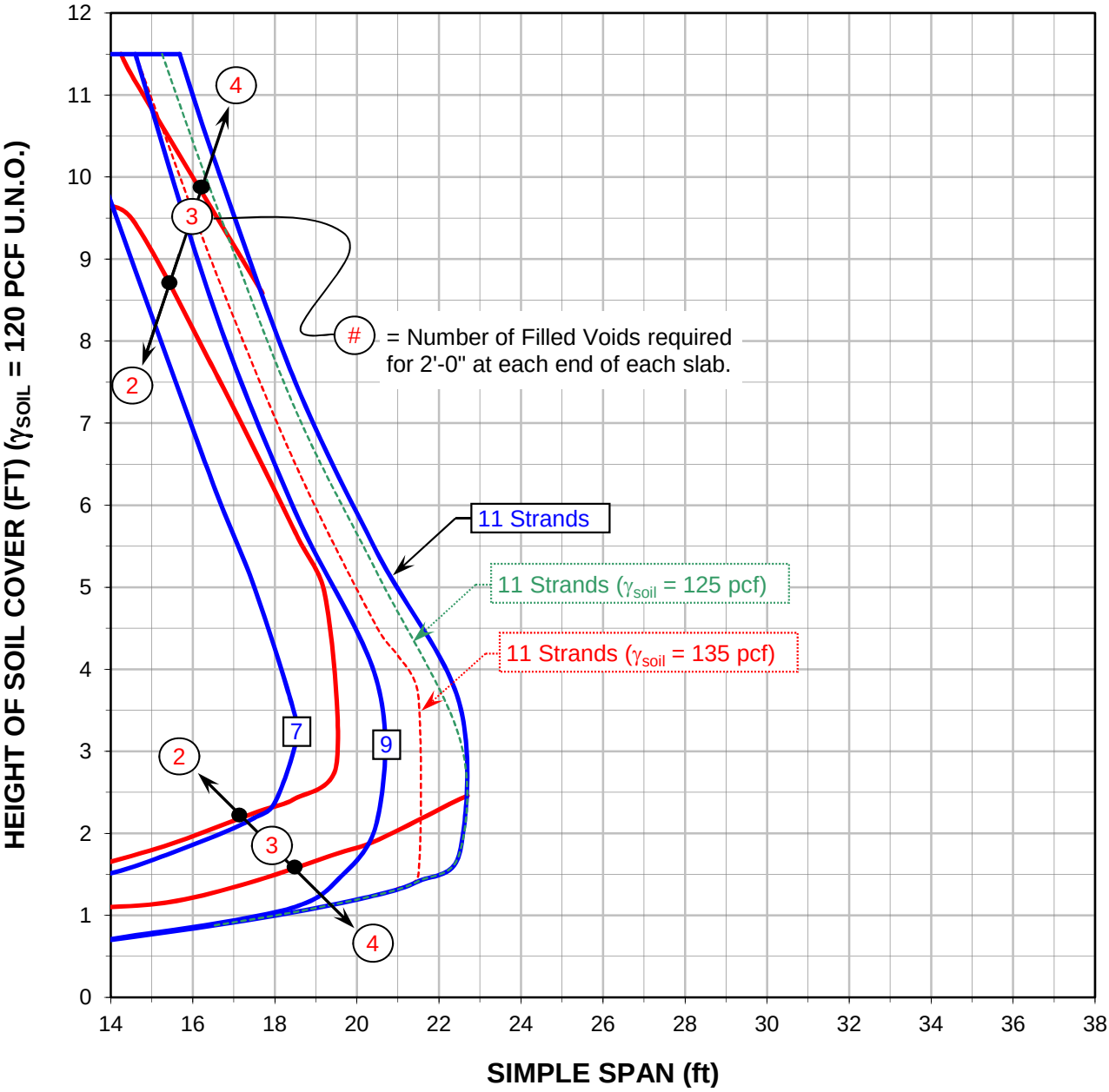

**GENERAL NOTES:**

1.) A minimum cover depth of six inches OR a three inch thick cast in place concrete topping slab is required.
2.) Simple Span is centerline of bearing to centerline of bearing.
3.) The Knee Wall envelope represents the maximum span and height of soil cover that can be supported by slabs with standard notches for manhole openings, assuming void fill concrete f'c = 3,000 psi. Points falling outside this envelope require knee walls to support the slabs at manhole openings.
4.) Interpolation between strand contours is acceptable. DO NOT extrapolate beyond the bounds of this chart.
5.) Soil cover is assumed to be uniform.
6.) Except as noted, soil cover unit weight is assumed to be 120 pcf.
7.) Minimum span length = 14'-0".
8.) The values shown on this chart are in compliance with IBC 2012 & ACI 318-11.
9.) The Vent Notch envelope represents the maximum span and height of soil cover that can be supported by slabs with 6½" standard notches in adjacent slabs to accommodate 12" diameter vents, assuming void fill concrete f'c = 3,000 psi. Refer to Detail 3 on page 13 of this brochure for vent notch details.

# CONCRETE TECHNOLOGY CORPORATION

## 12½" HOLLOW CORE SLAB

### 45 KIP OUTRIGGER ON 18"x18" PADS @ 15'-0" O.C.




**GENERAL NOTES:**

1.) A minimum cover depth of nine inches is required.
2.) Simple Span is centerline of bearing to centerline of bearing.
3.) Knee walls are required at all manhole and vent openings.
4.) Interpolation between strand contours is acceptable. DO NOT extrapolate beyond the bounds of this chart.
5.) Soil cover is assumed to be uniform.
6.) Except as noted, soil cover unit weight is assumed to be 120 pcf.
7.) Minimum span length = 14'-0".
8.) The values shown on this chart are in compliance with IBC 2012 & ACI 318-11.