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Consulting Engineers
14 Penn Plaza · 225 West 34th Street · New York, NY 10122
Tel: (917) 339-9300 · Fax: (917) 339-9400
www.mrce.com

EE MEMORANDUM B2

Date:	January, 2016
To:	Office
From:	Krishna Haridas
Re:	Memo 2 – Engineering Evaluation of Existing Vaults 3 and 4
File:	12582B

Available Information

1. VMH-905 Vault 3 Shop Drawing
2. VMH-906 Vault 3 Shop Drawing
3. VMH-907 Vault 3 Shop Drawing
4. VMH-908 Vault 3 Shop Drawing
5. Design Calculations By Rotondo Precast dated 11-14-1996

Vaults 3 & 4

Review of the shop drawings VMH-905, VMH-906, VMH-907 and VMH-908 for the precast vaults supplied by Rotondo Precast and the design package submitted by Black & Veatch indicates Vaults 3 and 4 are designed to carry up to 5 feet of granular fill plus HS20 truck live load. Top of Vault 3 is at Elev. +13.6 and for Vault 4 is at Elev. +12.4 per data provided by CH2M Hill dated 10-16-2015. The construction of proposed Wills Street requires adding fill to the site resulting in approximately 13.4 feet of normal weight of fill over Vault 3 and 4.6 feet of normal weight of fill over Vault 4. A structural capacity evaluation of Vault 4 was not performed as the proposed loading does not exceed that permitted by the designer of vaults

Structural Capacity Evaluation of Vault 3

Loads:

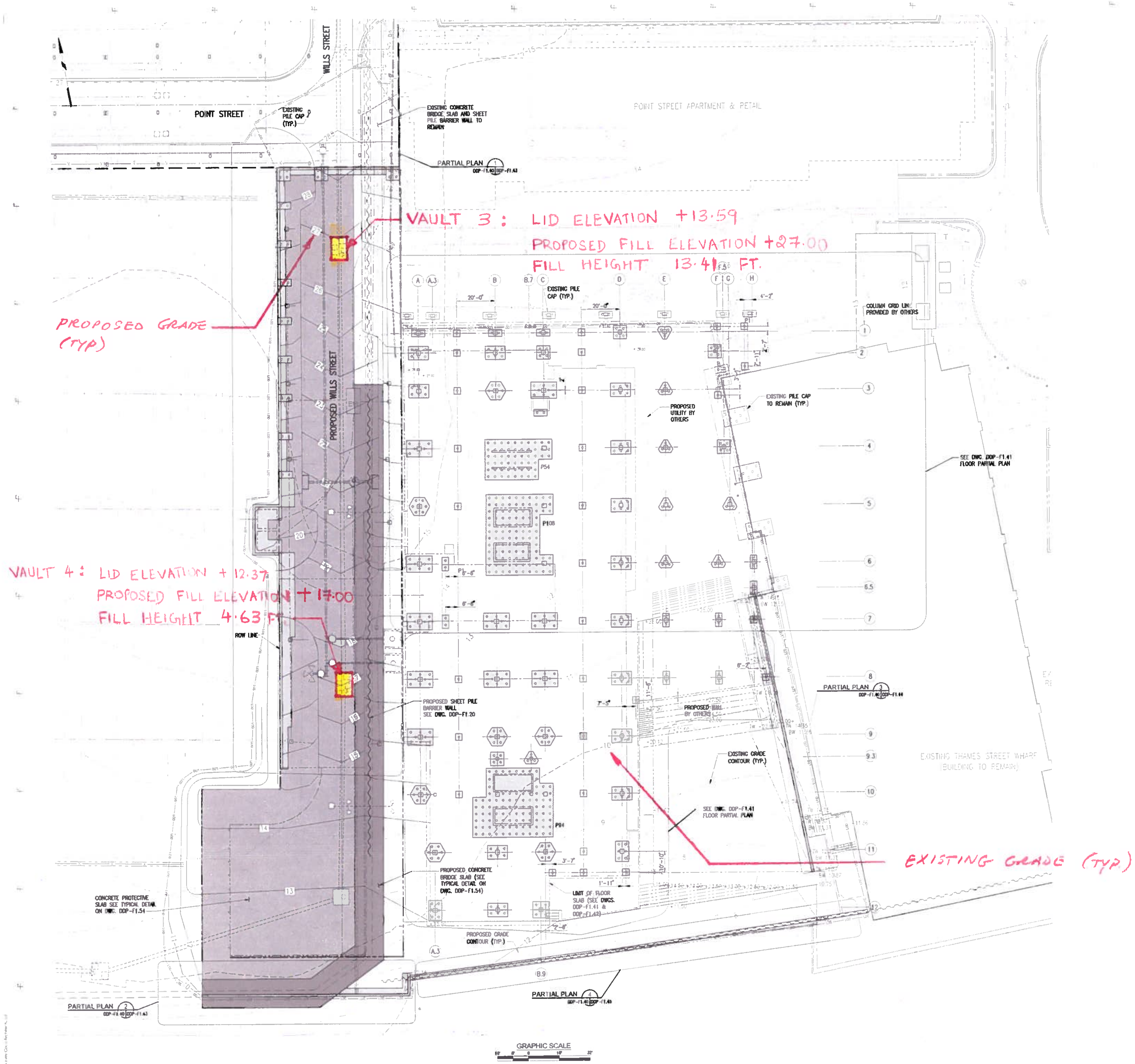
- HS-20 Truck Loading per AASHTO LRFD Bridge Design Specifications
- Construction surcharge equivalent to 2 feet of fill
- Weight of the proposed fill

Since this is a review of the vault design performed in 1996, the load factors and code provisions used by the original designers are adopted. The concrete side walls and roof and floor slabs are analyzed as continuous one way slabs ignoring the openings shown on the shop drawings. Wall corner moments are obtained using an equivalent frame analysis assuming fixed wall to slab connections similar to original design.

Conclusion

Vault 3: MRCE structural evaluation finds that the structural capacity of Vault 3 is inadequate to carry the proposed 13.4 feet of fill and will require structural modifications to handle the load. Structural modifications should follow the latest code provisions.

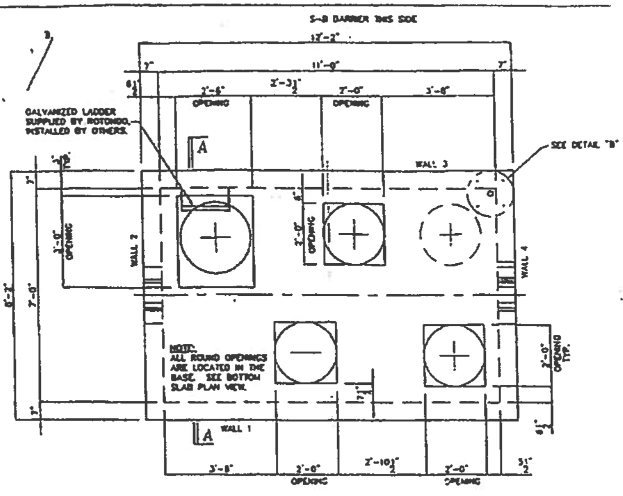
Vault 4: Increased height of fill above Vault 4 (4.6 feet) is within the permissible fill height of 5 feet per original design by Rotondo Precast dated 11-14-1996 and hence Vault 4 is capable of carrying the additional fill without structural modifications.



LOCATION OF VAULTS IN PLAN

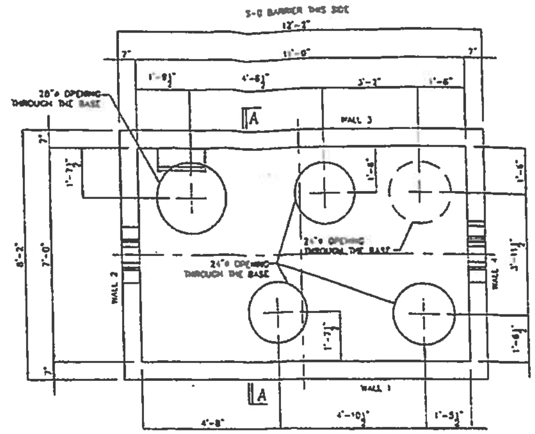
1. VAULT DRAWINGS

ALLIEDSIGNAL CONTRACT 35-74185
ENSR PROJECT NO. 0186-053
SUBMITTAL NO. 235
Vault U3 Shop Dwgs & Design Calcs
RE: 3-02105

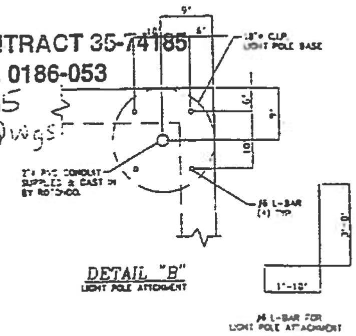


PLAN VIEW

CONTRACTOR TO PROVIDE CSE STUDLINER UNITS ON EXTERIOR OF MANHOLE.

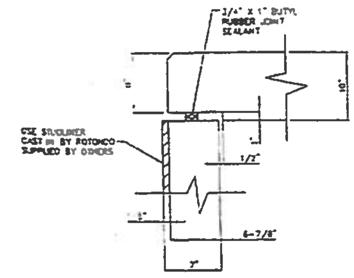


PLAN VIEW BOTTOM SLAB ONLY

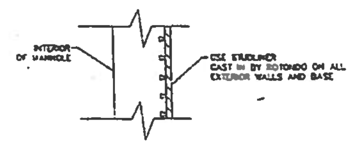


DETAIL "B"
LIGHT POLE ATTACHMENT

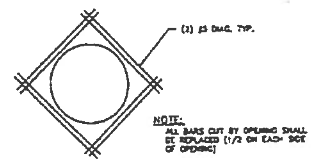
#6 L-BAR FOR LIGHT POLE ATTACHMENT



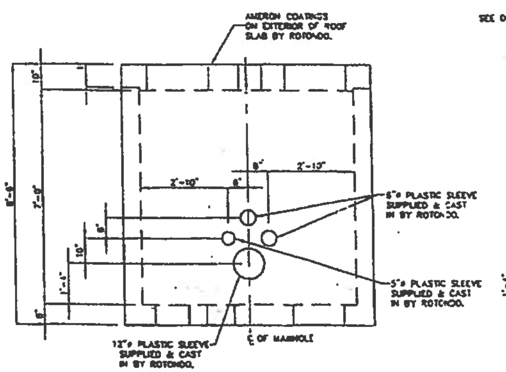
TYP. DAP JOINT DETAIL



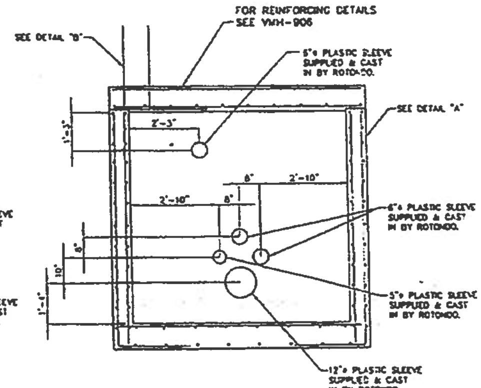
DETAIL "A"



TYP. REINF. AROUND OPENINGS



ELEVATION
WALL 2



SECTION A-A
WALL 4

DESIGN NOTES

CONCRETE MINIMUM STRENGTH - 5000 PSI @ 28 DAYS
STEEL REINFORCEMENT - ASTM A-615, GRADE 60
COVER TO STEEL: 1" UNLESS OTHERWISE NOTED
DESIGN LOADING - AASHTO HS20-44 (30% IMPACT ALLOWANCE)
CONSTRUCTION JOINT - SEALED W/1" DIA. BUTYL RUBBER
DESIGN SPECIFICATION - ACI 318 & AASHTO LOAD FACTOR DESIGN METHOD

ASSUMPTIONS

GROUND WATER @ 2'-0" BELOW FINISHED GRADE
EARTH COVER 2'-0" MIN. 5'-0" MAX.
2'-0" LIVE LOAD SURCHARGE APPLIED TO 8'-0" DEPTH
LIVE LOAD IMPACT 0" TO 1'-0" COVER I=30%
COEFFICIENT OF ACTIVE EARTH PRESSURE Ka= .33
DRY EARTH DENSITY - 120 PCF
DRY EARTH LATERAL PRESSURE= 120 (.33) = 39.6 PSF
SATURATED EARTH DENSITY - 120 PCF
120 PCF - 62.4 = 57.6 PCF
57.6 PCF (.33) = 19.0 PSF
SATURATED EARTH LATERAL PRESSURE = 19.0 + 62.4 = 81.4 PSF

APPROXIMATE SECTION WEIGHT : BASE - 16.7 TONS (8.25 C.Y.)
TOP - 6.1 TONS (3.1 C.Y.)

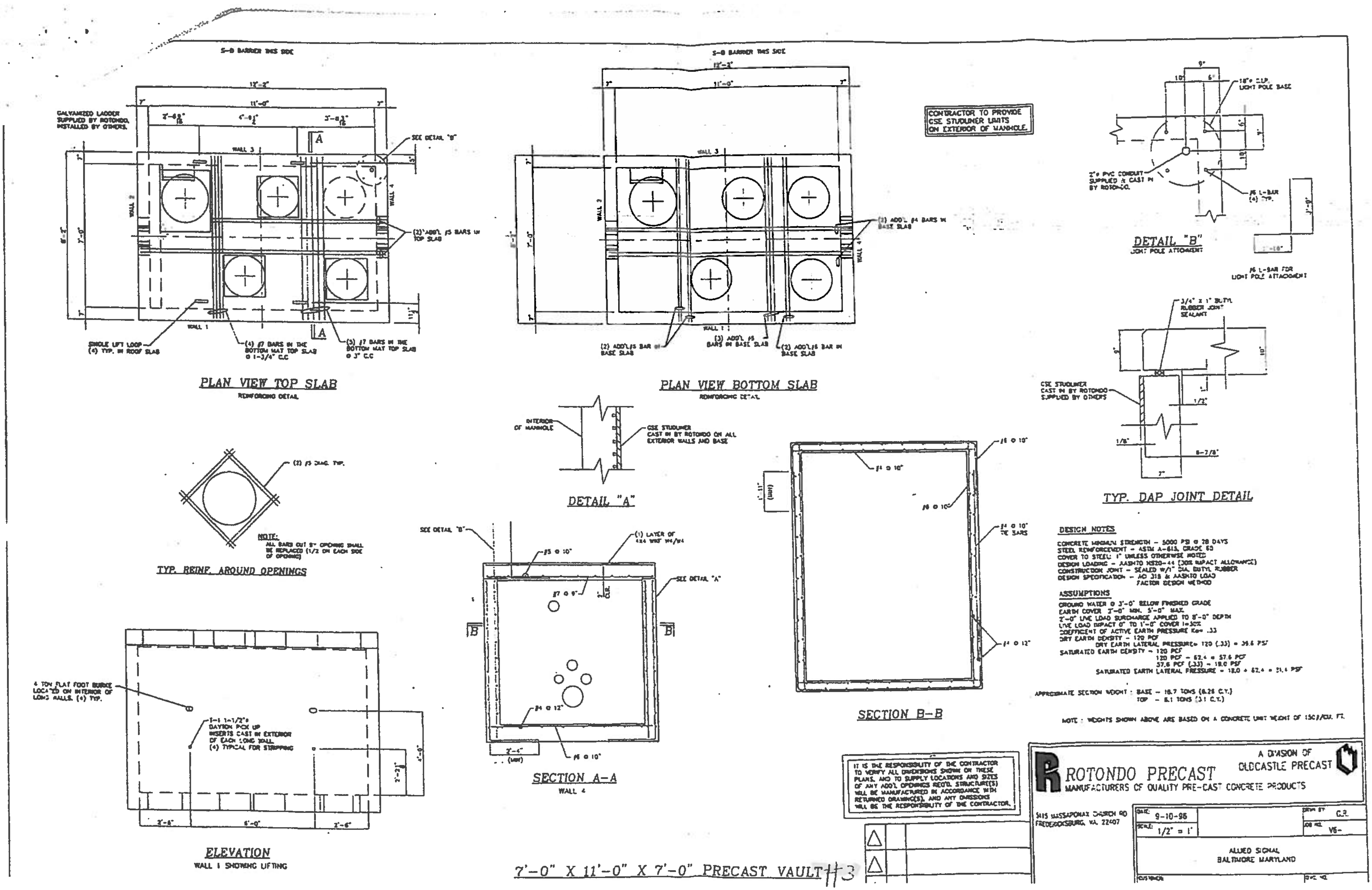
NOTE : WEIGHTS SHOWN ABOVE ARE BASED ON A CONCRETE UNIT WEIGHT OF 150#/CU. FT.

IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL DIMENSIONS SHOWN ON THESE PLANS, AND TO SUPPLY LOCATIONS AND SIZES OF ANY ADD'L OPENINGS REQ'D. STRUCTURE(S) WILL BE MANUFACTURED IN ACCORDANCE WITH RETURNED DRAWING(S), AND ANY OMISSIONS WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.

ROTONDO PRECAST
A DIVISION OF OLDCASTLE PRECAST
MANUFACTURERS OF QUALITY PRE-CAST CONCRETE PRODUCTS

DATE: 9-10-95		DRWN BY: G.R.
SCALE: 1/2" = 1'		JOB NO: VS-
ALLIED SIGNAL BALTIMORE MARYLAND		
CUSTOMER: ENSR REMEDIATION & CONSTRUCTION		DWG NO: VMH-905

7'-0" X 11'-0" X 7'-0" PRECAST VAULT
DOUBLE EXTRACTION VAULT MARK #V-3


PLAN VIEW TOP SLAB
REINFORCING DETAIL
S-B BARRIER THIS SIDE
GALVANIZED LADDER SUPPLIED BY ROTONDO, INSTALLED BY OTHERS.
SEE DETAIL "B"
(2) ADD'L #5 BARS IN TOP SLAB
SINGLE LIFT LOOP (4) TYP. IN ROOF SLAB
(4) #7 BARS IN THE BOTTOM MAT TOP SLAB @ 1-3/4" C.C
(3) #7 BARS IN THE BOTTOM MAT TOP SLAB @ 3" C.C
WALL 1
WALL 2
WALL 3
WALL 4
PLAN VIEW BOTTOM SLAB
REINFORCING DETAIL
(2) ADD'L #4 BARS IN BASE SLAB
(2) ADD'L #5 BAR IN BASE SLAB
(3) ADD'L #5 BARS IN BASE SLAB
CONTRACTOR TO PROVIDE CSE STUDLINER UNITS ON EXTERIOR OF MANHOLE.
DETAIL "B"
LIGHT POLE ATTACHMENT
18" Ø C.I.P. LIGHT POLE BASE
2" Ø PVC CONDUIT SUPPLIED & CAST IN BY ROTONDO
#6 L-BAR (4) TYP.
#6 L-BAR FOR LIGHT POLE ATTACHMENT
TYP. DAP JOINT DETAIL
3/4" x 1" BUTYL RUBBER JOINT SEALANT
CSE STUDLINER CAST IN BY ROTONDO SUPPLIED BY OTHERS
DETAIL "A"
INTERIOR OF MANHOLE
CSE STUDLINER CAST IN BY ROTONDO ON ALL EXTERIOR WALLS AND BASE
TYP. REINF. AROUND OPENINGS
(2) #5 DIAG. TYP.
NOTE: ALL BARS CUT BY OPENING SHALL BE REPLACED (1/2 ON EACH SIDE OF OPENING)
SECTION A-A
WALL 4
SEE DETAIL "B"
(1) LAYER OF 4x4 W4/W4
SEE DETAIL "A"
#5 @ 10"
#7 @ 9"
#4 @ 12"
#6 @ 10"
SECTION B-B
#4 @ 10"
#6 @ 10"
#4 @ 10" TIE BARS
#4 @ 12"
ELEVATION
WALL 1 SHOWING LIFTING
4 TON FLAT FOOT BURKE LOCATED ON INTERIOR OF LONG WALLS. (4) TYP.
1-1 1-1/2" Ø DAYTON PICK UP INSERTS CAST IN EXTERIOR OF EACH LONG WALL. (4) TYPICAL FOR STRIPPING
DESIGN NOTES
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DRY EARTH LATERAL PRESSURE= 120 (.33) = 39.6 PSF
SATURATED EARTH DENSITY – 120 PCF
120 PCF – 62.4 = 57.6 PCF
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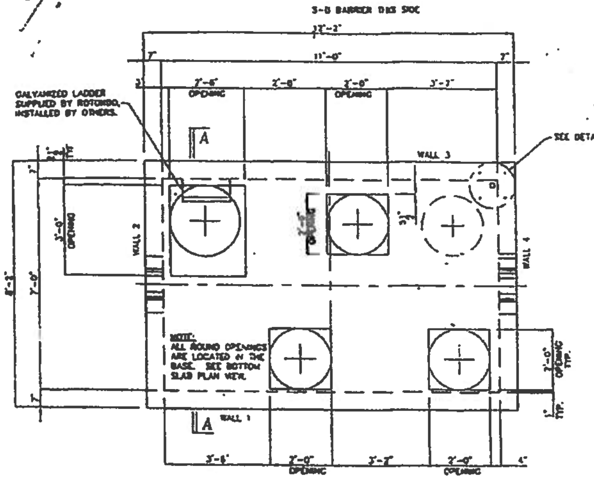
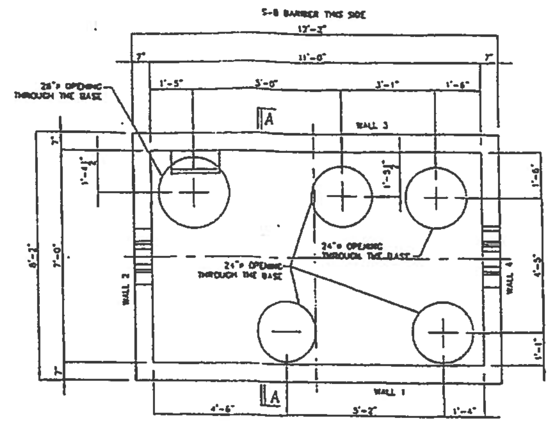
ROTONDO PRECAST
MANUFACTURERS OF QUALITY PRE-CAST CONCRETE PRODUCTS
A DIVISION OF OLDCASTLE PRECAST
5415 MASSAPONAX CHURCH RD
FREDERICKSBURG, VA. 22407
DATE: 9-10-96
SCALE: 1/2" = 1'
DRWN BY: C.R.
JOB NO. VB-
ALLIED SIGNAL
BALTIMORE MARYLAND
CUSTOMER
DWG. NO.
7'-0" X 11'-0" X 7'-0" PRECAST VAULT #3

ALLIEDSIGNAL CONTRACT 35-74185
ENSR PROJECT NO. 0186-053
SUBMITTAL NO. 236
Vault V4 Shop Dwgs & design calcs.
RE: 3-02605

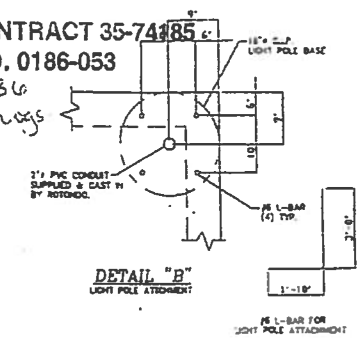


PLAN VIEW

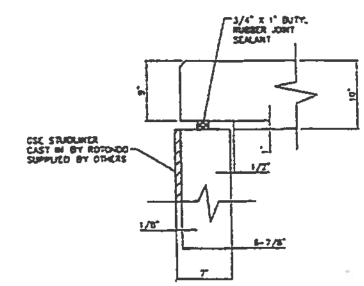
CONTRACTOR TO PROVIDE
OSE STUDLINER LIMITS
ON EXTERIOR OF MANHOLE.



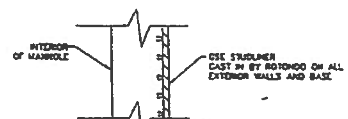
PLAN VIEW BOTTOM SLAB ONLY



DETAIL "B"
LIGHT POLE ATTACHMENT



TYP. DAP JOINT DETAIL



DETAIL "A"

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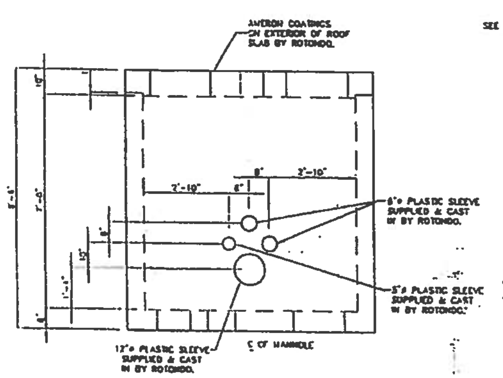
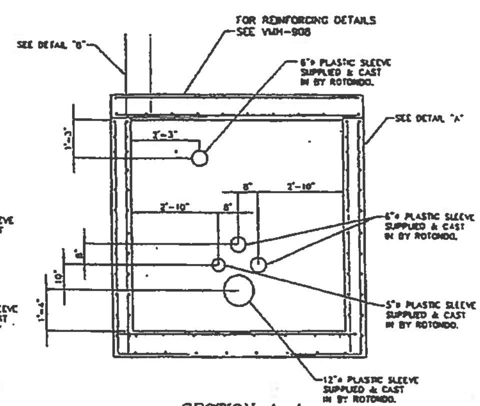
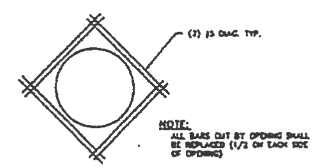


ELEVATION
WALL 2



SECTION A-A
WALL 4



TYP. REINF. AROUND OPENINGS

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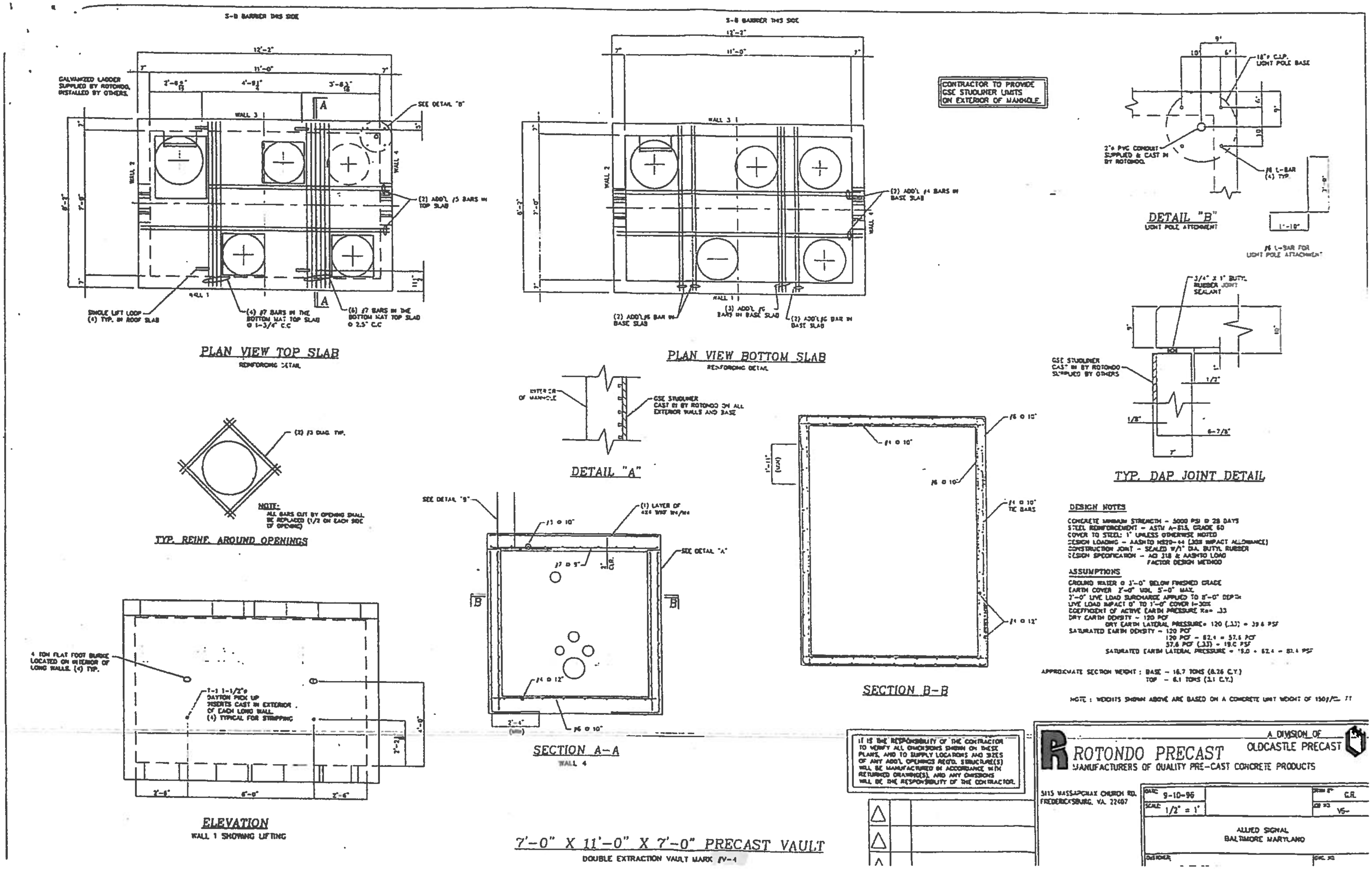
7'-0" X 11'-0" X 7'-0" PRECAST VAULT
DOUBLE EXTRACTION VAULT MARK #V-4

ROTONDO PRECAST
MANUFACTURERS OF QUALITY PRE-CAST CONCRETE PRODUCTS
A DIVISION OF OLDCASTLE PRECAST
5115 MASSAPONAX CHURCH RD. FREDERICKSBURG, VA. 22407

DATE 9-10-96		DRAWN BY G.R.	
SCALE 1/2" = 1'		JOB NO. V6-	
	ALLIED SIGNAL BALTIMORE MARYLAND		
CUSTOMER	ENSR REMEDIATION & CONSTRUCTION	DWG NO.	VMH-907



7'-0" X 11'-0" X 7'-0" PRECAST VAULT

DOUBLE EXTRACTION VAULT MARK IV-4

2. VAULT 3 – ROOF SLAB EVALUATION

SUBJECT: **VAULT REVIEW**

Inside Dimensions of Vault

Slab Length 11 ft

Slab Width 7 ft

Headroom 7ft

Roof slab thickness $r_t := 10in$

Floor slab thickness $f_t := 7.875in$

Wall thickness $s_t := 6.875in$

Material Properties

$f_c := 5ksi$

$V_{conc} := 150pcf$

$f_y := 60ksi$

Soil Properties

$V_{soil} := 120pcf$

$K_a := 0.33$

Load Factors

Live Load $LLF := 2.17$

Dead Load $DLF := 1.3$

Lateral Earth Pressure $EPF := 1.7$

Earth Surcharge $ESF := 2.17$

Capacity Reduction Factors

$phi_m := 0.9$

$phi_v := 0.85$

Codes Referenced

ACI 318-89

ACI 350 R7

AASHTO LRFD

MUESER RUTLEDGE CONSULTING ENGINEERS

FOR WILLS WHARF HOTEL, HARBOR POINT, MD

Made By K.H. Date 12/31/15
Checked By M.J Date 1/11/16

SUBJECT **VAULT REVIEW**

Roof Slab Loading

Surface area of roof slab $A_{ls} := (11ft + 2 \cdot s_l) \cdot (7ft + 2 \cdot s_l) = 98.94\,ft^{2.00}$

Critical depth of fill above the roof slab $H := 13.4ft$

Load distribution from the two wheels will overlap at the bottom slab level, so the total live load will be uniformly distributed over the slab area. Impact load is considered, Per AASHTO 2012 4.6.2.10.4

Wheel load $Whl := 16kip$

Live Load $w_L := \dfrac{2Whl \cdot LLF}{A_{ls}} = 0.70 \cdot ksf$

Dead Load $w_D := r_t \cdot V_{conc} \cdot DLF + H \cdot V_{soil} \cdot ESF = 3.65 \cdot ksf$

Bending

Ultimate Moment $M_u := (w_L + w_D) \cdot \dfrac{(7ft)^2}{8} = 26.67 \cdot \dfrac{kip \cdot ft}{ft}$

Effective Depth $d_{eff} := r_t - 2in - .4375in = 7.56 \cdot in$

Width considered $b := 1ft$

Area of steel provided #7 @ 9" $A_{st} := 0.80 \cdot \dfrac{in^2}{ft}$

$a := \dfrac{A_{st} \cdot 1ft \cdot f_y}{0.85 \cdot f_c \cdot b}$ $a = 0.94 \cdot in$

Moment capacity $M_c := \left[A_{st} \cdot f_y \cdot \left(d_{eff} - \dfrac{a}{2}\right)\right] \cdot phi_m = 25.53 \cdot \dfrac{kip \cdot ft}{ft}$

$M_c < M_u$ Additional reinforcement required.

Shear

$w_u := w_L + w_D = 0.03 \cdot ksi$

$V_u := w_u \cdot \left(\dfrac{7ft}{2} - d_{eff}\right) = 12.49 \cdot \dfrac{kip}{ft}$

Shear capacity $Vc := phi_v \cdot 2 \cdot \sqrt{\dfrac{f_c}{psi}} \cdot 12 \dfrac{d_{eff}}{in}$

$V_c := \dfrac{Vc}{1000} \cdot \dfrac{kip}{ft} = 10.91 \cdot \dfrac{kip}{ft}$

$V_c < V_u$ Additional reinforcement required.

3. VAULT 3 – WALL EVALUATION

MUESER RUTLEDGE CONSULTING ENGINEERS

Sheet No. ______ Of ______
File 12582B
Made By KH Date 12-30-15
Checked By MJ Date 1/11/16

FOR WILLS WHARF HOTEL - HARBOR PT, MD

SUBJECT: **Lateral Earth Pressure with 13.4' fill**

Lateral Earth Pressures:

	DRIVING FORCES									RESISTING FORCES						
Layer[1]	Elev [ft]	H [ft]	γ [pcf]	σ_v [psf]	k_a	c [psf]	Active Pressure [psf]	2' Earth Surcharge (psf)	Water Pressure (psf)	H [ft]	γ [pcf]	σ_v [psf]	k_p	R_p [psf]	c [psf]	Passive Pressure [psf]
S	27.0	0.0	120	0	0.33		0	79.2								
	13.6	13.4	120	1609	0.33		531	79.2								
	12.8	0.8	120	1709	0.33		564	79.2								
	5.8	7.0	120	2549	0.33		841	79.2								
	5.1	0.7	120	2628	0.33		867	79.2								

Net Pressure [psf]	Elev [ft]
79	27.0
610	13.6
643	12.8
920	5.8
946	5.1

Active Pressure: $\sigma_a = \gamma \cdot H \cdot k_a - 2C \cdot \sqrt{k_a}$

Passive Pressure: $\sigma_p = \gamma \cdot H \cdot k_p + 2C \cdot \sqrt{k_p}$

NOTES:

[1] Soil profile and parameters as used in the original design by Rotondo Precast dated 1996-11-14.

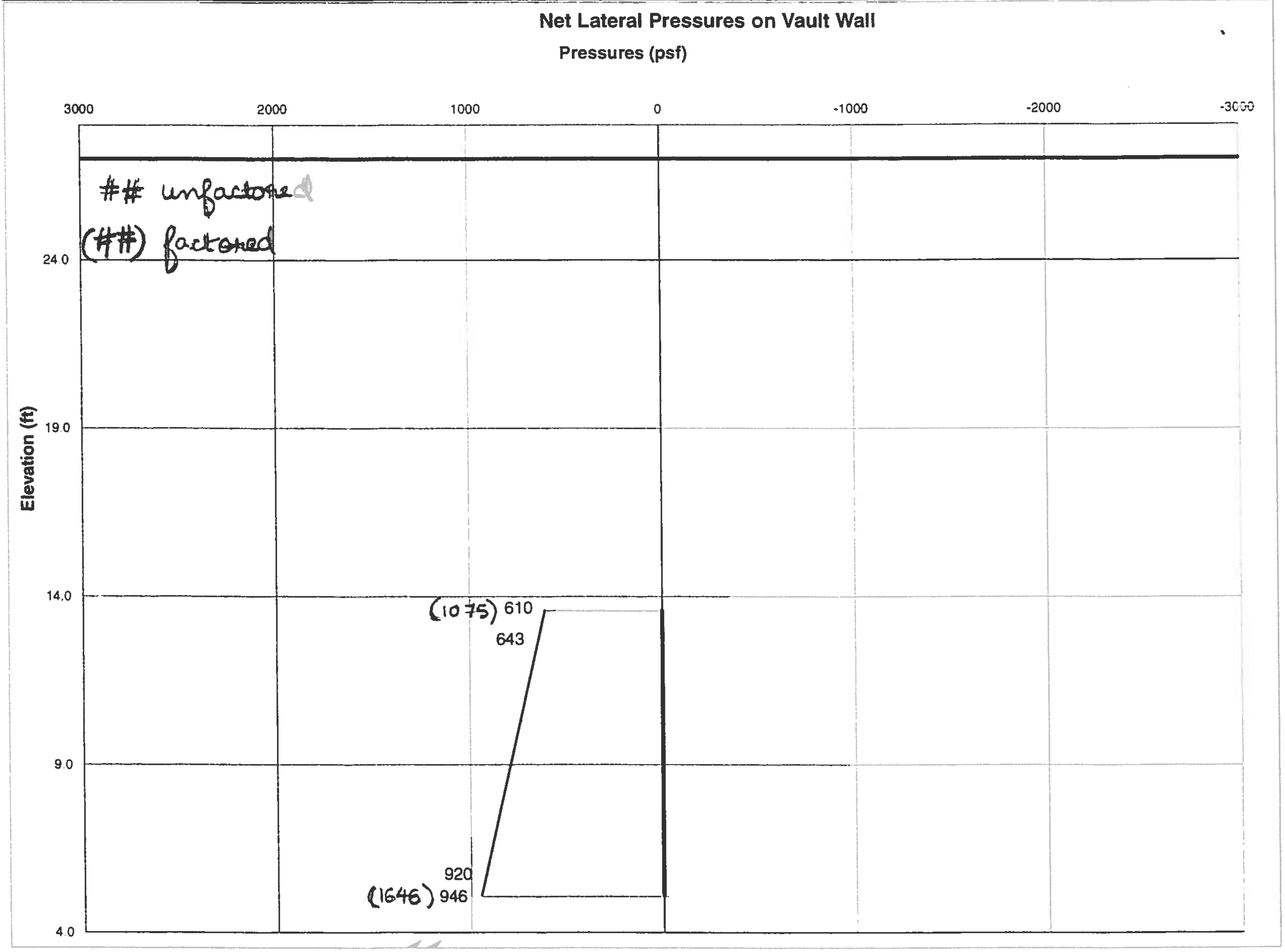
[2] Sand Properties: $\varnothing = 30^0$, $\gamma = 120$ pcf

MUESER RUTLEDGE CONSULTING ENGINEERS

Sheet No. ______ Of ______
File 12582B
Made By KH Date 12-30-15
Checked By MJ Date 1/11/16

FOR WILLS WHARF HOTEL - HARBOR PT. MD

SUBJECT: **Lateral Earth Pressure with 13.4' fill**



MUESER RUTLEDGE CONSULTING ENGINEERS

SHEET ___ OF ___

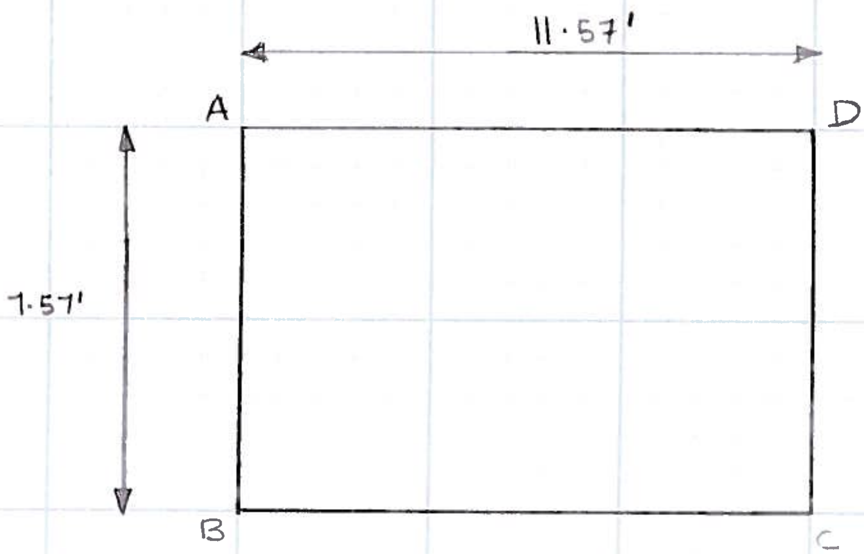
FILE 12582 B

MADE BY KH DATE 1/12/16

CHECKED BY MJ DATE 1/12/16

PROJECT Wills Wharf Hotel - Harbor Pt, MD

SUBJECT Long Span Wall



Corner Labels For Wall

Equivalent frame method is used to evaluate the corner moments in walls. Stiffness values used are as per the design calculations by Rotondo Precast dated 11/14/1996.

MUESER RUTLEDGE CONSULTING ENGINEERS

SHEET ____ OF ____

FILE 12582B

MADE BY KH DATE 1/5/16

CHECKED BY MJ DATE 1/11/16

PROJECT Wills Wharf Hotel, Harbor Pt, MD

SUBJECT Moment Distribution for corner moments (factored)

Wall Thickness (in)	Wall length (ft)	Moment of Inertia (in^4)	Stiffness
6.875	11.57292	324.9512	112.3144
6.875	7.572917	324.9512	171.6386
6.875	11.57292	324.9512	112.3144
6.875	7.572917	324.9512	171.6386

* FROM REF. CALCULATION BY ROTONDO PRECAST DATED 11/14/96

Uniform load on the wall due to lateral earth pressure $w = \frac{1.075 + 1.646}{2}$

$= 1.36$ ksf

Fixed end moment $= w\ell^2/12$

JOINT	A		B		C		D	
MEMB.	AD	AB	BA	BC	CB	CD	DC	DA
D.F.	0.4	0.6	0.6	0.4	0.4	0.6	0.6	0.4
FEM	−15.18	6.5	−6.5	15.18	−15.18	6.5	−6.5	15.18
Distr.	3.47	5.21	−5.21	−3.47	3.47	5.21	−5.21	−3.47
C.O	−1.74	−2.61	2.61	1.74	−1.74	−2.61	2.61	1.74
Distr.	1.74	2.61	−2.61	−1.74	1.74	2.61	−2.61	−1.74
	−11.71	11.71	−11.71	11.71	−11.71	11.71	−11.71	11.71

Area of steel provided = #6 @ 10" ≈ 0.5302 in^2/ft

Whitney stress block $a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.5302 in^2 \times 60 ksi}{0.85 \times 5 ksi \times 12''}$

$= 0.624''$

Moment Capacity $\phi M_n = 0.9 \times 0.5302 \times 60 \left(5.5 - \frac{0.624}{2}\right)$

$= 12.4$ k-ft/ft $> M_u = 11.71 \frac{k\text{-}ft}{ft}$

SHEET ____ OF ____

MUESER RUTLEDGE CONSULTING ENGINEERS

FILE 12582B

PROJECT Wills Wharf Hotel - Harbor Pt, MD

MADE BY KH DATE 1/5/16

CHECKED BY MJ DATE 1/11/16

SUBJECT WALL LONG SPAN (11')

Factored loads :

$M_u = w_u l^2/8$

$= 1.36 \times 11^2 / 8 = 20.57$ k-ft/ft

$d_{eff} = 5.5''$

Area of steel = #6 @ 10'' = 0.5302 in²/ft

Whitney Stress Block, $a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.5302 \times 60}{0.85 \times 5 \times 12''} = 0.62''$

Moment Capacity $\phi M_n = 0.9 A_s f_y \left(d - \frac{a}{2}\right) = 12.4$ k-ft/ft

$\phi M_n < M_u$

Shear Force $V_u = 1.36\left(\frac{11}{2} - \frac{5.5}{12}\right) = 10.83$ k/ft

Shear stress $\tau_u = V_u / b d_{eff} = 0.16$ ksi

Allowable shear stress $\tau_a = 0.85 \times 2\sqrt{f'_c}$

$= 0.12$ ksi

$\tau_a < \tau_u$

MUESER RUTLEDGE CONSULTING ENGINEERS

PROJECT Wills Wharf Hotel - Harbor Pt, MD

MADE BY KH DATE 1/5/16

CHECKED BY MJ DATE 1/11/2016

SUBJECT WALL SHORT SPAN (7')

Factored loads

$M_u = w_u l^2/8 = 1.36 \times 7^2/8 = 8.33$ k-ft/ft

$d_{eff} = 5.625''$

Area of steel = #4 @ 10'' = 0.24 in²/ft

Whitney block, stress a $= \frac{A_s f_y}{0.85 f'_c b} = \frac{0.24 \times 60}{0.85 \times 5 \times 12} = 0.28''$

Moment capacity $\phi M_n = 0.9 \times 0.24 \times 60 \left(5.625 - \frac{0.28}{2}\right)$

$= 6$ k-ft/ft

$\phi M_n < M_u$

Shear force $V_u = 1.36\left(\frac{7}{2} - \frac{5.625}{12}\right) = 4.12$ k/ft

Shear stress $\tau_u = \frac{V_u}{bd} = 0.06$ ksi

Allowable shear stress $\tau_a = 0.85 \times 2\sqrt{f'_c} = 0.12$ ksi

$\tau_a > \tau_u$

4. VAULT 3 – FLOOR SLAB EVALUATION

Sheet No.________ Of ________

MUESER RUTLEDGE CONSULTING ENGINEERS

File 12582B

Made By K.H. Date 12/31/15

FOR WILLS WHARF HOTEL, HARBOR POINT, MD

Checked By M.J. Date 1/11/16

SUBJECT **VAULT REVIEW**

Floor Slab Loading

Surface area of floor slab $A_b := (11\,ft + 2\cdot s_t)\cdot(7\,ft + 2\cdot s_t) = 98.94\,ft^{2.00}$

Critical depth of fill above the floor slab $H := 13.4\,ft$

Load distribution from the two wheels will overlap at the bottom slab level, so the total live load will be uniformly distributed over the slab area. No impact load since more than 8' fill available.

Live Load $w_L := \dfrac{2\,Whl\cdot LLF}{A_b} = 0.70\cdot ksf$ Per AASHTO 2012 4.6.2.10.4

Dead Load = weight of structure and earth cover

Volume of the structure $Vol := (11\,ft + 2\cdot s_t)\cdot(7\,ft + 2\cdot s_t)\cdot(7\,ft + r_t + f_t) - 11\,ft\cdot 7\,ft\cdot 7\,ft = 300.94\,ft^{3.00}$

$$w_D := \frac{(Vol\cdot V_{conc}\cdot DLF + H\cdot A_b\cdot V_{soil}\cdot ESF)}{A_b} = 0.03\cdot ksi$$

Bending

Ultimate Moment $M_u := (w_L + w_D)\cdot\dfrac{(7\,ft)^2}{8} = 29.30\cdot\dfrac{kip\cdot ft}{ft}$

Effective Depth $d_{eff} := f_t - 1\,in - .375\,in = 6.50\cdot in$

Width considered $b := 1\,ft$

Area of steel provided $A_{st} := 0.53\cdot\dfrac{in^2}{ft}$

$a := \dfrac{A_{st}\cdot 1\,ft\cdot f_y}{0.85\cdot f_c\cdot b}$ $a = 0.94\cdot in$

Moment capacity $M_c := \left[A_{st}\cdot f_y\cdot\left(d_{eff} - \dfrac{a}{2}\right)\right]\cdot phi_m = 14.76\cdot\dfrac{kip\cdot ft}{ft}$

$M_c < M_u$ Additional reinforcement required.

Shear

$w_u := w_L + w_D = 0.03\cdot ksi$

$V_u := w_u\cdot\left(\dfrac{7\,ft}{2} - d_{eff}\right) = 14.15\cdot\dfrac{kip}{ft}$

Shear capacity = $Vc := phi_v\cdot 2\cdot\sqrt{\dfrac{f_c}{psi}}\cdot 12\dfrac{d_{eff}}{in}$

$V_c := \dfrac{Vc}{1000}\cdot\dfrac{kip}{ft} = 9.38\cdot\dfrac{kip}{ft}$ $V_c < V_u$ Additional reinforcement required.