APPENDIX A – PHOTOGRAPHS

PHOTOGRAPHS

Figure 1A: Rendering of the House of Sweden Development

Figure 2A: Night View of the North Building

PHOTOGRAPHS

Figure 3A: Main Entrance of the North Building

Figure 4A: Comparison of the North and South building Exterior Cladding

APPENDIX B – GRAVITY LOAD CALCULATIONS

SNOW AND RAIN LOAD CALCULATIONS

Presented below are table summaries of the snow load calculations performed for the north building. Hand calculations can be reviewed upon request.

Roof Snow Load		
Factor	Design Value	Code Section
Ground Snow Load, P_g	25 psf	Figure 7-1
Exposure Factor, C_e	1.0	Table 7-2
Thermal Factor, C_t	1.0	Table 7-3
Importance Factor, I	1.0	Table 7-4
Flat Roof Snow Load, P_f	17.5 psf	§7.3
Minimum Flat Roof Snow Load P_f	20 psf	§7.3.4

Snow Drift (North Building)		
Factor	Design Value	Code Section
γ	17.25 psf	§7.7.1
h_b	1.16'	
h_c	10.84'	
h_c/h_b	9.34'	
l_u N-S top	148'	
Leeward Drift, h_d N-S top	4.03'	Figure 7-9
l_u N-S lower	11'	
Leeward Drift, h_d N-S lower	1.56'	Figure 7-9
l_u E-W top	162'	
Leeward Drift, h_d E-W top	4.20'	Figure 7-9
l_u E-W lower	11'	
Leeward Drift, h_d E-W lower	1.56'	Figure 7-9
l_u N-S top	11'	
Windward Drift, h_d N-S top	1.17'	Figure 7-9
l_u N-S lower	11'	
Windward Drift, h_d N-S lower	1.17'	Figure 7-9
l_u E-W top	11'	
Windward Drift, h_d E-W top	1.17'	Figure 7-9
l_u E-W lower	11'	
Windward Drift, h_d E-W lower	1.17'	Figure 7-9
$w=4*h_d$, N-S top	16.12'	
$p_d=h_d\gamma$, N-S top	69.5 psf	§7.7
$w=4*h_d$, N-S lower	6.24'	
$p_d=h_d\gamma$, N-S lower	26.9 psf	§7.7
$w=4*h_d$, E-W top	16.8'	
$p_d=h_d\gamma$, E-W top	72.5 psf	§7.7
$w=4*h_d$, E-W lower	6.24'	
$p_d=h_d\gamma$, E-W lower	26.9 psf	§7.7

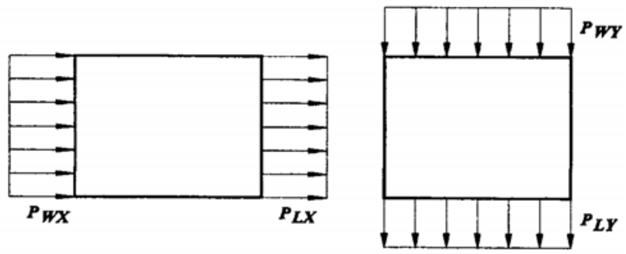
APPENDIX C – LATERAL LOAD CALCULATIONS

WIND LOAD CALCULATIONS

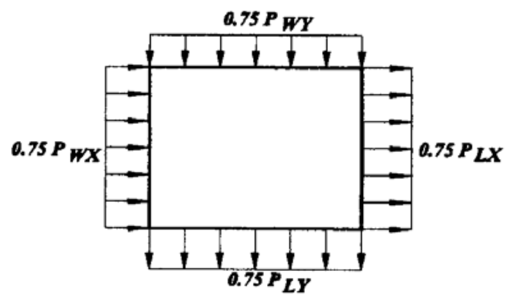
Static Load Cases

The load cases below were considered for wind loading of the structure. They were taken from ASCE7-05 Figure 6-9.

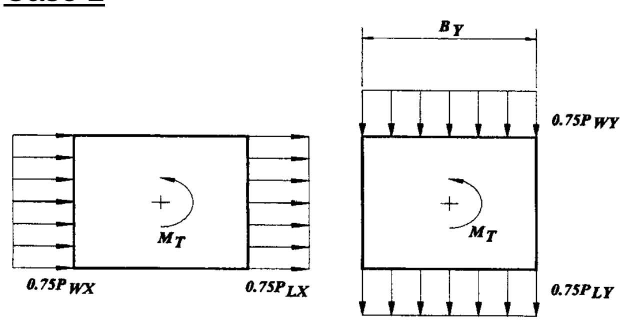
Case 1



Case 3



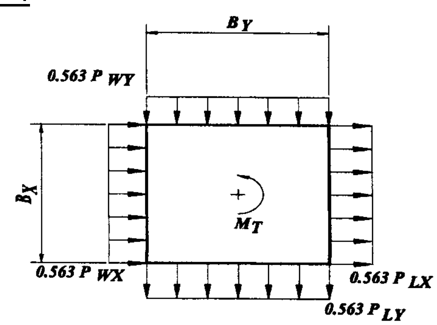
Case 2



$M_T = 0.75\ (P_{WX}+P_{LX})B_X e_X$
$e_X = \pm\ 0.15\ B_X$

$M_T = 0.75\ (P_{WY}+P_{LY})B_Y e_Y$
$e_Y = \pm\ 0.15\ B_Y$

Case 4



$M_T = 0.563\ (P_{WX}+P_{LX})B_X e_X + 0.563\ (P_{WY}+P_{LY})B_Y e_Y$
$e_X = \pm\ 0.15\ B_X$ $e_Y = \pm\ 0.15\ B_Y$

WIND LOAD CALCULATIONS

Factor (Both Buildings)	Design Value	Reference
K_{zt}	1	§6.5.7
K_d	0.85	Table 6-4
Exposure Category	B	§6.5.6
V	90	Figure 6-1
I	1	Table 6-1

North Building in the N-S Direction

Wind Pressures (North Building N-S)						
Height (ft)	K_z	q_z (psf)	Windward Wall (psf)	Leeward Walls (psf)	Total (psf)	Length in E-W Direction (ft)
77	0.918	16.18	10.54	-3.95	14.49	160
59	0.846	14.91	9.71	-3.95	13.66	190
48.17	0.801	14.12	9.19	-3.95	13.14	206
37.33	0.746	13.15	8.56	-3.95	12.51	206
26.5	0.672	11.84	7.71	-3.95	11.66	206
15.67	0.587	10.35	6.74	-3.95	10.69	206
4.83	0.57	10.05	6.54	-3.95	10.49	162

Gust Factor (North Building N-S)	
Factor	Design Value
g_q	3.4
g_v	3.4
g_r	4.18
$\dot{z}$	46.2
$I_{\dot{z}}$	0.284
$L_{\dot{z}}$	358
Q	0.80
$V_{\dot{z}}$	64.6
N_1	5.4
R_n	0.05
R_h	0.17
R_B	0.07
R_L	0.02
R	0.08
G_f	0.814

North Building N-S				
Story	Height (ft)	Force (K)	Shear (K)	Moment (ft-K)
PH	77'-0"	14	0.0	1071
MR	59'-0"	31	14	1805
6	48'-2"	30	44	1442
5	37'-4"	29	74	1069
4	26'-6"	81	103	2143
3	15'-8"	75	184	1178
2	4'-10"	18	259	85
1	-6'-0"	0.0	277	0.0
			V = 277	**ΣM = 8792**

North Building in the E-W Direction

Wind Pressures (North Building E-W)						
Height (ft)	K_z	q_z (psf)	Windward Wall (psf)	Leeward Walls (psf)	Total (psf)	Length in N-S Direction (ft)
77	0.918	16.18	10.57	-6.61	17.18	135.5
59	0.846	14.91	9.74	-6.61	16.35	176.5
48.17	0.801	14.12	9.22	-6.61	15.83	192
37.33	0.746	13.15	8.59	-6.61	15.20	192
26.5	0.672	11.84	7.74	-6.61	14.35	192
15.67	0.587	10.35	6.76	-6.61	13.37	163.5
4.83	0.57	10.05	6.56	-6.61	13.17	163.5

Gust Factor (North Building E-W)	
Factor	Design Value
g_q	3.4
g_v	3.4
g_r	4.18
$\dot{z}$	46.2
$I_{\dot{z}}$	0.28
$L_{\dot{z}}$	358
Q	0.81
$V_{\dot{z}}$	64.6
N_1	5.40
R_n	0.05
R_h	0.17
R_B	0.07
R_L	0.02
R	0.08
G_f	0.817

North Building E-W				
Story	Height (ft)	Force (K)	Shear (K)	Moment (ft-K)
PH	77'-0"	14	0.0	1075
MR	59'-0"	34	14	1996
6	48'-2"	33	48	1613
5	37'-4"	35	81	1293
4	26'-6"	97	116	2579
3	15'-8"	90	213	1404
2	4'-10"	22	303	107
1	-6'-0"	0.0	325	0.0
			V = 325	**ΣM = 10069**

Presented above are table summaries of the wind load calculations performed for the north building. Hand calculations were also performed and can be reviewed upon request.

SEISMIC LOAD CALCULATIONS

Presented below are summaries of the seismic load factors and tables summaries of the loads for both the north and south buildings. Hand calculations were also performed as well as manual calculations of story weights and can be reviewed upon request.

Factor **Reference**

Site Class D .... (Table 20.3.1)
S_s = 0.15 .... (Figure 22-1)
S_1 = 0.051 .... (Figure 22-2)
T_L = 8... (Figure 22-15)
Occupancy Category II
S_{ms} = 0.24... (Table 11.4.1)
S_{m1} = 0.1224 .... (Table 11.4.2)
S_{DS} = 0.16 .... (eq. 11.4-3)
S_{D1} = 0.0816... (eq. 11.4-4)
SDC = B
TS = 0.51
North Building T_L = 0.816 s
North Building R = 3 .... (Table 12.2-1)
North Building Moment Frame C_UT_A = 1.63 s
North Building Moment Frame C_s = 0.01669
North Building Normal Weight Concrete Braced Frame C_UT_A = 1.39 s
North Building Normal Weight Concrete Braced Frame C_s = 0.01957
North Building Lightweight Concrete Braced Frame T = 1.244 s (the calculated building period was less that C_UT_A therefore, the calculated period was used for the calculations)
North Building Lightweight Concrete Braced Frame C_s = 0.02186

SEISMIC LOAD DISTRIBUTIONS

Normal Weight Concrete:

Vertical Distribution of Seismic Forces (Moment Frame)					
Level	Height h_x (ft)	Story Weight w_x (K)	Lateral Force Fx (K)	Story Shear Vx (K)	Moment at Floor (ft-K)
P	83'-0"	1533	58	58	4775
MR	65'-0"	1613	41	99	2679
6	54'-2"	1982	38	137	2061
5	43'-4"	1995	27	164	1169
4	32'-6"	1782	15	179	498
3	21'-8"	1109	5	184	109
2	10'-10"	1098	5	186	18
$\Sigma w_i h_i^k$ =	5,103,746	**$\Sigma F_x = V$ =**	186 K	**ΣM =**	11,330 ft-k

Vertical Distribution of Seismic Forces (Braced Frame)					
Level	Height h_x (ft)	Story Weight w_x (K)	Lateral Force Fx (K)	Story Shear Vx (K)	Moment at Floor (ft-K)
P	83'-0"	1524	64	64	5308
MR	65'-0"	1604	47	111	3069
6	54'-2"	1972	45	156	2414
5	43'-4"	1968	32	188	1394
4	32'-6"	1769	19	207	619
3	21'-8"	1098	7	214	142
2	10'-10"	1076	2	216	26
$\Sigma w_i h_i^k$ =	3,119,645	**$\Sigma F_x = V$ =**	216 K	**ΣM =**	12,972 ft-k

SEISMIC LOAD DISTRIBUTIONS

Lightweight Concrete:

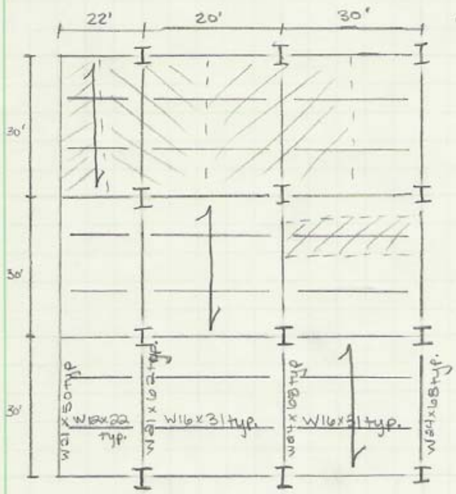
Vertical Distribution of Seismic Forces (Moment Frame)					
Level	Height h_x (ft)	Story Weight w_x (K)	Lateral Force Fx (K)	Story Shear Vx (K)	Moment at Floor (ft-K)
P	83'-0"	1014	38	39	3280
MR	65'-0"	1094	28	67	1831
6	54'-2"	1336	26	93	1399
5	43'-4"	1328	18	111	784
4	32'-6"	1202	10	121	339
3	21'-8"	778	4	125	77
2	10'-10"	747	1	126	12
$\Sigma w_i h_i^k$ =	3,423,048	**ΣF_x = V =**	126 K	**ΣM =**	7,623 ft-k

Vertical Distribution of Seismic Forces (Braced Frame)					
Level	Height h_x (ft)	Story Weight w_x (K)	Lateral Force Fx (K)	Story Shear Vx (K)	Moment at Floor (ft-K)
P	83'-0"	1006	47	47	3936
MR	65'-0"	1086	36	83	2334
6	54'-2"	1314	33	117	1807
5	43'-4"	1312	24	141	1044
4	32'-6"	1185	14	155	466
3	21'-8"	761	5	160	111
2	10'-10"	727	2	162	19
$\Sigma w_i h_i^k$ =	2,084,780	**ΣF_x = V =**	162 K	**ΣM =**	9,718 ft-k

APPENDIX D – Wide-Flange Beam Preliminary Design

WIDE-FLANGE BEAM DESIGN

Composite Steel Deck | Composite Beams



• Volcraft Steel Roof + Floor Deck Catalog
Loading: 80 psf + 20 psf partitions
Dead load of Structure
$w_u = 1.6(100) = 160$ psf

Materials: $f'_c = 3000$ psi
$f_y = 50$ ksi (beams + girders)

2" metal deck, Volcraft
18 gauge

5¼" concrete (3¼" above rib)
LWC - dead weight of deck + concrete = 42 psf

recommended welded wire fabric 6×6 - W1.4 × W1.4

Superimposed live load @ 10' clearspan = 176 psf > 160 psf ✓

10' beam spacing
Assume fully laterally braced

Design the Beams

• Interior Beam

Tributary width: worst case 10'

$L_r = 100\left(0.25 + \frac{15}{\sqrt{2(30)(10)}}\right) = 86.2$ psf

$w_u = 1.6(86.2) + 1.2(42) = 188$ psf

$w = 188(10) = 1.88$ K/ft

$M_n = \frac{wl^2}{8} = \frac{1.88(30)^2}{8} = 212$ ft-K $\qquad V_n = \frac{wl}{2} = \frac{1.88(30)}{2} = 28.2$K

Steel Construction Manual - Table 3-19
assume $a = 1.5"$
$Y_2 = 3\frac{1}{4}" - a/2 = 3\frac{1}{4} - 1.5/2 = 2.5"$

W12×26 PNA location 3 $\phi M_n = 225$ ft-K $> M_n = 212$ ft-K ✓
$\Sigma Q_n = 259$ K

$a = \frac{259}{0.85(3)(90)} = 1.13" < 1.5"$ ✓

Table 3-21
3/4" stud, perpendicular deck, 1 stud weak, 3ksi LWC = 17.2K

# of studs = 259K/17.2K = 16 studs per side = 32 studs

WIDE-FLANGE BEAM DESIGN

Composite Steel Deck | Composite Beams

Table 3-19

W14×26 PNA location 6 $\phi M_n = 220$ ft-K $> M_n = 212$ ft-K ✓
$\Sigma Q_n = 135$ K

$$a = \frac{135}{0.85(3)(66)} = 0.80'' < 1.5'' \checkmark$$

$$\#\text{ of studs} = \frac{135}{17.2} = 8 \text{ studs per side} = 16 \text{ studs}$$

- Exterior "Cantilevered" Beam

tributary width : 10'
$w = 1.6(100) + 1.2(42) = 210$ psf
$w = 210(10) = 2.10$ K/ft

$$M_n = \frac{wl^2}{8} = \frac{2.10(22)^2}{8} = 127 \text{ ft-K} \qquad V_n = \frac{wl}{2} = \frac{2.10(22)}{2} = 23.1 \text{ K}$$

Steel Construction Manual - Table 3-19
assume $a = 1.5''$
$Y_2 = 3'/4'' - a/2 = 3'/4'' - 1.5/2 = 2.5''$

W12×19 PNA location 7 $\phi M_n = 130$ ft-K $> M_n = 127$ ft-K ✓
$\Sigma Q_n = 69.7$ K

$$a = \frac{69.7}{0.85(3)(66)} = 0.41'' < 1.5'' \checkmark$$

Table 3-21
$Q_n = 17.2$ K

$\#$ of studs $= 69.7/17.2 = 5$ studs per side $= 10$ studs

WIDE-FLANGE BEAM DESIGN

Composite Steel Deck | Composite Beams

Check Deflections in Beams

- Interior Beam (worst case span)

Table 3-20
$I = 424 \text{ in}^4$

$\Delta_{max} = l/360 = 30(12)/360 = 1''$

$\Delta_{LL} = \frac{5wl^4}{384EI} = \frac{5(1)(30)^4(12)^3}{384(29000)(424)} = 1.48'' > 1''$ No!

$I_{req} = 629 \text{ in}^4$

Try W16×31 PNA location 6 $\phi M_n = 294 \text{ ft-K} > M_n = 212 \text{ ft-K}$
$\Sigma Q_n = 164 \text{ K}$

$a = \frac{164}{0.85(3)(66)} = 0.97'' < 1.5''$ ✓

# of studs $= 164/17.2 = 10$ studs per side $= 20$ studs

$\Delta_{LL} = \frac{5(1)(30)^4(12)^3}{384(29000)(638)} = 0.98'' < 1''$ ✓

$\Delta_{max} = l/240 = 30(12)/240 = 1.5''$

$\Delta_{D+L} = \frac{5(1.42)(30)^4(12)^3}{384(29000)(638)} = 1.40'' < 1.5''$ ✓

- Exterior "Cantilevered" Beam

Table 3-20
$I = 212 \text{ in}^4$

$\Delta_{max} = l/360 = 22(12)/(360) = 0.73''$

$\Delta_{LL} = \frac{5wl^4}{384EI} = \frac{5(1)(22)^4(12)^3}{384(29000)(212)} = 0.86'' > 0.73''$ No!

$I_{req} = 249 \text{ in}^2$

Try W12×22 PNA location 7 $\phi M_n = 153 \text{ ft-K} > M_n = 127 \text{ ft-K}$
$\Sigma Q_n = 81.0$

$a = \frac{81.0}{0.85(3)(66)} = 0.48'' < 1.5''$ ✓

# of studs $= 81/17.2 = 5$ studs per side $= 10$ studs

$\Delta_{LL} = \frac{5(1)(22)^4(12)^3}{384(29000)(253)} = 0.72'' < 0.73''$ ✓

$\Delta_{max} = l/240 = 22(12)/240 = 1.1''$

$\Delta_{D+L} = \frac{5(1.42)(22)^4(12)^3}{384(29000)(253)} = 1.02'' < 1.1''$ ✓

WIDE-FLANGE BEAM DESIGN

Composite Steel Deck | Composite Beams

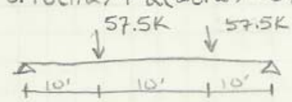
Design the Girders

Interior Girder

Tributary width : worst case 30'

beam self-weight : 31 plf (30) = 0.93

0.93(1.2) + 2(28.2) = 57.5K



Vn = 57.5K

Mn = Pa = 57.5(10) = 575 ft-K

Steel Construction Manual - Table 3-2

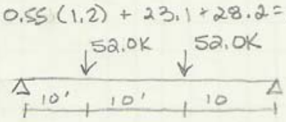
W21×68 ØMn = 600ft-K > Mn = 575ft-K ✓ ØVn = 273K > Vn = 57.5K ✓

Exterior Girder

Tributary width : 11' + 10'

beam self-weight : 31 plf (10) + 22 plf (11) = 0.552K

0.55 (1.2) + 23.1 + 28.2 = 52.0K



Vn = 52.0K

Mn = Pa = 52.0(10) = 520 K

Steel Construction Manual - Table 3-2

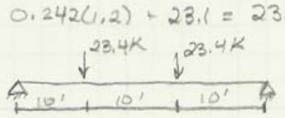
W21×62 ØMn = 540ft-K > Mn = 520K ✓ ØVn = 252K > Vn = 52.0K ✓

"Cantilevered" Girder

Tributary width : 11'

beam self-weight : 22 plf (11) = 0.242 K

0.242(1.2) + 23.1 = 23.4K



Vn = 23.4K

Mn = Pa = 23.4(10) = 234 ft-K

Steel Construction Manual - Table 3-2

W18×35 ØMn = 249ft-K > Mn = 234 ft-K ✓ ØVn = 159K > Vn = 23.4K ✓

WIDE-FLANGE BEAM DESIGN

Composite Steel Deck | Composite Beams

Check Deflections in Girders

Interior Girder (worst case 30')

$\Delta_{max} = \ell/360 = 30(12)/360 = 1''$

$\Delta_{LL} = \frac{P\ell^3}{28EI} = \frac{30(30)^3(12)^3}{28(29000)(1480)} = 1.16'' > 1''$ No!

Try a W24x68

$\Delta_{LL} = \frac{P\ell^3}{28EI} = \frac{30(30)^3(12)^3}{28(29000)(1830)} = 0.94'' < 1''$ ✓

$\Delta_{max} = \ell/240 = 30(12)/(240) = 1.5''$

$\Delta_{D+L} = \frac{P\ell^3}{28EI} = \frac{43.9(30)^3(12)^3}{28(29000)(1830)} = 1.38'' < 1.5''$ ✓

Exterior Girder

$\Delta_{max} = \ell/360 = 30(12)/360 = 1''$

$\Delta_{LL} = \frac{P\ell^3}{28EI} = \frac{21.9(30)^3(12)^3}{28(29000)(1330)} = 0.95'' < 1''$ ✓

$\Delta_{max} = \ell/240 = 30(12)/240 = 1.5''$

$\Delta_{D+L} = \frac{P\ell^3}{28EI} = \frac{30.5(30)^3(12)^3}{28(29000)(1330)} = 1.32'' < 1.5''$ ✓

"Cantilevered" Girder

$\Delta_{max} = \ell/360 = 30(12)/360 = 1''$

$\Delta_{LL} = \frac{P\ell^3}{28EI} = \frac{15(30)^3(12)^3}{28(29000)(510)} = 1.69'' > 1''$ No!

Try W21x50

$\Delta_{LL} = \frac{P\ell^3}{28EI} = \frac{15(30)^3(12)^3}{28(29000)(984)} = 0.88'' < 1''$ ✓

$\Delta_{max} = \ell/240 = 30(12)/240 = 1.5''$

$\Delta_{D+L} = \frac{P\ell^3}{28EI} = \frac{15.9(30)^3(12)^3}{28(29000)(984)} = 0.93'' < 1.5''$ ✓

APPENDIX E – Castellated Beam Preliminary Design

Exterior Beam – CB 15x19

CASTELLATED BEAM INFORMATION

Job Name	NWC	
Beam Mark #	Exterior	
Span	20.000	ft
Spac. Left	10.000	ft
Spac. Right	10.000	ft
Mat. Strength-Fy	50	ksi
Round Duct Diam.	8.114	in
Duct W x H	4.500 in	7.980 in
Castellated Beam	CB15X19	
Root Beams (T/B)	W10X19	W10X19
d	10.24	10.24
bf	4.02	4.02
tf	0.395	0.395
tw	0.25	0.25

CASTELLATION PARAMETERS:

e	5.000	in
b	2.500	in
dt	3.000	in
S	15.000	in
dg	14.480	in
phi	59.475	deg
ho	8.480	in
wo	10.000	in

LOADING INFORMATION

Uniform Distributed Loads

Live Load	1000	plf	Pre-comp %	0%
Dead Load	660	plf	Pre-comp %	80%

Concentrated Point Loads

Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Percent DL (%)	Percent Pre-Comp.
P1	0.00	0.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION

Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	5/8"
conc. wt. - wc (pcf)	150	stud ht. (in)	5
conc. above deck - tc (in)	3 1/2	studs per rib	1
rib height - hr (in)	2	composite %	100%
rib width - wr (in)	6	Stud Spacing:	
		N=26,Uniformly Dist.	

RESULTS

Failure Mode	Interaction	Status
Bending	0.726	<=1.0 OK!!
Web Post	0.914	<=1.0 OK!!
Shear	0.800	<=1.0 OK!!
Concrete	0.340	<=1.0 OK!!
Pre-Comp.	0.458	<=1.0 OK!!
Overall	0.914	<=1.0 OK!!
Pre-Composite Deflec.	0.361"	=L/665
Live Load Deflection	0.178"	=L/1351

WARNINGS

EXPAND'D. SXN. PROP'S

Avg. wt.	19.0	plf
Anet	4.556	in^2
Agross	6.676	in^2
Ix net	201.85	in^4
Ix gross	214.55	in^4
Sx net	27.88	in^3
Sx gross	29.63	in^3
rx min	5.67	in
Iy	4.29	in^4
Sy	2.14	in^3

COMPOSITE SXN. PROP'S

n	7.89	
beffec.	60.00	in
Actr	26.607	in^2
N.A. ht.	16.63	in Conc.
Itr	698.79	in^4
Ieffec.	698.79	in^3
Sxconc	208.34	in^3
Sxsteel	42.03	in^3

CONSTRUCTION BRIDGING

End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging. Spacing (ft)	28

Interior Beam – CB 21x26

CASTELLATED BEAM INFORMATION

Job Name	NWC	
Beam Mark #	Interior	
Span	30.000	ft
Spac. Left	10.000	ft
Spac. Right	10.000	ft
Mat. Strength-Fy	50	ksi
Round Duct Diam.	11.184	in
Duct W x H	6.250 in	11.161 in
Castellated Beam	CB21X26	
Root Beams (T/B)	W14X26	W14X26
d	13.91	13.91
bf	5.025	5.025
tf	0.42	0.42
tw	0.255	0.255

CASTELLATION PARAMETERS:

e	5.500	in
b	4.000	in
dt	3.500	in
S	19.000	in
dg	20.820	in
phi	59.935	deg
ho	13.820	in
wo	13.500	in

LOADING INFORMATION

Uniform Distributed Loads

Live Load	862	plf	Pre-comp %	0%
Dead Load	660	plf	Pre-comp %	80%

Concentrated Point Loads

Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Percent DL (%)	Percent Pre-Comp.
P1	0.00	0.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION

Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	5/8"
conc. wt. - wc (pcf)	150	stud ht. (in)	5
conc. above deck - tc (in)	3 1/2	studs per rib	1
rib height - hr (in)	2	composite %	100%
rib width - wr (in)	6	Stud Spacing:	
		N=32,Uniformly Dist.	

RESULTS

Failure Mode	Interaction	Status
Bending	0.886	<=1.0 OK!!
Web Post	0.955	<=1.0 OK!!
Shear	0.874	<=1.0 OK!!
Concrete	0.322	<=1.0 OK!!
Pre-Comp.	0.544	<=1.0 OK!!
Overall	0.955	<=1.0 OK!!
Pre-Composite Deflec.	0.661"	=L/544
Live Load Deflection	0.333"	=L/1081

WARNINGS

EXPAND'D. SXN. PROP'S

Avg. wt.	26.0	plf
Anet	5.869	in^2
Agross	9.393	in^2
Ix net	560.22	in^4
Ix gross	616.31	in^4
Sx net	53.82	in^3
Sx gross	59.20	in^3
rx min	8.10	in
Iy	8.90	in^4
Sy	3.54	in^3

COMPOSITE SXN. PROP'S

n	7.89	
beffec.	90.00	in
Actr	39.910	in^2
N.A. ht.	22.76	In Deck
Itr	1626.88	in^4
Ieffec.	1626.88	in^3
Sxconc	456.37	in^3
Sxsteel	71.49	in^3

CONSTRUCTION BRIDGING

End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging. Spacing (ft)	33

Exterior Girder – CB 21x83

BEAM INFORMATION		
Job Name:	NWC	
Beam Mark #	Exterior	
Span	30.000	ft
Unbraced Length	10.000	ft
Mat. Strength-Fy	50	ksi
Castellated Beam	CB30X83	
Root beam	W21X83	
d	21.4	in
bf	8.36	in
tf	0.835	in
tw	0.515	in
Castellation Parameters:		
e	6.000	in
b	5.500	in
dt	6.000	in
S	23.000	in
dg	30.800	in
phi	59.668	deg
ho	18.800	in
wo	17.000	in

LOADING INFORMATION			
Uniform Distributed Loads			
Live Load	0	plf	
Dead Load	0	plf	
Concentrated Point Loads			
Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Perc. DL (%)
P1	40.00	10.00	0%
P2	40.00	20.00	0%
P3	0.00	0.00	0%
P4	0.00	0.00	0%
RESULTS			
Failure Mode	Interaction	Status	
Bending	0.939	<=1.0 OK!!	
Shear	0.580	<=1.0 OK!!	
Web Post	0.630	<=1.0 OK!!	
Overall	**0.939**	**<=1.0 OK!!**	
Live Load Deflection		0.685"	=L/526
Dead Load Deflection		0.016"	=L/22959
WARNINGS			

EXPAND'D. SXN. PROP'S		
Anet	19.281	in^2
Agross	28.963	in^2
Ix net	3910.423	in^4
Ix gross	4195.6	in^4
Sx net	253.924	in^3
Sx gross	272.441	in^3
rx net	14.241	in
rx gross	12.036	in
Iy	81.429	in^4
Sy	19.481	in^3
ry	2.055	in
rT	2.274	in
deffec	28.310	in
CONSTRUCTION BRIDGING		
End Connection type		Shear Tab
Min No. Of Bridging Rows		0
Max. Bridging. Spacing (ft)		43
MAXIMUM PASSABLE DUCTS		
Round (Diam.(in))	RECTANGULAR Width (in) x Height (in)	
14.173	8.000	14.027

Interior Girder – CB 24x94

BEAM INFORMATION		
Job Name:	NWC	
Beam Mark #	Interior	
Span	30.000	ft
Unbraced Length	10.000	ft
Mat. Strength-Fy	50	ksi
Castellated Beam	CB36X94	
Root beam	W24X94	
d	24.3	in
bf	9.07	in
tf	0.875	in
tw	0.515	in
Castellation Parameters:		
e	7.000	in
b	7.000	in
dt	6.000	in
S	28.000	in
dg	36.600	in
phi	60.356	deg
ho	24.600	in
wo	21.000	in

LOADING INFORMATION			
Uniform Distributed Loads			
Live Load	0	plf	
Dead Load	0	plf	
Concentrated Point Loads			
Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Perc. DL (%)
P1	46.00	10.00	0%
P2	46.00	20.00	0%
P3	0.00	0.00	0%
P4	0.00	0.00	0%
RESULTS			
Failure Mode	Interaction	Status	
Bending	0.982	<=1.0 OK!!	
Shear	0.585	<=1.0 OK!!	
Web Post	0.646	<=1.0 OK!!	
Overall	**0.982**	**<=1.0 OK!!**	
Live Load Deflection		0.528"	=L/682
Dead Load Deflection		0.012"	=L/30365
WARNINGS			

EXPAND'D. SXN. PROP'S		
Anet	21.151	in^2
Agross	33.820	in^2
Ix net	6243.032	in^4
Ix gross	6881.9	in^4
Sx net	341.149	in^3
Sx gross	376.062	in^3
rx net	17.180	in
rx gross	14.265	in
Iy	108.929	in^4
Sy	24.020	in^3
ry	2.269	in
rT	2.485	in
deffec	34.228	in
CONSTRUCTION BRIDGING		
End Connection type		Shear Tab
Min No. Of Bridging Rows		0
Max. Bridging. Spacing (ft)		46
MAXIMUM PASSABLE DUCTS		
Round (Diam.(in))	RECTANGULAR Width (in) x Height (in)	
17.751	10.000	17.950

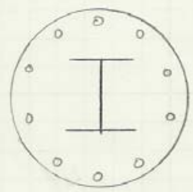
APPENDIX F – GARAGE LEVEL COLUMN DESIGN

GARAGE LEVEL COLUMN DESIGN

Column Design | Reinforced Concrete | Garage Level | 1/3

Critical Column Tributary Area: 30' x 30'

Column Dimensions: 24" ϕ $f'c = 5000$ psi



Thickness of Slab: 10"

150 pcf · 10/12 = 125 psf

Super imposed DL: 12 psf
Live Load: 100 psf

Live Load Reduction:

Loads from the Steel:
P = 1037.59 K
M_{major} = 56.75 K-ft
M_{minor} = 10.14 K-ft

$$LL = LL_o\left(0.25 + \frac{15}{\sqrt{K_A A_T}}\right) = 100\left(0.25 + \frac{15}{\sqrt{4(900)}}\right)$$
$$= 100(0.5 < 0.6) = 100(0.60) = 60\text{ psf}$$

P = 1.2(125+12)(900) + 1.6(60)(900) + 1037.59 K = 1272 K
Y-axis: 56.75 K-ft
X-axis: 10.14 K-ft

Use PCA column to investigate column designs

- Start with 6 #9 bars
- Analyze in the X and Y direction - works (see PCA printouts)

By ACI code, 6 bars is the least amount of reinforcing that can be confined by spiral ties

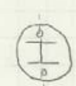
Use spiral reinforcing

- Size and Pitch of spirals based on Table A.14 of Design of Concrete Structures and the ACI code

for f_{yt} = 60,000 psi
f'c = 5000 psi
24" ϕ column

use #4 spiral reinforcing at a 3" pitch

Will the reinforcing fit with the wide flange? -



ϕ cc ϕbar ϕspiral spacing Wshape
24" - 2(3") - 2(1.128) - 2(0.5) - 4(2") - 14.8" = -8"

GARAGE LEVEL COLUMN DESIGN

Column Design | Reinforced Concrete | Garage Level | 2/3

Try a 30" column with 10 #8 bars

ϕ cc ϕbar ϕspiral spacing Wshape

30" - 2(3") - 2(1.0) - 2(0.5) - 4(1.5") - 14.8" = 0.2" ✓

for f_{yt} = 60,000 psi
f'_c = 5000 psi
30" ϕ column

use #4 spiral reinforcing at a 3 1/4" pitch

• See PCA Column printouts for the column interaction diagrams

Transfer of the load from the steel column $P = 1037.59$ K

3/4" ϕ stud, no deck $Q_n = 26.1$k

# of studs needed to transfer the load

1037.59/26.1 = 39.8 = 40 studs

~10' column, 20 studs per web side, 2 per foot

Check as the Composite Column Section

$A_s = 42.7 in^2$, $A_{SR} = 10(0.79) = 7.90 in^2$, $A_c = \pi(15)^2 - 42.7 - 7.90 = 656 in^2$

$\frac{42.7}{(\pi(15)^2)} = 0.60 > 0.01$ ✓

$P_o = A_s f_y + A_{sr} F_{yr} + 0.85 f'_c A_c = 5397$K

y-axis is weak assume $K=1$

$I_s = I_y = 677 in^4$

$I_{SR} = 2(0.79(9.5)^2) + 2(0.79(6)^2) = 199 in^4$

$I_C = \frac{\pi r^4}{4} = \frac{\pi(15)^4}{4} - 677 - 199 = 38885 in^4$

$C_1 = 0.1 + 2\left[\frac{A_S}{(A_c + A_S)}\right] \le 0.3$

$= 0.1 + 2\left[\frac{42.7}{42.7 + 656}\right] = 0.22 < 0.3$ ✓

GARAGE LEVEL COLUMN DESIGN

Column Design | Reinforced Concrete | Garage Level | 3/3

$$EI_{eff} = 29000(677) + 0.5(29000)(199) + 0.22(3904)(38885)$$
$$= 55{,}900{,}000 \text{ k-in}$$

$$P_e = \frac{\pi^2 (55{,}900{,}000)}{(10.833 \cdot 12)^2} = 32{,}648 \text{ K}$$

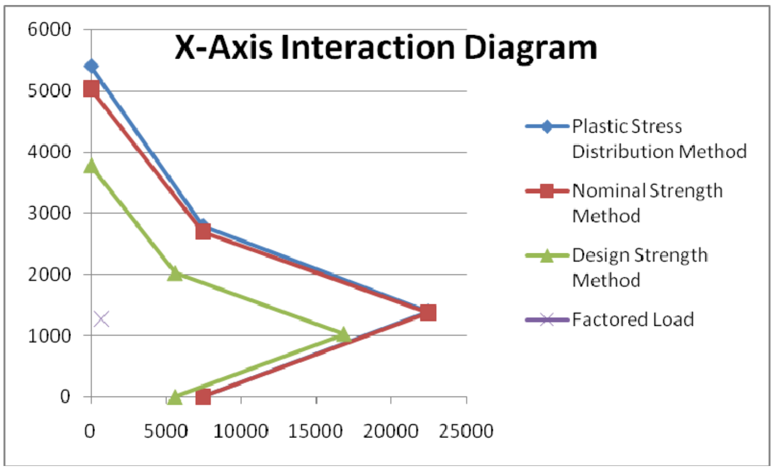
$$0.44 P_o = 2375\text{K} < P_e$$

$$P_n = P_o \left[0.658^{P_o/P_e}\right]$$
$$= 5397 \left[0.658^{5397/32648}\right] = 5036\text{K}$$

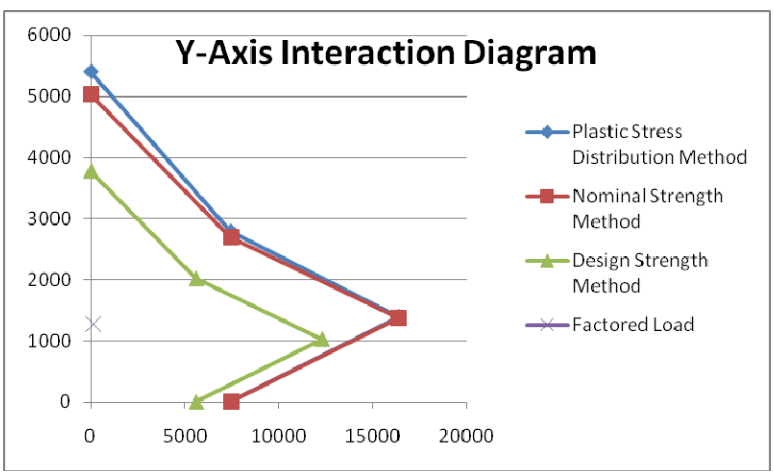
$$\phi P_n = 0.75(5036\text{ K}) = 3777\text{K}$$

INTERACTION DIAGRAMS

X-Axis	Plastic Stress Distribution Method		Nominal Strength Method		Design Strength Method	
Point	P (K)	M (in-K)	P (K)	M (in-K)	P (K)	M (in-K)
A	5397	0	5036	0	3777	0
C	2788	7448	2690	7448	2018	5586
D	1394	16389	1369	16389	1027	12292
B	0	7448	0	7448	0	5586



Y-Axis	Plastic Stress Distribution Method		Nominal Strength Method		Design Strength Method	
Point	P (K)	M (in-K)	P (K)	M (in-K)	P (K)	M (in-K)
A	5397	0	5036	0	3777	0
C	2788	7448	2690	7448	2018	5586
D	1394	22470	1369	22470	1027	16852
B	0	7448	0	7448	0	5586



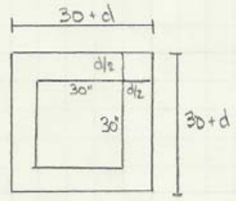
APPENDIX G – FOUNDATION CHECKS

FOUNDATION CHECKS

Foundation

Determine if the north building was the driving factor for the 48" thick mat foundation.

Critical Column: 43N 30" x 30"
P = 2320 K from the structural drawings



Critical Section is at d/2 from the column

$b_o = 4(30+d) = 120 + 4d$

$\phi V_c \geq V_u$

$\phi V_c = \phi\, 4\sqrt{f'c}\; b_o d = 0.85(4)\sqrt{4000}\,(120+4d)d$

$\Rightarrow \dfrac{0.75(4)\sqrt{4000}\,(120+4d)d}{1000} \geq 2320$

$(120+4d)d \geq 12227.47$

$d \approx 42.3"$

Use d = 43"

with a minimum cover of 3" over the steel reinforcement and 1.27" ϕ steel bars;

Total thickness:

$h = 43" + 3" + 1.27" = 47.27" \approx 48"$

North Building Columns were probably the driving force behind the 48" thick mat.

The largest embedded sewer pipes are only 6" and there are no existing conditions sewer pipes to impact the size of the mat foundation.

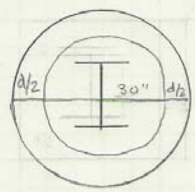
FOUNDATION CHECKS

Foundation

Determining the thickness of the mat slab for a critical braced frame column in the North Building.

Critical Column: Frame 4, column 2 W14x109
$P = 1323.27$ K

Critical Section is at $d/2$ from the column



$b_o = \pi D = \pi(30+d)$

$\phi V_c \geq V_u$

$\phi V_c = \phi 4\sqrt{f'c}\, b_o d = 0.75(4)\sqrt{4000}\,\pi(24+d)\,d$

$\Rightarrow \dfrac{0.75(4)\sqrt{4000}\,\pi(30+d)d}{1000} \geq 1323.27$

$(30+d)d \geq 2219.97$
$d \approx 34.4"$

Use $d = 35"$

with a minimum cover of 3" over the steel reinforcement and 1.27" ϕ steel bars:

Total thickness:

$h = 35" + 3" + 1.27" = 39.27" \approx 40"$
use 42" for ease of excavation

Original Mat: 48" deep

New Mat: 42" deep under the North Building

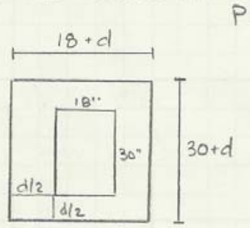
See if mat can be thinned under the South Building

FOUNDATION CHECKS

Foundation

Determine the thickness of the mat slab for a critical column in the South Building.

Critical column: S5 18" x 30"
P=1277 K from the structural drawings



Critical section is at $d/2$ from the column

$b_o = 2(18+d) + 2(30+d) = 96 + 4d$

$\phi V_c \geq V_u$

$\phi V_c = \phi 4\sqrt{f'c}\, b_o d = 0.85(4)\sqrt{4000}\,(96+4d)d$

$\Rightarrow \dfrac{0.75(4)\sqrt{4000}\,(96+4d)d}{1000} \geq 1277$

$(96+4d)d \geq 6730.38$

$d \approx 30.7''$

Use $d = 31''$

with a minimum cover of 3" over the steel reinforcement and 1.27" ϕ steel bars:

Total thickness:

$h = 31'' + 3'' + 1.27'' = 35.27'' \approx 36''$

Original Mat: 48" deep

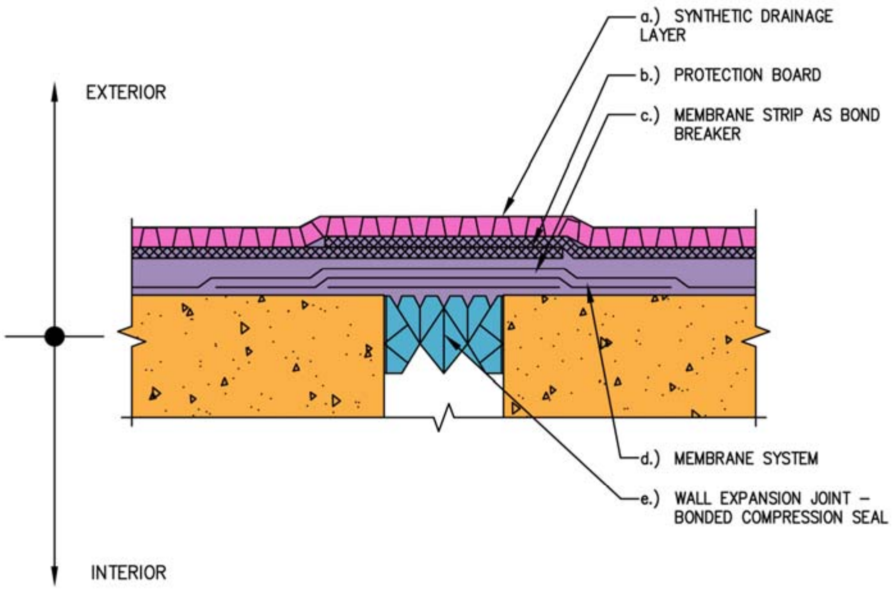
New Mat: 36" deep under the south Building

∴ New mat foundation is 42" deep

$\boxed{\text{Save 6" of excavation}}$

APPENDIX H – WATERPROOFING

FOUNDATION WALL DETAILS



General Notes:

1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Primary flow path for invasive surface water.

b. Serves as a base for geogrid. Protects membrane.

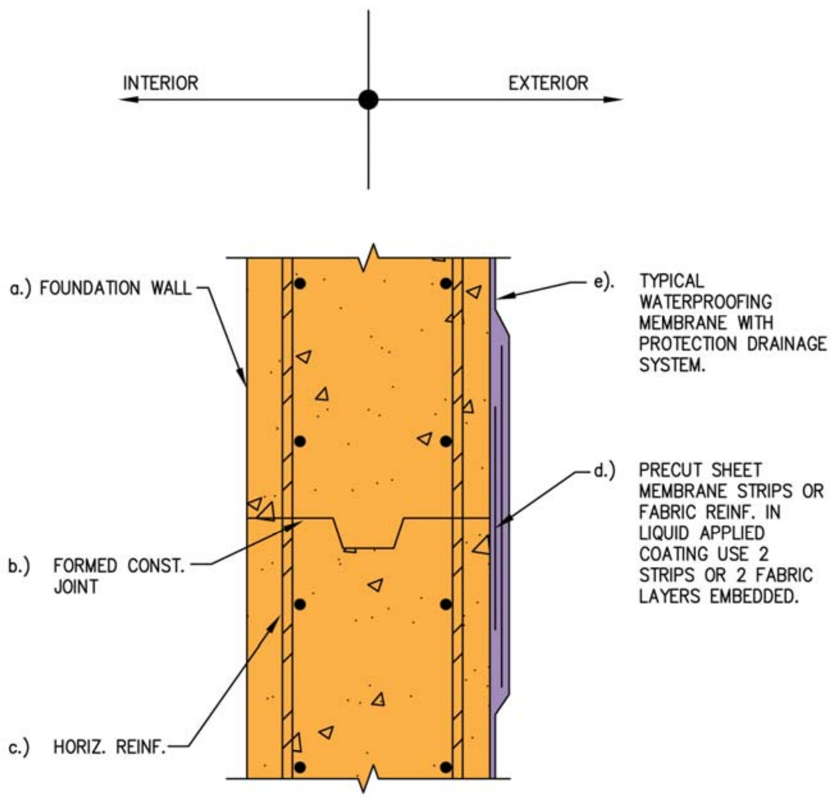
c. Provides expansion capability at joint opening.

d. Prevents water leaking through wall and into occupied spaces.

e. Absorbs expansion/contraction of concrete wall.

FOUNDATION WALL - WALL EXPANSION JOINT

FOUNDATION WALL DETAILS



FOUNDATION WALL PARTIAL PLAN

General Notes:

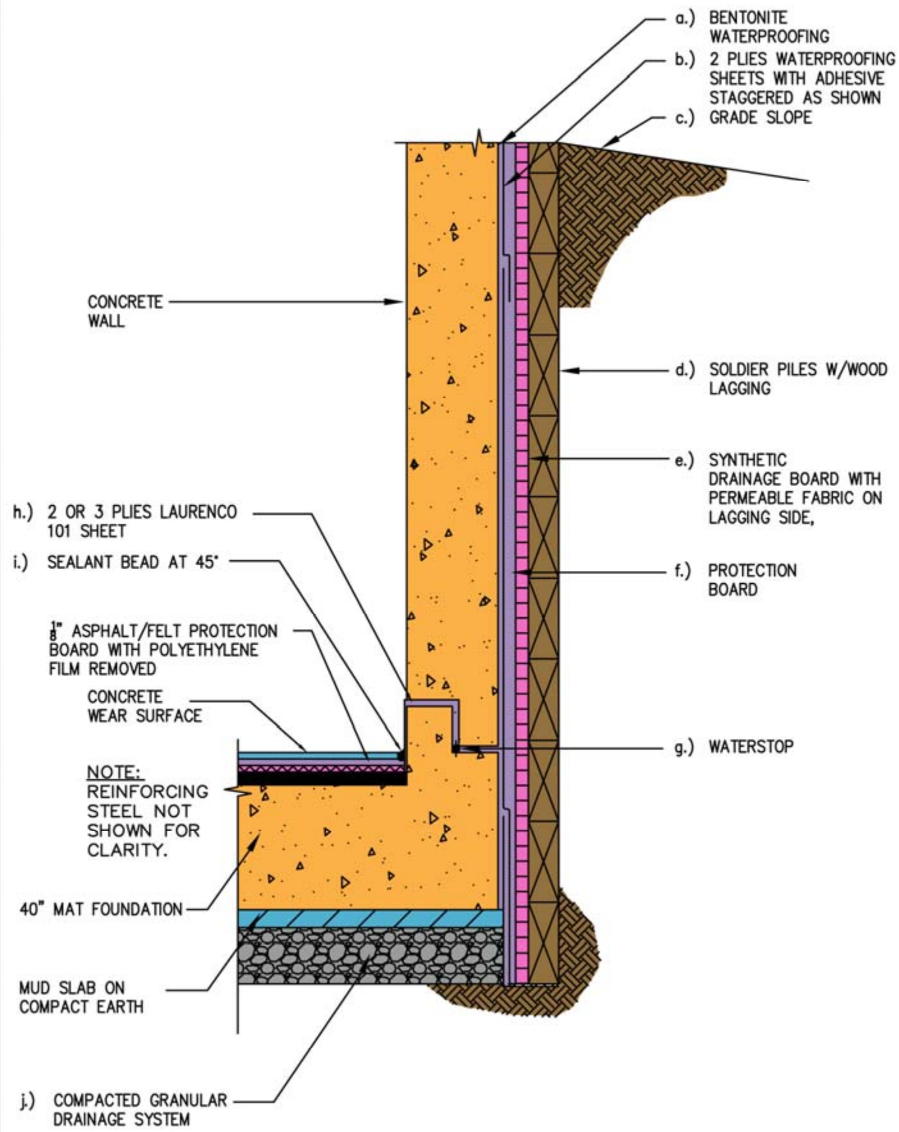
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Load transfer
b. Facilitates const. operations.
c. Provide reinforcing continuity.
d. Prevents leakage into building at wall const. joint.
e. Prevents leaking thru wall cracks.

FOUNDATION WALL - CONSTRUCTION JOINT

FOUNDATION WALL DETAILS



General Notes:

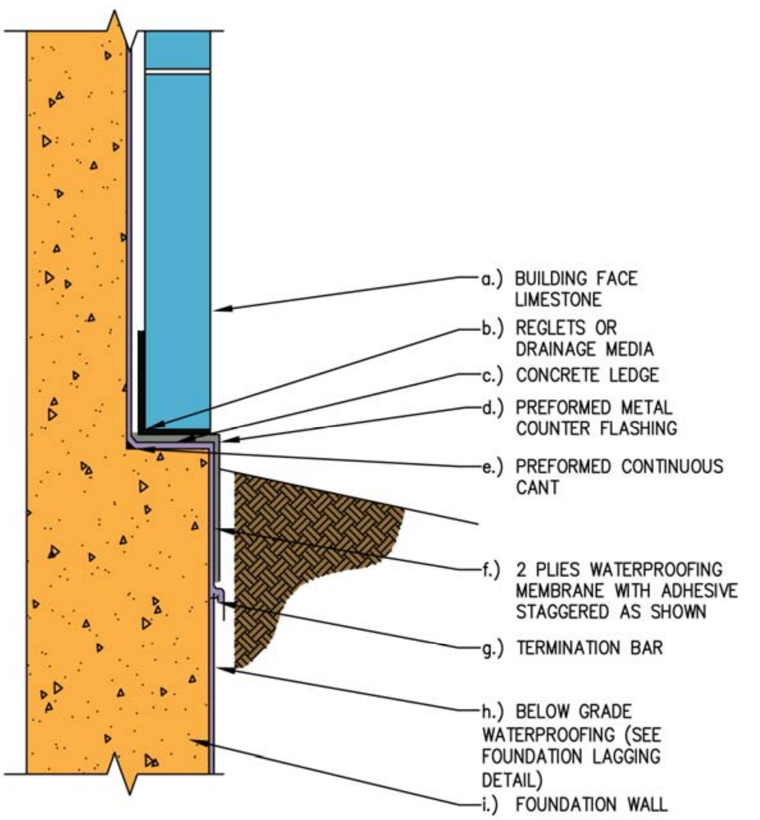
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Protects/prevents moisture penetration through wall
b. Provides continuity between above grade building envelope weather shield & below grade waterproofing
c. Directs building face sheet runoff & gutter overspill away from below grade waterproofing and drainage system
d. Resists/contains earth load forces
e. Intercepts soil moisture
f. Protects membrane from construction damage
g. Prevents moisture migration through footer wall cold joint
h. Prevents moisture entry
i. Seals joint and prevents water buildup at joint
j. Intercepts soil moisture

FOUNDATION WALL SYSTEM - FOUNDATION LAGGING

FOUNDATION WALL DETAILS



General Notes:

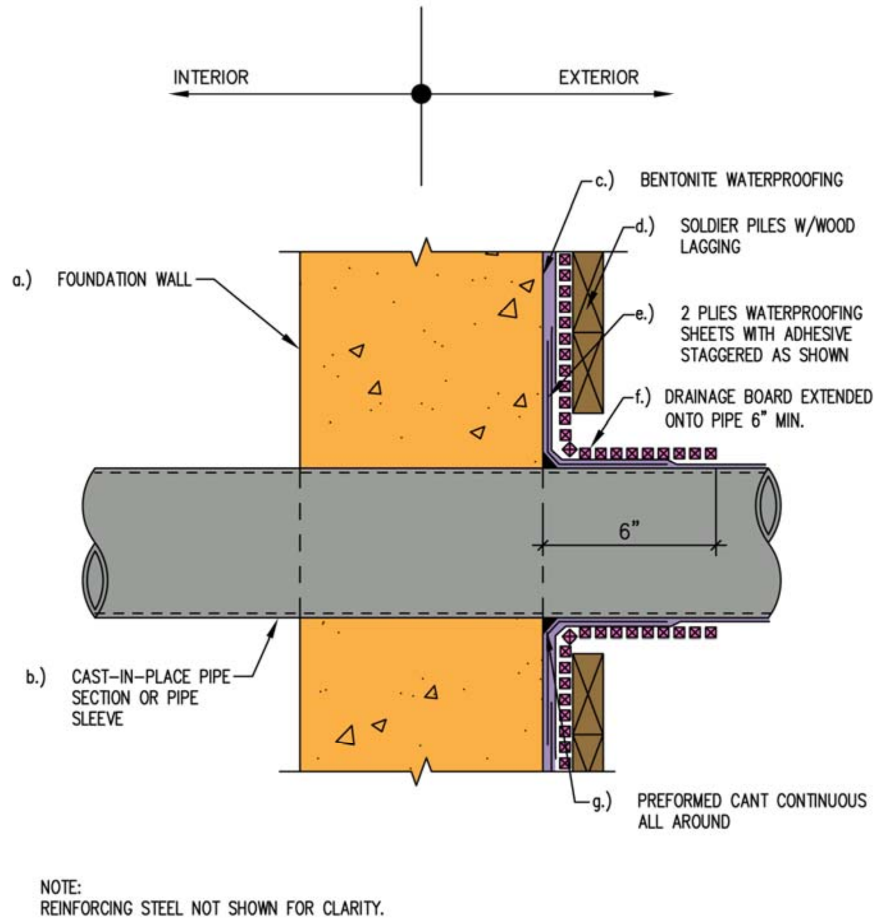
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Exterior building cladding
b. Allows cavity wall drainage
c. Supports facade masonry
d. Protects membrane from physical damage
e. Reduces stress concentration for membrane flashing
f. Prevents upper wall leaks
g. Prevents wall waterproofing pull off
h. Prevents wall leaks
i. Load transfer

FOUNDATION WALL - FACADE TRANSITION

FOUNDATION WALL DETAILS



General Notes:

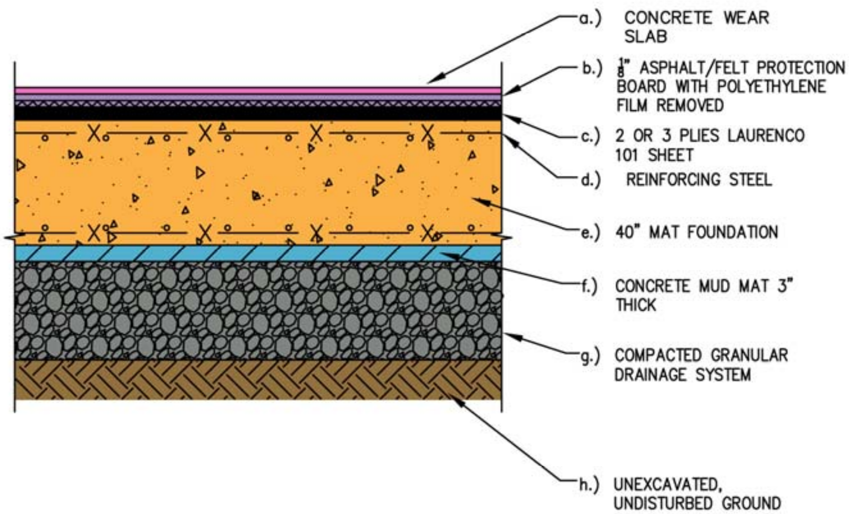
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Resists earth loads transfers bldg loads to footer
b. Conveys fluids to occupied space
c. Protects/prevents moisture penetration through wall
d. Resists/contains earth load forces
e. Protects joint/wall against water leakage
f. Remove vagrant water to subdrain system
g. Reduces stress concentration for membrane flashing

FOUNDATION WALL - PIPE PENETRATION DETAIL

SLAB DETAILS



General Notes:

1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

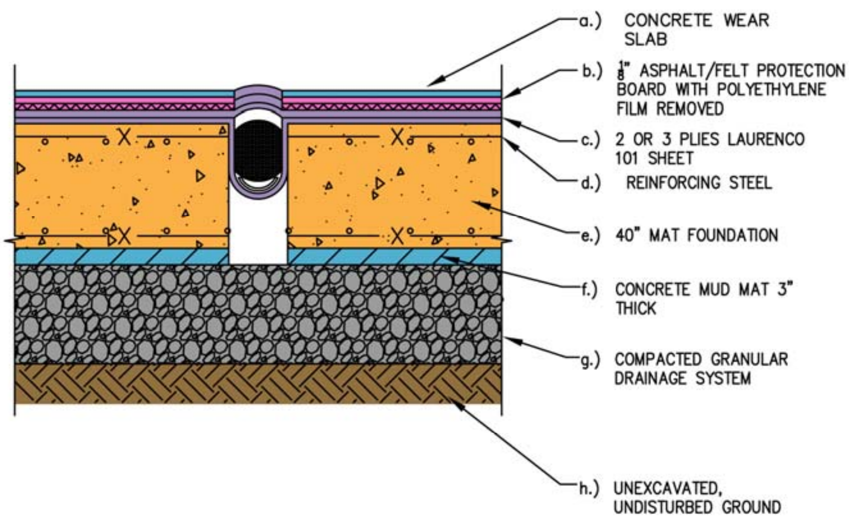
a. Completes aesthetic affect.
b. Protects membrane
c. Prevents moisture entry
d. Provides structural support to wear surface
e. Provides structural support to wear surface
f. Provides uniform slab base
g. Promotes water flow to subdrain pipes or sumps
h. Slab system foundation material

BELOW GRADE MAT - WATERPROOF SYSTEM

SLAB DETAILS

JOINT INSTALLATION:

1. COAT BOTH SIDES OF CONSTRUCTION JOINT WITH ADHESIVE
2. LOOP IN 1 PLY OF WATERPROOFING SHEET INTO JOINT
3. COAT WITH ADHESIVE
4. INSERT NEOPRENE RUBBER ROD 1½ TIMES THE SIZE OF THE JOINT, SQUEEZE TO INSERT AND USE WET ADHESIVE
5. COAT WITH ADHESIVE
6. INSTALL FLASHING OVER JOINT
7. COAT WITH ADHESIVE
8. APPLY CONTINUOUS SHEETS OF WATERPROOFING OVER JOINT
9. INSTALL SEALANT OVER WATERPROOFING TO PROVIDE WEARING SURFACE



General Notes:

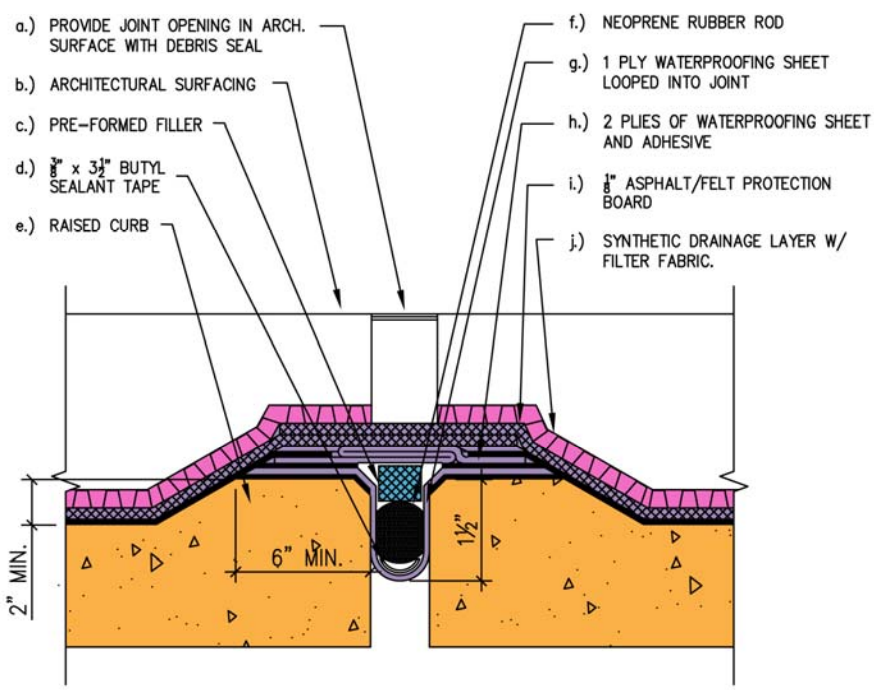
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Completes aesthetic affect.
b. Protects membrane
c. Prevents moisture entry
d. Provides structural support to wear surface
e. Provides structural support to wear surface
f. Provides uniform slab base
g. Promotes water flow to subdrain pipes or sumps
h. Slab system foundation material

BELOW GRADE MAT - WATERPROOF SYSTEM

PLAZA DETAILS



General Notes:

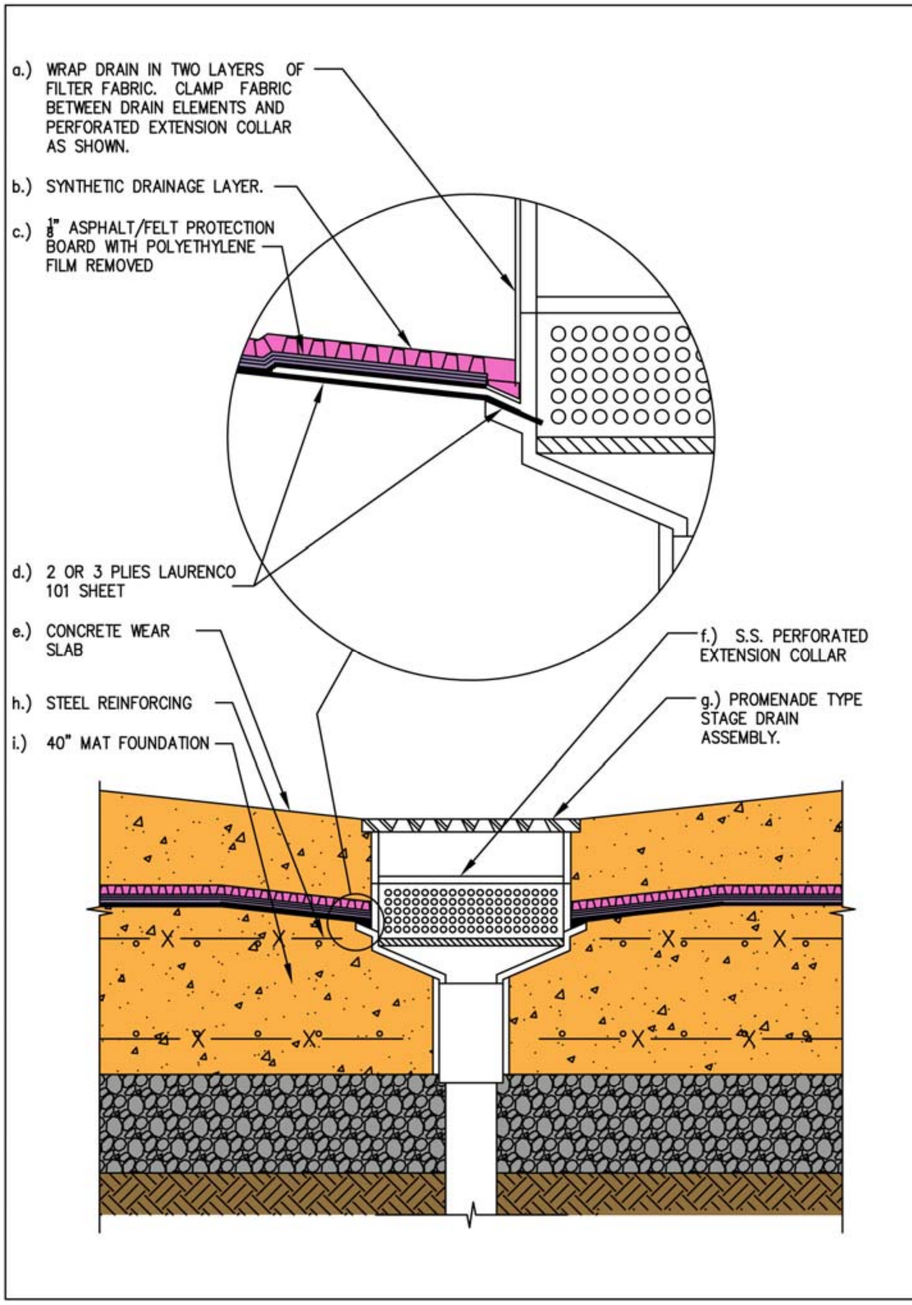
1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Opening to accommodate topping slab movement
b. Finished surfacing
c. Ensure that waterproofing layers do not allow water to collect
d. Keep rubber rod in place
e. Raised concrete at expansion joint to keep water away from joint
f. Provides expansion capability at joint opening.
g. Provide back-up moisture protection
h. Provides moisture protection to occupied spaces. Also provides primary drainage to drainage basins
i. Protection board
j. Provides flow path to drainage basins

EXPANSION JOINT - PLAZA AREA

PLAZA DETAILS



General Notes:

1. Install all materials and details in accordance with manufacturer recommendations and details.
2. Submit product data and perform adhesion tests on actual substrates prior to wide scale installation of work.
3. Notify owner, general contractor, and consultant (if one is retained) before using a substitute product than the one specified.
4. All dimensions to be field verified and coordinated with owner, general contractor, and consultant (if one is retained).

Notes: Component Functions

a. Prevents soil and backfill from entering drain and causing settlement/voids around drain
b. Primary flow path for invasive surface water
c. Protects membrane
d. Provides moisture protection to occupied spaces
e. Finished surface
f. Provides effective drainage into drain
g. Provides surface and subsurface moisture removal
h. Provides structural support to wear surface
i. Provides structural support to wear surface

FLOOR DRAIN - PLAZA AREA

WATERPROOFING CHECKLIST

1. **Hire a building envelop consultant to review the waterproofing details.** On most projects, architects normally deal with waterproofing details, but there is no one in the field checking the work. Most waterproofing details in construction documents are just standard details that have not been tailored for specific jobs. A consultant can perform a document review of the details and point out problem areas and this service normally only costs around $5,000. This may seem costly, but it can save time and money later in the project when waterproofing details either need to be clarified, or are installed incorrectly and need to be taken out and reinstalled.

2. **Hire a consultant to oversee correct installation of the waterproofing during the construction of the building.** This is an expansive endeavor, but it is cheaper than hiring the consultant a few years after the final fit-out of the building when leaks start to occur and all the waterproofing has to be ripped out and reinstalled.

3. **Hire experienced construction firms.** There is an organization called the National Organization of Waterproofing and Structural Repair Contractors. This organization is a professional trade association whose members are required to uphold a strict standard of practice and cannon of ethics. These documents can be reviewed on their website http://nawsrc.org. It is also possible to locate members and suppliers in the area of the construction project who are required to do the best possible job of waterproofing the construction job.

4. **Ensure that the waterproofing is continuous around the entire building.** This is one of the most important details. Even a small tear in the waterproofing can allow enough water to penetrate to the interior of the building that an identifiable leak can be found. Ideally, there should be no penetrations in the waterproofing, but this is impossible as windows and doors are a necessary part of design. Unnecessary penetrations as part of installation should be avoided. These include nail holes, tears in the waterproofing sheets, or outlet penetrations to name a few. If these occur, a new sheet of waterproofing should be installed, or at the very least, they should be repaired with mastic.

5. **Create a mock-up of the system and/or perform tests during construction.** It is possible to hire testing firms to come in and test curtain walls, brick panels, and other water sensitive areas to find trouble areas before the fit-out of the building when they will become harder and more costly to repair. These tests can cost approximately $10,000/day, but they will again be cheaper than trying to fix the problem areas later during the lifetime of the building when leaks occur.

6. **Perform regular building maintenance.** Replacing all the sealant on a building every 5 years is cheaper than removing all the curtain walls, ripping out the steel that is now corroded because of water infiltration, and then replacing all the steel and the curtain walls every 10 years.

APPENDIX I –ACOUSTICS STUDY

ACOUSTICS STUDY

TL DATA FOR COMMON BUILDING ELEMENTS*

Building Construction	Transmission Loss (dB) 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC Rating	IIC Rating†
Walls[2-6]‡								
Monolithic:								
1. 3/8-in plywood (1 lb/ft²)	14	18	22	20	21	26	22	
2. 26-gauge sheet metal (1.5 lb/ft²)	12	14	15	21	21	25	20	
3. 1/2-in gypsum board (2 lb/ft²)	15	20	25	31	33	27	28	
4. 2 layers 1/2-in gypsum board, laminated with joint compound (4 lb/ft²)	19	26	30	32	29	37	31	
5. 1/32-in sheet lead (2 lb/ft²)	15	21	27	33	39	45	31	
6. Glass-fiber roof fabric (37.5 oz/yd²)	6	9	11	16	20	25	16	
Interior:								
7. 2 by 4 wood studs 16 in oc with 1/2-in gypsum board both sides (5 lb/ft²)	17	31	33	40	38	36	33	
8. Construction no. 7 with 2-in glass-fiber insulation in cavity	15	30	34	44	46	41	37	
9. 2 by 4 staggered wood studs 16 in oc each side with 1/2-in gypsum board both sides (8 lb/ft²)	23	28	39	46	54	44	39	
10. Construction no. 9 with 2 1/4-in glass-fiber insulation in cavity	29	38	45	52	58	50	48	
11. 2 by 4 wood studs 16 in oc with 5/8-in gypsum board both sides, one side screwed to resilient channels. 3-in glass-fiber insulation in cavity (7 lb/ft²)	32	42	52	58	53	54	52	
12. Double row of 2 by 4 wood studs 16 in oc with 3/8-in gypsum board on both sides of construction. 9-in glass-fiber insulation in cavity (4 lb/ft²)	31	44	55	62	67	65	54	
13. 6-in dense concrete block, 3 cells, painted (34 lb/ft²)	37	36	42	49	55	58	45	
14. 8-in lightweight concrete block, 3 cells, painted (38 lb/ft²)	34	40	44	49	59	64	49	
15. Construction no. 14 with expanded mineral loose fill in cells	34	40	46	52	60	66	51	
16. 6-in lightweight concrete block with 1/2-in gypsum board supported by resilient metal channels on one side, other side painted (26 lb/ft²)	35	42	50	64	67	65	53	
17. 2 1/2-in steel channel studs 24 in oc with 5/8-in gypsum board both sides (6 lb/ft²)	22	27	43	47	37	46	39	
18. Construction no. 17 with 2-in glass-fiber insulation in cavity	26	41	52	54	45	51	45	
19. 3 5/8-in steel channel studs 16 in oc with 1/2-in gypsum board both sides (5 lb/ft²)	26	36	43	51	48	43	43	
20. Construction no. 19 with 3-in mineral-fiber insulation in cavity	28	45	54	55	47	54	48	
21. 2 1/2-in steel channel studs 24 in oc with two layers 5/8-in gypsum board one side, one layer other side (8 lb/ft²)	28	31	46	51	53	47	44	
22. Construction no. 21 with 2-in glass-fiber insulation in cavity	31	43	55	58	61	51	51	
23. 3 5/8-in steel channel studs 24 in oc with two layers 5/8-in gypsum board both sides (11 lb/ft²)	34	41	51	54	46	52	48	
24. Construction no. 23 with 3-in mineral-fiber insulation in cavity	38	52	59	60	56	62	57	

ACOUSTICS STUDY

Airspace (in)	Improvement in TL (dB) 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
2	5	7	19	25	30	30
4	10	12	24	30	35	35

Type of Space (and Listening Requirements)	Preferred Range of Noise Criteria	Equivalent dBA Level *
Concert halls, opera houses, broadcasting and recording studios, large auditoriums, large churches, recital halls (for excellent listening conditions)	< NC-20	< 30
Small auditoriums, theaters, music practice rooms, large meeting rooms, teleconference rooms, audiovisual facilities, large conference rooms, executive offices, small churches, courtrooms, chapels (for very good listening conditions)	NC-20 to NC-30	30 to 38
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels (for sleeping, resting, relaxing)	NC-25 to NC-35	34 to 42
Private or semiprivate offices, small conference rooms, classrooms, libraries (for good listening conditions)	NC-30 to NC-35	38 to 42
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, gymnasiums (for moderately good listening conditions)	NC-35 to NC-40	42 to 47
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas, maintenance shops such as for electrical equipment (for fair listening conditions)	NC-40 to NC-45	47 to 52
Kitchens, laundries, school and industrial shops, computer equipment rooms (for moderately fair listening conditions)	NC-45 to NC-55	52 to 61

* Do not use A-weighted sound levels (dBA) for specification purposes. Spectrum shapes and noise characteristics can vary widely for background noises with identical A-weighted sound levels (see Chap. 1).

Curve	Sound Pressure Level (dB) 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
RC-50	65	60	55	50	45	40
RC-45	60	55	50	45	40	35
RC-40	55	50	45	40	35	30
RC-35	50	45	40	35	30	25
RC-30	45	40	35	30	25	20
RC-25	40	35	30	25	20	15
Threshold*	22	13	8	5	3	..

*Approximate threshold of hearing for continuous noise by listeners with normal hearing.

APPENDIX J –SUPPLEMENTAL COST INFORMATION

STRUCTURAL COST INFORMATION

Column Takeoff	Column	Length (ft)	Cost/ft	Cost
	W14x43	1800.50	$29.90	$53,834.95
	W14x61	715.00	$40.83	$29,193.45
	W14x74	335.90	$47.52	$15,961.97
	W14x82	216.60	$52.25	$11,317.35
	W14x90	260.00	$58.58	$15,230.80
	W14x109	162.50	$71.06	$11,547.25
	W14x120	65.00	$77.76	$5,054.40
	W14x132	65.00	$85.04	$5,527.60
	W14x145	32.50	$112.75	$3,664.38
			Total Cost:	$151,332.14
			Adjusted Cost:	$112,529.03

Beam Takeoff	Beam	Length (ft)	Cost/ft	Cost
	CB12x15	6863.50	$32.77	$224,916.90
	CB15x19	5383.45	$24.57	$132,271.37
	CB18x26	2592.00	$26.00	$67,392.00
	CB27x46	6671.07	$42.23	$281,719.29
	CB27x60	2070.14	$51.03	$105,639.24
	CB27x76	877.00	$65.83	$57,732.91
	CB27x97	379.59	$81.97	$31,114.99
	CB27x119	160.55	$98.35	$15,790.09
	CB36x162	139.50	$125.81	$17,550.50
	CB50x221	50.00	$193.45	$9,672.50
			Total Cost:	$943,799.78
			Adjusted Cost:	$701,799.84

STRUCTURAL COST INFORMATION

Brace Takeoff

Brace	Length (ft)	Cost/ft	Cost
HSS7.5x0.5	865.30	$75.46	$65,295.54
HSS10.0x0.625	207.50	$114.30	$23,717.25
		Total Cost:	$89,012.79
		Adjusted Cost:	$66,189.00

Steel Deck Takeoff

Floor	Area (ft^2)	Cost/ft^2	Cost
Roof	16269	$1.10	$17,895.90
Penthouse	25914	$1.10	$28,505.40
Sixth	32427	$1.10	$35,669.70
Fifth	32427	$1.10	$35,669.70
Fourth	32427	$1.10	$35,669.70
Third	28646	$1.10	$31,510.60
Second	17037	$1.10	$18,740.70
		Total Cost:	$185,765.80
		Adjusted Cost:	$138,133.54

Concrete Takeoff

Floor	Area (ft^2)	Thickness (ft)	Volume (yd^3)	Cost/yd^3	Cost
Roof	16269	0.46	276	$85.00	$23,474.56
Penthouse	25914	0.46	440	$85.00	$37,391.34
Sixth	32427	0.46	550	$85.00	$46,788.96
Fifth	32427	0.46	550	$85.00	$46,788.96
Fourth	32427	0.46	550	$85.00	$46,788.96
Third	28646	0.46	486	$85.00	$41,333.35
Second	17037	0.46	289	$85.00	$24,582.71
				Total Cost:	$267,148.83