Appendix A: Existing Conditions

Roof Live Load [From ASCE7-02, section 4.9]

$L_r = 20R_1R_2$ where $12 \leq L_r \leq 20$

$R_1 = 1.2\text{-}0.001A_t$ for $200ft^2 \leq A_t \leq 600ft^2$

Average Atrib= $700ft^2$, use R_1=0.5

R_2 = 1.0 (flat roof)

$L_r = 20(0.5)(1.0) = 10$ psf

Snow Load [From ASCE7-02, section 7.3]

$P_f = 0.7C_eC_tIp_g$

C_e = 0.9
I = 1.0
p_g = 20 psf
C_t = 1.0

$P_f = 0.7(0.9)(1.0)(1.0)(20psf) = 22psf$

Assume average total roof load of 30 psf

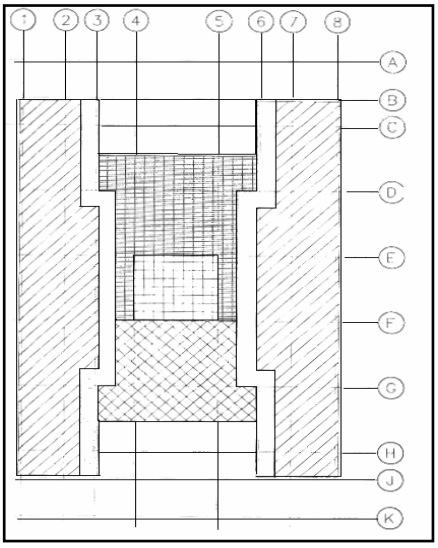


Figure A1- Shows the load distribution over the penthouse level of the structure. This distribution was used to determine the weight of the roof for the seismic analysis.

- Roof Load
-Mechanical Load
-Elevator Room Load
-Cooling Towers
-Snow Drift

(Drawings not to scale)

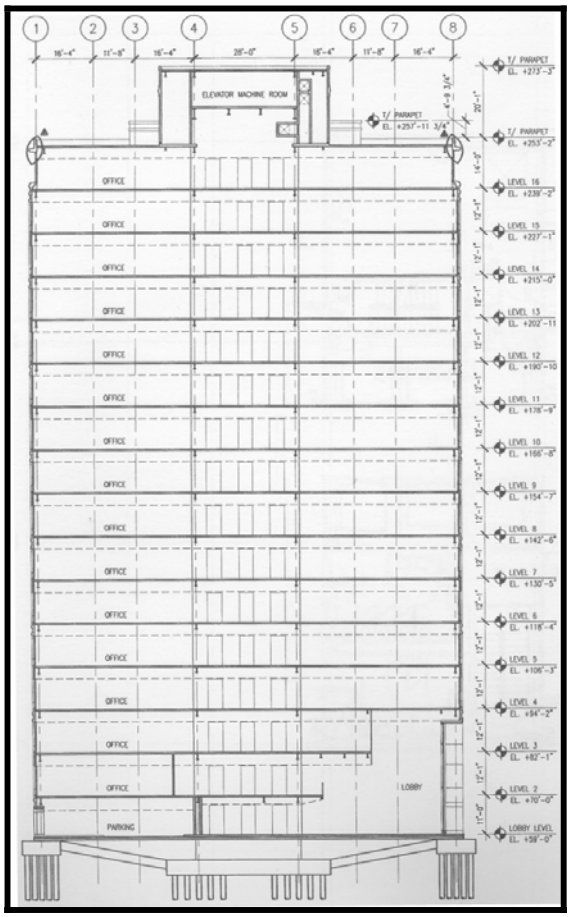


Figure A2- East/West Section

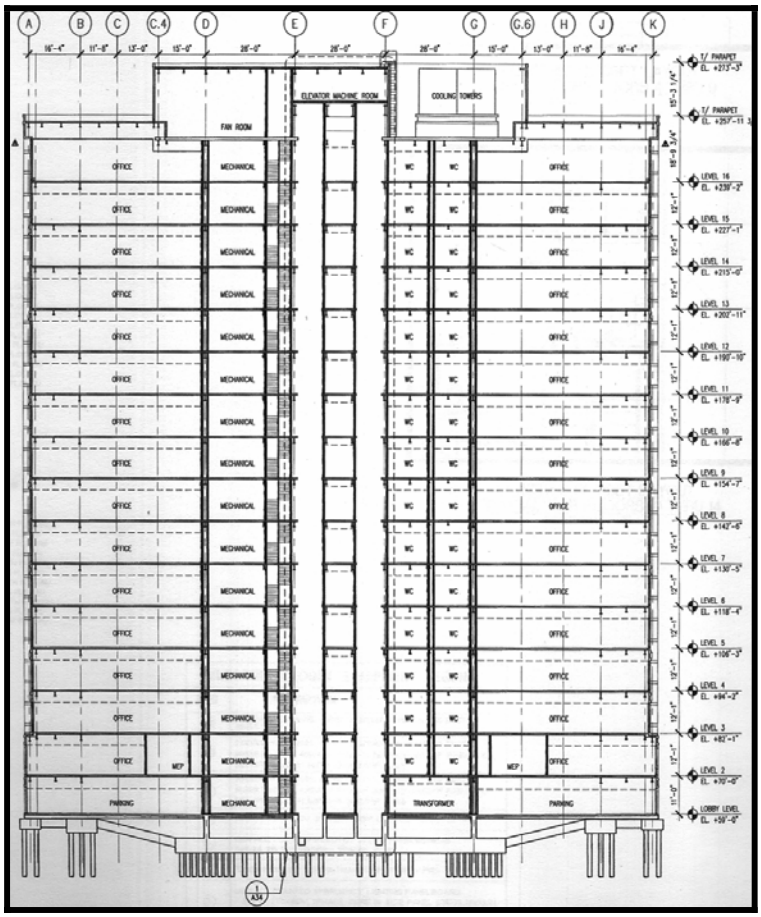


Figure A3- North/South Section

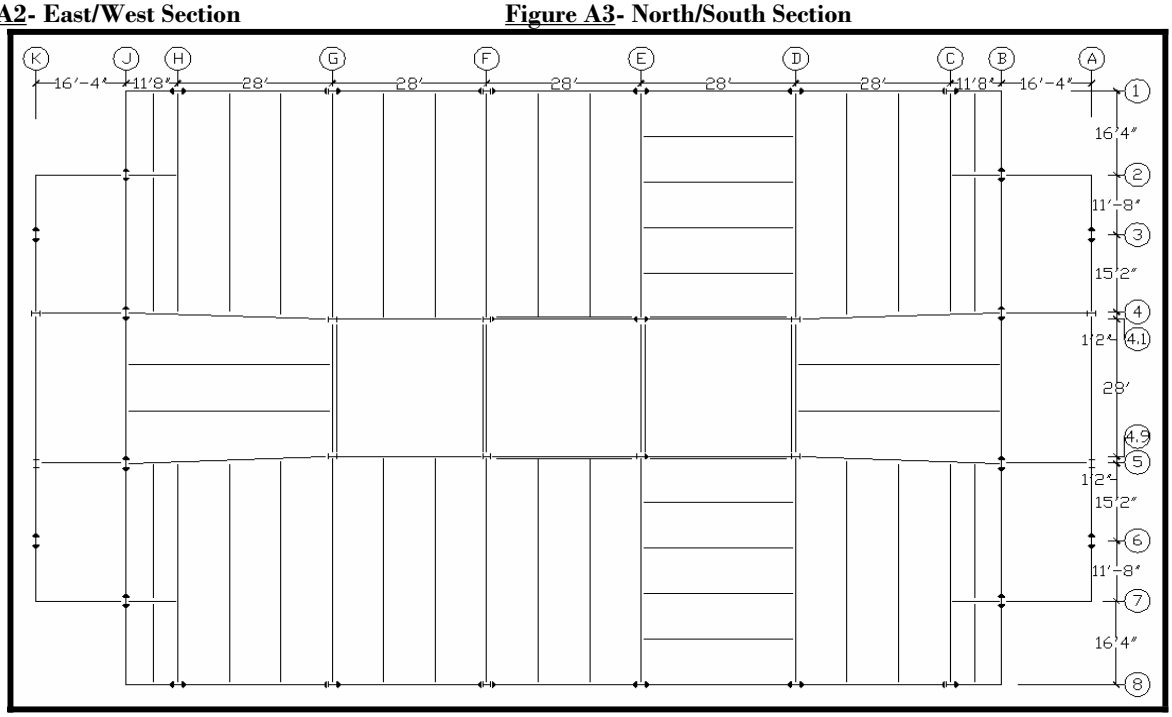


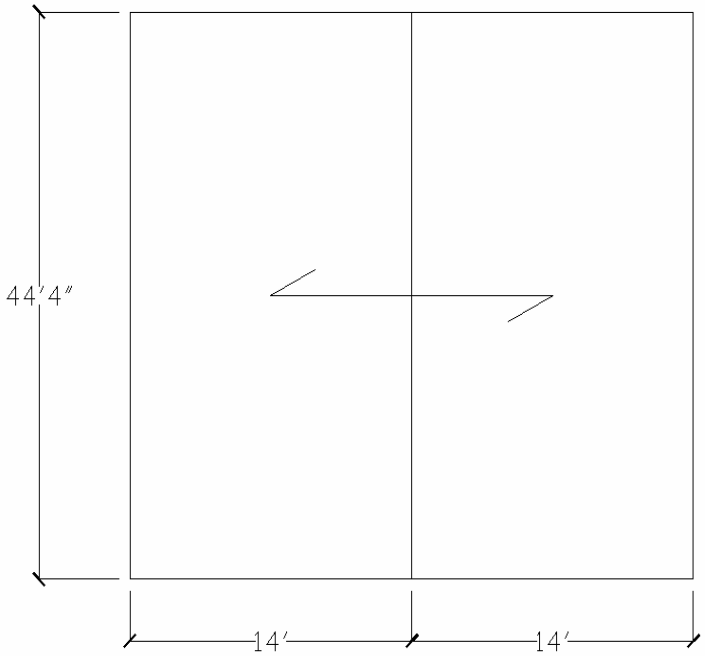
Figure A4: Typical framing plan with moment connections shown

Appendix B: Floor System

Reinforced Concrete Slab Calculation

Material Properties
F'c=5000 psi
Fy= 60ksi

Loads:
Live: Office: 80psf
Dead
Superimposed: 20psf
MEP: 5 psf
Finish/Misc: 5psf
Total: 30 psf



Estimate of thickness: l/28 [ACI 318-05, table 9.5(a)]

(14' x 12"/ft) / 28 = 6"

Design Load:
1.6(80psf) + 1.2(30psf+ ((6"/12)*150pcf)= 254 psf

Design Moments: [ACI 318-05 8.3]

$-M_1$ Interior Support: $w_n l_n^2/11 = (1/11)*.254ksf*14^2 = 4.53$ k-ft
$+M_1$ Interior Support: $w_n l_n^2/16 = (1/16)*.254ksf*14^2 = 3.11$ k-ft
$-M_1$ Interior Support: $w_n l_n^2/11 = (1/11)*.254ksf*14^2 = 4.53$k-ft

Minimum Reinforcing: estimate d = 6"- 3/4" - 4/16" =4.875"

$A_{smin} = .003\ b_w d$
$A_{smin} = .003\ (12in)(4.875in)$
$A_{smin} = .1755\ in^2$
→ can use #4 bars, resize d to 5"
$A_{smin} = .003\ (12in)(5in) = .18\ in^2 < .20in^2$

Flexure Check:

$a = As*fy/(.85)(f'c)b = .235$ in $c = .235in/.85 = .277 < 1.875$ $\therefore \varphi = .9$

Flexure Check (cont)

φMn= φAs*fy(d-a/2)
φMn= (.9)(.20in^2)(60ksi)(5in- .235/2)
φMn= 52.73 in-k = 4.39 ft-k < 4.53 ft-k

∴ No Good, use #5's

(a= .365in)
φMn= φAs*fy(d-a/2)
φMn= (.9)(.31in^2)(60ksi)(4.94in- .365/2)
φMn= 79.64 in-k = 6.64 ft-k > 4.53 ft-k

∴OK, use #5's@12" o.c.

Shrinkage and Temperature Check

[ACI 318-05 7.12.2.1] Grade 60 steel, ρmin= .0018

A_{smin}= .0018(6")(12")
A_{smin}= .1296 in^2 < .20in^2 ∴ OK

USE #5 BARS SPACED @ 12" o.c FOR SLAB REINFORCMENT

Estimate of Prestess Losses

-Unbonded Tendons

½"φ, 7-wire strands, A=0.153 in^2
F_{pu} =270 ksi

-Esitmated prestress losses = 15 ksi (ACI 18.6)

F_{se} = .7(270 ksi)-15 ksi =174 ksi (ACI 18.5.1)
P_{eff} = A*f_{se} = (0.153)*(174 ksi) =26.6 kips/tendon

Moment Distribution Spreadsheets

Available upon request

The table on the left shows equal cable forces for profiles adjusted across different span lengths. The table on the right has aconstant sag regardless of span.

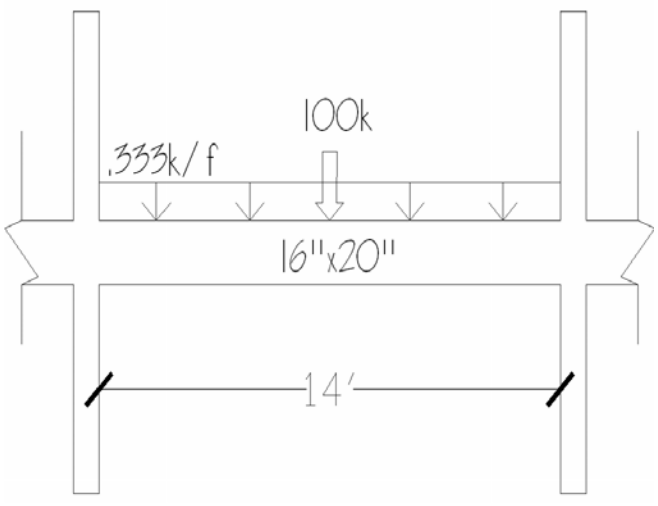
		% DL	80%DL	90%DL	95%DL	100%DL	110%DL
		m	1.07	1.21	1.27	1.34	1.48
Span	L	Sag (in)	Fc (kips)				
1	44.33	10.00	316.39	355.94	375.71	395.49	435.03
2	28	4	315.56	355.01	374.73	394.45	433.90
3	44.33	10.00	316.39	355.94	375.71	395.49	435.03
Span 1		# Tendons	12	13	14	15	16
		precomp	369.61	415.81	438.92	462.02	508.22
Span 2		# Tendons	12	13	14	15	16
		precomp	368.64	414.73	437.77	460.81	506.89
Span 3		# Tendons	12	13	14	15	16
		precomp	369.61	415.81	438.92	462.02	508.22

		% DL	80%DL	90%DL	95%DL	100%DL	110%DL
		m	1.07	1.21	1.27	1.34	1.48
Span	L	Sag (in)	Fc (kips)				
1	44.33	10.00	316.39	355.94	375.71	395.49	435.03
2	28	10	126.22	142.00	149.89	157.78	173.56
3	44.33	10.00	316.39	355.94	375.71	395.49	435.03
Span 1		# Tendons	12	13	14	15	16
		precomp	369.61	415.81	438.92	462.02	508.22
Span 2		# Tendons	5	5	6	6	7
		precomp	147.46	165.89	175.11	184.32	202.75
Span 3		# Tendons	12	13	14	15	16
		precomp	369.61	415.81	438.92	462.02	508.22

Moment Capacity Check for Reinforced Beam

Material Properties
F'c=5000 psi
Fy= 60ksi

Loads:
Live: Office: 80psf
Dead
Superimposed: 20psf
MEP: 5 psf
Finish/Misc: 5psf
Total: 30 psf



As= 4-#8 bars (3.16in^2) → taken from Concept output

Load from Beam

Live Load: 80psf (14') = 1120lb/ft
Dead Load: 30psf(14') = 420lb/ft
Slab Load: (6"/12)*150 lb/cu. ft * 14' = 1050lb/ft
Beam self weight: (16'*20")/144in^2 *150lb/cu.ft. = 333.3lb/ft

Point Load: [1.2(833.3+1050+420) + 1.6(1120)]*22/1000 = 100k

Beam Self weight: (16"x16")/144*150lb/cu.ft =266.6*1.2= .333k/ft

Moments at Ends [LRFD Table 5-17]

Fixed End, Uniform Load: M= wl^2/12= 5.39k-ft
Fixed End, Point Load: M=Pl/8= 175 ft-k Total: 180.4 ft-k

Moments at Middle

Fixed End, Uniform Load: M= wl^2/24= 2.7k-ft
Fixed End, Point Load: M=Pl/8= 175 ft-k Total: 177.7 ft-k

Capacity Check

a= As*fy/(.85)(f'c)b = 2.78 in Mn=.9* As*fy(d-a/2) =224 ft-k > 180.4ft-k
∴ OK

Floor System #1

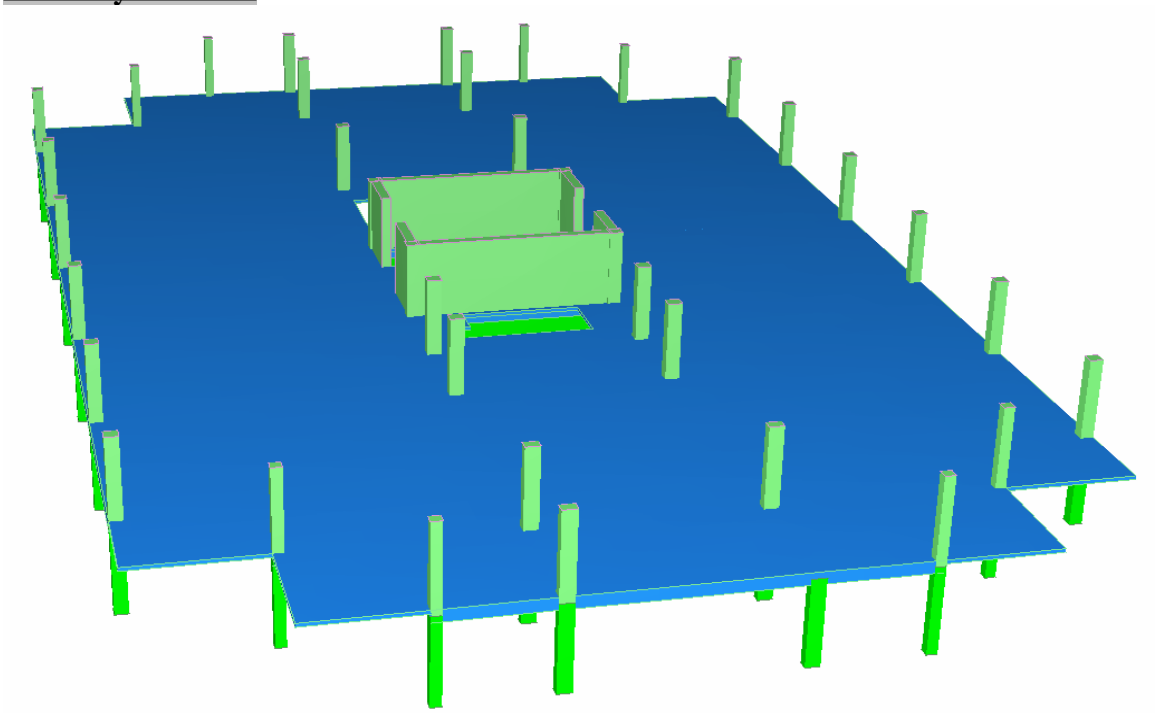


Figure B1: Floor system overhead view

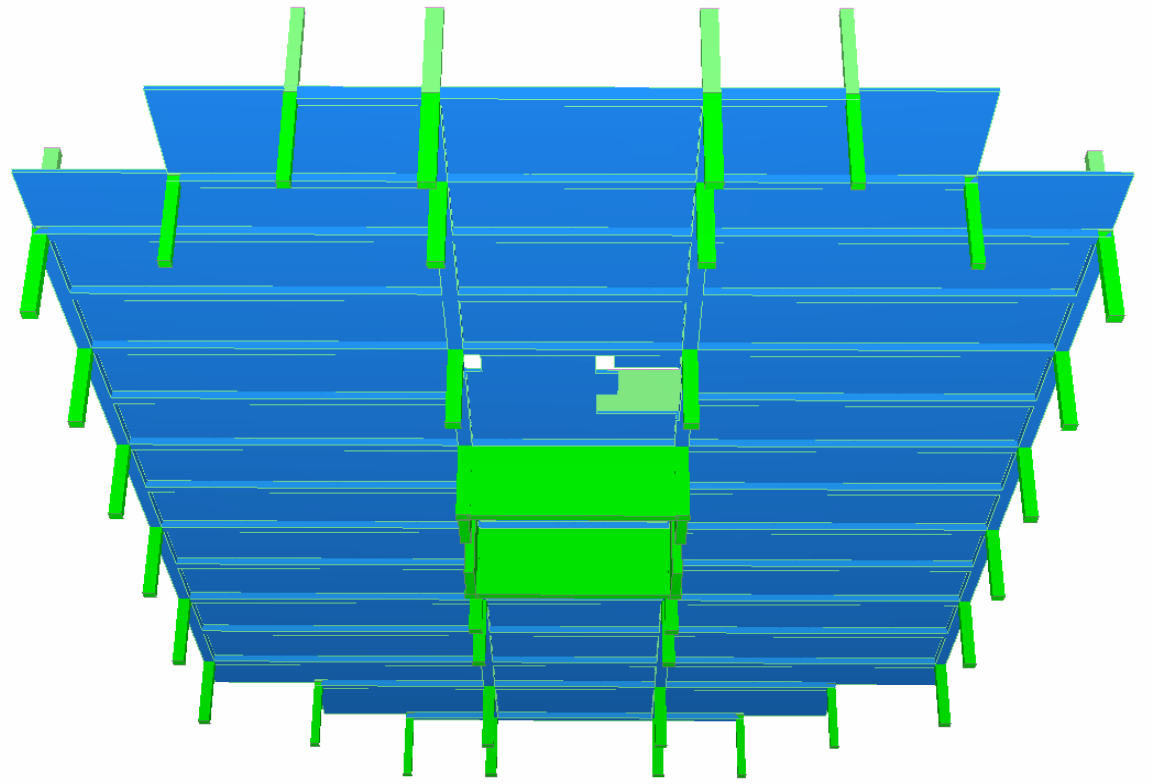


Figure B2: Floor system #1 underside view

Floor System #1

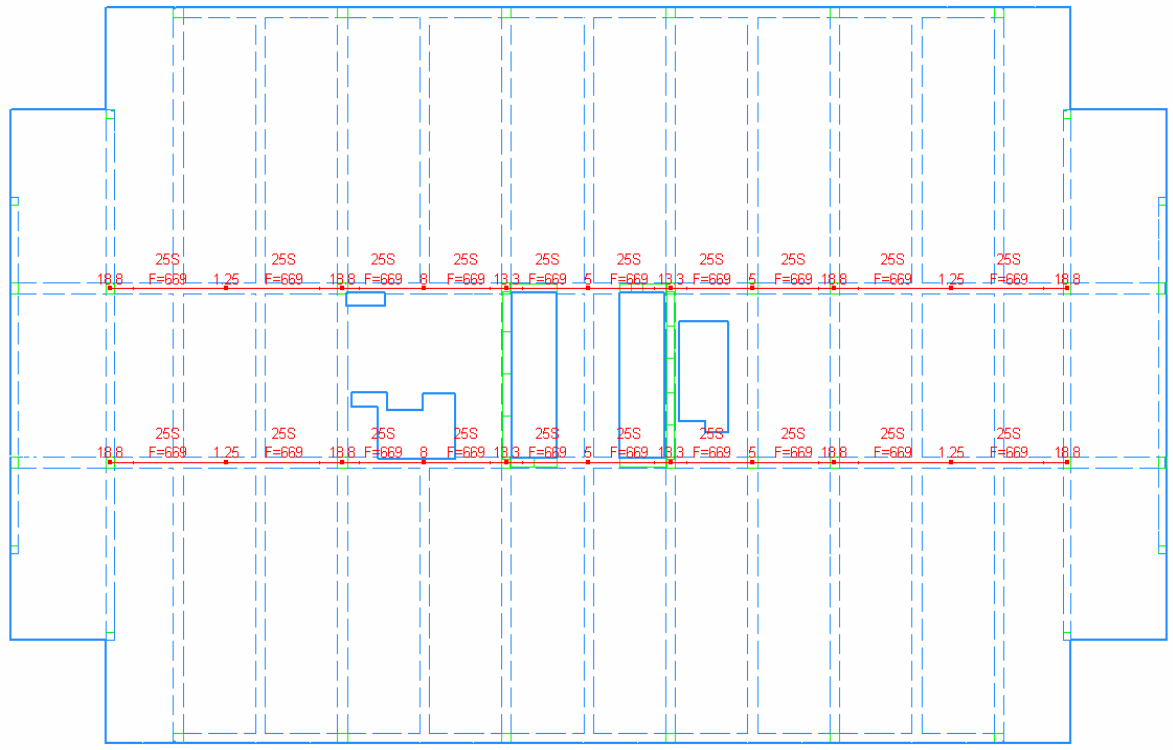


Figure B3 Latitude tendon plan view with tendon forces labeled

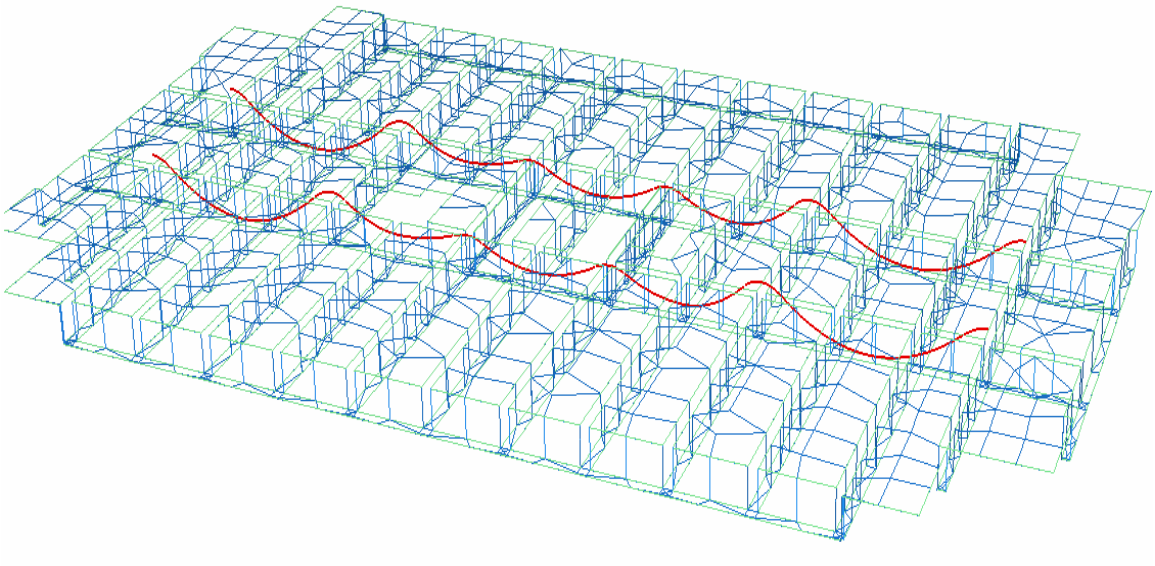


Figure B4: 3-D View of lateral tendon profiles

Floor System #1

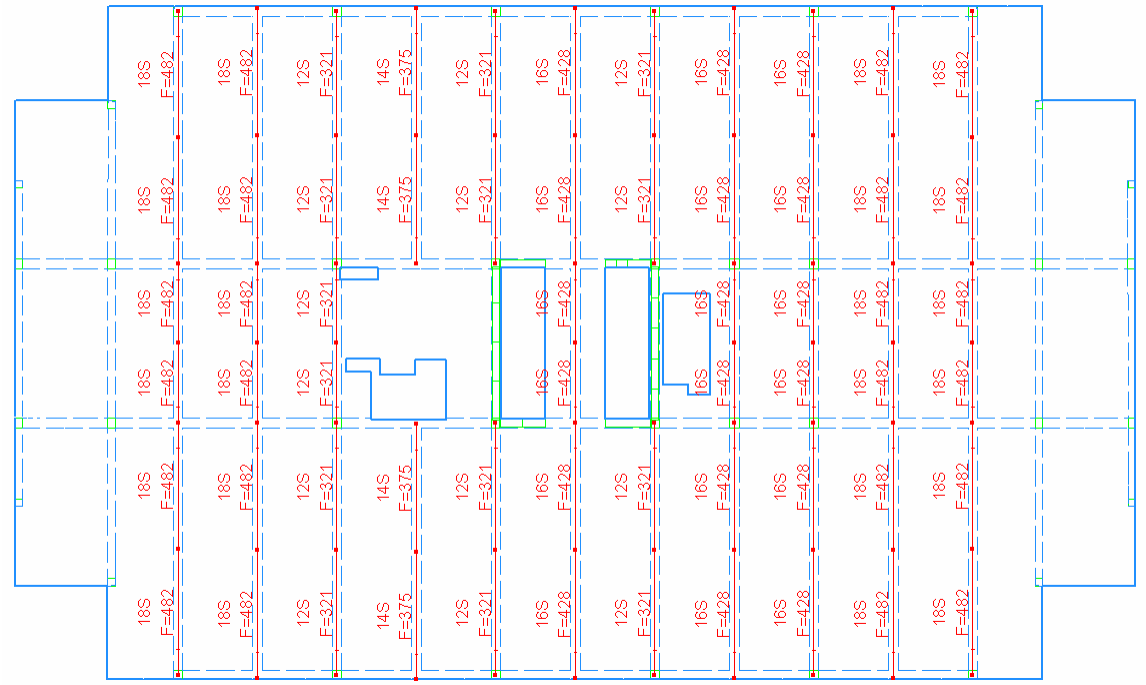


Figure B5: Longitude tendon plan view with tendon forces labeled

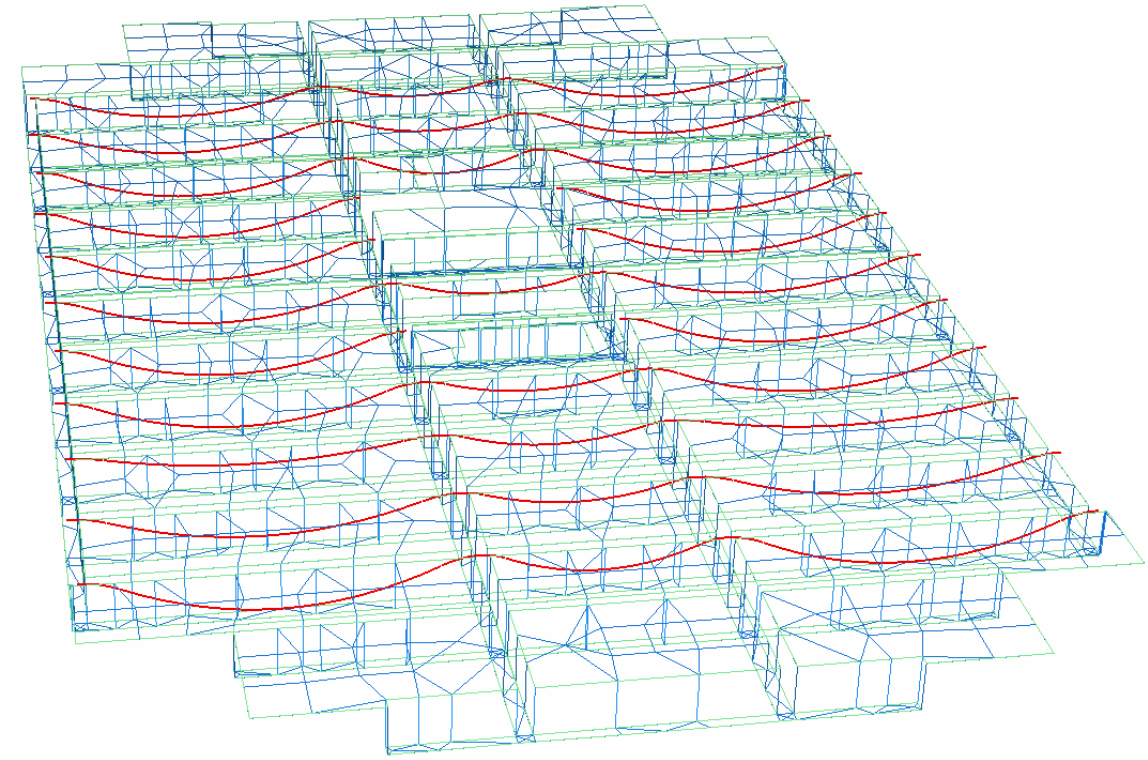


Figure B6: 3-D View of longitudinal tendon profiles

Floor System #2

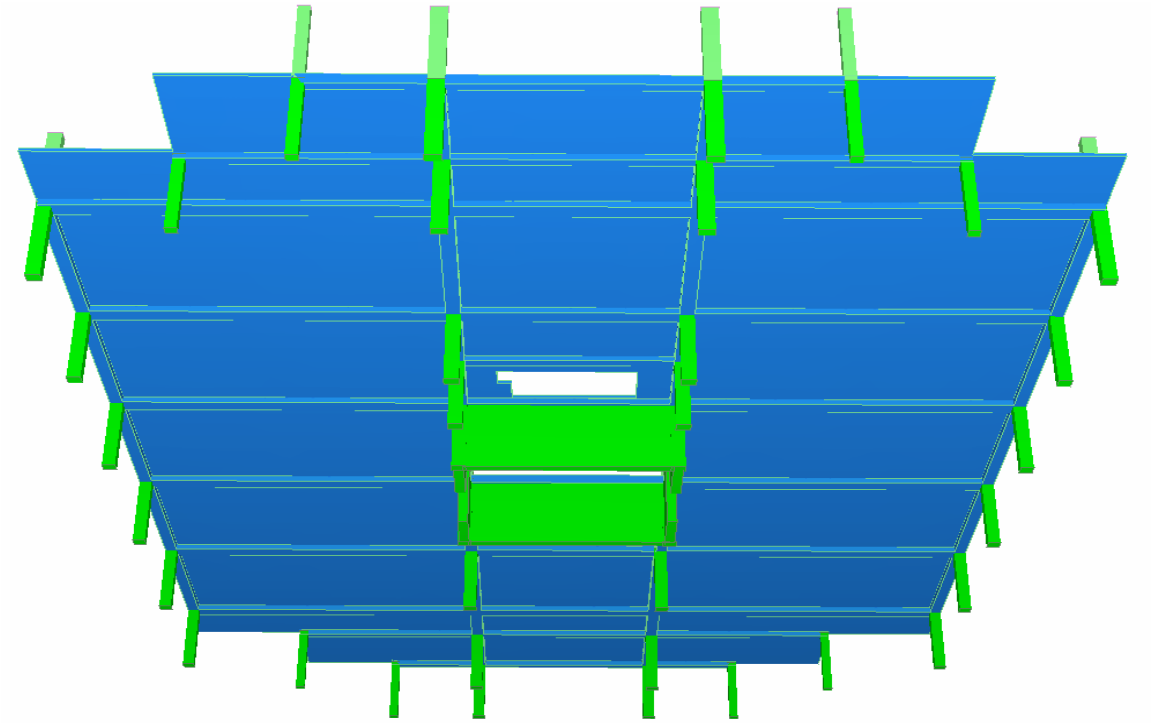


Figure B7: Underside of flooring system #2

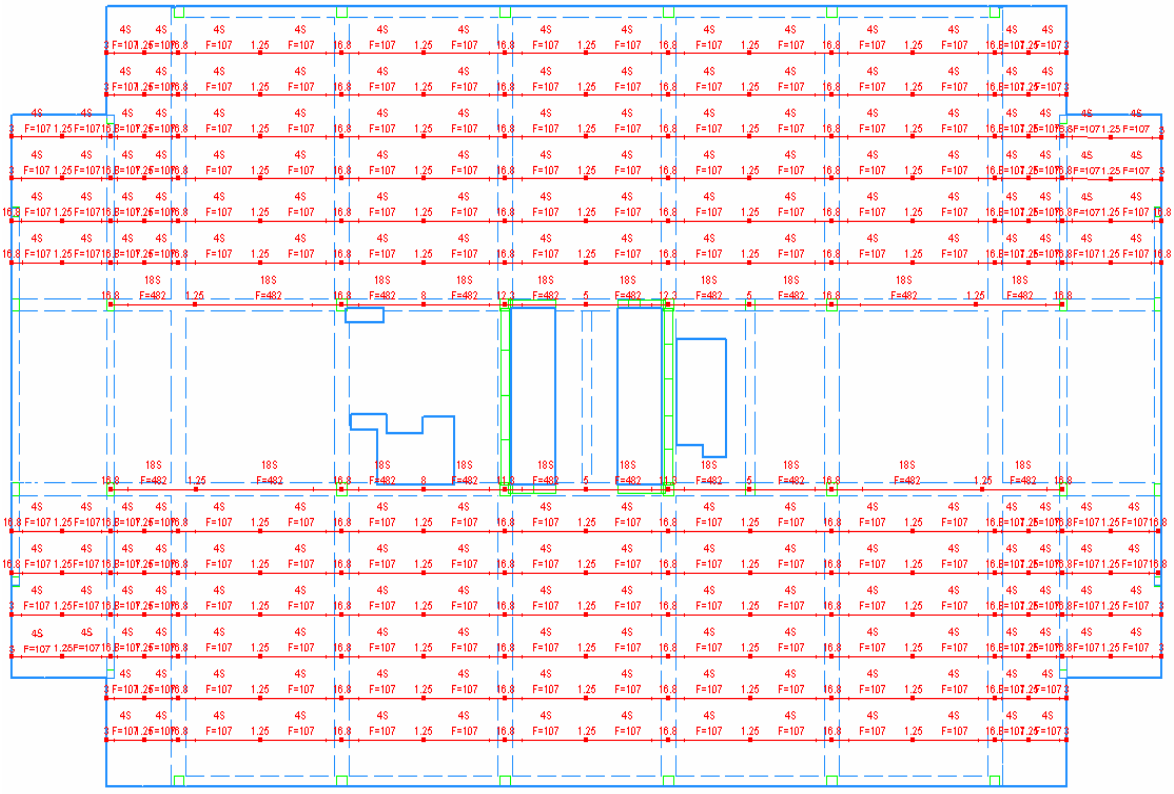


Figure B8: Latitude tendon plan view with tendon forces labeled

Floor System #2

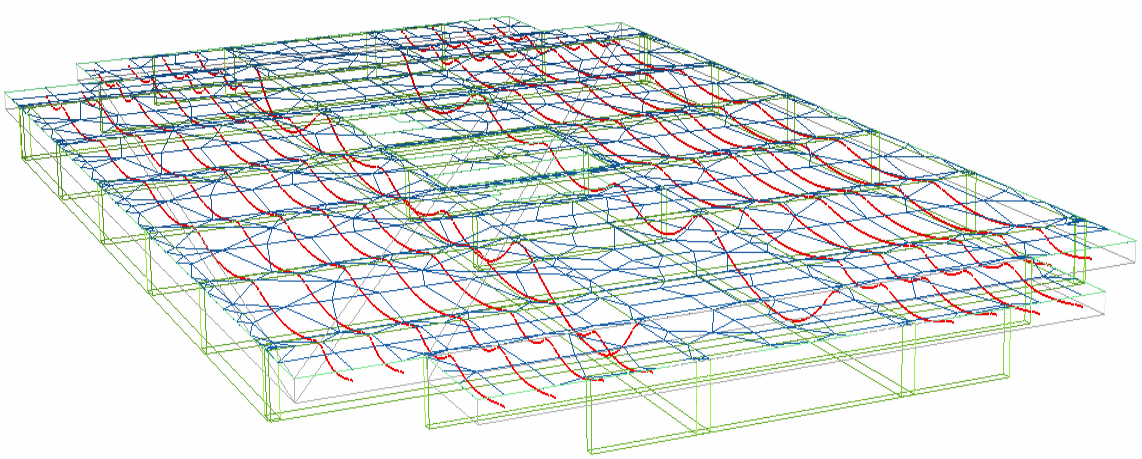


Figure B9: 3-D View of lateral tendon profiles

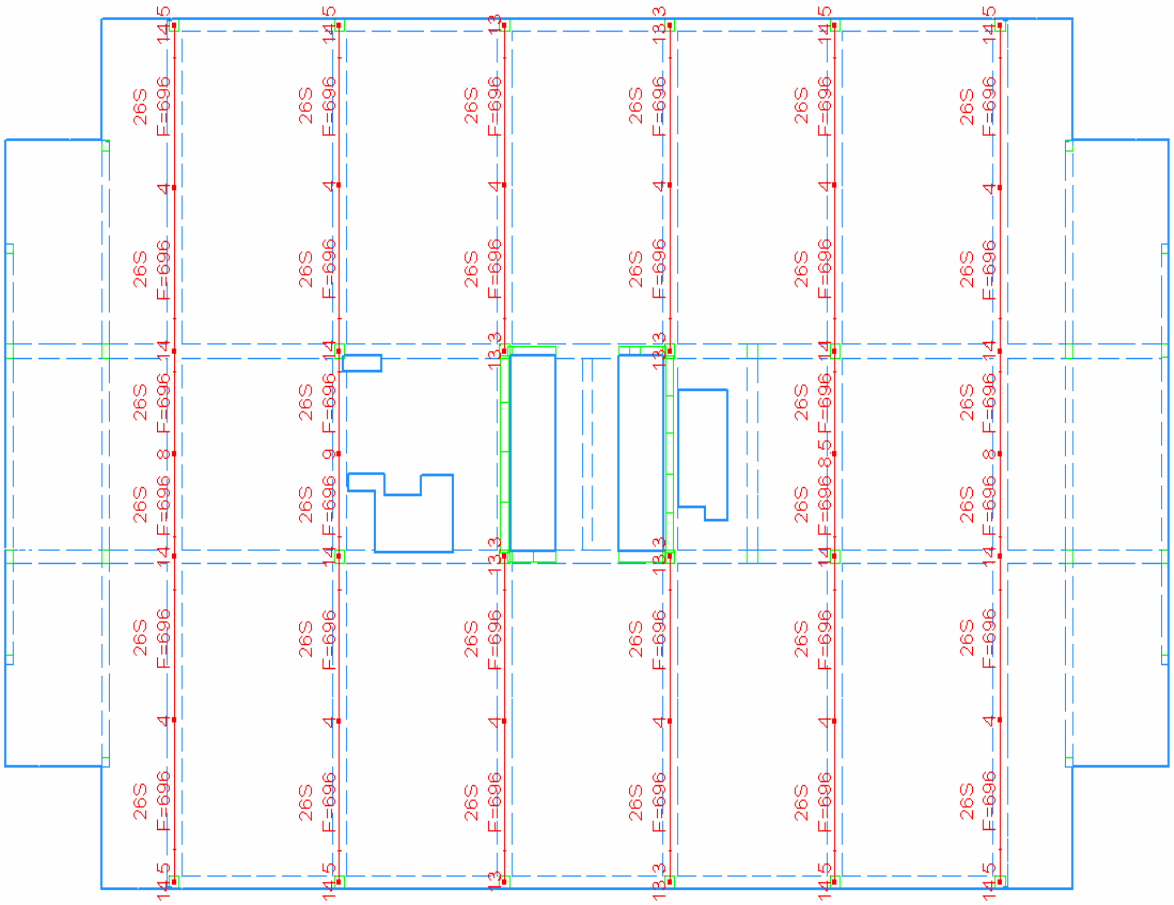


Figure B10: Longitudinal tendon plan view with tendon forces labeled

Quantity Estimates

Floor System #1

Concrete Costs

Materials:	1	per	cu. yds	x	552.1	cu. yds	=	552.1
Labor:	1	per	cu. yds	x	552.1	cu. yds	=	552.1
Total:	2	per	cu. yds	x	552.1	cu. yds	=	1104

Post-Tensioning Costs

Materials:	1	per	pounds	x	14070	pounds	=	14070
Labor:	1	per	pounds	x	14070	pounds	=	14070
Total:	2	per	pounds	x	14070	pounds	=	28150

Formwork Costs

Materials:	1	per	sq. ft.	x	21570	sq. ft.	=	21570
Labor:	1	per	sq. ft.	x	21570	sq. ft.	=	21570
Total:	2	per	sq. ft.	x	21570	sq. ft.	=	43140

Mild Steel Reinforcing Costs

Materials:	1	per	tons	x	31.36	tons	=	31.36
Labor:	1	per	tons	x	31.36	tons	=	31.36
Total:	2	per	tons	x	31.36	tons	=	62.72

Total Costs

Materials:	1.68	per	sq. ft.	x	21570	sq. ft.	=	36230
Labor:	1.68	per	sq. ft.	x	21570	sq. ft.	=	36230
Total:	3.359	per	sq. ft.	x	21570	sq. ft.	=	72450

Floor System #2

Concrete Costs

Materials:	1	per	cu. yds	x	520.5	cu. yds	=	520.5
Labor:	1	per	cu. yds	x	520.5	cu. yds	=	520.5
Total:	2	per	cu. yds	x	520.5	cu. yds	=	1041

Post-Tensioning Costs

Materials:	1	per	pounds	x	16430	pounds	=	16430
Labor:	1	per	pounds	x	16430	pounds	=	16430
Total:	2	per	pounds	x	16430	pounds	=	32870

Formwork Costs

Materials:	1	per	sq. ft.	x	21570	sq. ft.	=	21570
Labor:	1	per	sq. ft.	x	21570	sq. ft.	=	21570
Total:	2	per	sq. ft.	x	21570	sq. ft.	=	43140

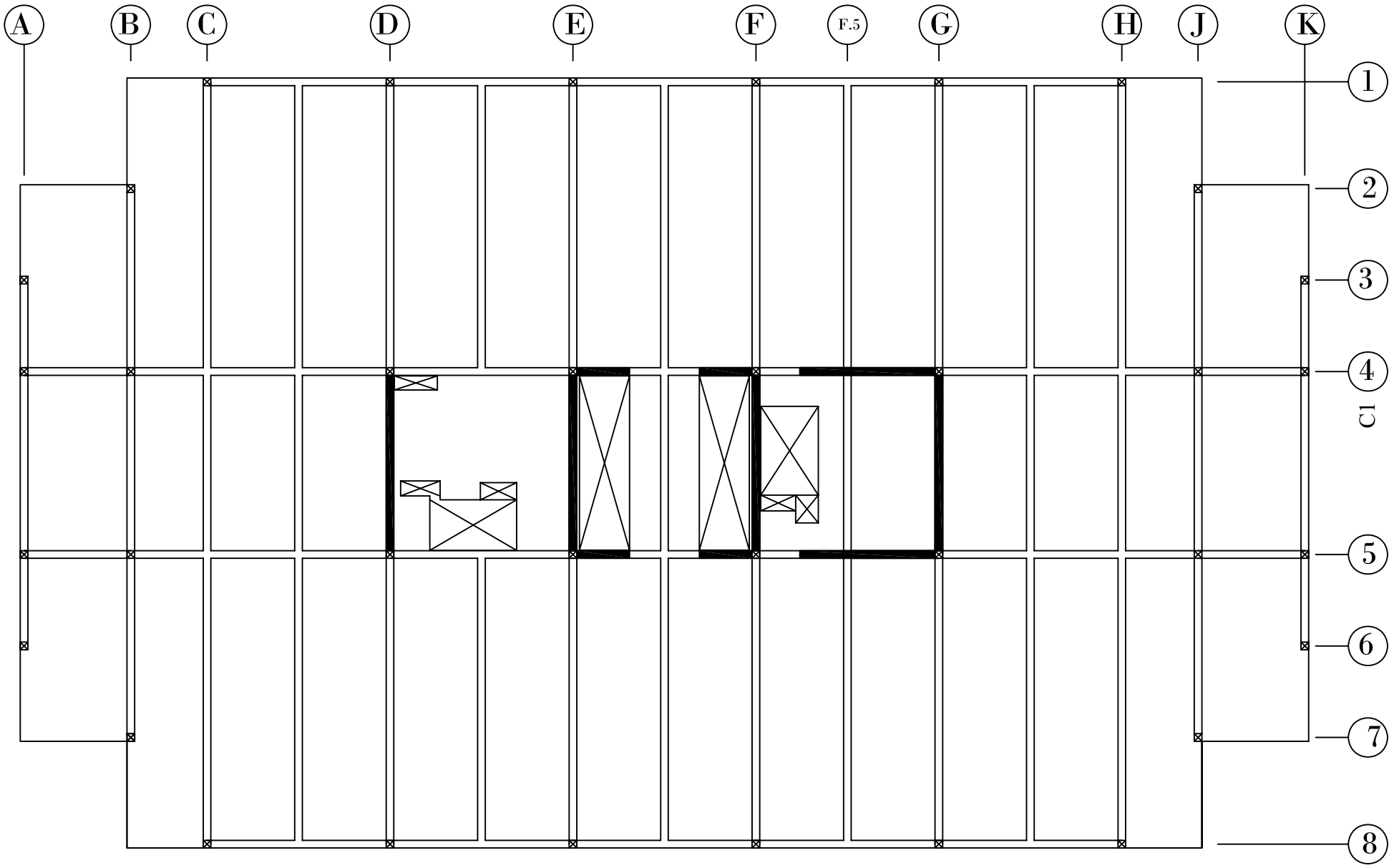
Mild Steel Reinforcing Costs

Materials:	1	per	tons	x	29.9	tons	=	29.9
Labor:	1	per	tons	x	29.9	tons	=	29.9
Total:	2	per	tons	x	29.9	tons	=	59.79

Total Costs

Materials:	1.787	per	sq. ft.	x	21570	sq. ft.	=	38550
Labor:	1.787	per	sq. ft.	x	21570	sq. ft.	=	38550
Total:	3.575	per	sq. ft.	x	21570	sq. ft.	=	77110

Appendix C: Column Design



Concrete framing plan with grid

A_{trib}	662
K_{LL}	4
A_l	2648

DEVELOPMENT OF AXIAL COLUMN LOADS

Couln D1, E1, F1, G1, D8, E8, F8, G8													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	662	---	---	19.86	9.93		29.79
2	16	80	---	30	---	75	662	2648	0.54	28.68	19.86	49.65	127.98
3	15	80	---	30	---	75	1324	5296	0.46	48.31	39.72	99.3	217.12
4	14	80	---	30	---	75	1986	7944	0.42	66.46	59.58	148.95	304.78
5	13	80	---	30	---	75	2648	10592	0.40	83.84	79.44	198.6	391.67
6	12	80	---	30	---	75	3310	13240	0.40	105.92	99.3	248.25	483.26
7	11	80	---	30	---	75	3972	15888	0.40	127.10	119.16	297.9	573.95
8	10	80	---	30	---	75	4634	18536	0.40	148.29	139.02	347.55	664.65
9	9	80	---	30	---	75	5296	21184	0.40	169.47	158.88	397.2	755.34
10	8	80	---	30	---	75	5958	23832	0.40	190.66	178.74	446.85	846.04
11	7	80	---	30	---	75	6620	26480	0.40	211.84	198.6	496.5	936.73
12	6	80	---	30	---	75	7282	29128	0.40	233.02	218.46	546.15	1027.42
13	5	80	---	30	---	75	7944	31776	0.40	254.21	238.32	595.8	1118.12
14	4	80	---	30	---	75	8606	34424	0.40	275.39	258.18	645.45	1208.81
15	3	80	---	30	---	75	9268	37072	0.40	296.58	278.04	695.1	1299.51
16	2	80	---	30	---	75	9930	39720	0.40	317.76	297.9	744.75	1390.20
	Base	---	---	---	---		---	---					

A_{trib}	174
K_{LL}	4
A_l	696

DEVELOPMENT OF AXIAL COLUMN LOADS

Couln A3, A6, K3, K6													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	174	---	---	5.22	2.61		7.83
2	16	80	---	30	---	75	174	696	0.82	11.39	5.22	13.05	37.49
3	15	80	---	30	---	75	348	1392	0.65	18.15	10.44	26.10	62.52
4	14	80	---	30	---	75	522	2088	0.58	24.15	15.66	39.15	86.79
5	13	80	---	30	---	75	696	2784	0.53	29.75	20.88	52.20	110.66
6	12	80	---	30	---	75	870	3480	0.50	35.10	26.1	65.25	134.28
7	11	80	---	30	---	75	1044	4176	0.48	40.27	31.32	78.30	157.72
8	10	80	---	30	---	75	1218	4872	0.46	45.30	36.54	91.35	181.02
9	9	80	---	30	---	75	1392	5568	0.45	50.23	41.76	104.40	204.22
10	8	80	---	30	---	75	1566	6264	0.44	55.06	46.98	117.45	227.32
11	7	80	---	30	---	75	1740	6960	0.43	59.83	52.2	130.50	250.36
12	6	80	---	30	---	75	1914	7656	0.42	64.53	57.42	143.55	273.33
13	5	80	---	30	---	75	2088	8352	0.41	69.18	62.64	156.60	296.25
14	4	80	---	30	---	75	2262	9048	0.41	73.78	67.86	169.65	319.12
15	3	80	---	30	---	75	2436	9744	0.40	78.33	73.08	182.70	341.94
16	2	80	---	30	---	75	2610	10440	0.40	83.52	78.3	195.75	365.40
	Base	---	---	---	---		---	---					

A_{trib}	665
K_{LL}	4
A_l	2660

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns C1, C8, H1, H8													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	665	---	---	19.95	9.975		29.93
2	16	80	---	30	---	75	665	2660	0.54	28.77	19.95	49.88	128.52
3	15	80	---	30	---	75	1330	5320	0.46	48.48	39.9	99.75	218.06
4	14	80	---	30	---	75	1995	7980	0.42	66.70	59.85	149.63	306.10
5	13	80	---	30	---	75	2660	10640	0.40	84.15	79.8	199.50	393.37
6	12	80	---	30	---	75	3325	13300	0.40	106.40	99.75	249.38	485.45
7	11	80	---	30	---	75	3990	15960	0.40	127.68	119.7	299.25	576.56
8	10	80	---	30	---	75	4655	18620	0.40	148.96	139.65	349.13	667.66
9	9	80	---	30	---	75	5320	21280	0.40	170.24	159.6	399.00	758.77
10	8	80	---	30	---	75	5985	23940	0.40	191.52	179.55	448.88	849.87
11	7	80	---	30	---	75	6650	26600	0.40	212.80	199.5	498.75	940.98
12	6	80	---	30	---	75	7315	29260	0.40	234.08	219.45	548.63	1032.08
13	5	80	---	30	---	75	7980	31920	0.40	255.36	239.4	598.50	1123.19
14	4	80	---	30	---	75	8645	34580	0.40	276.64	259.35	648.38	1214.29
15	3	80	---	30	---	75	9310	37240	0.40	297.92	279.3	698.25	1305.40
16	2	80	---	30	---	75	9975	39900	0.40	319.20	299.25	748.13	1396.50
	Base	---	---	---	---		---	---					

A_{trib}	998
K_{LL}	4
A_l	3992

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns G4, G5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
0	roof	---	30	---	15	---	998	---	---	29.94	14.97		44.91
1	pent	175	---	15	---	75	998	---	---	174.65	14.97	74.85	189.62
2	16	91.25	---	30	---	75	998	3992	0.49	44.39	29.94	74.85	338.80
3	15	91.25	---	30	---	75	1996	7984	0.42	76.11	59.88	149.7	475.31
4	14	91.25	---	30	---	75	2994	11976	0.40	109.28	89.82	224.55	613.27
5	13	91.25	---	30	---	75	3992	15968	0.40	145.71	119.76	299.4	754.49
6	12	91.25	---	30	---	75	4990	19960	0.40	182.14	149.7	374.25	895.71
7	11	91.25	---	30	---	75	5988	23952	0.40	218.56	179.64	449.1	1036.92
8	10	91.25	---	30	---	75	6986	27944	0.40	254.99	209.58	523.95	1178.14
9	9	91.25	---	30	---	75	7984	31936	0.40	291.42	239.52	598.8	1319.36
10	8	91.25	---	30	---	75	8982	35928	0.40	327.84	269.46	673.65	1460.57
11	7	91.25	---	30	---	75	9980	39920	0.40	364.27	299.4	748.5	1601.79
12	6	91.25	---	30	---	75	10978	43912	0.40	400.70	329.34	823.35	1743.01
13	5	91.25	---	30	---	75	11976	47904	0.40	437.12	359.28	898.2	1884.22
14	4	91.25	---	30	---	75	12974	51896	0.40	473.55	389.22	973.05	2025.44
15	3	91.25	---	30	---	75	13972	55888	0.40	509.98	419.16	1047.9	2166.66
16	2	91.25	---	30	---	75	14970	59880	0.40	546.41	449.1	1122.75	2307.88
	Base	---	---	---	---		---	---					

A_{trib}	494
K_{LL}	4
A_l	1976

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns F.5 4, F.5 5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
0	roof	---	30	---	15	---	494	---	---	14.82	7.41		22.23
1	pent	175	---	15	---	75	494	---	---	86.45	7.41	37.05	93.86
2	16	91.25	---	30	---	75	494	1976	0.59	26.48	14.82	37.05	172.21
3	15	91.25	---	30	---	75	988	3952	0.49	44.05	29.64	74.1	241.65
4	14	91.25	---	30	---	75	1482	5928	0.44	60.15	44.46	111.15	309.62
5	13	91.25	---	30	---	75	1976	7904	0.42	75.50	59.28	148.2	376.84
6	12	91.25	---	30	---	75	2470	9880	0.40	90.36	74.1	185.25	443.57
7	11	91.25	---	30	---	75	2964	11856	0.40	108.19	88.92	222.3	513.27
8	10	91.25	---	30	---	75	3458	13832	0.40	126.22	103.74	259.35	583.17
9	9	91.25	---	30	---	75	3952	15808	0.40	144.25	118.56	296.4	653.07
10	8	91.25	---	30	---	75	4446	17784	0.40	162.28	133.38	333.45	722.97
11	7	91.25	---	30	---	75	4940	19760	0.40	180.31	148.2	370.5	792.87
12	6	91.25	---	30	---	75	5434	21736	0.40	198.34	163.02	407.55	862.77
13	5	91.25	---	30	---	75	5928	23712	0.40	216.37	177.84	444.6	932.67
14	4	91.25	---	30	---	75	6422	25688	0.40	234.40	192.66	481.65	1002.57
15	3	91.25	---	30	---	75	6916	27664	0.40	252.43	207.48	518.7	1072.47
16	2	91.25	---	30	---	75	7410	29640	0.40	270.47	222.3	555.75	1142.38
	Base	---	---	---	---		---	---					

A_{trib}	741
K_{LL}	4
A_l	2964

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns F4, F5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
0	roof	---	30	---	15	---	741	---	0.53	22.23	11.115		33.35
1	pent	---	175	---	15	---	741	---	---	129.675	11.115		140.79
2	16	80	---	30	---	75	741	2964	0.53	31.15	22.23	55.58	249.75
3	15	80	---	30	---	75	1482	5928	0.44	52.74	44.46	111.15	349.14
4	14	80	---	30	---	75	2223	8892	0.41	72.75	66.69	166.73	446.95
5	13	80	---	30	---	75	2964	11856	0.40	94.85	88.92	222.30	546.86
6	12	80	---	30	---	75	3705	14820	0.40	118.56	111.15	277.88	648.38
7	11	80	---	30	---	75	4446	17784	0.40	142.27	133.38	333.45	749.89
8	10	80	---	30	---	75	5187	20748	0.40	165.98	155.61	389.03	851.41
9	9	80	---	30	---	75	5928	23712	0.40	189.70	177.84	444.60	952.93
10	8	80	---	30	---	75	6669	26676	0.40	213.41	200.07	500.18	1054.44
11	7	80	---	30	---	75	7410	29640	0.40	237.12	222.3	555.75	1155.96
12	6	80	---	30	---	75	8151	32604	0.40	260.83	244.53	611.33	1257.48
13	5	80	---	30	---	75	8892	35568	0.40	284.54	266.76	666.90	1358.99
14	4	80	---	30	---	75	9633	38532	0.40	308.26	288.99	722.48	1460.51
15	3	80	---	30	---	75	10374	41496	0.40	331.97	311.22	778.05	1562.03
16	2	80	---	30	---	75	11115	44460	0.40	355.68	333.45	833.63	1663.55
	Base	---	---	---	---		---	---					

A_{trib}	988
K_{LL}	4
A_l	3952

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns E4, E5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
0	roof	---	30	---	15		988	---	---	2.69	14.82		17.51
1	mech	150	---	---	15	75	988	---	---	148.2	14.82	74.1	163.02
2	16	80	---	30	---	75	988	3952	0.49	38.62	29.64	74.1	305.38
3	15	80	---	30	---	75	1976	7904	0.42	66.19	59.28	148.2	436.69
4	14	80	---	30	---	75	2964	11856	0.40	94.85	88.92	222.3	569.09
5	13	80	---	30	---	75	3952	15808	0.40	126.46	118.56	296.4	704.44
6	12	80	---	30	---	75	4940	19760	0.40	158.08	148.2	370.5	839.80
7	11	80	---	30	---	75	5928	23712	0.40	189.70	177.84	444.6	975.16
8	10	80	---	30	---	75	6916	27664	0.40	221.31	207.48	518.7	1110.51
9	9	80	---	30	---	75	7904	31616	0.40	252.93	237.12	592.8	1245.87
10	8	80	---	30	---	75	8892	35568	0.40	284.54	266.76	666.9	1381.22
11	7	80	---	30	---	75	9880	39520	0.40	316.16	296.4	741	1516.58
12	6	80	---	30	---	75	10868	43472	0.40	347.78	326.04	815.1	1651.94
13	5	80	---	30	---	75	11856	47424	0.40	379.39	355.68	889.2	1787.29
14	4	80	---	30	---	75	12844	51376	0.40	411.01	385.32	963.3	1922.65
15	3	80	---	30	---	75	13832	55328	0.40	442.62	414.96	1037.4	2058.00
16	2	80	---	30	---	75	14820	59280	0.40	474.24	444.6	1111.5	2193.36
	Base	---	---	---	---		---	---					

A_{trib}	1245
K_{LL}	4
A_l	4980

DEVELOPMENT OF AXIAL COLUMN LOADS

Coulmns D4, D5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
0	roof	---	30	---	15	---	1245	---	---	37.35	18.675		56
1	mech	200	---	---	---	75	1245	---	0.46	57.27	---	93.38	207
2	16	80	---	30	---	75	1245	4980	0.46	46.07	37.35	93.38	233
3	15	80	---	30	---	75	2490	9960	0.40	79.74	74.7	186.75	397
4	14	80	---	30	---	75	3735	14940	0.40	119.52	112.05	280.13	568
5	13	80	---	30	---	75	4980	19920	0.40	159.36	149.4	373.50	738
6	12	80	---	30	---	75	6225	24900	0.40	199.20	186.75	466.88	909
7	11	80	---	30	---	75	7470	29880	0.40	239.04	224.1	560.25	1079
8	10	80	---	30	---	75	8715	34860	0.40	278.88	261.45	653.63	1250
9	9	80	---	30	---	75	9960	39840	0.40	318.72	298.8	747.00	1421
10	8	80	---	30	---	75	11205	44820	0.40	358.56	336.15	840.38	1591
11	7	80	---	30	---	75	12450	49800	0.40	398.40	373.5	933.75	1762
12	6	80	---	30	---	75	13695	54780	0.40	438.24	410.85	1027.13	1932
13	5	80	---	30	---	75	14940	59760	0.40	478.08	448.2	1120.50	2103
14	4	80	---	30	---	75	16185	64740	0.40	517.92	485.55	1213.88	2273
15	3	80	---	30	---	75	17430	69720	0.40	557.76	522.9	1307.25	2444
16	2	80	---	30	---	75	18675	74700	0.40	597.60	560.25	1400.63	2615
	Base	---	---	---	---		---	---					

A_{trib}	174
K_{LL}	4
A_l	696

DEVELOPMENT OF AXIAL COLUMN LOADS

Couln A4,A5, K4, K5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	174	---		5.22	2.61		7.83
2	16	80	---	30	---	75	174	696	0.82	11.39	5.22	13.05	37.49
3	15	80	---	30	---	75	348	1392	0.65	18.15	10.44	26.1	62.52
4	14	80	---	30	---	75	522	2088	0.58	24.15	15.66	39.15	86.79
5	13	80	---	30	---	75	696	2784	0.53	29.75	20.88	52.2	110.66
6	12	80	---	30	---	75	870	3480	0.50	35.10	26.1	65.25	134.28
7	11	80	---	30	---	75	1044	4176	0.48	40.27	31.32	78.3	157.72
8	10	80	---	30	---	75	1218	4872	0.46	45.30	36.54	91.35	181.02
9	9	80	---	30	---	75	1392	5568	0.45	50.23	41.76	104.4	204.22
10	8	80	---	30	---	75	1566	6264	0.44	55.06	46.98	117.45	227.32
11	7	80	---	30	---	75	1740	6960	0.43	59.83	52.2	130.5	250.36
12	6	80	---	30	---	75	1914	7656	0.42	64.53	57.42	143.55	273.33
13	5	80	---	30	---	75	2088	8352	0.41	69.18	62.64	156.6	296.25
14	4	80	---	30	---	75	2262	9048	0.41	73.78	67.86	169.65	319.12
15	3	80	---	30	---	75	2436	9744	0.40	78.33	73.08	182.7	341.94
16	2	80	---	30	---	75	2610	10440	0.40	83.52	78.3	195.75	365.40
	Base	---	---	---	---		---	---					

A_{trib}	309
K_{LL}	4
A_l	1236

DEVELOPMENT OF AXIAL COLUMN LOADS

Couln B2, B7, J2, J7													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	309	---		9.27	4.635		13.91
2	16	80	---	30	---	75	309	1236	0.68	16.73	9.27	23.18	63.08
3	15	80	---	30	---	75	618	2472	0.55	27.28	18.54	46.35	106.07
4	14	80	---	30	---	75	927	3708	0.50	36.81	27.81	69.53	148.05
5	13	80	---	30	---	75	1236	4944	0.46	45.81	37.08	92.70	189.50
6	12	80	---	30	---	75	1545	6180	0.44	54.48	46.35	115.88	230.61
7	11	80	---	30	---	75	1854	7416	0.42	62.91	55.62	139.05	271.49
8	10	80	---	30	---	75	2163	8652	0.41	71.16	64.89	162.23	312.18
9	9	80	---	30	---	75	2472	9888	0.40	79.27	74.16	185.40	352.74
10	8	80	---	30	---	75	2781	11124	0.40	88.99	83.43	208.58	394.90
11	7	80	---	30	---	75	3090	12360	0.40	98.88	92.7	231.75	437.24
12	6	80	---	30	---	75	3399	13596	0.40	108.77	101.97	254.93	479.57
13	5	80	---	30	---	75	3708	14832	0.40	118.66	111.24	278.10	521.90
14	4	80	---	30	---	75	4017	16068	0.40	128.54	120.51	301.28	564.23
15	3	80	---	30	---	75	4326	17304	0.40	138.43	129.78	324.45	606.57
16	2	80	---	30	---	75	4635	18540	0.40	148.32	139.05	347.63	648.90
	Base	---	---	---	---		---	---					

A_{trib}	743
K_{LL}	4
A_l	2972

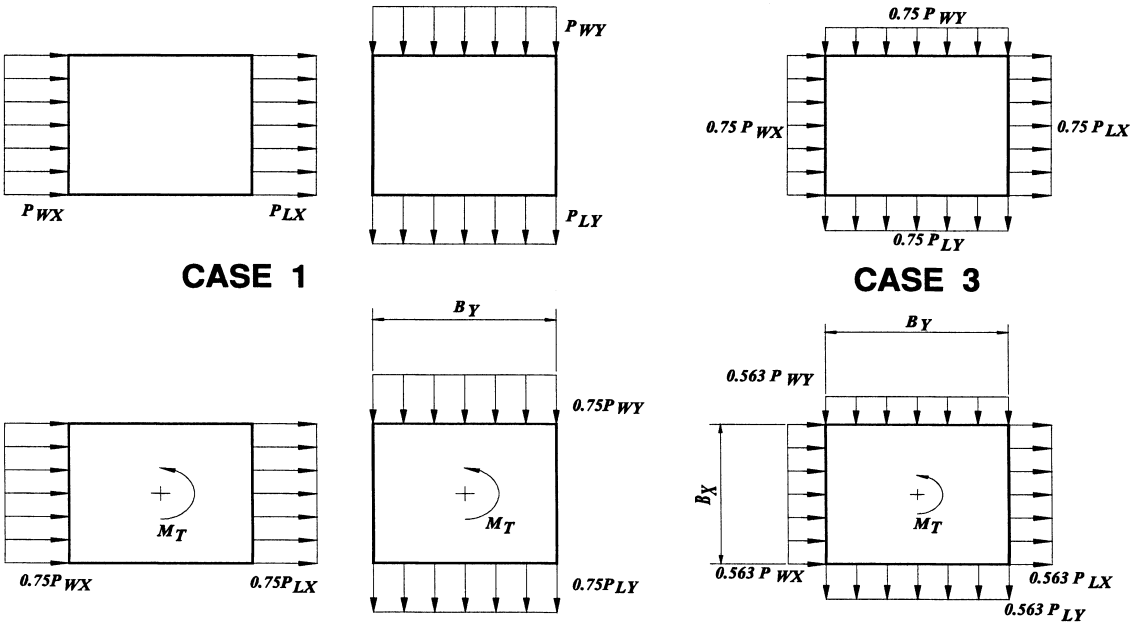
DEVELOPMENT OF AXIAL COLUMN LOADS

Couln B4, B5, J4, J5													
Level	Floor	LL (psf)	LL_R (psf)	DL (psf)	DL_R (psf)	Wt_{slab} (psf)	A_{trib} (sq ft)	A_l (sq ft)	LL_{red}	LL (kip)	DL (kip)	Slab Load (kip)	Total Axial (kip)
1	roof	---	30	---	15	---	743	---	---	22.29	11.145		33.44
2	16	80	---	30	---	75	743	2972	0.53	31.21	22.29	55.73	142.66
3	15	80	---	30	---	75	1486	5944	0.44	52.85	44.58	111.45	242.31
4	14	80	---	30	---	75	2229	8916	0.41	72.91	66.87	167.18	340.39
5	13	80	---	30	---	75	2972	11888	0.40	95.10	89.16	222.90	440.60
6	12	80	---	30	---	75	3715	14860	0.40	118.88	111.45	278.63	542.39
7	11	80	---	30	---	75	4458	17832	0.40	142.66	133.74	334.35	644.18
8	10	80	---	30	---	75	5201	20804	0.40	166.43	156.03	390.08	745.97
9	9	80	---	30	---	75	5944	23776	0.40	190.21	178.32	445.80	847.76
10	8	80	---	30	---	75	6687	26748	0.40	213.98	200.61	501.53	949.55
11	7	80	---	30	---	75	7430	29720	0.40	237.76	222.9	557.25	1051.35
12	6	80	---	30	---	75	8173	32692	0.40	261.54	245.19	612.98	1153.14
13	5	80	---	30	---	75	8916	35664	0.40	285.31	267.48	668.70	1254.93
14	4	80	---	30	---	75	9659	38636	0.40	309.09	289.77	724.43	1356.72
15	3	80	---	30	---	75	10402	41608	0.40	332.86	312.06	780.15	1458.51
16	2	80	---	30	---	75	11145	44580	0.40	356.64	334.35	835.88	1560.30
	Base	---	---	---	---		---	---					

MARK / LEVEL	A3 A6 K3 K6	A4 A5 K4 K5	B2 B7 J2 J7	B4 B5 J4 J5	C1 C8 H1 H8	D1 D8 E1 E8 F1 F8 G1 G8	D4 D5	E4 E5	F4 F5	F.5 4 F.5 5	G4 G5	f'c (psi)
PENTHOUSE ROOF	14 x 14 45k 6-#6	14 x 14 45k 6-#6					18 x 18 82k 4-#11	18 x 18 22k 4-#8	18 x 18 57k 4-#10	18 x 18 33k 4-#8	18 x 18 65k 4-#10	5000
PENTHOUSE	14 x 14 45k 6-#6	14 x 14 45k 6-#6	18 x 18 20k 4-#9	18 x 18 49k 4-#10	18 x 18 44k 4-#10	18 x 18 44k 4-#10	20 x 20 293k 4-#11	24 x 24 419k 8-#8	18 x 18 221k 4-#10	20 x 20 147k 6-#8	20 x 20 387k 6-#10	5000
LEVEL 16	14 x 14 53k 6-#6	14 x 14 53k 6-#6	18 x 18 88k 8-#9	18 x 18 197k 4-#10	20 x 20 178k 4-#10	18 x 18 177k 4-#10	20 x 20 321k 4-#11	24 x 24 447k 8-#8	18 x 18 368k 4-#10	20 x 20 255k 6-#8	20 x 20 500k 6-#10	5000
LEVEL 15	14 x 14 85k 6-#6	14 x 14 85k 6-#6	18 x 18 144k 8-#9	18 x 18 325k 4-#10	20 x 20 293k 4-#10	18 x 18 292k 4-#10	20 x 20 531k 4-#11	24 x 24 616k 8-#8	18 x 18 496k 4-#10	20 x 20 345k 6-#8	20 x 20 677k 6-#10	5000
LEVEL 14	14 x 14 117k 6-#6	14 x 14 117k 6-#6	18 x 18 198k 6-#9	18 x 18 451k 4-#10	20 x 20 406k 4-#10	18 x 18 404k 4-#10	20 x 20 751k 6-#11	24 x 24 786k 8-#8	18 x 18 622k 4-#10	20 x 20 493k 6-#8	20 x 20 855k 6-#10	5000
LEVEL 13	14 x 14 148k 6-#6	14 x 14 148k 6-#6	18 x 18 251k 6-#9	20 x 20 580k 4-#10	20 x 20 518k 4-#10	20 x 20 515k 4-#10	20 x 20 972k 6-#11	24 x 24 961k 8-#8	18 x 18 750k 6-#10	20 x 20 520k 4-#10	20 x 20 1040k 6-#10	5000
LEVEL 12	14 x 14 178k 6-#6	14 x 14 178k 6-#6	18 x 18 304k 6-#9	20 x 20 712k 4-#10	20 x 20 637k 4-#10	20 x 20 634k 4-#10	20 x 20 1193k 6-#11	24 x 24 1136k 8-#8	18 x 18 882k 6-#10	20 x 20 606k 4-#10	20 x 20 1224k 6-#10	5000
LEVEL 11	14 x 14 208k 6-#6	14 x 14 208k 6-#6	18 x 18 357k 6-#9	20 x 20 843k 4-#10	20 x 20 755k 4-#10	20 x 20 752k 4-#10	20 x 20 1413k 6-#11	24 x 24 1311k 8-#8	20 x 20 1013k 6-#10	20 x 20 697k 4-#10	20 x 20 1408k 6-#10	5000
LEVEL 10	14 x 14 238k 6-#6	14 x 14 238k 6-#6	18 x 18 409k 4-#9	20 x 20 975k 4-#10	20 x 20 873k 4-#10	20 x 20 869k 4-#10	24 x 24 1634k 6-#11	24 x 24 1486k 8-#10	20 x 20 1144k 4-#10	20 x 20 788k 6-#10	24 x 24 1592k 6-#10	6000
LEVEL 9	14 x 14 268k 6-#6	14 x 14 268k 6-#6	18 x 18 461k 4-#9	20 x 20 1107k 4-#10	20 x 20 991k 4-#10	20 x 20 986k 4-#10	24 x 24 1855k 6-#11	24 x 24 1661k 8-#10	20 x 20 1276k 4-#10	20 x 20 879k 6-#10	24 x 24 1776k 6-#10	6000
LEVEL 8	14 x 14 298k 6-#6	14 x 14 298k 6-#6	18 x 18 515k 4-#9	20 x 20 1238k 4-#10	20 x 20 1108k 4-#10	20 x 20 1103k 4-#10	24 x 24 2075k 6-#11	24 x 24 1836k 8-#10	20 x 20 1407k 4-#10	20 x 20 970k 6-#10	24 x 24 1960k 6-#10	6000
LEVEL 7	16 x 16 327k 6-#6	16 x 16 327k 6-#6	18 x 18 570k 4-#9	24 x 24 1370k 6-#10	24 x 24 1226k 6-#10	20 x 20 1221k 6-#10	28 x 28 2296k 8-#11	28 x 28 2012k 10-#10	24 x 24 1538k 8-#10	20 x 20 1061k 8-#10	28 x 28 2144k 6-#11	6000
LEVEL 6	16 x 16 357k 6-#6	16 x 16 357k 6-#6	18 x 18 625k 4-#9	24 x 24 1502k 6-#10	24 x 24 1344k 6-#10	20 x 20 1338k 8-#10	28 x 28 2516k 8-#11	28 x 28 2187k 10-#10	24 x 24 1670k 8-#10	20 x 20 1152k 8-#10	28 x 28 2328k 6-#11	6000
LEVEL 5	16 x 16 386k 6-#6	16 x 16 386k 6-#6	18 x 18 679k 4-#9	24 x 24 1633k 6-#10	24 x 24 1462k 6-#10	20 x 20 1455k 8-#10	28 x 28 2737k 8-#11	28 x 28 2362k 10-#10	24 x 24 1801k 8-#10	20 x 20 1243k 8-#10	28 x 28 2512k 6-#11	6000
LEVEL 4	16 x 16 416k 6-#6	16 x 16 416k 6-#6	18 x 18 734k 4-#9	24 x 24 1765k 8-#10	24 x 24 1580k 8-#10	20 x 24 1573k 10-#10	32 x 32 2958k 10-#11	28 x 28 2537k 10-#11	24 x 24 1932k 10-#11	24 x 24 1334k 6-#10	32 x 32 2696k 8-#11	6000
LEVEL 3	16 x 16 445k 6-#6	16 x 16 445k 6-#6	18 x 18 789k 4-#9	24 x 24 1897k 10-#10	24 x 24 1698k 8-#10	20 x 24 1690k 10-#10	32 x 32 3178k 14-#11	28 x 28 2712k 10-#11	24 x 24 2064k 12-#11	24 x 24 1425k 6-#10	32 x 32 2880k 8-#11	6000
LEVEL 2	16 x 16 475k 6-#6	16 x 16 475k 6-#6	18 x 18 844k 8-#8	24 x 24 2028k 12-#10	24 x 24 1851k 8-#10	20 x 24 1807k 10-#10	32 x 32 3399k 18-#11	28 x 28 2887k 10-#11	24 x 24 2195k 12-#11	24 x 24 1517k 6-#10	32 x 32 3064k 8-#11	6000
BASE (Dowels)	6-#6	6-#6	8-#8	10-#10	8-#10	10-#10	14-#11	10-#11	12-#11	6-#10	8-#11	

Appendix D: Lateral System

Main Wind Force Resisting System– Method 2		All Heights
Figure 6-9	Design Wind Load Cases	



Case 1. Full design wind pressure acting on the projected area perpendicular to each principal axis of the structure, considered separately along each principal axis.

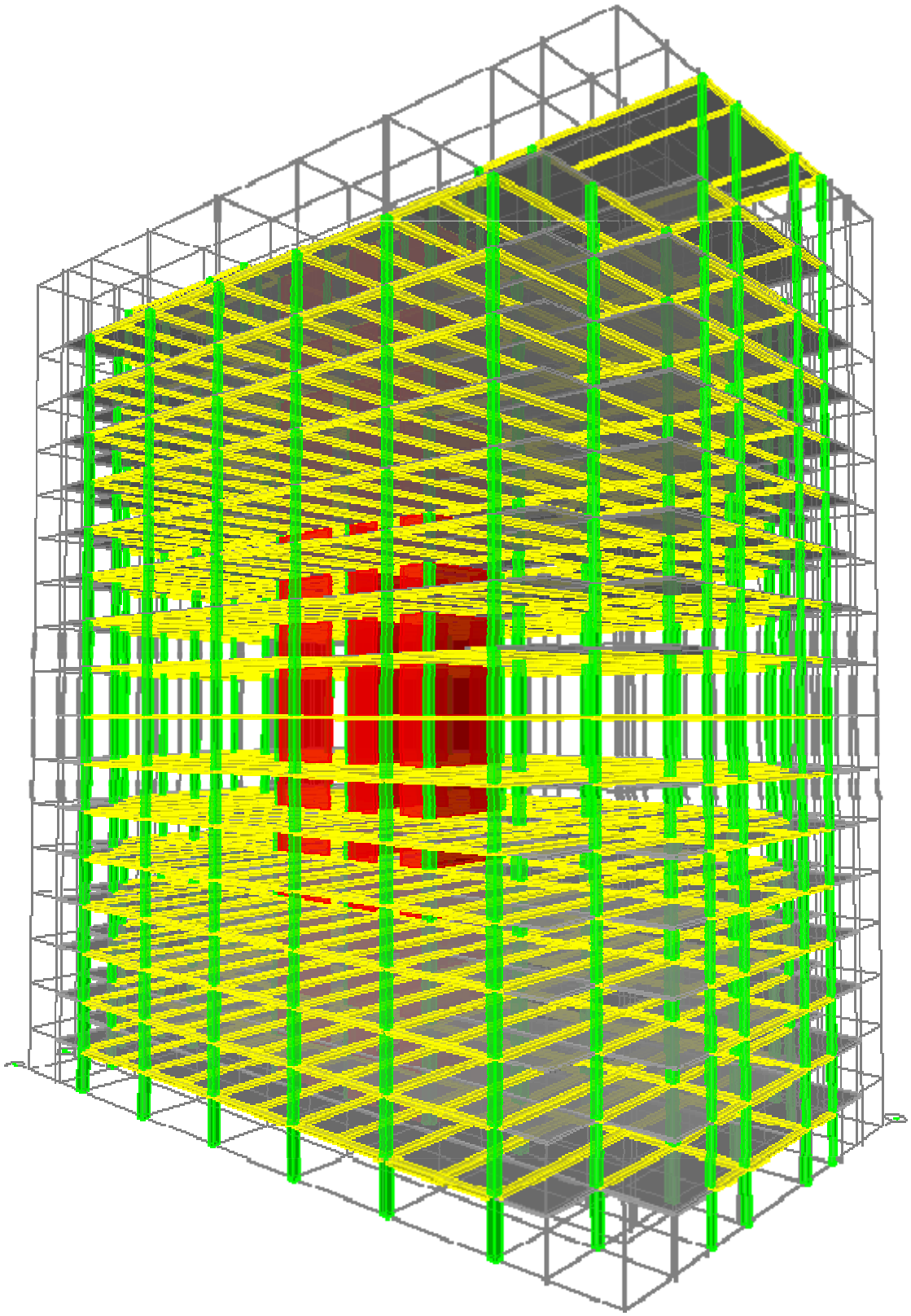
Case 2. Three quarters of the design wind pressure acting on the projected area perpendicular to each principal axis of the structure in conjunction with a torsional moment as shown, considered separately for each principal axis.

Case 3. Wind loading as defined in Case 1, but considered to act simultaneously at 75% of the specified value.

Case 4. Wind loading as defined in Case 2, but considered to act simultaneously at 75% of the specified value.

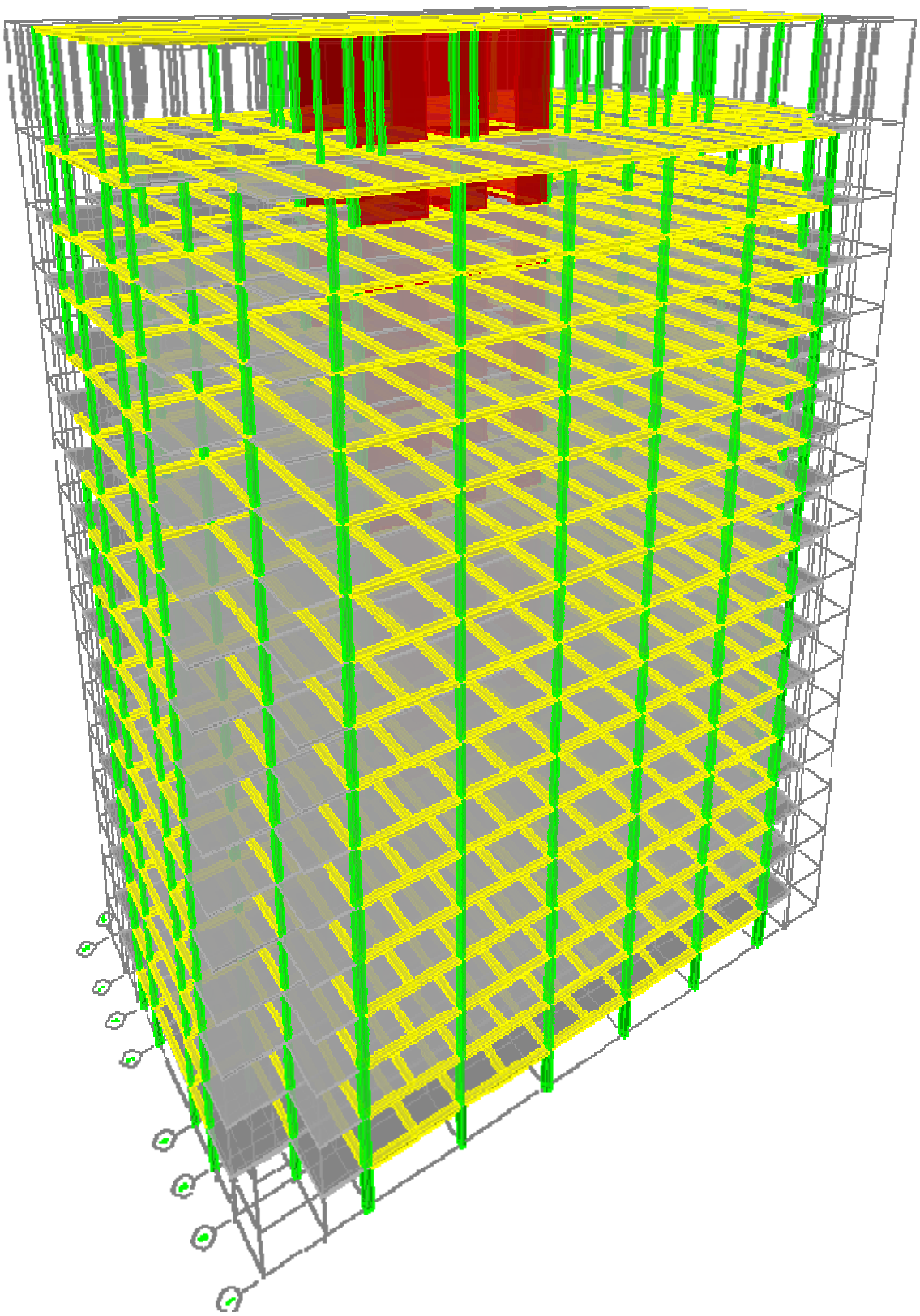
Notes:

1. Design wind pressures for windward and leeward faces shall be determined in accordance with the provisions of 6.5.12.2.1 and 6.5.12.2.3 as applicable for building of all heights.
2. Diagrams show plan views of building.
3. Notation:
   P_{WX}, P_{WY}: Windward face design pressure acting in the x, y principal axis, respectively.
   P_{LX}, P_{LY}: Leeward face design pressure acting in the x, y principal axis, respectively.
   e (e_X. e_Y) : Eccentricity for the x, y principal axis of the structure, respectively.
   M_T: Torsional moment per unit height acting about a vertical axis of the building.



ETABS Concrete Model

ETABS Concrete model



Location:	**Conshohocken, PA**				
				Penthouse	
Dimension	N-S	**196** ft	N-S	**114** ft	
	E-W	**118** ft	E-W	**44** ft	
	Total Height, h	**209** ft	Height	**22** ft	
	Inter-story Height, h_s	**12.03** ft			
Velocity Pressure	K_{zt}	**1.0**		(Table 6-4) Assumed area is flat	
	K_d	**0.85**		(Table 6-4)	
	V	**90** mph		(Figure 6-1)	
	Group	**II**		Office Building	
	Importance Factor, I	**1.0**		(Table 6-1)	
	Exposure	**B**		Assumed area is flat	
	$q_z/K_z = 0.00256K_{zt}K_dV^2I$ =	**17.6256**			

	N-S	E-W
Gust Factor Effect, G	**0.832**	**0.821**

Location:	**Conshohocken, PA**				
				Penthouse	
Dimension	N-S	**118** ft	N-S	**114** ft	
	E-W	**196** ft	E-W	**44** ft	
	Total Height, h	**209** ft	Height	**22** ft	
	Inter-story Height, h_s	**12.03** ft			
Velocity Pressu	K_{zt}	**1.0**		(Table 6-4) Assume area is flat	
	K_d	**0.85**		(Table 6-4)	
	V	**90** mph		(Figure 6-1)	
	Group	**II**		Office Building	
	Importance Factor, I	**1.0**		(Table 6-1)	
	Exposure	**B**		Assume area is flat	
	$q_z/K_z = 0.00256K_{zt}K_dV^2I$ =	**17.6256**			

ASCE7-02 Chapter 6: Wind Analysis
Method 2- Analytical Procedure

	Resultant pressure	
	N-S	E-W
External Pressure Coefficients, C_p Windward	**0.8**	**0.8**
Leeward	**-0.368**	**-0.50**

Story No.	z (ft)	K_z	q_z (lb/ft²)	q_h (lb/ft²)	$q_zC_pG - q_hC_pG$ (lb/ft²)	$q_zC_pG - q_hC_pG$ (lb/ft²)
Penthouse Roof	209	1.214	21.405	21.405	20.812	22.851
Penthouse Level	187	1.181	20.814	21.405	20.419	22.463
16	176	1.161	20.463	21.405	20.185	22.232
15	164	1.138	20.049	21.405	19.909	21.960
14	152	1.114	19.635	21.405	19.634	21.688
13	140	1.091	19.221	21.405	19.358	21.416
12	129	1.061	18.705	21.405	19.014	21.077
11	117	1.032	18.187	21.405	18.670	20.737
10	105	1.003	17.670	21.405	18.325	20.397
9	93.3	0.970	17.092	21.405	17.940	20.018
8	81.5	0.935	16.471	21.405	17.527	19.610
7	69.8	0.889	15.669	21.405	16.992	19.083
6	58	0.842	14.841	21.405	16.441	18.539
5	46.3	0.791	13.946	21.405	15.845	17.951
4	34.5	0.727	12.814	21.405	15.091	17.207
3	22.8	0.642	11.316	21.405	14.093	16.223
2	11	0.570	10.047	21.405	13.248	15.389
Base	0	0.570	10.047	21.405	13.248	15.389

ASCE7-02 Chapter 6: Wind Analysis
Method 2- Analytical Procedure

Story Forces		Story Shear		Moment	
N-S	E-W	N-S	E-W	N-S	E-W
(kips)	(kips)	(kips)	(kips)	(ft-kips)	(ft-kips)
10.07	28.65			2,105.26	5,988.88
26.75	30.06	10.07	28.65	5,008.61	5,628.68
28.65	52.42	36.82	58.71	5,028.73	9,199.98
28.26	51.78	65.47	111.14	4,627.93	8,478.96
27.87	51.14	93.74	162.92	4,236.33	7,773.02
27.48	50.50	121.61	214.05	3,853.93	7,082.16
26.99	49.70	149.09	264.55	3,468.42	6,386.20
26.50	48.90	176.08	314.25	3,094.12	5,708.61
26.01	48.09	202.58	363.15	2,731.33	5,049.87
25.47	47.20	228.59	411.24	2,374.79	4,401.38
24.88	46.24	254.06	458.44	2,027.69	3,768.35
24.12	45.00	278.94	504.68	1,682.47	3,138.41
23.34	43.71	303.06	549.67	1,353.62	2,535.29
22.49	42.33	326.40	593.38	1,040.29	1,957.59
21.42	40.57	348.89	635.71	739.06	1,399.74
20.01	38.25	370.31	676.28	455.13	870.22
18.81	36.29	390.32	714.53	206.87	399.14
	Total Shear	**409.13**	**750.82**		
			Total Moment	**44,034.56**	**79,766.47**

ASCE7-02 Chapter 9- Seismic Analysis

Reference				
	Building Location :			Conshohocken, Pennsylvania
	Number of Stories :	N		16
	Inter-story Height	h_s		12.08
	Building Height :	h_n		192 ft
Table 1.1	Seismic Use Group :	I		I
Table 9.1.4	Occupany Importance Factor :			1.00
	Site Classification :			D
Figure 9.4.1.1a	0.2s Acceleration :	S_S		0.31 g-s
Figure 9.4.1.1b	1s Acceleration :	S_1		0.08 g-s
Table 9.4.1.2.4a	Site Class Factor :	F_a		1.55
Table 9.4.1.2.4b	Site Class Factor :	F_v		2.40
	Adjusted Accelerations :	S_{MS}	$= F_a S_S$	0.481 g-s
		S_{M1}	$= F_v S_1$	0.180 g-s
	Design Spectral Response Accelerati	S_{DS}	$= (2/3)S_{MS}$	0.320 g-s
		S_{D1}	$= (2/3)S_{M1}$	0.120 g-s
Table 9.4.2.1a	Seismic Design Category :			B
Table 9.4.2.1b	Both design category B			
	N-S Direction			
Table 9.5.2.2	Response Modification Factor :	R_{N-S}		3
	Seismic Response Coefficient :	$C_{s, N-S}$	$= S_{DS}/(R_{N-S}/I)$	**0.107**
Table 9.5.5.3.2		$C_{T, N-S}$		0.028
Table 9.5.5.3.2	(moment frames only)	x		0.80
	Approximate Period of Structure :	T_{N-S}	$= C_{T, N-S}h_n^{\ x}$	1.88
	Seismic Response Coefficient need not greater than	$C_{S\ max, N-S}$	$S_{D1}/T(R_{N-S}/I)$	**0.021**
	and	$C_{S\ min}$	$= 0.044IS_{DS}$	**0.0141**
	Seismic Response Coefficient ($C_{s, N-S}$)			**0.021**
	E-W Direction			
Table 9.5.2.2	Response Modification Factor :	R_{N-S}		3
	Seismic Response Coefficient :	$C_{s, E-W}$	$= S_{DS}/(R_{E-W}/I)$	**0.107**
Table 9.5.5.3.2		$C_{T, E-W}$		0.02
Table 9.5.5.3.2	(moment and braced frame)	x		0.75
	Approximate Period of Structure :	T_{N-S}	$= C_{T, E-W}h_n^{\ x}$	1.03
	Seismic Response Coefficient need not greater than	$C_{S\ max, N-S}$	$S_{D1}/T(R_{E-W}/I)$	**0.039**
	and	$C_{S\ min}$	$= 0.044IS_{DS}$	**0.0141**
	Seismic Response Coefficient ($C_{s, E-W}$)			**0.039**

Table 1 : Vertical Distribution of Seismic Forces (X-direction)

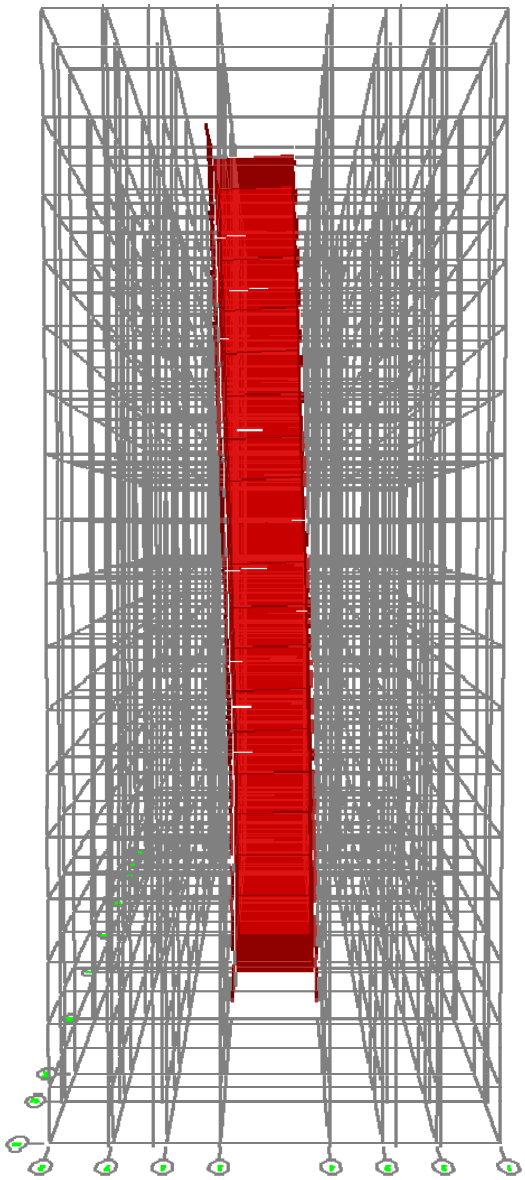
Seismic Base Shear, $V_{N-S} = C_{s,N-S}W =$ **873** kips

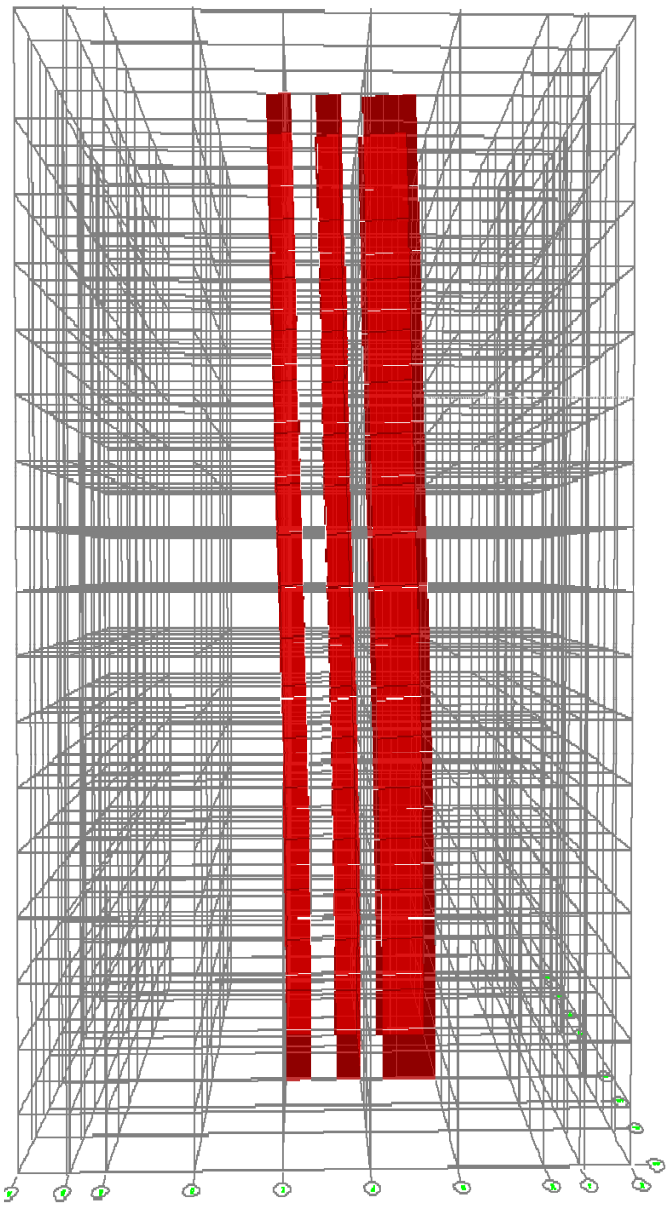
Exponent $k_{N-S} = 1 + (T_{N-S} - 0.5)/(2.5 - 0.5) =$ **1.689**

Level, x	w_x	h_x	$w_x h_x^{\ k}$	C_{vx}	F_x	V_x	M_x
	(kips)	(ft)			(kips)	(kips)	(ft-kips)
Roof	3100	192	22,342,508	0.136	118.4		22,760
16	3641	180	23,517,831	0.143	124.7	118.4	22,452
15	3641	168	20,915,508	0.127	110.9	243.1	18,628
14	3641	156	18,439,049	0.112	97.7	353.9	15,242
13	3641	144	16,091,409	0.098	85.3	451.7	12,271
12	3641	132	13,875,861	0.084	73.5	536.9	9,693
11	3641	120	11,796,062	0.072	62.5	610.5	7,485
10	3641	108	9,856,137	0.060	52.2	673.0	5,623
9	3641	96	8,060,797	0.049	42.7	725.3	4,083
8	3641	83	6,415,510	0.039	34.0	768.0	2,839
7	3641	71	4,926,739	0.030	26.1	802.0	1,864
6	3641	59	3,602,318	0.022	19.1	828.1	1,133
5	3641	47	2,452,068	0.015	13.0	847.2	614
4	3641	35	1,488,919	0.009	7.9	860.2	277
3	3641	23	731,238	0.004	3.9	868.1	89
2	3641	11	209,119	0.001	1.1	872.0	12
BASE						873.1	
	Σ = 57719		Σ = 164721074	Σ = 1.000	Σ = 873.1		Σ = 125067

BASED ON A DEAD WEIGHT OF 39,000 kips

Shear Wall deflection under Seismic Y loading





Shear Wall deflection under Seismic X loading

Shear Forces Wall A (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	5.62	-1	4.22	-0.75	3.47	2.61	12.47	1.95
PENTHOUSE LEVEL	10.97	0.21	8.23	0.16	8.38	6.29	31.85	3.49
LEVEL 16	15.31	-2.49	11.48	-1.87	9.61	7.22	45.41	-7.06
LEVEL 15	18.06	-4.93	13.55	-3.7	9.85	7.39	54.47	-16.25
LEVEL 14	20.39	-6.69	15.29	-5.02	10.28	7.71	61.42	-23.17
LEVEL 13	22.62	-8.17	16.97	-6.13	10.84	8.13	67.26	-28.55
LEVEL 12	24.9	-10.13	18.68	-7.6	11.08	8.32	72.41	-34.31
LEVEL 11	27.09	-12.36	20.32	-9.27	11.05	8.29	76.6	-40.66
LEVEL 10	29.04	-14.44	21.78	-10.83	10.95	8.22	79.46	-45.96
LEVEL 9	30.59	-16.48	22.95	-12.36	10.58	7.95	80.71	-50.61
LEVEL 8	30.88	-13.93	23.16	-10.45	12.71	9.54	77.77	-41.7
LEVEL 7	30.74	-14.95	23.06	-11.21	11.84	8.89	74.02	-42.3
LEVEL 6	32.32	-20.82	24.24	-15.62	8.62	6.47	75.11	-56.95
LEVEL 5	30.31	-22.95	22.74	-17.21	5.52	4.15	66.37	-60.22
LEVEL 4	29.98	-24.86	22.48	-18.64	3.84	2.88	61.98	-62.65
LEVEL 3	32.34	-26.05	24.26	-19.53	4.72	3.55	63.51	-63.23
LEVEL 2	52.28	-13.71	39.21	-10.28	28.93	21.72	99.95	-38.85

Shear Forces Wall B (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	N/A	23.66	N/A	17.75	17.47	13.11	N/A	7.82
PENTHOUSE LEVEL	N/A	48.67	N/A	36.51	36.2	27.17	N/A	91.33
LEVEL 16	N/A	79.26	N/A	59.45	59.05	44.32	N/A	206.33
LEVEL 15	N/A	104.43	N/A	78.32	77.81	58.41	N/A	303.04
LEVEL 14	N/A	127.52	N/A	95.64	95.16	71.43	N/A	386.99
LEVEL 13	N/A	147.25	N/A	110.44	110.27	82.77	N/A	455
LEVEL 12	N/A	165.31	N/A	123.98	124.23	93.26	N/A	511.53
LEVEL 11	N/A	186.97	N/A	140.23	140.42	105.41	N/A	572.28
LEVEL 10	N/A	207.9	N/A	155.92	156.1	117.18	N/A	624.7
LEVEL 9	N/A	228.46	N/A	171.35	171.5	128.74	N/A	670.33
LEVEL 8	N/A	249	N/A	186.75	186.88	140.29	N/A	710.49
LEVEL 7	N/A	264.53	N/A	198.39	198.52	149.03	N/A	730.74
LEVEL 6	N/A	285.29	N/A	213.97	214.11	160.72	N/A	762.79
LEVEL 5	N/A	302.18	N/A	226.64	226.81	170.26	N/A	779.38
LEVEL 4	N/A	320.37	N/A	240.27	241.2	181.06	N/A	796.33
LEVEL 3	N/A	335.79	N/A	251.84	252.72	189.71	N/A	802.13
LEVEL 2	N/A	370.6	N/A	277.95	278.14	208.79	N/A	860.3

Shear Forces Wall C (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	5.52	0.98	4.14	0.74	4.87	3.66	12.17	-1.99
PENTHOUSE LEVEL	10.86	-0.24	8.14	-0.18	7.96	5.98	31.57	-3.59
LEVEL 16	15.17	2.46	11.38	1.85	13.23	9.93	45.02	6.97
LEVEL 15	17.85	4.9	13.39	3.67	17.06	12.81	53.86	16.15
LEVEL 14	20.17	6.66	15.13	5	20.13	15.11	60.76	23.09
LEVEL 13	22.57	8.15	16.93	6.11	23.04	17.29	67.03	28.47
LEVEL 12	24.99	10.1	18.75	7.58	26.32	19.76	72.56	34.24
LEVEL 11	27.13	12.34	20.35	9.26	29.61	22.23	76.6	40.59
LEVEL 10	29.08	14.43	21.81	10.82	32.63	24.5	79.45	45.91
LEVEL 9	30.63	16.47	22.98	12.35	35.33	26.52	80.69	50.56
LEVEL 8	30.93	13.93	23.2	10.44	33.64	25.25	77.76	41.67
LEVEL 7	30.79	14.95	23.09	11.21	34.3	25.75	74.02	42.27
LEVEL 6	32.36	20.82	24.27	15.61	39.88	29.94	75.06	56.93
LEVEL 5	30.26	22.94	22.7	17.21	39.9	29.95	66.11	60.18
LEVEL 4	30.31	24.86	22.74	18.64	41.38	31.06	62.65	62.69
LEVEL 3	32.61	26.04	24.46	19.53	43.99	33.02	63.88	63.23
LEVEL 2	52.25	13.73	39.19	10.29	49.48	37.14	99.36	38.88

Shear Forces Wall D (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	3.47	-1.06	2.6	-0.79	1.81	1.36	6.45	1.87
PENTHOUSE LEVEL	4.78	-2.24	3.59	-1.68	1.91	1.43	14.66	-3.46
LEVEL 16	8.75	-4.39	6.56	-3.29	3.27	2.45	27.19	-10.07
LEVEL 15	11.07	-6.21	8.31	-4.66	3.65	2.74	35.07	-16.66
LEVEL 14	13.28	-7.98	9.96	-5.98	3.98	2.98	41.68	-22.71
LEVEL 13	15.52	-10.24	11.64	-7.68	3.96	2.97	47.63	-29.5
LEVEL 12	17.72	-12.52	13.29	-9.39	3.91	2.93	52.79	-35.99
LEVEL 11	19.75	-14.18	14.81	-10.63	4.18	3.14	56.76	-40.13
LEVEL 10	21.69	-15.98	16.27	-11.98	4.28	3.21	59.88	-44.23
LEVEL 9	23.38	-17.64	17.54	-13.23	4.3	3.23	61.82	-47.53
LEVEL 8	24.56	-14.35	18.42	-10.76	7.66	5.75	61.59	-36.56
LEVEL 7	24.98	-15.09	18.74	-11.31	7.42	5.57	59.6	-37.03
LEVEL 6	26.68	-20.59	20.01	-15.44	4.57	3.43	61.1	-50.02
LEVEL 5	25.39	-22.24	19.04	-16.68	2.36	1.77	54.35	-52.2
LEVEL 4	26.57	-23.6	19.92	-17.7	2.22	1.67	53.75	-53.25
LEVEL 3	30.37	-24.44	22.78	-18.33	4.45	3.34	58.6	-53.42
LEVEL 2	51.28	-11.26	38.46	-8.45	30.02	22.53	97.15	-18.02

Shear Forces Wall E (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	N/A	11.35	N/A	8.52	8.73	6.55	N/A	-21.12
PENTHOUSE LEVEL	N/A	30.61	N/A	22.96	23.08	17.32	N/A	49.41
LEVEL 16	N/A	58.6	N/A	43.95	44.12	33.12	N/A	149.99
LEVEL 15	N/A	80.79	N/A	60.6	60.98	45.78	N/A	232.99
LEVEL 14	N/A	102.76	N/A	77.07	77.46	58.15	N/A	308.92
LEVEL 13	N/A	127.74	N/A	95.81	95.83	71.94	N/A	385.99
LEVEL 12	N/A	152.36	N/A	114.27	114.12	85.66	N/A	456.07
LEVEL 11	N/A	174.85	N/A	131.13	130.98	98.33	N/A	513.83
LEVEL 10	N/A	196.82	N/A	147.61	147.49	110.71	N/A	564.27
LEVEL 9	N/A	218.63	N/A	163.97	163.87	123.01	N/A	608.66
LEVEL 8	N/A	240.27	N/A	180.2	180.12	135.21	N/A	646.85
LEVEL 7	N/A	258.02	N/A	193.51	193.44	145.21	N/A	671.33
LEVEL 6	N/A	280.05	N/A	210.04	209.96	157.61	N/A	701.92
LEVEL 5	N/A	298.4	N/A	223.8	223.69	167.91	N/A	718.65
LEVEL 4	N/A	318.47	N/A	238.85	238.01	178.67	N/A	736.69
LEVEL 3	N/A	336.04	N/A	252.03	251.24	188.6	N/A	745.81
LEVEL 2	N/A	365.93	N/A	274.45	274.33	205.93	N/A	786.77

Shear Forces Wall F (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	3.55	1.04	2.66	0.78	3.44	2.59	6.69	-1.91
PENTHOUSE LEVEL	4.85	2.21	3.64	1.66	5.29	3.97	14.81	3.37
LEVEL 16	8.83	4.37	6.62	3.27	9.9	7.43	27.43	10
LEVEL 15	11.25	6.19	8.43	4.64	13.07	9.81	35.57	16.58
LEVEL 14	13.47	7.96	10.1	5.97	16.07	12.06	42.26	22.64
LEVEL 13	15.56	10.22	11.67	7.66	19.33	14.51	47.82	29.44
LEVEL 12	17.64	12.5	13.23	9.38	22.6	16.97	52.65	35.93
LEVEL 11	19.72	14.16	14.79	10.62	25.41	19.08	56.8	40.08
LEVEL 10	21.66	15.97	16.24	11.97	28.22	21.18	59.92	44.19
LEVEL 9	23.35	17.64	17.52	13.23	30.74	23.08	61.87	47.49
LEVEL 8	24.53	14.34	18.4	10.76	29.15	21.88	61.64	36.54
LEVEL 7	24.95	15.08	18.71	11.31	30.02	22.54	59.64	37
LEVEL 6	26.66	20.59	19.99	15.44	35.44	26.6	61.18	50.01
LEVEL 5	25.46	22.24	19.1	16.68	35.78	26.86	54.65	52.17
LEVEL 4	26.25	23.63	19.69	17.72	37.41	28.08	53.13	53.36
LEVEL 3	30.13	24.47	22.59	18.35	40.94	30.74	58.28	53.51
LEVEL 2	51.33	11.29	38.5	8.47	46.96	35.25	97.77	18.08

Shear Forces Wall G (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	-3.2	6.38	-2.4	4.78	2.38	1.79	-20.55	17.76
PENTHOUSE LEVEL	-4.84	11.64	-3.63	8.73	5.1	3.83	-8.99	33.42
LEVEL 16	6.11	12.82	4.58	9.62	14.2	10.66	30.84	34.96
LEVEL 15	16.16	12.71	12.12	9.54	21.66	16.26	65.47	34.13
LEVEL 14	26.37	12.42	19.78	9.31	29.09	21.84	96.86	32.99
LEVEL 13	36.38	13.22	27.29	9.92	37.2	27.93	124.23	34.81
LEVEL 12	46.57	13.88	34.93	10.41	45.33	34.03	148.78	36.58
LEVEL 11	57.03	12.9	42.77	9.67	52.45	39.37	170.91	33.46
LEVEL 10	67.59	12.2	50.69	9.15	59.84	44.92	190.4	31.21
LEVEL 9	78.66	11.63	59	8.72	67.72	50.84	208.76	29.25
LEVEL 8	92.09	11.44	69.07	8.58	77.65	58.29	231.13	28.07
LEVEL 7	102.57	10.69	76.93	8.02	84.94	63.76	243.03	26.32
LEVEL 6	114.85	8.72	86.14	6.54	92.68	69.57	257.03	20.08
LEVEL 5	131.53	7.85	98.65	5.88	104.53	78.47	280.95	16.85
LEVEL 4	143.79	6.03	107.84	4.52	112.36	84.35	292.87	10.76
LEVEL 3	147.75	3.31	110.81	2.48	113.29	85.05	286.05	1.32
LEVEL 2	140.97	-0.5	105.73	-0.38	105.35	79.08	266.03	-17.87

Shear Forces Wall H (kips)								
	Wind X	Wind Y	Case 2X	Case 2Y	Case 3	Case 4	Seismic X	Seismic Y
ROOF	-3.27	-6.4	-2.45	-4.8	-7.25	-5.44	-20.74	-17.85
PENTHOUSE LEVEL	-4.84	-11.7	-3.63	-8.78	-12.4	-9.31	-8.85	-33.62
LEVEL 16	6.05	-12.89	4.54	-9.66	-5.13	-3.85	30.74	-35.16
LEVEL 15	15.87	-12.78	11.9	-9.59	2.32	1.74	64.72	-34.34
LEVEL 14	26.01	-12.47	19.51	-9.36	10.15	7.62	95.87	-33.17
LEVEL 13	36.38	-13.28	27.29	-9.96	17.33	13.01	124.18	-34.99
LEVEL 12	46.86	-13.93	35.15	-10.44	24.7	18.54	149.5	-36.74
LEVEL 11	57.15	-12.94	42.86	-9.71	33.16	24.89	171.15	-33.6
LEVEL 10	67.66	-12.24	50.75	-9.18	41.57	31.2	190.52	-31.34
LEVEL 9	78.71	-11.66	59.04	-8.75	50.29	37.75	208.8	-29.37
LEVEL 8	92.12	-11.47	69.09	-8.61	60.48	45.4	231.08	-28.17
LEVEL 7	102.57	-10.72	76.92	-8.04	68.88	51.71	242.93	-26.42
LEVEL 6	114.79	-8.74	86.09	-6.56	79.54	59.7	256.77	-20.16
LEVEL 5	131.28	-7.88	98.46	-5.91	92.55	69.47	280.21	-16.97
LEVEL 4	144.64	-6.02	108.48	-4.51	103.97	78.04	294.68	-10.59
LEVEL 3	148.57	-3.32	111.43	-2.49	108.94	81.78	287.31	-1.23
LEVEL 2	140.97	0.45	105.73	0.34	106.06	79.62	264.83	17.73

Appendix E: Construction Management

MATERIAL QUANTITIES

Column Concrete Required (6000psi)								
Column Size	h (in)	d (in)	Area (ft^2)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
14 x 14	14	14	1.36	15.65	2348	24	376	
16 x 16	16	16	1.78	21.33	3200	48	1024	
18 x 18	18	18	2.25	27.00	4050	36	972	
20 x 20	20	20	2.78	33.33	5000	90	3000	
20 x 24	20	24	3.33	40.00	6000	24	960	
24 x 24	24	24	4.00	48.00	7200	84	4032	
28 x 28	28	28	5.44	65.33	9800	24	1568	
32 x 32	32	32	7.11	85.33	12800	12	1024	Vol. of Conc (CY)
							12956	480

Column Concrete Required (5000psi)								
Column Size	h (in)	d (in)	Area (ft^2)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
14 x 14	14	14	1.36	15.65	2348	64	1002	
18 x 18	18	18	2.25	27.00	4050	104	2808	
20 x 20	20	20	2.78	33.33	5000	102	3400	
24 x 24	24	24	4.00	48.00	7200	14	672	Vol. of Conc (CY)
							7882	292

Shear Wall Concrete Required (5000psi)								
Shear Wall	l (ft)	t (in)	Area (ft^2)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
1	9.33	12	9.33	111.96	16794	68	7613	
2	28	12	28.00	336.00	50400	34	11424	
3	20	12	20.00	240.00	36000	34	8160	Vol. of Conc (CY)
							19037	705

Slab Concrete Required (5000psi)								
Slab	l (ft)	t (in)	Area (ft^2)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
6" slab	-	6	21500	10750	1612500	1	10750	
							X 16 Floors	Vol. of Conc (CY)
							172000	6370

Column Reinforcing Steel								
Bar Size	l (ft)	t (in)	Area (in^2)	Cubic Feet	Weight (lb)	Qty	Total Weight (lbs)	
6	12	-	0.44	0.04	15.4	816	12566	
8	12	-	0.79	0.07	27.65	208	5751	
9	12	-	1.00	0.08	35	304	10640	
10	12	-	1.27	0.11	44.45	2536	112725	
11	12	-	1.56	0.13	54.6	778	42479	Tons of Steel
							184162	92

Beam Concrete Required (5000psi)								
Beam Size	d (in)	w (in)	length (ft)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
14 x 16	14	16	56.00	87.11	13067	2	174	
14 x 16	14	16	84.00	130.67	19600	2	261	
14 x 20	14	20	116.00	225.56	33833	10	2256	
14 x 20	14	20	140.00	272.22	40833	2	544	
14 x 22	14	22	196.00	419.22	62883	2	838	
							X 16 Floors	Vol. of Conc (CY)
							65184	2414
add 6" to depth of beam to get actual beam depth. Takes into account 6" slab already calculated above								

Beam Concrete Required (5000psi) for Post Tensioned Slab System								
Beam Size	d (in)	w (in)	length (ft)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
12 x 16	12	16	56.00	74.67	11200	2	149	
12 x 16	12	16	84.00	112.00	16800	2	224	
12 x 26	12	30	116.00	290.00	43500	6	1740	
12 x 20	12	20	140.00	233.33	35000	2	467	
12 x 22	12	22	196.00	359.33	53900	2	719	
							X 16 Floors	Vol. of Conc (CY)
							52779	1955
add 6" to depth of beam to get actually beam depth. Takes into account 6" slab already calculated above								

Slab Concrete Required for Steel Building (4000psi)								
Slab	l (ft)	t (in)	Area (ft^2)	Cubic Feet	Weight (lb)	Qty	Total Volume (ft^3)	
6" slab	-	3.25	21500	5823	576468.75	1	5823	
							X 16 Floors	Vol. of Conc (CY)
							93167	3451
The total volume of concrete was multiplie by 2/3 to account for the flutes of the metal decking								

Cost Esitmate for Concrete Structure- Post Tensioned Beams (Crane Placed)												
Line Number	Item	QTY.	Unit	Crew	Daily Output	Labor Hours	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total with O&P	Cost
03 310 200 0400	5000 psi Concrete											
	from Beams	2414	C.Y.				$90.00	-	-	-	$99.00	$238,986
	from Slab	6370	C.Y.				$90.00	-	-	-	$99.00	$630,630
	from Columns	292	C.Y.				$90.00	-	-	-	$99.00	$28,908
	from Shear Walls	990	C.Y.				$90.00	-	-	-	$99.00	$98,010
											TOTAL	$996,534
03 310 220 0411	6000 psi Concrete											
	from Columns	480	C.Y.				$103.00				$113.00	$54,240
											TOTAL	$54,240
03 310 700	Concrete Placing											
0650	Columns, 18", w/ crane	466	C.Y.	C7	55	1309	-	$38.00	$17.45	$55.45	$77.00	$35,882
0850	Columns, 24", w/ crane	306	C.Y.	C7	70	1029	-	$29.50	$13.70	$43.20	$60.50	$18,513
5200	12" walls, w/ crane	990	C.Y.	C7	90	0.8	-	$23.00	$10.65	$33.65	$47.50	$47,025
0250	Beams, w/ crane	2414	C.Y.	C7	65	1108	-	$32.00	$14.75	$46.75	$65.50	$158,117
1550	Slabs, 6", w/ crane	6370	C.Y.	C7	110	0.655	-	$18.90	$8.75	$27.65	$38.50	$245,245
3500	>5 stories, add per floor	8858	C.Y.	C7	2100	0.034	-	$0.99	$0.46	$1.45	$2.02	$17,893
												x 11stories
												$196,825
											BASE	$701,607
											Total w/Adjustment Factor, x 1.1	$771,767
03 110 410	Formwork											
6150	16"x16" column, 4 use	18000	SFCA	C1	235	0.136	$0.70	$4.41	-	$5.11	$7.60	$136,800
6500	24"x24" column, 4 use	29600	SFCA	C1	238	0.134	$0.80	$4.35	-	$5.15	$7.70	$227,920
7150	36"x36" column, 4 use	1500	SFCA	C1	250	0.128	$0.72	$4.14	-	$4.86	$7.25	$10,875
03 110 420 2150	Beam and Slab, 4 use	345136	SF	C2	545	0.088	-	$1.44	$2.94	$4.38	$6.15	$2,122,586
2440	Shear Walls, 4 use	51970	SFCA	C2	395	0.122	$1.40	$4.05	-	$5.45	$7.85	$407,965
												$2,906,146
												div by 4 uses
											BASE	$726,536
											Total w/Adjustment Factor, x 1.295	$940,865
03 210 600	Steel Reinforcement											
0100	Beams/Girders, #3-#7	83.7	TONS	4Rdmn	1.6	20	$800.00	$760.00	-	$1,560.00	$2,125.00	$177,863
0150	Beams/Girders, #8-#18	83.7	TONS	4Rdmn	2.7	11.85	$800.00	$450.00	-	$1,250.00	$1,625.00	$136,013
0250	Columns, #8-#18	92	TONS	4Rdmn	2.3	13.9	$800.00	$530.00	-	$1,330.00	$1,750.00	$161,000
0400	Elevated Slabs, #4-#7	335	TONS	4Rdmn	2.9	11.03	$850.00	$420.00	-	$1,270.00	$1,625.00	$544,375
											BASE	$1,019,250
											10% splice allowance	$1,121,175
											Total w/Adjustment Factor, x 1.2	$1,451,922
03 230 600	Stressing Tendons											
1450	100' span, 300 kip	14070	lbs	C4	1650	0.019	$0.46	$0.75	$0.02	$1.23	$1.77	$24,904
												x16 stories
											TOTAL	$398,462
03 350 300	Floor Finishing											
0250	floor, monoltic, machine	21500	SF	1 Cemfi	550	0.015	-	$0.48	-	$0.48	$0.70	$15,050
												x16 stories
											TOTAL	$240,800
03 150 600	Shoring											
1500	Reshoring	21500	SF Flr	2 Carp	1400	0.011	$0.38	$0.39	-	$0.77	$1.02	$21,930
												x16 stories
												$350,880
3060	rent, steel adjust. Per mo	21500	SF Flr	-	-	-	$1.50	-	-	$1.50	$1.65	$35,475
												x 7mos
											BASE	$599,205
											Total w/Adjustment Factor, x 1.295	$775,970
											TOTAL STRUCTURE ESTIMATE:	$5,630,561
											ESTIMATE IN 2001 DOLLARS:	$5,004,943
											COST PER SQUARE FOOT:	$14.51

Cost Esitmate for Concrete Structure- Post Tensioned Slab (Crane Placed)												
Line Number	**Item**	**QTY.**	**Unit**	**Crew**	**Daily Output**	**Labor Hours**	**Bare Material**	**Bare Labor**	**Bare Equipment**	**Bare Total**	**Total with O&P**	**Cost**
03 310 200 0400	**5000 psi Concrete**											
	from Beams	1955	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$193,545
	from Slab	6370	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$630,630
	from Columns	292	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$28,908
	from Shear Walls	990	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$98,010
											TOTAL	**$951,093**
03 310 220 0411	**6000 psi Concrete**											
	from Columns	480	C.Y.	-	-	-	$103.00	-	-	-	$113.00	$54,240
											TOTAL	**$54,240**
03 310 700	**Concrete Placing**											
0600	Columns, 18", w/crane	466	C.Y.	C7	55	1309	-	$38.00	$17.45	$55.45	$77.00	$35,882
0800	Columns, 24", w/crane	306	C.Y.	C7	70	1029	-	$29.50	$13.70	$43.20	$60.50	$18,513
5100	12" walls, w/crane	990	C.Y.	C7	90	0.8	-	$23.00	$10.65	$33.65	$47.50	$47,025
0200	Beams, w/crane	1955	C.Y.	C7	65	1108	-	$32.00	$14.75	$46.75	$65.50	$128,053
1500	Slabs, 6", w/crane	6370	C.Y.	C7	110	0.655	-	$18.90	$8.75	$27.65	$38.50	$245,245
3500	>5 stories, add per floor	7067	C.Y.	C7	2100	0.034	-	$0.99	$0.46	$1.45	$2.02	$14,275
												x 11stories
												$157,029
											BASE	**$631,746**
											Total w/Adjustment Factor, x 1.1	**$694,921**
03 110 410	**Formwork**											
6150	16"x16" column, 4 use	18000	SFCA	C1	235	0.136	$0.70	$4.41	-	$5.11	$7.60	$136,800
6500	24"x24" column, 4 use	29600	SFCA	C1	238	0.134	$0.80	$4.35	-	$5.15	$7.70	$227,920
7150	36"x36" column, 4 use	1500	SFCA	C1	250	0.128	$0.72	$4.14	-	$4.86	$7.25	$10,875
03 110 420 2150	Beam and Slab, 4 use	345120	SF	C2	545	0.088	-	$1.44	$2.94	$4.38	$6.15	$2,122,488
2440	Shear Walls, 4 use	51970	SFCA	C2	395	0.122	$1.40	$4.05	-	$5.45	$7.85	$407,965
												$2,906,048
												div by 4 uses
											BASE	**$726,512**
											Total w/Adjustment Factor, x 1.295	**$940,833**
03 210 600	**Steel Reinforcement**											
0100	Beams/Girders, #3-#7	79.7	TONS	4Rdmn	1.6	20	$800.00	$760.00	-	$1,560.00	$2,125.00	$169,363
0150	Beams/Girders, #8-#18	79.7	TONS	4Rdmn	2.7	11.85	$800.00	$450.00	-	$1,250.00	$1,625.00	$129,513
0250	Columns, #8-#18	92	TONS	4Rdmn	2.3	13.9	$800.00	$530.00	-	$1,330.00	$1,750.00	$161,000
0400	Elevated Slabs, #4-#7	318.8	TONS	4Rdmn	2.9	11.03	$850.00	$420.00	-	$1,270.00	$1,625.00	$518,050
											BASE	**$977,925**
											10% splice allowance	**$1,075,718**
											Total w/Adjustment Factor, x 1.2	**$1,393,054**
03 230 600	**Stressing Tendons**											
1450	100' span, 300 kip	16446	lbs	C4	1650	0.019	$0.46	$0.75	$0.02	$1.23	$1.77	$29,109
												x16 stories
											TOTAL	**$465,751**
03 350 300	**Floor Finishing**											
0250	floor, monoltic, machine	21500	SF	1 Cemfi	550	0.015	-	$0.48	-	$0.48	$0.70	$15,050
												x16 stories
											TOTAL	**$240,800**
03 150 600	**Shoring**											
1500	Reshoring	21500	SF Flr	2 Carp	1400	0.011	$0.38	$0.39	-	$0.77	$1.02	$21,930
												x16 stories
												$350,880
3060	Rent, steel adjust. per mo	21500	SF Flr	-	-	-	$1.50	-	-	$1.50	$1.65	$35,475
												x 7mos
											BASE	**$599,205**
											Total w/Adjustment Factor, x 1.295	**$775,970**
											TOTAL STRUCTURE ESTIMATE:	**$5,516,662**
											ESTIMATE IN 2001 DOLLARS:	**$4,903,700**
											COST PER SQUARE FOOT:	**$14.21**

Cost Esitmate for Concrete Structure- Post Tensioned Beams (Pumped Concrete)												
Line Number	Item	QTY.	Unit	Crew	Daily Output	Labor Hours	Bare Material	Bare Labor	Bare Equipment	Bare Total	Total with O&P	Cost
03 310 200 0400	5000 psi Concrete											
	from Beams	2414	C.Y.				$90.00	-	-	-	$99.00	$238,986
	from Slab	6370	C.Y.				$90.00	-	-	-	$99.00	$630,630
	from Columns	292	C.Y.				$90.00	-	-	-	$99.00	$28,908
	from Shear Walls	990	C.Y.				$90.00	-	-	-	$99.00	$98,010
											TOTAL	$996,534
03 310 220 0411	6000 psi Concrete											
	from Columns	480	C.Y.				$103.00				$113.00	$54,240
											TOTAL	$54,240
03 310 700	Concrete Placing											
0600	Columns, 18", pumped	466	C.Y.	C20	90	0.711	-	$20.50	$8.35	$28.85	$40.50	$18,873
0800	Columns, 24", pumped	306	C.Y.	C20	92	0.696	-	$19.95	$8.15	$28.10	$39.50	$12,087
5100	12" walls, pumped	990	C.Y.	C20	110	0.582	-	$16.70	$6.85	$23.55	$33.00	$32,670
0200	Beams, pumped	2414	C.Y.	C20	90	0.711	-	$20.50	$8.35	$28.85	$40.50	$97,767
1500	Slabs, 6", pumped	6370	C.Y.	C20	160	0.4	-	$11.50	$4.70	$16.20	$23.00	$146,510
3500	>5 stories, add per floor	8858	C.Y.	C20	2100	0.03	-	$0.88	$0.36	$1.24	$1.74	$15,413
												x 11stories
												$169,542
											BASE	$477,449
											Total w/Adjustment Factor, x 1.1	$525,194
03 110 410	Formwork											
6150	16"x16" column, 4 use	18000	SFCA	C1	235	0.136	$0.70	$4.41	-	$5.11	$7.60	$136,800
6500	24"x24" column, 4 use	29600	SFCA	C1	238	0.134	$0.80	$4.35	-	$5.15	$7.70	$227,920
7150	36"x36" column, 4 use	1500	SFCA	C1	250	0.128	$0.72	$4.14	-	$4.86	$7.25	$10,875
03 110 420 2150	Beam and Slab, 4 use	345136	SF	C2	545	0.088	-	$1.44	$2.94	$4.38	$6.15	$2,122,586
2440	Shear Walls, 4 use	51970	SFCA	C2	395	0.122	$1.40	$4.05	-	$5.45	$7.85	$407,965
												$2,906,146
												div by 4 uses
											BASE	$726,536
											Total w/Adjustment Factor, x 1.295	$940,865
03 210 600	Steel Reinforcement											
0100	Beams/Girders, #3-#7	83.7	TONS	4Rdmn	1.6	20	$800.00	$760.00	-	$1,560.00	$2,125.00	$177,863
0150	Beams/Girders, #8-#18	83.7	TONS	4Rdmn	2.7	11.85	$800.00	$450.00	-	$1,250.00	$1,625.00	$136,013
0250	Columns, #8-#18	92	TONS	4Rdmn	2.3	13.9	$800.00	$530.00	-	$1,330.00	$1,750.00	$161,000
0400	Elevated Slabs, #4-#7	335	TONS	4Rdmn	2.9	11.03	$850.00	$420.00	-	$1,270.00	$1,625.00	$544,375
											BASE	$1,019,250
											10% splice allowance	$1,121,175
											Total w/Adjustment Factor, x 1.2	$1,451,922
03 230 600	Stressing Tendons											
1450	100' span, 300 kip	14070	lbs	C4	1650	0.019	$0.46	$0.75	$0.02	$1.23	$1.77	$24,904
												x16 stories
											TOTAL	$398,462
03 350 300	Floor Finishing											
0250	floor, monoltic, machine	21500	SF	1 Cemfi	550	0.015	-	$0.48	-	$0.48	$0.70	$15,050
												x16 stories
											TOTAL	$240,800
03 150 600	Shoring											
1500	Reshoring	21500	SF Flr	2 Carp	1400	0.011	$0.38	$0.39	-	$0.77	$1.02	$21,930
												x16 stories
												$350,880
3060	rent, steel adjust. Per mo	21500	SF Flr	-	-	-	$1.50	-	-	$1.50	$1.65	$35,475
												x 6mos
											BASE	$563,730
											Total w/Adjustment Factor, x 1.295	$730,030
											TOTAL STRUCTURE ESTIMATE:	$5,338,047
											ESTIMATE IN 2001 DOLLARS:	$4,744,931
											COST PER SQUARE FOOT	$13.75

Cost Esitmate for Concrete Structure- Post Tensioned Slab (Pumped Concrete)												
Line Number	**Item**	**QTY.**	**Unit**	**Crew**	**Daily Output**	**Labor Hours**	**Bare Material**	**Bare Labor**	**Bare Equipment**	**Bare Total**	**Total with O&P**	**Cost**
03 310 200 0400	**5000 psi Concrete**											
	from Beams	1955	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$193,545
	from Slab	6370	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$630,630
	from Columns	292	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$28,908
	from Shear Walls	990	C.Y.	-	-	-	$90.00	-	-	-	$99.00	$98,010
											TOTAL	**$951,093**
03 310 220 0411	**6000 psi Concrete**											
	from Columns	480	C.Y.	-	-	-	$103.00	-	-	-	$113.00	$54,240
											TOTAL	**$54,240**
03 310 700	**Concrete Placing**											
0600	Columns, 18", pumped	466	C.Y.	C20	90	0.711	-	$20.50	$8.35	$28.85	$40.50	$18,873
0800	Columns, 24", pumped	306	C.Y.	C20	92	0.696	-	$19.95	$8.15	$28.10	$39.50	$12,087
5100	12" walls, pumped	990	C.Y.	C20	110	0.582	-	$16.70	$6.85	$23.55	$33.00	$32,670
0200	Beams, pumped	1955	C.Y.	C20	90	0.711	-	$20.50	$8.35	$28.85	$40.50	$79,178
1500	Slabs, 6", pumped	6370	C.Y.	C20	160	0.4	-	$11.50	$4.70	$16.20	$23.00	$146,510
3500	>5 stories, add per floor	7067	C.Y.	C20	2100	0.03	-	$0.88	$0.36	$1.24	$1.74	$12,297
												x 11stories
												$135,262
											BASE	**$424,580**
											Total w/Adjustment Factor, x 1.1	**$467,038**
03 110 410	**Formwork**											
6150	16"x16" column, 4 use	18000	SFCA	C1	235	0.136	$0.70	$4.41	-	$5.11	$7.60	$136,800
6500	24"x24" column, 4 use	29600	SFCA	C1	238	0.134	$0.80	$4.35	-	$5.15	$7.70	$227,920
7150	36"x36" column, 4 use	1500	SFCA	C1	250	0.128	$0.72	$4.14	-	$4.86	$7.25	$10,875
03 110 420 2150	Beam and Slab, 4 use	345120	SF	C2	545	0.088	-	$1.44	$2.94	$4.38	$6.15	$2,122,488
2440	Shear Walls, 4 use	51970	SFCA	C2	395	0.122	$1.40	$4.05	-	$5.45	$7.85	$407,965
												$2,906,048
												div by 4 uses
											BASE	**$726,512**
											Total w/Adjustment Factor, x 1.295	**$940,833**
03 210 600	**Steel Reinforcement**											
0100	Beams/Girders, #3-#7	79.7	TONS	4Rdmn	1.6	20	$800.00	$760.00	-	$1,560.00	$2,125.00	$169,363
0150	Beams/Girders, #8-#18	79.7	TONS	4Rdmn	2.7	11.85	$800.00	$450.00	-	$1,250.00	$1,625.00	$129,513
0250	Columns, #8-#18	92	TONS	4Rdmn	2.3	13.9	$800.00	$530.00	-	$1,330.00	$1,750.00	$161,000
0400	Elevated Slabs, #4-#7	318.8	TONS	4Rdmn	2.9	11.03	$850.00	$420.00	-	$1,270.00	$1,625.00	$518,050
											BASE	**$977,925**
											10% splice allowance	**$1,075,718**
											Total w/Adjustment Factor, x 1.2	**$1,393,054**
03 230 600	**Stressing Tendons**											
1450	100' span, 300 kip	16446	lbs	C4	1650	0.019	$0.46	$0.75	$0.02	$1.23	$1.77	$29,109
												x16 stories
											TOTAL	**$465,751**
03 350 300	**Floor Finishing**											
0250	floor, monoltic, machine	21500	SF	1 Cemfi	550	0.015	-	$0.48	-	$0.48	$0.70	$15,050
												x16 stories
											TOTAL	**$240,800**
03 150 600	**Shoring**											
1500	Reshoring	21500	SF Flr	2 Carp	1400	0.011	$0.38	$0.39	-	$0.77	$1.02	$21,930
												x16 stories
												$350,880
3060	Rent, steel adjust. per mo	21500	SF Flr	-	-	-	$1.50	-	-	$1.50	$1.65	$35,475
												x 6mos
											BASE	**$563,730**
											Total w/Adjustment Factor, x 1.295	**$730,030**
											TOTAL STRUCTURE ESTIMATE:	**$5,242,839**
											ESTIMATE IN 2001 DOLLARS:	**$4,660,301**
											COST PER SQUARE FOOT	**$13.51**

CRANE AND BUCKET CONCRETE CONSTRUCTION DURATIONS

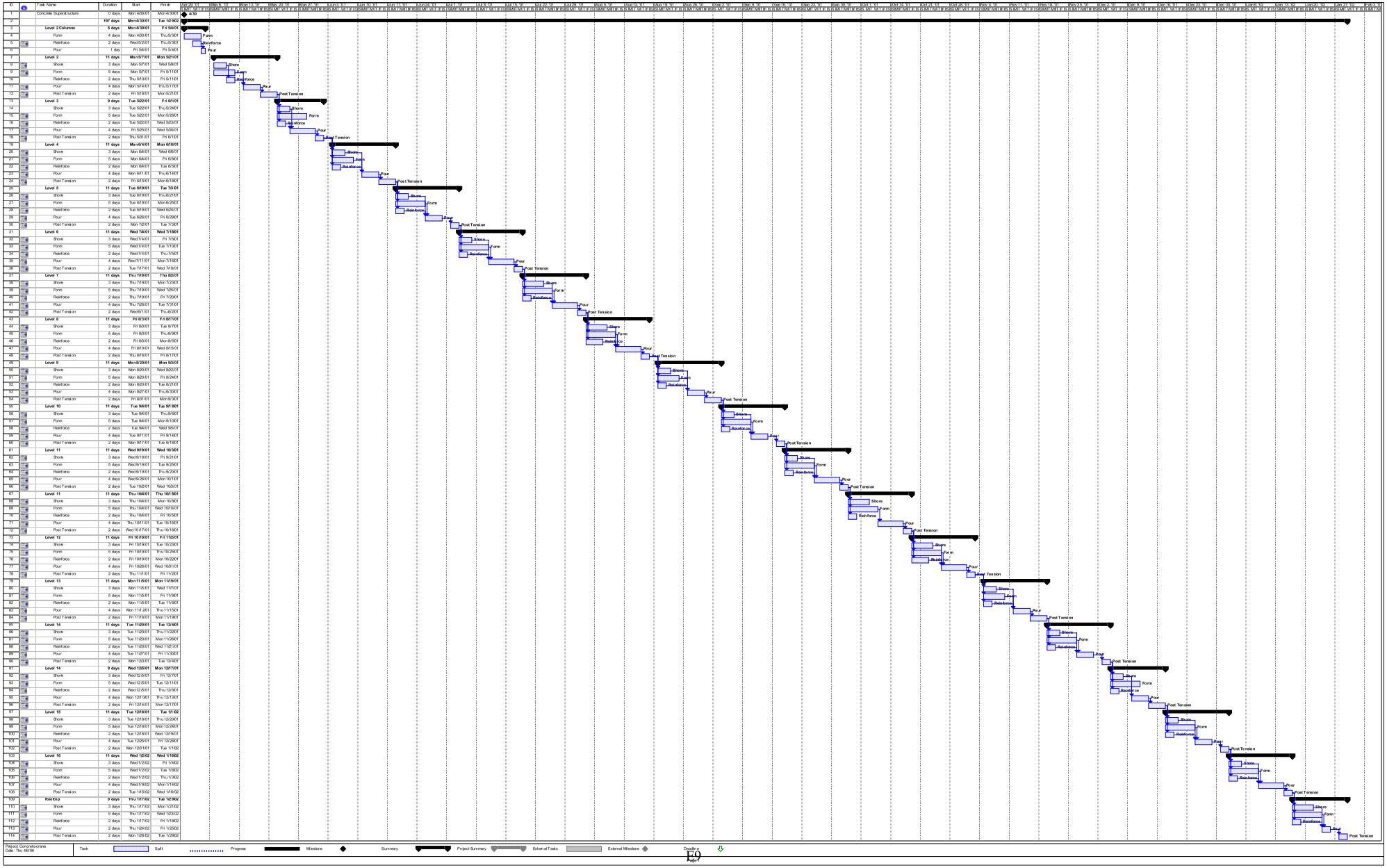
Construction Duration/Floor					
Task	**Crew**	**QTY**	**# of crews**	**Output**	**Duration**
Shoring	C1	21000	5	1400	3
Formwork					
Beams/Slabs	C1	21570	8	545	4.95
Columns	C1	3070	3	240	4.26
Shear Walls	C2	2288	3	395	1.93
				Total	**11.14**
Reinforce				**MAX**	5
Beams/Slabs	4 Rdmn	10.5	3	2.2	1.59
Columns	4 Rdmn	5.75	2	2.3	1.25
walls	4 Rdmn	21	5	2.9	1.45
				Total	**4.29**
Placing Conc				**MAX**	2
Beams	C7	151	2	65	1.16
Slabs	C7	398	2	110	2
Shear Walls	C7	44	2	90	0.24
Columns	C7	48	2	63	0.38
				Total	**3.60**
				MAX	2
Post Tension	C4	14070	4	1650	2.13
Reshoring	2 CARP	21000	3	1400	5.00
				Total	**15.48**

Construction Duration/Floor					
Task	**Crew**	**QTY**	**# of crews**	**Output**	**Duration**
Shoring	C1	21000	5	1400	3
Formwork					
Beams/Slabs	C1	21570	5	545	7.92
Columns	C1	3070	5	240	2.56
Shear Walls	C2	2288	4	395	1.45
				Total	**11.92**
Reinforce				**MAX**	8
Beams/Slabs	4 Rdmn	9.96	3	2.2	1.51
Columns	4 Rdmn	5.75	3	2.3	0.83
Slabs	4 Rdmn	19.9	4	2.9	1.72
				Total	**4.06**
Placing Conc				**MAX**	2
Beams	C7	114	5	65	0.35
Slabs	C7	398	5	110	0.72
Shear Walls	C7	44	5	90	0.10
Columns	C7	48	5	63	0.15
				Total	**1.32**
				MAX	1
Post Tensioning	C4	16100	4	1650	2.44

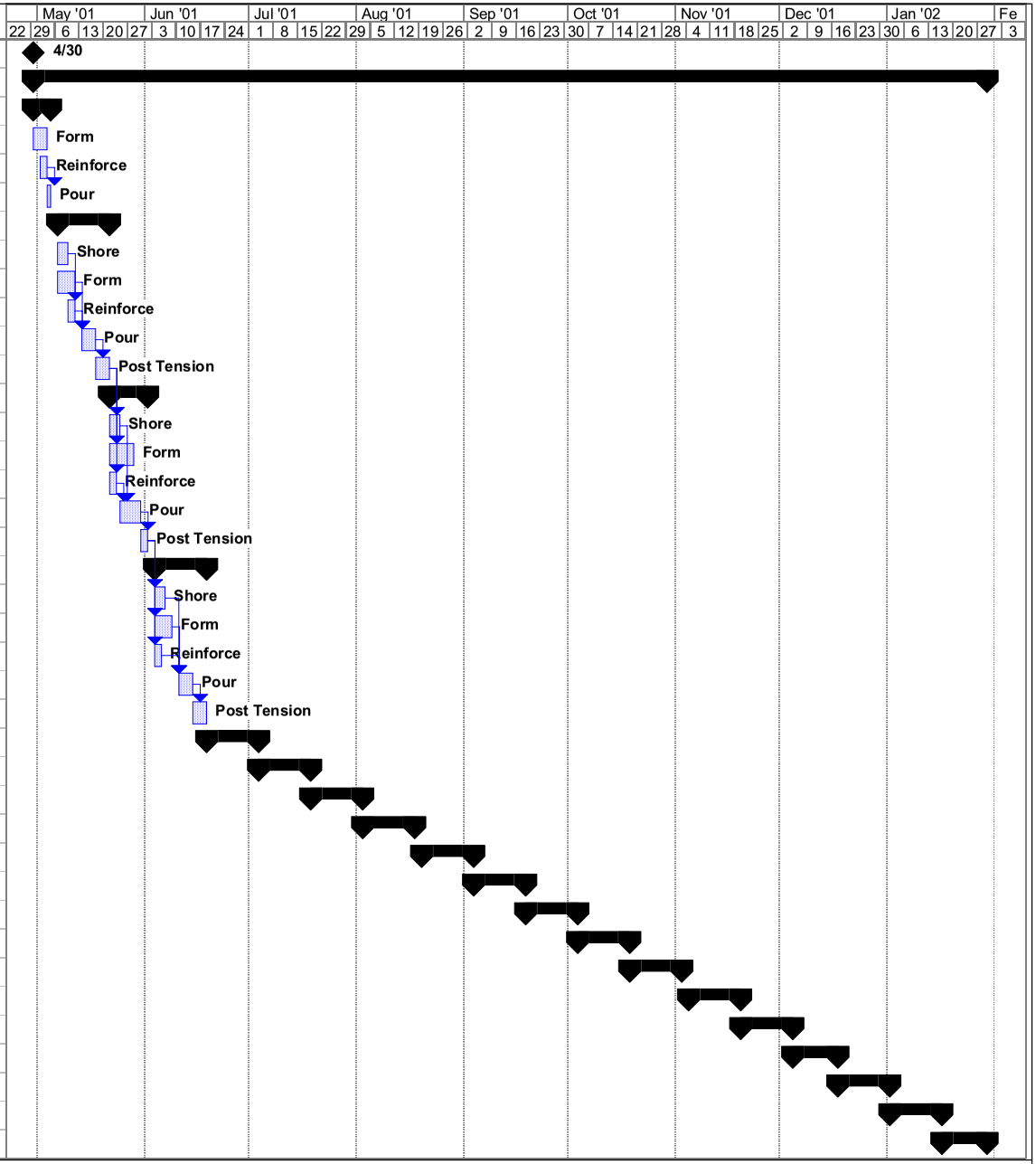
PUMPED CONCRETE CONSTRUCTION DURATIONS

Construction Duration/Floor System #1					
Task	**Crew**	**QTY**	**# of crews**	**Output**	**Duration**
Shoring	C1	21000	5	1400	3
Formwork					
Beams/Slabs	C1	21570	8	545	4.95
Columns	C1	3070	3	240	4.26
Shear Walls	C2	2288	2	395	2.90
				Total	**12.11**
Reinforce				**MAX**	5
Beams/Slabs	4 Rdmn	10.5	3	2.2	1.59
Columns	4 Rdmn	5.75	2	2.3	1.25
Slabs	4 Rdmn	21	4	2.9	1.81
				Total	**4.65**
Placing Conc				**MAX**	2
Beams	C20	151	3	90	0.56
Slabs	C20	398	3	160	1
Shear Walls	C20	44	2	110	0.20
Columns	C20	48	2	90	0.27
				Total	**1.86**
				MAX	1
Post Tension	C4	14070	5	1650	1.71
Reshoring	2 CARP	21000	5	1400	3.00
				Total	**15.29**

Construction Duration/Floor System #2					
Task	**Crew**	**QTY**	**# of crews**	**Output**	**Duration**
Shoring	C1	21000	5	1400	3
Formwork					
Beams/Slabs	C1	21570	8	545	4.95
Columns	C1	3070	3	240	4.26
Shear Walls	C2	2288	2	395	2.90
				Total	**12.11**
Reinforce				**MAX**	5
Beams/Slabs	4 Rdmn	9.96	3	2.2	1.51
Columns	4 Rdmn	5.75	2	2.3	1.25
Slabs	4 Rdmn	19.9	4	2.9	1.72
				Total	**4.47**
Placing Conc				**MAX**	2
Beams	C20	114	3	90	0.42
Slabs	C20	398	3	160	0.83
Shear Walls	C20	44	2	110	0.20
Columns	C20	48	2	90	0.27
				Total	**1.72**
				MAX	1
Post Tensioning	C4	16100	5	1650	1.95
Reshoring	2 CARP	21000	5	1400	3.00
				Total	**15.44**

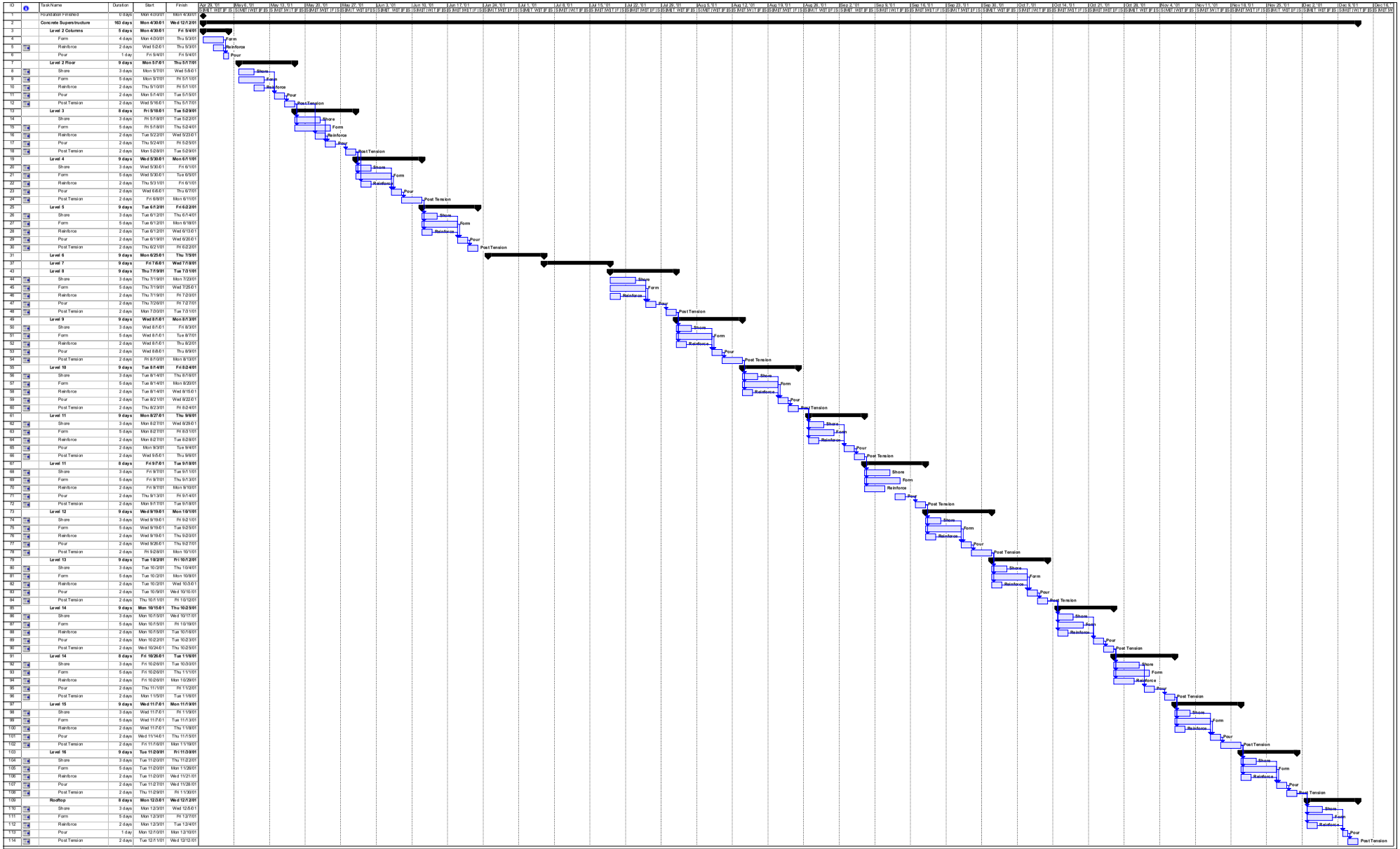

ID
Task Name
Duration
Start
Finish
Concrete Superstructure
Level 2 Columns
Form
Reinforce
Pour
Level 2
Shore
Level 3
Level 4
Post Tension
Level 5
Level 6
Level 7
Level 8
Level 9
Level 10
Level 11
Level 12
Level 13
Level 14
Level 15
Level 16
Rooftop
Project: Concretecrane
Date: Thu 4/6/06
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

ID	Task Name	Duration	Start	Finish
1	Concrete Superstructure	0 days	Mon 4/30/01	Mon 4/30/01
2		**197 days**	**Mon 4/30/01**	**Tue 1/29/02**
3	**Level 2 Columns**	**5 days**	**Mon 4/30/01**	**Fri 5/4/01**
4	Form	4 days	Mon 4/30/01	Thu 5/3/01
5	Reinforce	2 days	Wed 5/2/01	Thu 5/3/01
6	Pour	1 day	Fri 5/4/01	Fri 5/4/01
7	**Level 2**	**11 days**	**Mon 5/7/01**	**Mon 5/21/01**
8	Shore	3 days	Mon 5/7/01	Wed 5/9/01
9	Form	5 days	Mon 5/7/01	Fri 5/11/01
10	Reinforce	2 days	Thu 5/10/01	Fri 5/11/01
11	Pour	4 days	Mon 5/14/01	Thu 5/17/01
12	Post Tension	2 days	Fri 5/18/01	Mon 5/21/01
13	**Level 3**	**9 days**	**Tue 5/22/01**	**Fri 6/1/01**
14	Shore	3 days	Tue 5/22/01	Thu 5/24/01
15	Form	5 days	Tue 5/22/01	Mon 5/28/01
16	Reinforce	2 days	Tue 5/22/01	Wed 5/23/01
17	Pour	4 days	Fri 5/25/01	Wed 5/30/01
18	Post Tension	2 days	Thu 5/31/01	Fri 6/1/01
19	**Level 4**	**11 days**	**Mon 6/4/01**	**Mon 6/18/01**
20	Shore	3 days	Mon 6/4/01	Wed 6/6/01
21	Form	5 days	Mon 6/4/01	Fri 6/8/01
22	Reinforce	2 days	Mon 6/4/01	Tue 6/5/01
23	Pour	4 days	Mon 6/11/01	Thu 6/14/01
24	Post Tension	2 days	Fri 6/15/01	Mon 6/18/01
25	**Level 5**	**11 days**	**Tue 6/19/01**	**Tue 7/3/01**
31	**Level 6**	**11 days**	**Wed 7/4/01**	**Wed 7/18/01**
37	**Level 7**	**11 days**	**Thu 7/19/01**	**Thu 8/2/01**
43	**Level 8**	**11 days**	**Fri 8/3/01**	**Fri 8/17/01**
49	**Level 9**	**11 days**	**Mon 8/20/01**	**Mon 9/3/01**
55	**Level 10**	**11 days**	**Tue 9/4/01**	**Tue 9/18/01**
61	**Level 11**	**11 days**	**Wed 9/19/01**	**Wed 10/3/01**
67	**Level 11**	**11 days**	**Thu 10/4/01**	**Thu 10/18/01**
73	**Level 12**	**11 days**	**Fri 10/19/01**	**Fri 11/2/01**
79	**Level 13**	**11 days**	**Mon 11/5/01**	**Mon 11/19/01**
85	**Level 14**	**11 days**	**Tue 11/20/01**	**Tue 12/4/01**
91	**Level 14**	**9 days**	**Wed 12/5/01**	**Mon 12/17/01**
97	**Level 15**	**11 days**	**Tue 12/18/01**	**Tue 1/1/02**
103	**Level 16**	**11 days**	**Wed 1/2/02**	**Wed 1/16/02**
109	**Rooftop**	**9 days**	**Thu 1/17/02**	**Tue 1/29/02**

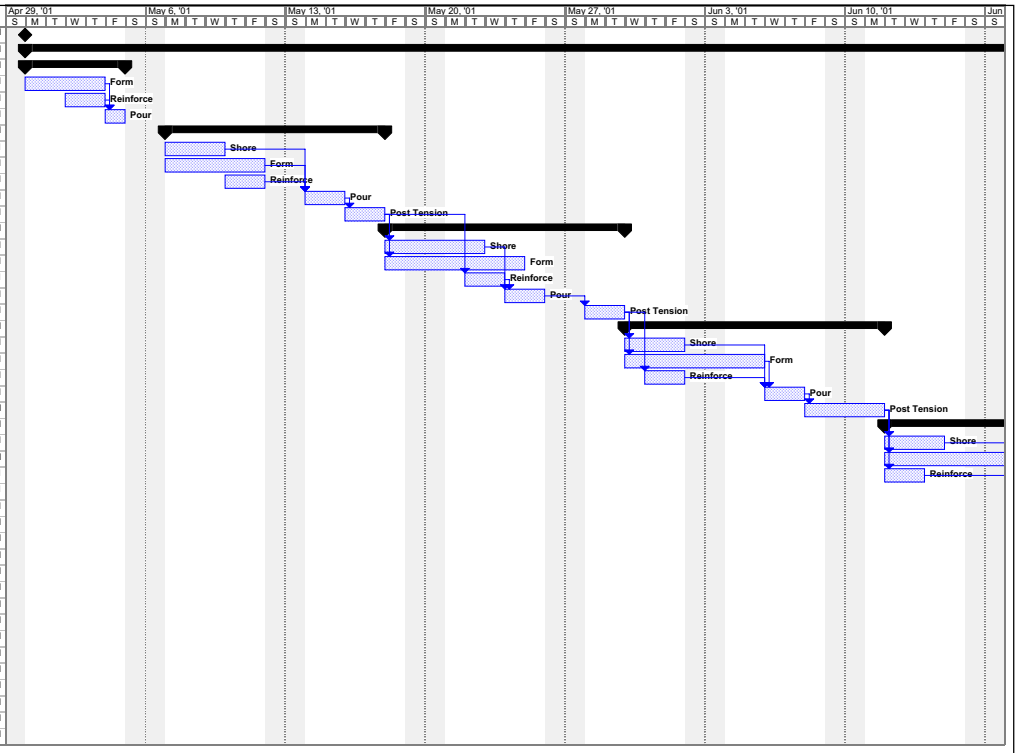


Project: Concrete-crane
Date: Thu 4/6/06

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline


ID
Task Name
Duration
Start
Finish
1 Foundation Finished 0 days Mon 4/30/01 Mon 4/30/01
2 Concrete Superstructure 163 days Mon 4/30/01 Wed 12/12/01
3 Level 2 Columns 5 days Mon 4/30/01 Fri 5/4/01
4 Form 4 days Mon 4/30/01 Thu 5/3/01
5 Reinforce 2 days Wed 5/2/01 Thu 5/3/01
6 Pour 1 day Fri 5/4/01 Fri 5/4/01
7 Level 2 Floor 9 days Mon 5/7/01 Thu 5/17/01
8 Shore 3 days Mon 5/7/01 Wed 5/9/01
9 Form 5 days Mon 5/7/01 Fri 5/11/01
10 Reinforce 2 days Thu 5/10/01 Fri 5/11/01
11 Pour 2 days Mon 5/14/01 Tue 5/15/01
12 Post Tension 2 days Wed 5/16/01 Thu 5/17/01
13 Level 3 8 days Fri 5/18/01 Tue 5/29/01
14 Shore 3 days Fri 5/18/01 Tue 5/22/01
15 Form 5 days Fri 5/18/01 Thu 5/24/01
16 Reinforce 2 days Tue 5/22/01 Wed 5/23/01
17 Pour 2 days Thu 5/24/01 Fri 5/25/01
18 Post Tension 2 days Mon 5/28/01 Tue 5/29/01
19 Level 4 9 days Wed 5/30/01 Mon 6/11/01
20 Shore 3 days Wed 5/30/01 Fri 6/1/01
21 Form 5 days Wed 5/30/01 Tue 6/5/01
22 Reinforce 2 days Thu 5/31/01 Fri 6/1/01
23 Pour 2 days Wed 6/6/01 Thu 6/7/01
24 Post Tension 2 days Fri 6/8/01 Mon 6/11/01
25 Level 5 9 days Tue 6/12/01 Fri 6/22/01
26 Shore 3 days Tue 6/12/01 Thu 6/14/01
27 Form 5 days Tue 6/12/01 Mon 6/18/01
28 Reinforce 2 days Tue 6/12/01 Wed 6/13/01
29 Pour 2 days Tue 6/19/01 Wed 6/20/01
30 Post Tension 2 days Thu 6/21/01 Fri 6/22/01
31 Level 6 9 days Mon 6/25/01 Thu 7/5/01
37 Level 7 9 days Fri 7/6/01 Wed 7/18/01
43 Level 8 9 days Thu 7/19/01 Tue 7/31/01
44 Shore 3 days Thu 7/19/01 Mon 7/23/01
45 Form 5 days Thu 7/19/01 Wed 7/25/01
46 Reinforce 2 days Thu 7/19/01 Fri 7/20/01
47 Pour 2 days Thu 7/26/01 Fri 7/27/01
48 Post Tension 2 days Mon 7/30/01 Tue 7/31/01
49 Level 9 9 days Wed 8/1/01 Mon 8/13/01
50 Shore 3 days Wed 8/1/01 Fri 8/3/01
51 Form 5 days Wed 8/1/01 Tue 8/7/01
52 Reinforce 2 days Wed 8/1/01 Thu 8/2/01
53 Pour 2 days Wed 8/8/01 Thu 8/9/01
54 Post Tension 2 days Fri 8/10/01 Mon 8/13/01
55 Level 10 9 days Tue 8/14/01 Fri 8/24/01
56 Shore 3 days Tue 8/14/01 Thu 8/16/01
57 Form 5 days Tue 8/14/01 Mon 8/20/01
58 Reinforce 2 days Tue 8/14/01 Wed 8/15/01
59 Pour 2 days Tue 8/21/01 Wed 8/22/01
60 Post Tension 2 days Thu 8/23/01 Fri 8/24/01
61 Level 11 9 days Mon 8/27/01 Thu 9/6/01
62 Shore 3 days Mon 8/27/01 Wed 8/29/01
63 Form 5 days Mon 8/27/01 Fri 8/31/01
64 Reinforce 2 days Mon 8/27/01 Tue 8/28/01
65 Pour 2 days Mon 9/3/01 Tue 9/4/01
66 Post Tension 2 days Wed 9/5/01 Thu 9/6/01
67 Level 11 8 days Fri 9/7/01 Tue 9/18/01
68 Shore 3 days Fri 9/7/01 Tue 9/11/01
69 Form 5 days Fri 9/7/01 Thu 9/13/01
70 Reinforce 2 days Fri 9/7/01 Mon 9/10/01
71 Pour 2 days Thu 9/13/01 Fri 9/14/01
72 Post Tension 2 days Mon 9/17/01 Tue 9/18/01
73 Level 12 9 days Wed 9/19/01 Mon 10/1/01
74 Shore 3 days Wed 9/19/01 Fri 9/21/01
75 Form 5 days Wed 9/19/01 Tue 9/25/01
76 Reinforce 2 days Wed 9/19/01 Thu 9/20/01
77 Pour 2 days Wed 9/26/01 Thu 9/27/01
78 Post Tension 2 days Fri 9/28/01 Mon 10/1/01
79 Level 13 9 days Tue 10/2/01 Fri 10/12/01
80 Shore 3 days Tue 10/2/01 Thu 10/4/01
81 Form 5 days Tue 10/2/01 Mon 10/8/01
82 Reinforce 2 days Tue 10/2/01 Wed 10/3/01
83 Pour 2 days Tue 10/9/01 Wed 10/10/01
84 Post Tension 2 days Thu 10/11/01 Fri 10/12/01
85 Level 14 9 days Mon 10/15/01 Thu 10/25/01
86 Shore 3 days Mon 10/15/01 Wed 10/17/01
87 Form 5 days Mon 10/15/01 Fri 10/19/01
88 Reinforce 2 days Mon 10/15/01 Tue 10/16/01
89 Pour 2 days Mon 10/22/01 Tue 10/23/01
90 Post Tension 2 days Wed 10/24/01 Thu 10/25/01
91 Level 14 8 days Fri 10/26/01 Tue 11/6/01
92 Shore 3 days Fri 10/26/01 Tue 10/30/01
93 Form 5 days Fri 10/26/01 Thu 1/1/01
94 Reinforce 2 days Fri 10/26/01 Mon 10/29/01
95 Pour 2 days Thu 11/1/01 Fri 11/2/01
96 Post Tension 2 days Mon 11/5/01 Tue 11/6/01
97 Level 15 9 days Wed 11/7/01 Mon 11/19/01
98 Shore 3 days Wed 11/7/01 Fri 11/9/01
99 Form 5 days Wed 11/7/01 Tue 11/13/01
100 Reinforce 2 days Wed 11/7/01 Thu 11/8/01
101 Pour 2 days Wed 11/14/01 Thu 11/15/01
102 Post Tension 2 days Fri 11/16/01 Mon 11/19/01
103 Level 16 9 days Tue 11/20/01 Fri 11/30/01
104 Shore 3 days Tue 11/20/01 Thu 11/22/01
105 Form 5 days Tue 11/20/01 Mon 11/26/01
106 Reinforce 2 days Tue 11/20/01 Wed 11/21/01
107 Pour 2 days Tue 11/27/01 Wed 11/28/01
108 Post Tension 2 days Thu 11/29/01 Fri 11/30/01
109 Rooftop 8 days Mon 12/3/01 Wed 12/12/01
110 Shore 3 days Mon 12/3/01 Wed 12/5/01
111 Form 5 days Mon 12/3/01 Fri 12/7/01
112 Reinforce 2 days Mon 12/3/01 Tue 12/4/01
113 Pour 1 day Mon 12/10/01 Mon 12/10/01
114 Post Tension 2 days Tue 12/11/01 Wed 12/12/01
Apr 29, '01
May 6, '01
May 13, '01
May 20, '01
May 27, '01
Jun 3, '01
Jun 10, '01
Jun 17, '01
Jun 24, '01
Jul 1, '01
Jul 8, '01
Jul 15, '01
Jul 22, '01
Jul 29, '01
Aug 5, '01
Aug 12, '01
Aug 19, '01
Aug 26, '01
Sep 2, '01
Sep 9, '01
Sep 16, '01
Sep 23, '01
Sep 30, '01
Oct 7, '01
Oct 14, '01
Oct 21, '01
Oct 28, '01
Nov 4, '01
Nov 11, '01
Nov 18, '01
Nov 25, '01
Dec 2, '01
Dec 9, '01
Dec 16, '01
Project: Concrete-pumped
Date: Thu 4/6/06
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

ID	Task Name	Duration	Start	Finish
1	Foundation Finished	0 days	Mon 4/30/01	Mon 4/30/01
2	**Concrete Superstructure**	**163 days**	**Mon 4/30/01**	**Wed 12/12/01**
3	**Level 2 Columns**	**5 days**	**Mon 4/30/01**	**Fri 5/4/01**
4	Form	4 days	Mon 4/30/01	Thu 5/3/01
5	Reinforce	2 days	Wed 5/2/01	Thu 5/3/01
6	Pour	1 day	Fri 5/4/01	Fri 5/4/01
7	**Level 2 Floor**	**9 days**	**Mon 5/7/01**	**Thu 5/17/01**
8	Shore	3 days	Mon 5/7/01	Wed 5/9/01
9	Form	5 days	Mon 5/7/01	Fri 5/11/01
10	Reinforce	2 days	Thu 5/10/01	Fri 5/11/01
11	Pour	2 days	Mon 5/14/01	Tue 5/15/01
12	Post Tension	2 days	Wed 5/16/01	Thu 5/17/01
13	**Level 3**	**8 days**	**Fri 5/18/01**	**Tue 5/29/01**
14	Shore	3 days	Fri 5/18/01	Tue 5/22/01
15	Form	5 days	Fri 5/18/01	Thu 5/24/01
16	Reinforce	2 days	Tue 5/22/01	Wed 5/23/01
17	Pour	2 days	Thu 5/24/01	Fri 5/25/01
18	Post Tension	2 days	Mon 5/28/01	Tue 5/29/01
19	**Level 4**	**9 days**	**Wed 5/30/01**	**Mon 6/11/01**
20	Shore	3 days	Wed 5/30/01	Fri 6/1/01
21	Form	5 days	Wed 5/30/01	Tue 6/5/01
22	Reinforce	2 days	Thu 5/31/01	Fri 6/1/01
23	Pour	2 days	Wed 6/6/01	Thu 6/7/01
24	Post Tension	2 days	Fri 6/8/01	Mon 6/11/01
25	**Level 5**	**9 days**	**Tue 6/12/01**	**Fri 6/22/01**
26	Shore	3 days	Tue 6/12/01	Thu 6/14/01
27	Form	5 days	Tue 6/12/01	Mon 6/18/01
28	Reinforce	2 days	Tue 6/12/01	Wed 6/13/01
29	Pour	2 days	Tue 6/19/01	Wed 6/20/01
30	Post Tension	2 days	Thu 6/21/01	Fri 6/22/01
31	**Level 6**	**9 days**	**Mon 6/25/01**	**Thu 7/5/01**
37	**Level 7**	**9 days**	**Fri 7/6/01**	**Wed 7/18/01**
43	**Level 8**	**9 days**	**Thu 7/19/01**	**Tue 7/31/01**
49	**Level 9**	**9 days**	**Wed 8/1/01**	**Mon 8/13/01**
55	**Level 10**	**9 days**	**Tue 8/14/01**	**Fri 8/24/01**
61	**Level 11**	**9 days**	**Mon 8/27/01**	**Thu 9/6/01**
67	**Level 11**	**8 days**	**Fri 9/7/01**	**Tue 9/18/01**
73	**Level 12**	**9 days**	**Wed 9/19/01**	**Mon 10/1/01**
79	**Level 13**	**9 days**	**Tue 10/2/01**	**Fri 10/12/01**
85	**Level 14**	**9 days**	**Mon 10/15/01**	**Thu 10/25/01**
91	**Level 14**	**8 days**	**Fri 10/26/01**	**Tue 11/6/01**
97	**Level 15**	**9 days**	**Wed 11/7/01**	**Mon 11/19/01**
103	**Level 16**	**9 days**	**Tue 11/20/01**	**Fri 11/30/01**
109	**Rooftop**	**8 days**	**Mon 12/3/01**	**Wed 12/12/01**



Project: Concrete-pumped
Date: Thu 4/6/06

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

Appendix F: Mechanical System

RETScreen® Energy Model - Ground-Source Heat Pump Project

Training & Support

Site Conditions		Estimate	Notes/Range
Project name		**Eight Tower Bridge**	See Online Manual
Project location		**Conshohocken, PA**	
Available land area	m²	3,716	
Soil type	-	Heavy soil - damp	
Design heating load	kW	45.3	→ Complete H&CLC sheet
Design cooling load	kW	123.4	

System Characteristics		Estimate	Notes/Range
Base Case HVAC System			
Building has air-conditioning?	yes/no	Yes	
Heating fuel type	-	**Electricity**	
Heating system seasonal efficiency	%	85%	55% to 350%
Air-conditioner seasonal COP	-	3.0	2.4 to 5.0
Ground Heat Exchanger System			
System type	-	Vertical closed-loop	
Design criteria	-	Cooling	
Typical land area required	m²	876	
Ground heat exchanger layout	-	Standard	
Total borehole length	m	3,054	
Heat Pump System			
Average heat pump efficiency	-	User-defined	See Product Database
Heat pump manufacturer		Trane	
Heat pump model		WPVJ060	
Standard cooling COP	-	4.50	
Standard heating COP	-	3.30	
Total standard heating capacity	kW	93.3	
	million Btu/h	0.318	
Total standard cooling capacity	kW	121.3	
	ton (cooling)	34.5	
Supplemental Heating and Heat Rejection System			
Suggested supplemental heating capacity	kW	0.0	
	million Btu/h	0.000	
Suggested supplemental heat rejection	kW	0.0	
	million Btu/h	0.000	

Annual Energy Production		Estimate	Notes/Range
Heating			
Electricity used	MWh	34.9	
Supplemental energy delivered	MWh	0.0	
GSHP heating energy delivered	MWh	**88.4**	
	million Btu	301.5	
Seasonal heating COP	-	2.5	2.0 to 5.0
Cooling			
Electricity used	MWh	47.5	
GSHP cooling energy delivered	MWh	**205.0**	
	million Btu	699.3	
Seasonal cooling COP	-	4.3	2.0 to 5.5
Seasonal cooling EER	(Btu/h)/W	14.7	7.0 to 19.0
			Complete Cost Analysis sheet

RETScreen® Heating and Cooling Load Calculation - Ground-Source Heat Pump Project

Site Conditions		Estimate	Notes/Range
Nearest location for weather data		Philadelphia, PA	See Weather Database
Heating design temperature	°C	-6.5	-40.0 to 15.0
Cooling design temperature	°C	27.3	10.0 to 40.0
Average summer daily temperature range	°C	7.3	5.0 to 15.0
Cooling humidity level	-	Medium	
Latitude of project location	°N	39.9	-90.0 to 90.0
Mean earth temperature	°C	11.7	Visit NASA satellite data site
Annual earth temperature amplitude	°C	18.4	5.0 to 20.0
Depth of measurement of earth temperature	m	0.0	0.0 to 3.0

Building Heating and Cooling Load		Estimate	Notes/Range
Type of building	-	Commercial	
Available information	-	Descriptive data	
Building floor area	m²	2,000	
Number of floors	floor	16	1 to 6
Window area	-	Standard	
Insulation level	-	Medium	
Occupancy type	-	Daytime	
Equipment and lighting usage	-	Moderate	
Building design heating load	kW	45.3	
	million Btu/h	0.155	
Building heating energy demand	MWh	88.4	
	million Btu	301.5	
Building design cooling load	kW	123.4	
	ton (cooling)	35.1	
Building cooling energy demand	MWh	205.0	
	million Btu	699.3	Return to Energy Model sheet

RETScreen® Cost Analysis - Ground-Source Heat Pump Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Other - Feasibility Study	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Development							
Other - Development	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Engineering							
Other - Engineering	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Energy Equipment							
Heat pumps	kW cooling	121.3	$ 330	$ 40,029		-	-
Well pumps	kW	0.0	$ -	$ -		-	-
Circulating pumps	kW	2.1	$ 850	$ 1,753		-	-
Circulating fluid	m³	0.54	$ 2,600	$ 1,403		-	-
Plate heat exchangers	kW	0.0	$ -	$ -		-	-
Trenching and backfilling	m	0	$ -	$ -		-	-
Drilling and grouting	m	3,054	$ 12.00	$ 36,646		-	-
Ground HX loop pipes	m	6,108	$ 2.50	$ 15,269		-	-
Fittings and valves	kW cooling	121.3	$ 12.00	$ 1,456		-	-
Other - Energy Equipment	Cost	0	$ -	$ -		-	-
Electric central heating system	Credit	1	$ 20,000	$ (20,000)		-	-
Sub-total:				**$ 76,555**	79.4%		
Balance of System							
Supplemental heating system	kW	0.0	$ -	$ -		-	-
Supplemental heat rejection	kW	0.0	$ -	$ -		-	-
Internal piping and insulation	kW cooling	121.3	$ 60	$ 7,278		-	-
Other - Balance of System	Cost	0	$ -	$ -		-	-
Credit - Balance of System	Credit	1	$ 1,000	$ (1,000)		-	-
Sub-total:				**$ 6,278**	6.5%		
Miscellaneous							
Training	p-h	14	$ 70	$ 980		-	-
Contingencies	%	15%	$ 83,813	$ 12,572		-	-
Sub-total:				**$ 13,552**	14.1%		
Initial Costs - Total				**$ 96,385**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Property taxes/Insurance	project	0	$ -	$ -		-	-
O&M labour	m²	1,000	$ 2.50	$ 2,500		-	-
Travel and accommodation	p-trip	0	$ -	$ -		-	-
Other - O&M	Cost	0	$ -	$ -		-	-
Credit - O&M	Credit	1	$ 3,500	$ (3,500)		-	-
Contingencies	%	5%	$ 82,833	$ 4,142		-	-
Sub-total:				**$ 3,142**	51.0%		
Fuel/Electricity							
Electricity	kWh	**82,338**	**$ 0.060**	$ 4,940		-	-
Incremental electricity load	kW	**-16.0**	**$ 120**	$ (1,923)		-	-
Sub-total:				**$ 3,018**	49.0%		
Annual Costs - Total				**$ 6,159**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Heat pump compressor	Cost	10 yr	$ 5,000	**$ 5,000**	-	-
Air-conditioner replacement	Credit	12 yr	$ 6,000	**$ (6,000)**	-	-
				$ -	-	-
End of project life	Credit	-	$ 2,000	**$ (2,000)**		*Go to GHG Analysis sheet*

RETScreen® Financial Summary - Ground-Source Heat Pump Project

Annual Energy Balance

Project name		Eight Tower Bridge	Electricity required	MWh	82.3
Project location		Conshohocken, PA	Incremental electricity load	kW	(16.0)
Heating energy delivered	MWh	88.4			
Cooling energy delivered	MWh	205.0			
Heating fuel displaced	-	Electricity			

Financial Parameters

Avoided cost of heating energy	$/kWh	0.060	Debt ratio	%	0.0%
			Income tax analysis?	yes/no	No
Retail price of electricity	$/kWh	0.060			
Demand charge	$/kW	120			
Energy cost escalation rate	%	2.0%			
Inflation	%	2.0%			
Discount rate	%	10.0%			
Project life	yr	25			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	0.0%	$	-	O&M	$	3,142
Development	0.0%	$	-	Fuel/Electricity	$	3,018
Engineering	0.0%	$	-			
Energy equipment	79.4%	$	76,555	**Annual Costs and Debt - Total**	**$**	**6,159**
Balance of system	6.5%	$	6,278			
Miscellaneous	14.1%	$	13,552	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**96,385**	Heating energy savings/income	$	6,237
				Cooling energy savings/income	$	4,099
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**10,336**
Periodic Costs (Credits)						
Heat pump compressor		$	5,000	Schedule yr # 10,20		
Air-conditioner replacement		$	(6,000)	Schedule yr # 12,24		
		$	-			
End of project life - Credit		$	(2,000)	Schedule yr # 25		

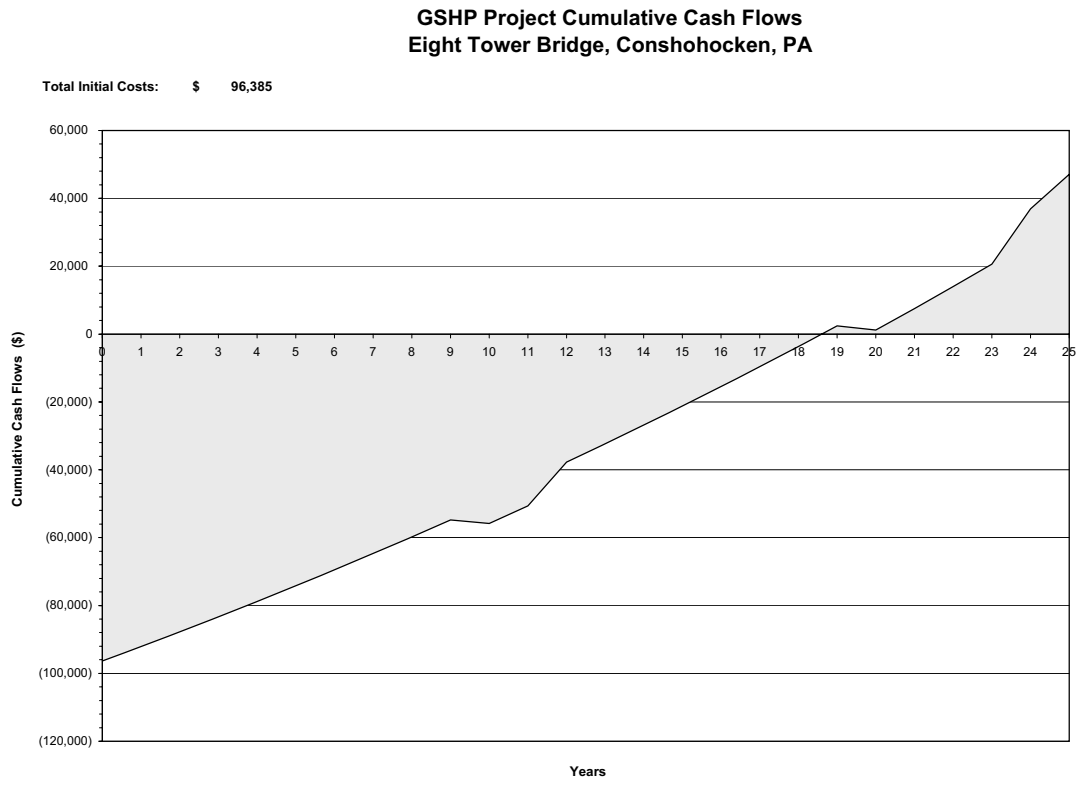
Financial Feasibility

Pre-tax IRR and ROI	%	2.9%			
After-tax IRR and ROI	%	2.9%			
Simple Payback	yr	23.1	Project equity	$	96,385
Year-to-positive cash flow	yr	18.6			
Net Present Value - NPV	$	(50,942)			
Annual Life Cycle Savings	$	(5,612)			
Benefit-Cost (B-C) ratio	-	0.47			

Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(96,385)	(96,385)	(96,385)
1	4,260	4,260	(92,125)
2	4,346	4,346	(87,779)
3	4,432	4,432	(83,347)
4	4,521	4,521	(78,826)
5	4,612	4,612	(74,214)
6	4,704	4,704	(69,511)
7	4,798	4,798	(64,713)
8	4,894	4,894	(59,819)
9	4,992	4,992	(54,827)
10	(1,003)	(1,003)	(55,831)
11	5,193	5,193	(50,637)
12	12,907	12,907	(37,731)
13	5,403	5,403	(32,328)
14	5,511	5,511	(26,816)
15	5,621	5,621	(21,195)
16	5,734	5,734	(15,461)
17	5,849	5,849	(9,613)
18	5,966	5,966	(3,647)
19	6,085	6,085	2,438
20	(1,223)	(1,223)	1,214
21	6,331	6,331	7,545
22	6,457	6,457	14,002
23	6,586	6,586	20,589
24	16,369	16,369	36,957
25	10,134	10,134	47,091

Cumulative Cash Flows Graph



RETScreen® Energy Model - Ground-Source Heat Pump Project

Training & Support

Site Conditions		Estimate	Notes/Range
Project name		**Eight Tower Bridge**	See Online Manual
Project location		**Conshohocken, PA**	
Available land area	m²	3,716	
Soil type	-	Heavy soil - damp	
Design heating load	kW	45.3	→ Complete H&CLC sheet
Design cooling load	kW	123.4	

System Characteristics		Estimate	Notes/Range
Base Case HVAC System			
Building has air-conditioning?	yes/no	Yes	
Heating fuel type	-	**Electricity**	
Heating system seasonal efficiency	%	85%	55% to 350%
Air-conditioner seasonal COP	-	3.0	2.4 to 5.0
Ground Heat Exchanger System			
System type	-	Vertical closed-loop	
Design criteria	-	Heating	
Typical land area required	m²	263	
Ground heat exchanger layout	-	Standard	
Total borehole length	m	938	
Heat Pump System			
Average heat pump efficiency	-	User-defined	See Product Database
Heat pump manufacturer		Trane	
Heat pump model		WPVJ060	
Standard cooling COP	-	4.50	
Standard heating COP	-	3.30	
Total standard heating capacity	kW	93.3	
	million Btu/h	0.318	
Total standard cooling capacity	kW	121.3	
	ton (cooling)	34.5	
Supplemental Heating and Heat Rejection System			
Suggested supplemental heating capacity	kW	0.0	
	million Btu/h	0.000	
Suggested supplemental heat rejection	kW	85.5	
	million Btu/h	0.292	

Annual Energy Production		Estimate	Notes/Range
Heating			
Electricity used	MWh	33.0	
Supplemental energy delivered	MWh	0.0	
GSHP heating energy delivered	MWh	**88.4**	
	million Btu	301.5	
Seasonal heating COP	-	2.7	2.0 to 5.0
Cooling			
Electricity used	MWh	46.3	
GSHP cooling energy delivered	MWh	**205.0**	
	million Btu	699.3	
Seasonal cooling COP	-	4.4	2.0 to 5.5
Seasonal cooling EER	(Btu/h)/W	15.1	7.0 to 19.0
			Complete Cost Analysis sheet

RETScreen® Heating and Cooling Load Calculation - Ground-Source Heat Pump Project

Site Conditions		Estimate	Notes/Range
Nearest location for weather data		Philadelphia, PA	See Weather Database
Heating design temperature	°C	-6.5	-40.0 to 15.0
Cooling design temperature	°C	27.3	10.0 to 40.0
Average summer daily temperature range	°C	7.3	5.0 to 15.0
Cooling humidity level	-	Medium	
Latitude of project location	°N	39.9	-90.0 to 90.0
Mean earth temperature	°C	11.7	Visit NASA satellite data site
Annual earth temperature amplitude	°C	18.4	5.0 to 20.0
Depth of measurement of earth temperature	m	0.0	0.0 to 3.0

Building Heating and Cooling Load		Estimate	Notes/Range
Type of building	-	Commercial	
Available information	-	Descriptive data	
Building floor area	m²	2,000	
Number of floors	floor	16	1 to 6
Window area	-	Standard	
Insulation level	-	Medium	
Occupancy type	-	Daytime	
Equipment and lighting usage	-	Moderate	
Building design heating load	kW	45.3	
	million Btu/h	0.155	
Building heating energy demand	MWh	88.4	
	million Btu	301.5	
Building design cooling load	kW	123.4	
	ton (cooling)	35.1	
Building cooling energy demand	MWh	205.0	
	million Btu	699.3	Return to Energy Model sheet

RETScreen® Cost Analysis - Ground-Source Heat Pump Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Other - Feasibility Study	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Development							
Other - Development	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Engineering							
Other - Engineering	Cost	0	$ -	$ -		-	-
Sub-total:				**$ -**	0.0%		
Energy Equipment							
Heat pumps	kW cooling	121.3	$ 330	$ 40,029		-	-
Well pumps	kW	0.0	$ -	$ -		-	-
Circulating pumps	kW	2.1	$ 850	$ 1,753		-	-
Circulating fluid	m³	0.17	$ 2,600	$ 431		-	-
Plate heat exchangers	kW	0.0	$ -	$ -		-	-
Trenching and backfilling	m	0	$ -	$ -		-	-
Drilling and grouting	m	938	$ 12.00	$ 11,257		-	-
Ground HX loop pipes	m	1,876	$ 2.50	$ 4,690		-	-
Fittings and valves	kW cooling	121.3	$ 12.00	$ 1,456		-	-
Other - Energy Equipment	Cost	0	$ -	$ -		-	-
Electric central heating system	Credit	1	$ 20,000	$ (20,000)		-	-
Sub-total:				**$ 39,616**	73.5%		
Balance of System							
Supplemental heating system	kW	0.0	$ -	$ -		-	-
Supplemental heat rejection	kW	85.5	$ -	$ -		-	-
Internal piping and insulation	kW cooling	121.3	$ 60	$ 7,278		-	-
Other - Balance of System	Cost	0	$ -	$ -		-	-
Credit - Balance of System	Credit	1	$ 1,000	$ (1,000)		-	-
Sub-total:				**$ 6,278**	11.6%		
Miscellaneous							
Training	p-h	14	$ 70	$ 980		-	-
Contingencies	%	15%	$ 46,873	$ 7,031		-	-
Sub-total:				**$ 8,011**	14.9%		
Initial Costs - Total				**$ 53,905**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Property taxes/Insurance	project	0	$ -	$ -		-	-
O&M labour	m²	1,000	$ 2.50	$ 2,500		-	-
Travel and accommodation	p-trip	0	$ -	$ -		-	-
Other - O&M	Cost	0	$ -	$ -		-	-
Credit - O&M	Credit	1	$ 3,500	$ (3,500)		-	-
Contingencies	%	5%	$ 45,893	$ 2,295		-	-
Sub-total:				**$ 1,295**	30.7%		
Fuel/Electricity							
Electricity	kWh	**79,314**	**$ 0.060**	$ 4,759		-	-
Incremental electricity load	kW	**-15.3**	**$ 120**	$ (1,833)		-	-
Sub-total:				**$ 2,926**	69.3%		
Annual Costs - Total				**$ 4,220**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Heat pump compressor	Cost	10 yr	$ 5,000	**$ 5,000**	-	-
Air-conditioner replacement	Credit	12 yr	$ 6,000	**$ (6,000)**	-	-
				$ -	-	-
End of project life	Credit	-	$ 2,000	**$ (2,000)**		Go to GHG Analysis sheet

RETScreen® Financial Summary - Ground-Source Heat Pump Project

Annual Energy Balance

Project name		Eight Tower Bridge	Electricity required	MWh	79.3
Project location		Conshohocken, PA	Incremental electricity load	kW	(15.3)
Heating energy delivered	MWh	88.4			
Cooling energy delivered	MWh	205.0			
Heating fuel displaced	-	Electricity			

Financial Parameters

Avoided cost of heating energy	$/kWh	0.060	Debt ratio	%	0.0%
			Income tax analysis?	yes/no	No
Retail price of electricity	$/kWh	0.060			
Demand charge	$/kW	120			
Energy cost escalation rate	%	2.0%			
Inflation	%	2.0%			
Discount rate	%	10.0%			
Project life	yr	25			

Project Costs and Savings

Initial Costs			**Annual Costs and Debt**		
Feasibility study	0.0%	$ -	O&M	$	1,295
Development	0.0%	$ -	Fuel/Electricity	$	2,926
Engineering	0.0%	$ -			
Energy equipment	73.5%	$ 39,616	**Annual Costs and Debt - Total**	**$**	**4,220**
Balance of system	11.6%	$ 6,278			
Miscellaneous	14.9%	$ 8,011	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$ 53,905**	Heating energy savings/income	$	6,237
			Cooling energy savings/income	$	4,099
Incentives/Grants		$ -			
			Annual Savings - Total	**$**	**10,336**
Periodic Costs (Credits)					
Heat pump compressor		$ 5,000	Schedule yr # 10,20		
Air-conditioner replacement		$ (6,000)	Schedule yr # 12,24		
		$ -			
End of project life - Credit		$ (2,000)	Schedule yr # 25		

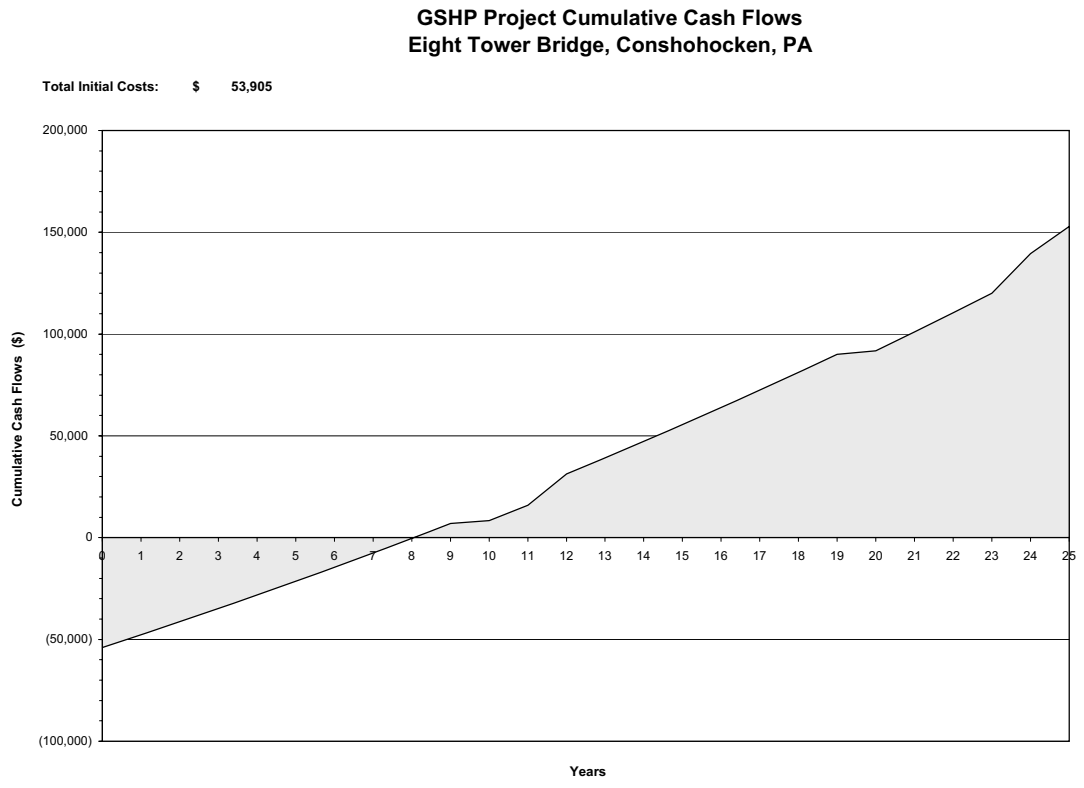
Financial Feasibility

Pre-tax IRR and ROI	%	12.6%			
After-tax IRR and ROI	%	12.6%			
Simple Payback	yr	8.8	Project equity	$	53,905
Year-to-positive cash flow	yr	8.0			
Net Present Value - NPV	$	12,518			
Annual Life Cycle Savings	$	1,379			
Benefit-Cost (B-C) ratio	-	1.23			

Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(53,905)	(53,905)	(53,905)
1	6,238	6,238	(47,666)
2	6,363	6,363	(41,304)
3	6,490	6,490	(34,813)
4	6,620	6,620	(28,193)
5	6,752	6,752	(21,441)
6	6,887	6,887	(14,554)
7	7,025	7,025	(7,529)
8	7,166	7,166	(363)
9	7,309	7,309	6,946
10	1,360	1,360	8,306
11	7,604	7,604	15,910
12	15,366	15,366	31,276
13	7,911	7,911	39,188
14	8,070	8,070	47,257
15	8,231	8,231	55,488
16	8,396	8,396	63,884
17	8,564	8,564	72,448
18	8,735	8,735	81,182
19	8,910	8,910	90,092
20	1,658	1,658	91,750
21	9,270	9,270	101,020
22	9,455	9,455	110,474
23	9,644	9,644	120,118
24	19,488	19,488	139,606
25	13,315	13,315	152,921

Cumulative Cash Flows Graph



IRR and ROI: 12.6% **Year-to-positive cash flow: 8 yr** **Net Present Value: $ 12,518**

Extra High Efficiency Vertical Water-Source Comfort System

1 1/2 -6 Tons – 60 HZ

February 2005 WSHP-PRC005-EN
E9

Introduction

A feature summary for the WPVJ unit includes:

1 High efficiency scroll Compressor

2 Co-axial Heat Exchanger *(copper or cupro-nickel)*

3 Right or Left Return-Air *Option*

4 75 VA Transformer *ZN510 Control Option*

5 Galvanized Finish

6 Thermal Expansion Metering designed for 25 to 120°F Range

7 1-inch FPT Connections

8 Acoutical Features

9 Choice of Standard Static or High Static Blower Motor

10 Removable, Cleanable Drain Pan

11 Integrated Controls

12 Factory Installed Desuperheater *Option*

13 Boilerless (external electric heat) Control *Option*

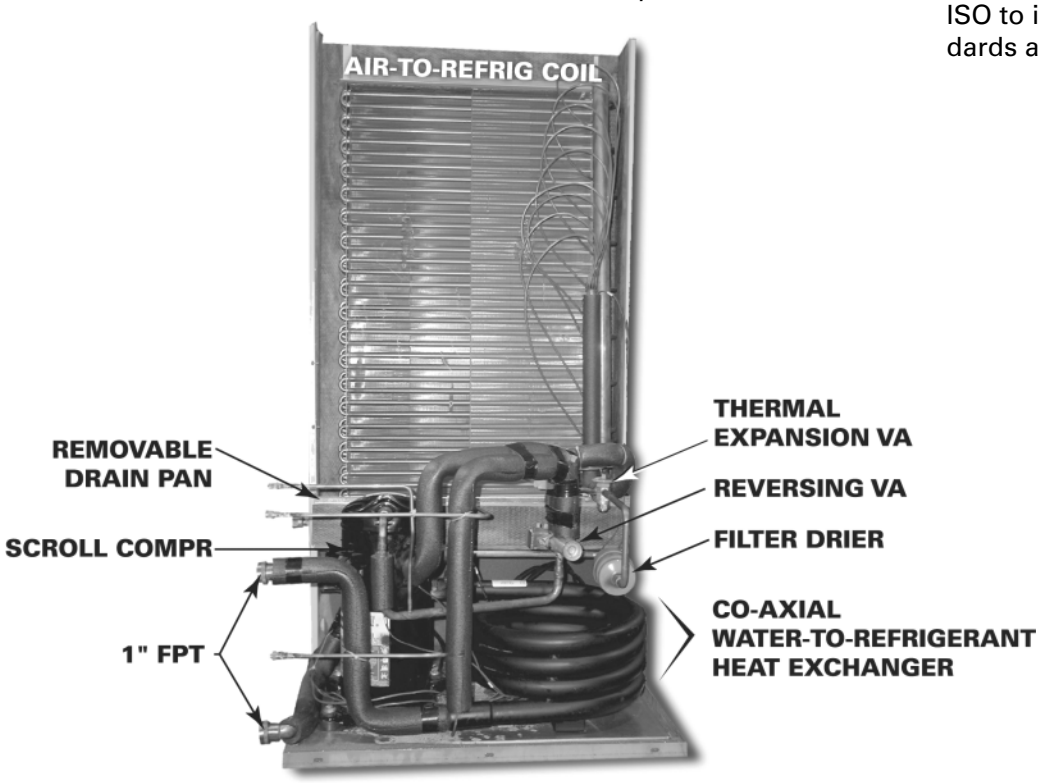
14 Leaving Water Freezestat 35° or 20° *Option*

The units are rated to ISO 13256-1 to provide an up-to-date configurations for today.

The units may be applied in a boiler/cooling tower setting, or in a geothermal closed or open loop application.

All units accommodate service access to the controls, blower motor and other major components to contribute to greater serviceability and maintainability of the unit.

Each unit is verified for total unit performance before shipping from the Waco Business Unit. Our equipment must meet the industry standards developed by ARI and ISO to insure global quality standards are inherent in every unit.



Features and Benefits

Unit Description
The cabinet design incorporates sturdy metal with a durable and corrosive resistive exterior galvanized finish. Before shipment, each unit is leak tested, dehydrated, charged with refrigerant and run tested for proper control operation.

The cabinet insulation meets UL 181 requirements. The air stream surface of the insulation is fabricated of a non-biodegradable source. The insulation in the wet section of the cabinet complies with ASHRAE standard 62 to accommodate indoor air quality (IAQ) standards.

Sound
The units operate quietly, with noise ratings of NC 40 to 45 in typical installations. All units have a thermal/acoustical insulated partition between the blower and compressor compartments to attenuate compressor noise and rumble.

Fan motors and compressors are internally isolated to reduce vibration. A compressor base plate and full-length channel stiffeners are installed to further reduce vibration.

Compressor
All units are equipped with a high efficiency scroll compressor to aid in the reduction of sound, increases reliability and provides a more efficient operation.

Condensate Pan
Each unit is equipped with a removable, cleanable condensate (drain) pan. It is removable from the unit to provide a means of cleaning the drain pan which is important to the improvement of indoor air quality. The condensate pan is designed to allow the condensate formed from the air-to-refrigerant coil to drain freely, discouraging condensate buildup and microbial growth in the pan.

Filter Rack and Filter
Each unit is equipped with an accessible filter rack to house a 1-inch or 2-inch *(option)* standard sized disposable fiberglass filter.

Filter Drier
Every unit is equipped with a bi-directional filter drier to dehydrate and clean the system, adding to the life of the unit.

Refrigeration Circuit
The 1-1/2 to 6-ton units incorporate a single circuit refrigeration design. All heat pump designs include a system reversing valve, thermal expansion valve, air-to-refrigerant coil, water-to-refrigerant coil, and compressor selected for the best optimization and efficiency of each circuit.

Air-to-Refrigerant Coil
The air-to-refrigerant coil is aluminum fin, mechanically bonded to the copper tubing.

Water-to-Refrigerant Coil
The water-to-refrigerant coil is a copper or cupro-nickel *(option)* coil within a coil (steel tube) design. It is leak tested to assure there is no cross leakage between the water tube (copper/cupro-nickel) and refrigerant gas (steel tube). The inner-tube of the coil is deeply fluted to enhance heat transfer, and to minimize fouling and scaling. *See Figure 1*.

Figure 1: Coaxial heat exchanger

Expansion Valve
The refrigerant flow metering is made through a thermal expansion valve (TXV). The TXV allows the unit to operate with an entering fluid temperature from 25 F to 120 F, and an entering air temperature from 55 F to 85 F. The valve precisely meters refrigerant flow through the circuitry to achieve desired heating or cooling. *See Figure 2.*

Unlike cap-tube assemblies, the TXV allows the exact amount of refrigerant required to meet the coil load demands. This precise metering increases the over-all efficiency of the unit.

Figure 2: Expansion valve

Features and Benefits

Unit Safety
All unit safety devices are provided to prevent compressor damage. Low and high pressure switches are added to protect the compressor operation under a low charge or during high discharge pressures. The low pressure switch is set to activate at refrigerant pressures of 20 psig, and the high pressure switch de-energizes the compressor when discharge pressure exceeds 395 psig. A safety lockout relay is designed to turn off the compressor, and the desuperheater pump if a problem is detected.

Duct Collar
A return-air duct collar is provided with each unit for adequate connection of duct work to the unit. Using the duct collar, ductwork may be easily fastened to the unit, eliminating the need for extra sheet metal work. In many applications, when the ductwork is insulated, the performance of the unit is enhanced.

Blower and Motor
The blower motor may be ordered as either a standard static, or a high static option. The multi-speed blower motor contains internal thermal overload protection. The motor bearings are permanently lubricated and sealed. Standard motors are rated up to .85 ESP. Optional high static motors are rated up to 1.35 ESP. The multi-speed motor offers the flexibility of manually changing the speed of the blower to adapt to various duct designs. *See Figure 3*.

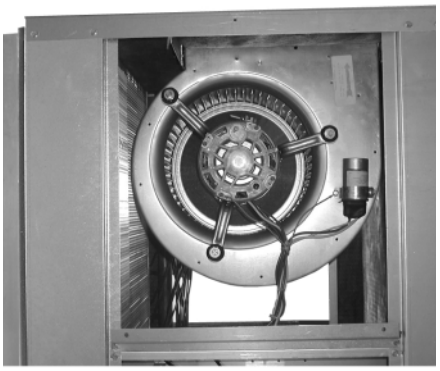


Figure 3: Blower and motor

Refrigerant and Service Ports
The unit includes high and low-side service ports and a water regulating valve connection external to the unit to provide quicker access during start-up and in a service situation.

Filters
The unit filters are removable from the front or back side of the unit, offering added flexibility for installation and replacing the standard, 1-inch or 2-inch disposable fiberglass filters. The hinged door feature of the filter rack allows the filter to be removed without detaching duct work.

Access Panels
The unit contains three, removable access panels (two front, one rear) for access to internal components. The majority of the unit's components may be readily reached through the two front access panels.

Water Connections
The water-in/water-out connections are constructed of copper material and include a National Female Pipe Thread (NFPT) junction.

Desuperheater and Pump
(Optional)
Through this desuperheater option, the high (hot) pressure energy that is rejected by the unit in cooling mode may be transfered to the facilities hot water heater through a water heater hook-up kit for virtually free hot water heating. This factory installed option provides higher efficiencies through the overall energy consumption by reducing the amount of time the hot water heater runs.

The desuperheater is controlled by two temperature control sensor. One sensor monitors the temperature of the compressor's discharge line. The desuperheater pump cannot operate until the compressor line reaches 145 F. The other sensor monitors the water temperature of the hot water heater. The desuperheater will automatically shut off if the water reaches 125 F to prevent scalding. For hook-up information pertaining to the desuperheater/hot water hook-up option see WSHPC-IN-4.

Leaving Water Freeze stat
(Optional)
A leaving water freeze stat may be provided with either a 35° or 20° trip point. The WPVJ model is standardly equipped with a low pressure switch to help detect water freeze-up. However, a leaving water freeze stat is an additional protection device to help protect the water coil from freezing.

Note: When the units leaving water falls below the designated trip point (35° or 20°), the unit will be placed in a lock-out (compressor off) mode.

Selection Procedure

The performance standard ARI/ ISO 13256-1 became effective Jan. 1, 2000. It replaces ARI standards 320, 325 and 330. This new standard has three major categories: Water Loop (ARI 320), Ground Water (ARI 325), Ground Loop (ARI 330). Although these standards are similar there are some differences.

The cooling efficiency is measured in EER but includes a Watt-per-Watt unit of measure similar to the traditional COP measurement.

The entering water temperature has changed to reflect the centigrade temperature scale. For instance the water loop heating test is performed with 68-degree F (20-degree C) water instead of 70-degree F. The cooling tests are performed with 80.6-degree F (27-degree C) dry bulb and 66.2-degree F (19-degree C) wet bulb entering air instead of the traditional 80-degree F dry bulb, and 67-degree F wet bulb entering air temperatures. This data (80.6/66.2) may be converted to 80/67 by using the entering air correction table.

A pump power correction has been added onto the existing power consumption. Within each model, only one water flow rate is specified for each performance category, and pumping watts are calculated utilizing the pump power correction formula: (gpm x 0.0631) x press drop x 2990) / 300

Note: gpm relates to water flow, and press drop relates to the drop through the unit heat exchanger at rated water flow in feet of head. The fan power is corrected to zero external static pressure. The nominal airflow is rated at a specific external static pressure. This effectively reduces the power consumption of the unit, and increases cooling capacity but decreases heating capacity. These watts are significant enough in most cases to increase EER and COP over ARI 320, 325, and 330 ratings.

Cooling Dominated Applications

If humidity levels are moderate to high in a cooling dominated application, the heat pump should be selected to meet or exceed the calculated sensible load. Also, the unit's sensible capacity should be no more than 115% of the total cooling load (sensible + latent), unless the calculated latent load is less than the latent capacity of the unit.

The sensible-to-total cooling ratio can be adjusted with airflow. If the airflow is lowered, the unit latent capacity will increase. When less air is pulled across the DX coil, more moisture will condense from the air.

Heating Dominated Applications

Unit sizing in heating dominated applications is based upon humidity levels for the climate, and goals for operating cost and installation costs.

If humidity levels are moderate, the heat pump should be selected with the heating capacity equal to 125% of the cooling load.

If humidity levels are low in the application and low operating cost is important, the heat pump and ground loop should be sized for 90% to 100% of the heating load.

If humidity levels are low and lower initial cost is important, then the heat pump and ground loop should be sized for 70% to 85% of the heating load, with the remaining load to be treated with electric resistance heat.

Installation cost will be reduced in this approach because of the smaller heat pump selection and less loop materials.

In general, the system will not use enough electric heat to offset the higher installation costs associated with a fully sized or oversized system.

Finally, a unit sized for the entire heating load in a heating dominated application will be oversized in cooling. Comfort is reduced from increased room humidity caused by short-run times. Short cycling will also shorten the life expectancy of the equipment and increase power consumption and operating cost.

Many rebate incentives require the heat pump and ground loop to be sized for the entire heating load. Check with you local utility for their requirements.

Model Number

Vertical Water-Source Heat Pump

W P V J 036 1 1 A 0 1 0 0 T L C 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 000
(5, 10, 15, 20, 25, 30)

DIGITS 1-3: UNIT CONFIGURATION
WPV = Extra High Efficiency Upflow Heat Pump

DIGIT 4: DEVELOPMENT SEQUENCE J

DIGITS 5-7: NOMINAL SIZE (MBH)
018 = 18.0 MBH
024 = 24.0 MBH
030 = 30.0 MBH
036 = 36.0 MBH
042 = 42.0 MBH
048 = 48.0 MBH
060 = 60.0 MBH
072 = 72.0 MBH

DIGIT 8: VOLTAGE (Volts/Hz/Phase)
1 = 208/60/1
2 = 230/60/1
3 = 208/60/3
4 = 460/60/3
5 = 575/60/3
7 = 265/60/1
8 = 230/60/3

DIGITS 9: HEAT EXCHANGER
1 = Copper-Water Coil
2 = Cupro-Nickel Water Coil

DIGITS 10: DESIGN SEQUENCE A

DIGITS 11: REFRIGERATION CIRCUIT
0 = Heating and Cooling Circuit
1 = Heating and Cooling Circuit with Desuperheater

DIGITS 12: BLOWER CONFIGURATION
1 = Standard Blower Motor
2 = High Static Blower Motor

DIGIT 13: FREEZE PROTECTION
0 = No Freeze Control
A = 20°F Freeze Stat
B = 35°F Freeze Stat

DIGIT 14: OPEN DIGIT = 0

DIGIT 15: SUPPLY-AIR ARRANGEMENT
T = Top Supply Air Arrangement

DIGIT 16: RETURN-AIR ARRANGEMENT
L = Left Return-Air Arrangement
R = Right Return-Air Arrangement

DIGIT 17: CONTROL TYPES
0 = Basic 24 V Controls
1 = Basic 24 V with Random Start/ Time Delay
C = Tracer ZN510 Controls

DIGITS 18: TSTAT/SENSOR LOCATION
0 = Wall Mounted Location

DIGITS 19: FAULT SENSORS
0 = No Fault Sensor
1 = Condensate Overflow Sensor
2 = Filter Maintenance Timer
3 = Condensate Overflow and Filter Maintenance Timer

DIGITS 20: TEMPERATURE SENSOR
0 = No Additional Temperature Sensor
1 = Entering Water Sensor

DIGITS 21: NIGHT SETBACK CONTROL
0 = No Night Setback Relay
N = Night Setback Relay

DIGITS 22: ELECTRIC HEAT
0 = No Electric Heat
4 = Boilerless Control with External Electric Heat

DIGITS 23: UNIT MOUNTED DISCONNECT
0 = No Unit Mounted Disconnect

DIGITS 24: FILTER TYPE
1 = 1" Throwaway Filter
2 = 2" Throwaway Filter

DIGITS 25: ACOUSTIC ARRANGEMENT
0 = Standard Factory Configuration

DIGITS 26: FACTORY CONFIGURATION
0 = Standard Factory Configuration

DIGITS 27: PAINT COLOR
0 = No Paint Selection Available

DIGITS 28: OUTSIDE AIR
0 = No Outside Air Option Available

DIGITS 29: PIPING ARRANGEMENT
1 = Standard Piping with Schrader Connection for Water Regulating Valve

DIGITS 30-36: DOES NOT APPLY TO WPVJ
0000000 = Digits 30-36 are not applicable to the WPVJ product

General Data

Table G1: General data about the units

Model		WPVJ 018	WPVJ 024	WPVJ 030	WPVJ 036
Unit Size	Depth (in)	21 1/2"	21 1/2"	27"	27"
	Height (in)	45"	45"	54 3/8"	54 3/8"
	Width (in) *includes filter*	22 1/4"	22 1/4"	23 3/4"	23 3/4"
Compressor Type		Scroll	Scroll	Scroll	Scroll
Approximate Weight	with Pallet (lb)	249	250	298	315
Approximate Weight	without Pallet (lb)	239	240	288	305
Air-to-Refrigerant Coil	no of rows	3	3	3	3
	Face Area (sq ft)	2.92	2.92	3.99	3.99
	Fins per inch	14	14	14	14
Filter Size	inches	16 x 20 x 1 (2)	16 x 20 x 1 (2)	20 x 25 x 1 (2)	20 x 25 x 1 (2)
Water in/out size (FPT)	inches	1	1	1	1
Condensate size (NPTI)	inches	3/4	3/4	3/4	3/4
Discharge-Air Collar	inches (L x H)	Not Provided			
Return-Air Collar	inches (L x H)	16 x 33	16 x 33	21 x 40 1/2	21 x 40 1/2
Refrigerant Charge	oz	58	62	73	66

Table G1: General data about the units *(continued)*

Model		WPVJ 042	WPVJ 048	WPVJ 060	WPVJ 072
Unit Size	Depth (in)	27"	31 1/2"	31 1/2"	31 1/2"
	Height (in)	54 3/8"	54 3/8"	54 3/8"	54 3/8"
	Width (in) *includes filter*	23 3/8"	26 1/4"	26 1/4"	26 1/4"
Compressor Type		Scroll	Scroll	Scroll	Scroll
Approximate Weight	with Pallet (lb)	324	398	439	440
Approximate Weight	without Pallet (lb)	314	388	429	430
Air-to-Refrigerant Coil	no of rows	3	3	3	3
	Face Area (sq ft)	5.13	5.56	6.94	6.94
	Fins per inch	14	14	14	14
Filter Size	inches	20 x 25 x 1 (2)	20 x 30 x 1 (2)	20 x 30 x 1 (2)	20 x 30 x 1 (2)
Water in/out size (FPT)	inches	1	1	1	1
Condensate size (NPTI)	inches	3/4	3/4	3/4	3/4
Discharge-Air Collar	inches (L x H)	Not Provided			
Return-Air Collar	inches (L x H)	21 x 40 1/2	26 x 40 1/2	26 x 40 1/2	26 x 40 1/2
Refrigerant Charge	oz	98	103	110	110

Performance Data
WPVJ 018-Cooling

Table P-2: 018 Cooling Performance

Performance data is tabulated for cooling at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM.

For conditions other than what is tabulated, multipliers must be used to correct performance. See the *fan correction factors table* for CFM other than rated and the *cooling correction factors* for variations in entering air temperature. WLHP data shown in **bold type** is performance data at ARI/ISO 13256-1. The **bold type** for GLHP is a rating point only. For ARI 13256-1 GLHP conditions, apply 15% methanol by volume per the antifreeze correction factors found on page 40.

Rated GPM 5.0 **Minimum CFM** 480
Rated CFM 600 **Maximum CFM** 720

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	DSH Mbtuh	Power kW	Reject Mbtuh	LWT	Feet Head	PSID Head	CFM	ISO Cap Mbtuh	ISO Power kW	ISO EER
45	3.3	21.0	14.6	0.70	0.7	0.96	24.3	59.7	4.7	2.04	600	21.5	0.84	25.6
45	4.0	21.2	14.7	0.69	0.6	0.94	24.4	57.2	6.4	2.77	600	21.7	0.82	26.5
45	4.5	21.3	14.8	0.69	0.6	0.93	24.5	55.9	7.7	3.33	600	21.8	0.82	26.6
45	5.0	21.5	14.8	0.69	0.6	0.92	24.6	54.8	9.1	3.94	600	22.0	0.81	27.2
45	5.3	21.5	14.9	0.69	0.5	0.91	24.6	54.3	10.0	4.33	600	22.0	0.81	27.2
45	5.8	21.6	14.9	0.69	0.5	0.90	24.7	53.5	11.5	4.98	600	22.1	0.81	27.3
45	6.0	21.7	15.0	0.69	0.5	0.90	24.8	53.3	12.2	5.28	600	22.2	0.81	27.4
55	3.3	20.5	14.3	0.70	1.6	1.06	24.1	69.6	4.4	1.91	600	21.0	0.94	22.3
55	4.0	20.6	14.5	0.70	1.5	1.04	24.2	67.1	6.0	2.60	600	21.1	0.92	22.9
55	4.5	20.8	14.5	0.70	1.5	1.03	24.3	65.8	7.2	3.12	600	21.3	0.92	23.2
55	5.0	20.9	14.6	0.70	1.5	1.01	24.4	64.8	8.5	3.68	600	21.4	0.90	23.8
55	5.3	20.9	14.6	0.70	1.4	1.01	24.4	64.2	9.4	4.07	600	21.4	0.91	23.5
55	5.8	21.0	14.7	0.70	1.4	1.00	24.4	63.4	10.8	4.68	600	21.5	0.91	23.6
55	6.0	21.1	14.7	0.70	1.4	1.00	24.5	63.2	11.4	4.94	600	21.6	0.91	23.7
68	3.3	19.6	13.9	0.71	2.4	1.21	23.7	82.4	4.0	1.73	600	20.1	1.08	18.6
68	4.0	19.8	14.0	0.71	2.4	1.19	23.9	80.0	5.5	2.38	600	20.3	1.07	19.0
68	4.5	19.9	14.0	0.70	2.3	1.17	23.9	78.6	6.6	2.86	600	20.4	1.05	19.4
68	5.0	20.0	14.1	0.71	2.3	1.16	24.0	77.6	7.9	3.42	600	20.5	1.05	19.5
68	5.3	20.0	14.2	0.71	2.3	1.15	23.9	77.0	8.6	3.72	600	20.5	1.04	19.7
68	5.8	20.1	14.2	0.71	2.2	1.15	24.0	76.3	10.0	4.33	600	20.6	1.05	19.6
68	6.0	20.2	14.3	0.71	2.2	1.14	24.1	76.0	10.6	4.59	600	20.7	1.05	19.7
77	3.3	18.9	13.4	0.71	2.6	1.34	23.5	91.3	3.8	1.65	600	19.4	1.21	16.0
77	4.0	19.0	13.6	0.72	2.5	1.32	23.5	88.8	5.2	2.25	600	19.5	1.20	16.3
77	4.5	19.2	13.6	0.71	2.5	1.30	23.6	87.5	6.3	2.73	600	19.7	1.18	16.7
77	**5.0**	**19.3**	**13.7**	**0.71**	**2.5**	**1.28**	**23.7**	**86.5**	**7.5**	**3.25**	**600**	**19.8**	**1.17**	**16.9**
77	5.3	19.3	13.7	0.71	2.4	1.27	23.6	85.9	8.2	3.55	600	19.8	1.16	17.1
77	5.8	19.4	13.8	0.71	2.4	1.26	23.7	85.2	9.5	4.11	600	19.9	1.16	17.2
77	6.0	19.5	13.8	0.71	2.4	1.26	23.8	85.0	10.1	4.37	600	20.0	1.16	17.2
86	3.3	18.1	13.0	0.72	2.7	1.50	23.2	100.1	3.6	1.56	600	18.6	1.37	13.6
86	4.0	18.3	13.1	0.72	2.6	1.47	23.3	97.7	5.0	2.17	600	18.8	1.35	13.9
86	4.5	18.4	13.2	0.72	2.6	1.44	23.3	96.4	6.0	2.60	600	18.9	1.32	14.3
86	**5.0**	**18.5**	**13.2**	**0.71**	**2.5**	**1.42**	**23.4**	**95.4**	**7.2**	**3.12**	**600**	**19.0**	**1.31**	**14.5**
86	5.3	18.5	13.3	0.72	2.5	1.42	23.4	94.9	7.9	3.42	600	19.0	1.31	14.5
86	5.8	18.6	13.3	0.72	2.5	1.40	23.4	94.1	9.1	3.94	600	19.1	1.30	14.7
86	6.0	18.6	13.4	0.72	2.5	1.40	23.4	93.8	9.7	4.20	600	19.1	1.30	14.7
95	3.3	17.3	12.5	0.72	2.7	1.68	23.0	109.0	3.5	1.52	600	17.8	1.55	11.5
95	4.0	17.4	12.6	0.72	2.7	1.64	23.0	106.6	4.7	2.04	600	17.9	1.52	11.8
95	4.5	17.5	12.7	0.73	2.6	1.62	23.0	105.3	5.8	2.51	600	18.0	1.50	12.0
95	5.0	17.6	12.8	0.73	2.6	1.59	23.0	104.3	6.9	2.99	600	18.1	1.48	12.2
95	5.3	17.6	12.8	0.73	2.6	1.58	23.0	103.7	7.6	3.29	600	18.1	1.47	12.3
95	5.8	17.7	12.9	0.73	2.6	1.57	23.1	103.0	8.8	3.81	600	18.2	1.47	12.4
95	6.0	17.8	12.9	0.72	2.5	1.56	23.1	102.7	9.3	4.03	600	18.3	1.46	12.5
105	3.3	16.2	12.0	0.74	2.8	1.92	22.8	118.9	3.3	1.43	600	16.7	1.79	9.3
105	4.0	16.4	12.1	0.74	2.8	1.87	22.8	116.5	4.5	1.95	600	16.9	1.75	9.7
105	4.5	16.4	12.2	0.74	2.7	1.84	22.7	115.2	5.5	2.38	600	16.9	1.72	9.8
105	5.0	16.5	12.2	0.74	2.7	1.82	22.7	114.2	6.6	2.86	600	17.0	1.71	9.9
105	5.3	16.6	12.3	0.74	2.7	1.80	22.7	113.6	7.3	3.16	600	17.1	1.69	10.1
105	5.8	16.7	12.4	0.74	2.6	1.79	22.8	112.9	8.5	3.68	600	17.2	1.69	10.2
105	6.0	16.7	12.4	0.74	2.6	1.78	22.8	112.7	9.0	3.90	600	17.2	1.68	10.2
115	3.3	15.1	11.5	0.76	3.0	2.21	22.6	128.9	3.1	1.36	600	15.6	2.08	7.50
115	4.0	15.2	11.6	0.76	2.9	2.15	22.5	126.4	4.4	1.89	600	15.7	2.03	7.73
115	4.5	15.3	11.6	0.76	2.9	2.12	22.5	125.1	5.3	2.32	600	15.8	2.00	7.90
115	5.0	15.4	11.7	0.76	2.8	2.08	22.5	124.1	6.4	2.77	600	15.9	1.97	8.07
115	5.3	15.4	11.7	0.76	2.8	2.07	22.5	123.6	7.1	3.06	600	15.9	1.96	8.11
115	5.8	15.5	11.8	0.76	2.8	2.04	22.5	122.8	8.2	3.57	600	16.0	1.94	8.25
115	6.0	15.5	11.8	0.76	2.8	2.04	22.5	122.6	8.7	3.78	600	16.0	1.94	8.25
120	3.3	14.5	11.2	0.77	3.1	2.37	22.6	133.9	3.1	1.33	600	15.0	2.24	6.70
120	4.0	14.6	11.3	0.77	3.0	2.31	22.5	131.4	4.3	1.85	600	15.1	2.19	6.89
120	4.5	14.7	11.3	0.77	3.0	2.27	22.5	130.1	5.3	2.28	600	15.2	2.15	7.07
120	5.0	14.8	11.4	0.77	2.9	2.24	22.5	129.1	6.3	2.73	600	15.3	2.13	7.18
120	5.3	14.8	11.5	0.78	2.9	2.22	22.4	128.5	7.0	3.02	600	15.3	2.11	7.25
120	5.8	14.9	11.5	0.77	2.9	2.19	22.4	127.8	8.1	3.52	600	15.4	2.09	7.37
120	6.0	14.9	11.6	0.78	2.9	2.18	22.3	127.5	8.6	3.73	600	15.4	2.08	7.40

E16