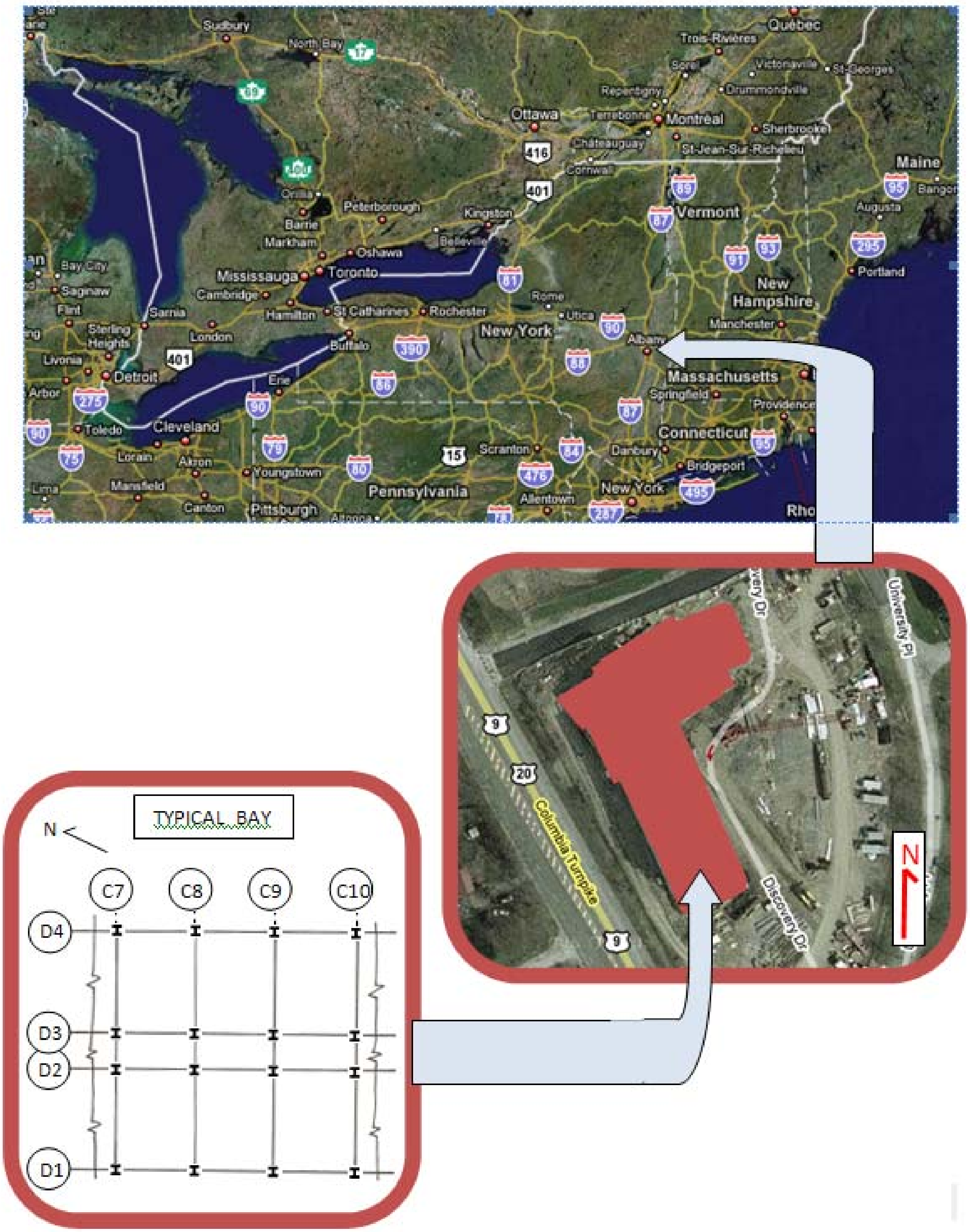
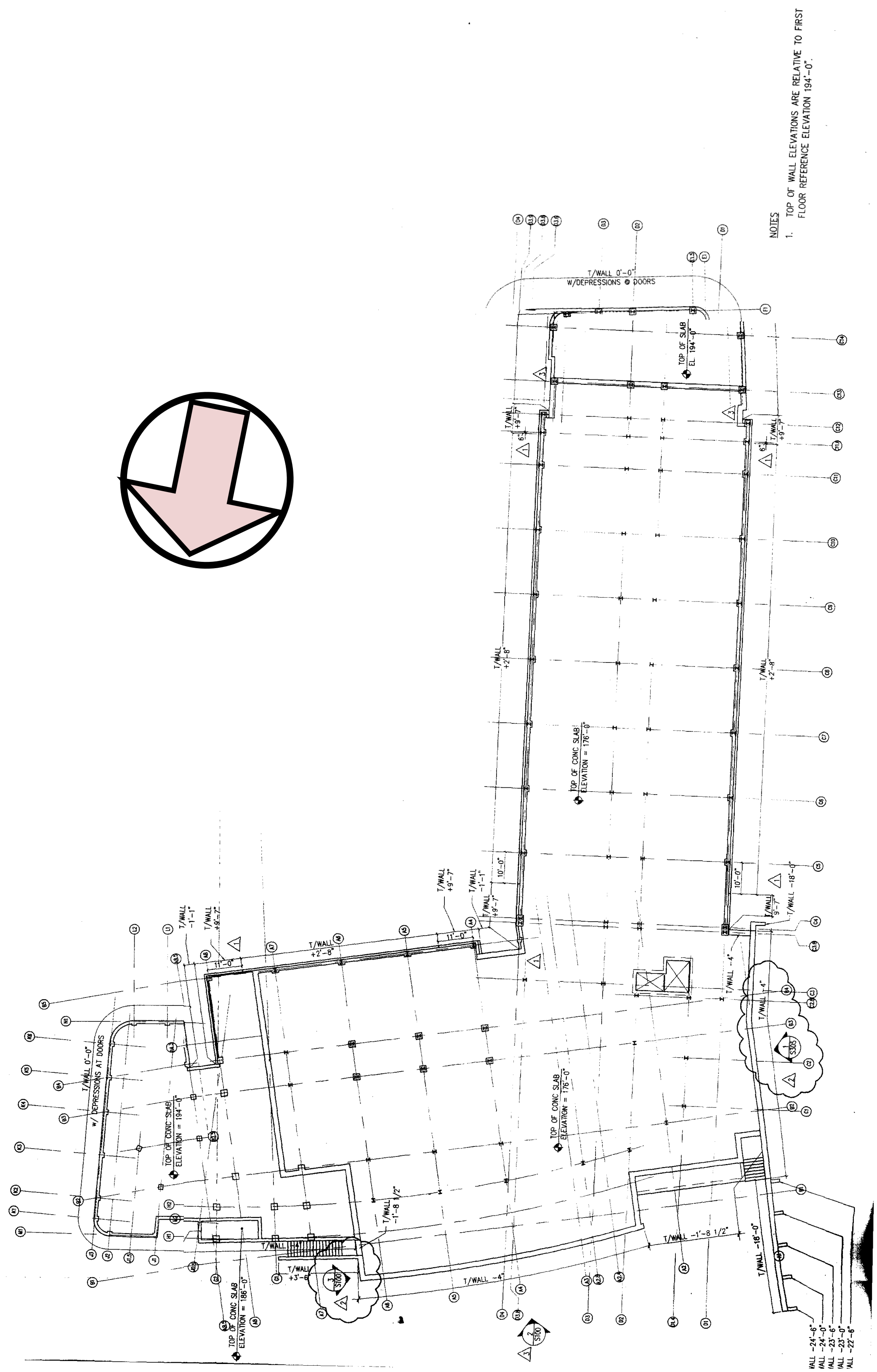
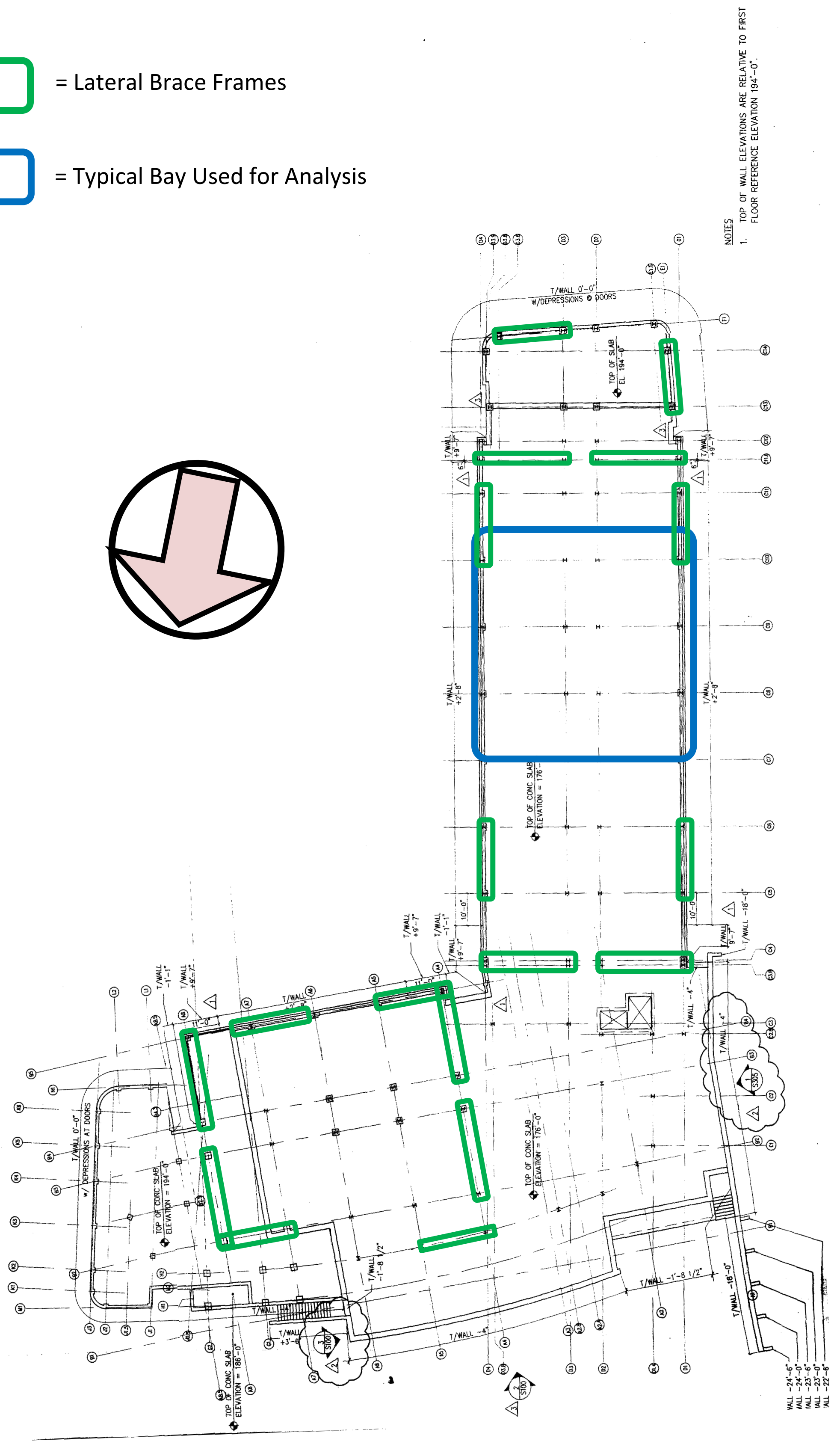

Sudbury
North Bay
Québec
Trois-Rivières
Sorel
Victoriaville
St-Georges
Drummondville
Repentigny
Ottawa
Terrebonne
Montréal
Sherbrooke
Châteauguay
St-Jean-Sur-Richelieu
Cornwall
Maine
Bangor
Augusta
Orillia
Peterborough
Kingston
Vermont
Barrie
Markham
Belleville
Oshawa
New Hampshire
Portland
Bay City
Saginaw
Flint
Mississauga
Toronto
Cambridge
Hamilton
St Catharines
Rochester
Rome
Utica
Manchester
Sarnia
Sterling Heights
London
New York
Albany
Livonia
Detroit
Buffalo
Massachusetts
Springfield
Providence
Arbor
Erie
Toledo
Cleveland
Connecticut
Lorain
Akron
Youngstown
Scranton
Danbury
Bridgeport
Mansfield
Canton
Pittsburgh
Pennsylvania
Allentown
New York
Lima
Altoona
Rho
Columbia Turnpike
Discovery Dr
University Pl
N
TYPICAL BAY
N
C7
C8
C9
C10
D4
D3
D2
D1


NOTES
1. TOP OF WALL ELEVATIONS ARE RELATIVE TO FIRST FLOOR REFERENCE ELEVATION 194'-0".
T/WALL 0'-0" W/DEPRESSIONS @ DOORS
TOP OF SLAB EL 194'-0"
TOP OF CONC SLAB ELEVATION = 176'-0"
TOP OF CONC SLAB ELEVATION = 194'-0"
TOP OF CONC SLAB ELEVATION = 186'-0"
T/WALL -18'-0"

= Lateral Brace Frames

= Typical Bay Used for Analysis



Breakdown of New Hershey Wind Loads

	Elevation	Height Above Base (ft)	Height Above Ground (ft)	K_1	K_2 (1- (12 /(1.4*40)))	K_3 (e^ -0.0625z)	K_{zt}	K_z	q_z
Penthouse	263'-0"	87.00	78.00	0.119	1.000	0.78	1.19	0.921	19.4
Roof	242'-0"	66.00	54.00	0.119	1.000	0.78	1.19	0.829	17.5
3rd	226'-0"	50.00	38.00	0.119	1.000	0.78	1.19	0.750	15.8
2nd	210'-0"	34.00	22.00	0.119	1.000	0.78	1.19	0.641	13.5
1st	194'-0"	18.00	6.00	0.119	1.000	0.78	1.19	0.442	9.3
Grade	188'-0"	12.00	0.00	0.119	1.000	0.78	1.19	0.570	12.0
Ground	176'-0"	0.00	-12.00	0.119	1.000	0.78	1.19	0.570	12.0
at h			67.20	0.119	1.000	0.78	1.19	0.878	18.5

BLDG SECT A	Elevation	Height Above Base (ft)	q_z	qGC_p (windward)	q_iGCp_i positive	q_iGCp_i negative	qGC_p (leeward)		Total WW (psf)	Total LW (psf)	Total Wind Load (psf)	Tributary Area (sf)	Load (kips)	Shear (kips)	Moment (ft-kips)
Penthouse	263'-0"	87.00	19.4	13.08	3.49	-3.33	-4.68	0.16	16.57	-8.01	24.58	3868	95.07	0	8271
Roof	242'-0"	66.00	17.5	11.77	3.14	-3.33	-4.68	-0.19	14.92	-8.01	22.92	3868	88.66	95.07	5852
3rd	226'-0"	50.00	15.8	10.65	2.84	-3.33	-4.68	-0.48	13.49	-8.01	21.50	3868	83.17	183.73	4158
2nd	210'-0"	34.00	13.5	9.10	2.43	-3.33	-4.68	-0.90	11.53	-8.01	19.54	3868	75.58	266.89	2570
1st	194'-0"	18.00	9.3	6.28	1.67	-3.33	-4.68	-1.65	7.95	-8.01	15.96	3868	61.73	342.47	1111
BASE	176'-0"	0.00							64.47	-40.03	104.49	19341	404.20	404.20	35166

BLDG SECT B	Elevation	Height Above Base (ft)	q_z	qGC_p (windward)	q_iGCp_i positive	q_iGCp_i negative	qGC_p (leeward)		Total WW (psf)	Total LW (psf)	Total Wind Load (psf)	Tributary Area (sf)	Load (kips)	Shear (kips)	Moment (ft-kips)
Penthouse	263'-0"	87.00	19.4	12.61	3.49	-3.33	-7.52	0.16	16.10	-10.85	26.95	1197	32.27	0	2807
Roof	242'-0"	66.00	17.5	11.35	3.14	-3.33	-7.52	-0.19	14.49	-10.85	25.34	1197	30.34	32.27	2002
3rd	226'-0"	50.00	15.8	10.27	2.84	-3.33	-7.52	-0.49	13.11	-10.85	23.96	1197	28.69	62.61	1434
2nd	210'-0"	34.00	13.5	8.78	2.43	-3.33	-7.52	-0.90	11.20	-10.85	22.05	1197	26.41	91.29	898
1st	194'-0"	18.00	9.3	6.05	1.67	-3.33	-7.52	-1.66	7.73	-10.85	18.58	1197	22.24	117.70	400
BASE	176'-0"	0.00							62.63	-54.25	116.88	5987	139.94	139.94	12175

New Hershey Seismic Criteria

0.2-Sec Spectral Response Acceleration			
	S_s	0.209	(%) of gravi
1.0-Sec Spectral Response Acceleration			
	S_1	0.055	(%) of gravi
Site Class	C		
Short-Period Site Coefficient			
	F_a	1.2	
Long-Period Site Coefficient			
	F_v	1.7	
	S_{MS}	0.2508	
	S_{M1}	0.094	
	S_{DS}	0.167	
	S_{D1}	0.062	
Seismic Design Category	B		
Importance Factor	I	1.0	
	R	4.0	
Approximate Fundamental Period			
	T_L	6.00	sec
	T_a	0.584	sec
	C_t	0.02	
	x	0.75	
	h_n	90.0	ft
Fundamental Period			
	T	0.993	
	C_u	1.7	
Seismic Response Coefficient			
	C_s	0.0267	
Building Weight	W	12400	kips
Seismic Design Shear			
	V	331	k

New Hershey Wind Criteria

Basic Wind Speed	V	90.0	mph
Importance Factor	I_w	1.0	
Exposure Category	B		
Surface Roughness	B		
Roof Angle	Θ	1.07	deg
Height and Exposure Coefficient			
	λ	1.22	
Topographic Factor	K_{zt}		
	α	7	
	zg	1200	
	c	0.3	
	ℓ	320	
	ϵ	0.333	
	zmin	30	
Mean Hourly Speed	z bar	40.32	
	Iz	0.29	
	L_z	342.08	
	Q (A)	0.859	
	Q (B)	0.806	
	G(A)	0.843	
	G(B)	0.813	
	K_d	0.85	
	K_z	0.951	
	GC_{pi}	0.18	
		-0.18	

	A	B
L/B (A)	3.0	0.3
Windward C_p (q_z)	0.8	0.8
Leeward C_p (q_h)	-0.3	-0.5
Side Wall C_p (q_h)	-0.7	-0.7

		Original		New	
		N-S	E-W	A	B
Shear	Wind	263.1	263.7	404.2	140.0
	Seismic	279.0	279.0	331.0	331.0
Moment	Wind	14244.0	14444.0	21962.0	7541.0
	Seismic	15997.0	15997.0	18962.0	18692.0

Comparison of New and Old Controlling Loads

		Penthouse	Roof	3rd	2nd	1st	Total
qz	Original	20	18.2	17	14.5	12.1	
	New	19.39	17.45	15.49	13.49	9.3	
Total WW (psf)	Original N-S	17.63	16.37	15.33	13.77	12.09	
	New Bldg A	16.57	14.92	13.49	11.53	7.95	
	Original E-W	10.35	9.1	8.26	6.52	4.84	
	New Bldg B	16.1	14.49	13.11	11.2	7.73	
Total LW (psf)	Original N-S	12.37	12.37	12.37	12.37	12.37	
	New Bldg A	8.01	8.01	8.01	8.01	8.01	
	Original E-W	12.32	12.32	12.32	12.32	12.32	
	New Bldg B	10.85	10.85	10.85	10.85	10.85	
Load (kips)	Original N-S	69.3	50.6	48.8	46	48.4	**263.1**
	New Bldg A	95.07	88.66	83.17	75.58	61.73	**404.21**
	Original E-W	71.4	51.4	49.4	45.2	46.3	**263.7**
	New Bldg B	32.27	30.34	28.69	26.41	22.24	**139.95**
Moment (ft-kips)	Original N-S	6029	3340	2440	1564	871	**14244**
	New Bldg A	8271	5852	4158	2570	1111	**21962**
	Original E-W	6212	3392	2470	1537	833	**14444**
	New Bldg B	2807	2002	1434	898	400	**7541**

Comparison of Albany Wind Loads to Hershey Wind Loads

		Penthouse	Roof	3rd	2nd	1st	Total
w_x (kips)	Original	564	1921	1947	1913	2644	
	New	1022	1921	1947	1913	2644	
$h_x^k w_x$ (ft-kips)	Original	418750	947223	636563	353430	190574	
	New	88914	126786	97350	65042	47592	
C_{vx}	Original	0.164	0.372	0.25	0.139	0.075	
	New	0.209	0.298	0.229	0.153	0.112	
$F_x = C_{vx}V$ (kips)	Original	45.8	103.6	69.6	38.7	20.9	
	New	69.1	98.6	75.7	50.6	37	
V (kips)	Original	0	46	149	219	258	**279**
	New	0	69.1	167.7	243.4	294	**331**
$M = F_x h_x$ (ft-kips)	Original	3984	6840	3482	1315	375	**15997**
	New	6015	6507	3785	1720	666	**18692**

Comparison of Albany Seismic Loads to Hershey Seismic Loads

Strand Pattern Designation
76-S

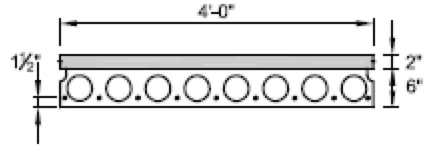
- S = straight
- Diameter of strand in 16ths
- No. of Strand (7)

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

Capacity of sections of other configurations are similar. For precise values, see local hollow-core manufacturer.

Key
444 – Safe superimposed service load, psf
0.1 – Estimated camber at erection, in.
0.2 – Estimated long-time camber, in.

HOLLOW-CORE
4'-0" x 6"
Normal Weight Concrete



$f'_c = 5{,}000$ psi
$f_{pu} = 270{,}000$ psi

Section Properties

		Untopped		Topped	
A	=	187	$in.^2$	283	$in.^2$
I	=	763	$in.^4$	1,640	$in.^4$
y_b	=	3.00	in.	4.14	in.
y_t	=	3.00	in.	3.86	in.
S_b	=	254	$in.^3$	396	$in.^3$
S_t	=	254	$in.^3$	425	$in.^3$
wt	=	195	plf	295	plf
DL	=	49	psf	74	psf
V/S	=	1.73	in.		

4HC6

Table of safe superimposed service load (psf) and cambers (in.) — **No Topping**

Strand Designation Code	Span, ft																				
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
66-S	444	382	333	282	238	203	175	151	131	114	100	88	77	68	59	52	46	40	33	28	
	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0	–0.1	–0.2	–0.4	–0.5	–0.7		
	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	–0.1	–0.3	–0.5	–0.7	–0.9	–1.2	–1.5	–1.9	
76-S		445	388	328	278	238	205	178	155	136	120	105	93	82	73	65	57	49	42	36	31
		0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.0	–0.1	–0.3	–0.4	–0.6
		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.0	–0.1	–0.2	–0.4	–0.7	–0.9	–1.2	–1.6	–2.0
96-S		466	421	386	338	292	263	229	201	177	157	139	124	110	99	88	78	68	60	53	46
		0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.1	0.0	–0.1
		0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.4	0.3	0.2	0.1	–0.1	–0.3	–0.6	–0.9	–1.3
87-S		478	433	398	362	322	290	264	240	212	188	167	149	134	119	107	95	85	76	68	60
		0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.6	0.5	0.4	0.3
		0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.3	0.2	0.0	–0.3	–0.6
97-S		490	445	407	374	346	311	276	242	220	203	186	166	148	133	119	107	96	86	78	70
		0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.8	0.7	0.6
		0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.5	0.3	0.1	–0.2

4HC6 + 2

Table of safe superimposed service load (psf) and cambers (in.) — **2 in. Normal Weight Topping**

Strand Designation Code	Span, ft																		
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
66-S	470	396	335	285	244	210	182	158	136	113	93	75	59	46	34				
	0.2	0.2	0.2	0.2	0.2	02	0.2	0.2	0.2	0.2	0.1	0.1	0.0	–0.1	–0.2				
	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	–0.1	–0.2	–0.3	–0.5	–0.7	–0.9	–1.2				
76-S		461	391	334	287	248	216	188	163	137	115	95	78	63	50	38	27		
		0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.1	–0.0	–0.1	–0.3		
		0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	–0.2	–0.3	–0.5	–0.7	–0.9	–1.2	–1.5		
96-S			473	424	367	319	279	245	216	186	160	137	116	98	82	68	55	43	33
			0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.1	0.0	–0.1
			0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.1	–0.1	–0.3	–0.5	–0.7	–1.0	–1.4	–1.7
87-S			485	446	415	377	331	292	258	224	195	169	147	127	109	94	80	67	55
			0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.6	0.5	0.4	0.3
			0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.2	0.1	–0.1	–0.3	–0.5	–0.8	–1.2
97-S			494	455	421	394	357	327	288	251	219	192	168	146	127	110	95	82	70
			0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.8	0.7	0.6
			0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.2	0.0	–0.2	–0.5	–0.8

Strength is based on strain compatibility; bottom tension is limited to $7.5\sqrt{f'_c}$; see pages 2–7 through 2–10 for explanation.

2–31

Specification for Roof Precast Slabs

Strand Pattern Design ation
76-S

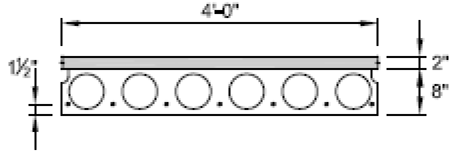
- S = straight
- Diameter of strand in 16ths
- No. of Strand (7)

Safe loads shown include dead load of 10 psf for untopped members and 15 psf for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

Capacity of sections of other configurations are similar. For precise values, see local hollow-core manufacturer.

Key
- 458 – Safe superimposed service load, psf
- 0.1 – Estimated camber at erection, in.
- 0.2 – Estimated long-time camber, in.

HOLLOW-CORE
4′-0″ x 8″
Normal Weight Concrete



f'_c = 5,000 psi
f_{pu} = 270,000 psi

Section Properties

	Untopped	Topped
A =	215 in.^{2}	311 in.^{2}
I =	1,666 in.^{4}	3,071 in.^{4}
y_b =	4.00 in.	5.29 in.
y_t =	4.00 in.	4.71 in.
S_b =	417 in.^{3}	581 in.^{3}
S_t =	417 in.^{3}	652 in.^{3}
wt =	224 plf	324 plf
DL =	56 psf	81 psf
V/S =	1.92 in.	

4HC8

Table of safe superimposed service load (psf) and cambers (in.) — **No Topping**

Strand Designation Code	Span, ft																													
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
66-S	458	415	378	346	311	269	234	204	179	158	140	124	110	98	87	77	69	61	54	48	43	38	33	29						
	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.0	0.0	−0.1	−0.2	−0.3	−0.5	−0.6						
	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.0	−0.1	−0.2	−0.3	−0.5	−0.7	−0.9	−1.2	−1.4						
76-S	470	424	387	355	326	303	276	242	213	188	167	149	133	119	106	95	86	77	69	62	55	50	44	39	35	31	26			
	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.0	−0.1	−0.2	−0.4	−0.5	−0.7	−0.9			
	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.1	0.0	−0.1	−0.2	−0.4	−0.6	−0.8	−1.1	−1.4	−1.7	−2.0			
58-S	464	421	384	352	323	300	280	260	244	229	211	194	177	160	144	130	118	107	97	88	80	72	66	60	54	48	42	37	32	28
	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.1	0.0	−0.4	−0.3	−0.5	−0.7	−0.9
	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.3	0.2	0.0	−0.2	−0.4	−0.6	−0.9	−1.2	−1.6	−2.0	−2.4
68-S	476	430	393	361	332	309	286	269	253	235	223	209	200	180	165	153	142	132	121	110	101	92	84	77	70	63	56	51	45	40
	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.2	0.1	−0.1	−0.3
	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.7	0.6	0.4	0.2	0.0	−0.2	−0.5	−0.8	−1.1	−1.5
78-S	488	442	402	370	341	318	295	275	259	241	229	215	203	195	180	168	157	144	135	126	118	110	101	92	84	77	70	64	58	52
	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.3
	0.4	0.5	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.1	1.0	0.8	0.7	0.5	0.3	0.0	−0.3	−0.7

4HC8 + 2

Table of safe superimposed service load (psf) and cambers (in.) — **2 in. Normal Weight Topping**

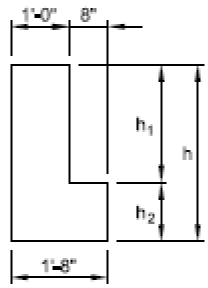
Strand Designation Code	Span, ft																											
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
66-S	489	445	394	340	294	256	224	197	173	153	135	119	105	93	82	68	56	45	36	26								
	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.0	−0.0	−0.1	−0.2	−0.3								
	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	−0.1	−0.2	−0.3	−0.4	−0.6	−0.7	−0.9	−1.2	−1.4								
76-S	498	457	420	387	347	304	267	235	208	184	164	146	130	116	103	88	74	62	51	41	31							
	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	−0.0	−0.1	−0.2							
	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.0	−0.1	−0.2	−0.4	−0.5	−0.7	−0.9	−1.2	−1.4							
58-S	492	451	414	384	357	333	310	293	274	245	219	196	177	159	143	126	110	95	82	70	59	49	40	32				
	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.1	0.3	0.2	0.1	0.0	−0.1				
	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.3	0.2	0.1	−0.1	−0.2	−0.4	−0.6	−0.9	−1.2	−1.5	−1.8				
68-S		463	426	393	366	342	319	299	282	267	251	239	216	195	177	158	140	124	110	97	84	73	62	53	44	36	28	
		0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.2	0.1	−0.1	
		0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.4	0.3	0.2	0.0	−0.2	−0.4	−0.6	−0.9	−1.2	−1.6	−2.0	−2.4	
78-S		472	435	402	375	348	325	305	288	273	257	245	232	220	207	186	167	149	133	119	106	94	83	73	64	55	46	38
		0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	0.9	0.9	0.7	0.6	0.5	0.3
		0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.4	0.3	0.1	−0.1	−0.3	−0.6	−0.9	−1.3	−1.7	−2.2

Strength is based on strain compatibility; bottom tension is limited to $7.5\sqrt{f'_c}$; see pages 2–7 through 2–10 for explanation.

2–32

Specification for Floor Precast Slabs

L-BEAMS



f'_c = 5,000 psi
f_{pu} = 270,000 psi
½ in. diameter
low-relaxation strand

Normal Weight Concrete

Designation	h in.	h_1/h_2 in./in.	A in.^{2}	I in.^{4}	y_b in.	S_b in.^{3}	S_t in.^{3}	wt plf
20LB20	20	12/8	304	10,160	8.74	1,163	902	317
20LB24	24	12/12	384	17,568	10.50	1,673	1,301	400
20LB28	28	16/12	432	27,883	12.22	2,282	1,767	450
20LB32	32	20/12	480	41,600	14.00	2,971	2,311	500
20LB36	36	24/12	528	59,119	15.82	3,737	2,930	550
20LB40	40	24/16	608	81,282	17.47	4,653	3,608	633
20LB44	44	28/16	656	108,107	19.27	5,610	4,372	683
20LB48	48	32/16	704	140,133	21.09	6,645	5,208	733
20LB52	52	36/16	752	177,752	22.94	7,749	6,117	783
20LB56	56	40/16	800	221,355	24.80	8,926	7,095	833
20LB60	60	44/16	848	271,332	26.68	10,170	8,143	883

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

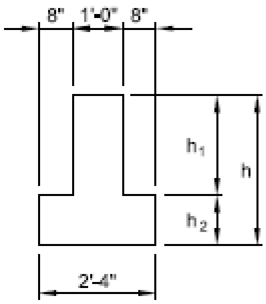
Key
6566 – Safe superimposed service load, plf.
0.3 – Estimated camber at erection, in.
0.1 – Estimated long-time camber, in.

Table of safe superimposed service load (plf) and cambers (in.)

Desig-nation	No. Strand	y_b(end) in. y_b(center) in.	Span, ft: 16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
20LB20	98-S	2.44 2.44	6566 0.3 0.1	5131 0.4 0.2	4105 0.5 0.2	3345 0.6 0.2	2768 0.7 0.2	2318 0.8 0.2	1961 0.9 0.3	1674 1.0 0.3	1438 1.0 0.3	1243 1.1 0.3	1079 1.2 0.2							
20LB24	108-S	2.80 2.80	9577 0.3 0.1	7495 0.3 0.1	6006 0.4 0.1	4904 0.5 0.1	4066 0.5 0.1	3414 0.6 0.2	2896 0.7 0.2	2479 0.8 0.2	2137 0.9 0.2	1854 0.9 0.2	1617 1.0 0.1	1416 1.0 0.1	1244 1.1 0.1	1097 1.1 0.0	969 1.2 0.0			
20LB28	128-S	3.33 3.33			8228 0.4 0.1	6733 0.4 0.1	5596 0.5 0.2	4711 0.6 0.2	4009 0.6 0.2	3443 0.7 0.2	2979 0.8 0.2	2595 0.9 0.2	2273 0.9 0.2	2000 1.0 0.2	1768 1.1 0.2	1567 1.1 0.2	1394 1.2 0.1	1243 1.2 0.1	1110 1.2 0.0	992 1.3 0.0
20LB32	148-S	3.71 3.71				8942 0.4 0.1	7446 0.5 0.2	6281 0.5 0.2	5356 0.6 0.2	4611 0.7 0.2	4001 0.7 0.2	3495 0.8 0.2	3071 0.9 0.3	2712 1.0 0.3	2406 1.0 0.3	2143 1.1 0.2	1914 1.2 0.2	1715 1.2 0.2	1540 1.3 0.2	1386 1.3 0.1
20LB36	168-S	4.25 4.25					9457 0.4 0.2	7988 0.5 0.2	6823 0.5 0.2	5883 0.6 0.2	5113 0.7 0.2	4476 0.8 0.3	3941 0.8 0.3	3489 0.9 0.3	3103 1.0 0.3	2771 1.1 0.3	2483 1.1 0.3	2231 1.2 0.3	2011 1.2 0.3	1816 1.3 0.2
20LB40	188-S	4.89 4.89						9812 0.4 0.2	8386 0.5 0.2	7235 0.6 0.2	6293 0.6 0.2	5513 0.7 0.2	4858 0.8 0.2	4305 0.8 0.3	3832 0.9 0.3	3425 1.0 0.3	3073 1.0 0.3	2765 1.1 0.3	2495 1.1 0.3	2257 1.2 0.3
20LB44	198-S	5.05 5.05								8959 0.5 0.2	7803 0.6 0.2	6845 0.6 0.2	6042 0.7 0.2	5363 0.8 0.2	4783 0.8 0.2	4284 0.9 0.2	3851 0.9 0.2	3474 1.0 0.2	3143 1.1 0.2	2850 1.1 0.2
20LB48	218-S	5.81 5.81									9226 0.5 0.2	8100 0.6 0.2	7158 0.6 0.2	6360 0.7 0.2	5678 0.8 0.2	5092 0.8 0.2	4584 0.9 0.3	4140 0.9 0.3	3751 1.0 0.3	3408 1.1 0.3
20LB52	238-S	6.17 6.17										9634 0.6 0.2	8521 0.6 0.2	7578 0.7 0.2	6774 0.7 0.3	6082 0.8 0.3	5482 0.9 0.3	4958 0.9 0.3	4499 1.0 0.3	4094 1.0 0.3
20LB56	258-S	6.64 6.64											9954 0.6 0.2	8860 0.7 0.2	7927 0.7 0.3	7124 0.8 0.3	6427 0.8 0.3	5820 0.9 0.3	5287 1.0 0.3	4816 1.0 0.3
20LB60	278-S	7.33 7.33													9089 0.7 0.3	8173 0.7 0.3	7380 0.8 0.3	6688 0.9 0.3	6080 0.9 0.3	5544 1.0 0.3

Specification for Edge L-Beam Precast Beams

INVERTED TEE BEAMS



Normal Weight Concrete

Section Properties								
Designation	h in.	h_1/h_2 in./in.	A $in.^2$	I $in.^4$	y_b in.	S_b $in.^3$	S_t $in.^3$	wt plf
28IT20	20	12/8	368	11,688	7.91	1,478	967	383
28IT24	24	12/12	480	20,275	9.60	2,112	1,408	500
28IT28	28	16/12	528	32,076	11.09	2,892	1,897	550
28IT32	32	20/12	576	47,872	12.67	3,778	2,477	600
28IT36	36	24/12	624	68,101	14.31	4,759	3,140	650
28IT40	40	24/16	736	93,503	15.83	5,907	3,869	767
28IT44	44	28/16	784	124,437	17.43	7,139	4,683	817
28IT48	48	32/16	832	161,424	19.08	8,460	5,582	867
28IT52	52	36/16	880	204,884	20.76	9,869	6,558	917
28IT56	56	40/16	928	255,229	22.48	11,354	7,614	967
28IT60	60	44/16	976	312,866	24.23	12,912	8,747	1,017

1. Check local area for availability of other sizes.
2. Safe loads shown include 50% superimposed dead load and 50% live load. 800 psi top tension has been allowed, therefore, additional top reinforcement is required.
3. Safe loads can be significantly increased by use of structural composite topping.

f'_c = 5,000 psi
f_{pu} = 270,000 psi
½ in. diameter
low-relaxation strand

Key

6511 – Safe superimposed service load, plf.
0.2 – Estimated camber at erection, in.
0.1 – Estimated long-time camber, in.

Table of safe superimposed service load (plf) and cambers (in.)

Designation	No. Strand	y_b(end) in. y_b(center) in.	Span, ft																	
			16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
28IT20	98-S	2.44	6511	5076	4049	3289	2711	2262	1905	1617	1381	1186	1022							
		2.44	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8							
			0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	–0.1							
28IT24	188-S	2.73	9612	7504	5997	4882	4034	3374	2850	2427	2081	1795	1555	1351	1178	1029				
		2.73	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8				
			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	–0.1	–0.2				
28IT28	138-S	3.08			8353	6822	5657	4750	4031	3451	2976	2582	2252	1973	1735	1530	1352	1197	1061	
		3.08			0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.8	0.8	
					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	–0.1	–0.2	–0.2	
28IT32	158-S	3.47				9049	7521	5333	5389	4628	4006	3490	3057	2691	2379	2110	1876	1673	1495	1337
		3.47				0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9
						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	–0.1
28IT36	168-S	3.50					9832	8295	7075	6092	5287	4619	4060	3587	3183	2835	2534	2271	2040	1836
		3.50					0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9
							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	–0.1
28IT40	198-S	4.21							8638	7440	6460	5647	4966	4390	3898	3474	3107	2787	2506	2258
		4.21							0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9
									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
28IT44	208-S	4.40								9186	7989	6997	6165	5462	4861	4344	3896	3505	3162	2859
		4.40								0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8
										0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
28IT48	228-S	4.55									9719	8525	7523	6676	5953	5330	4791	4320	3907	3542
		4.55									0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9
											0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
28IT52	248-S	5.17										9987	8823	7838	6998	6274	5647	4100	4619	4196
		5.17										0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8
												0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
28IT56	268-S	5.23												9307	8319	7469	6731	6088	5524	5026
		5.23												0.5	0.6	0.6	0.7	0.7	0.8	0.8
														0.2	0.2	0.2	0.2	0.2	0.2	0.2
28IT60	288-S	5.57													9645	8668	7820	7081	6432	5859
		5.57													0.6	0.6	0.7	0.7	0.8	0.8
															0.2	0.2	0.2	0.2	0.2	0.2

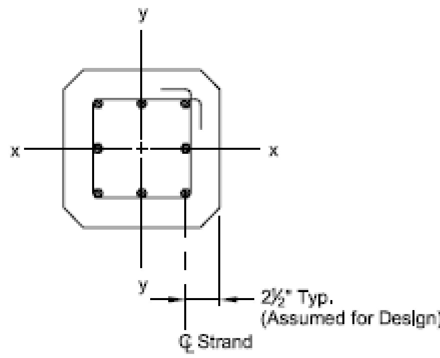
Specification for Inverted T Precast Girder

PRECAST, PRESTRESSED COLUMNS

Figure 2.7.1 Design strength interaction curves for precast, prestressed concrete columns

CRITERIA

1. Minimum prestress = 225 psi
2. All strand assumed ½ in. diameter, f_{pu} = 270 ksi
3. Curves shown for partial development of strand near member end where $f_{pu} \approx f_{se}$
4. Horizontal portion of curve is the maximum for tied columns = $0.80\phi P_c$
5. Varies linearly from 0.9 for tension-controlled section to 0.65 for compression-controlled sections in accordance with ACI 318-02 Section 9.3.2

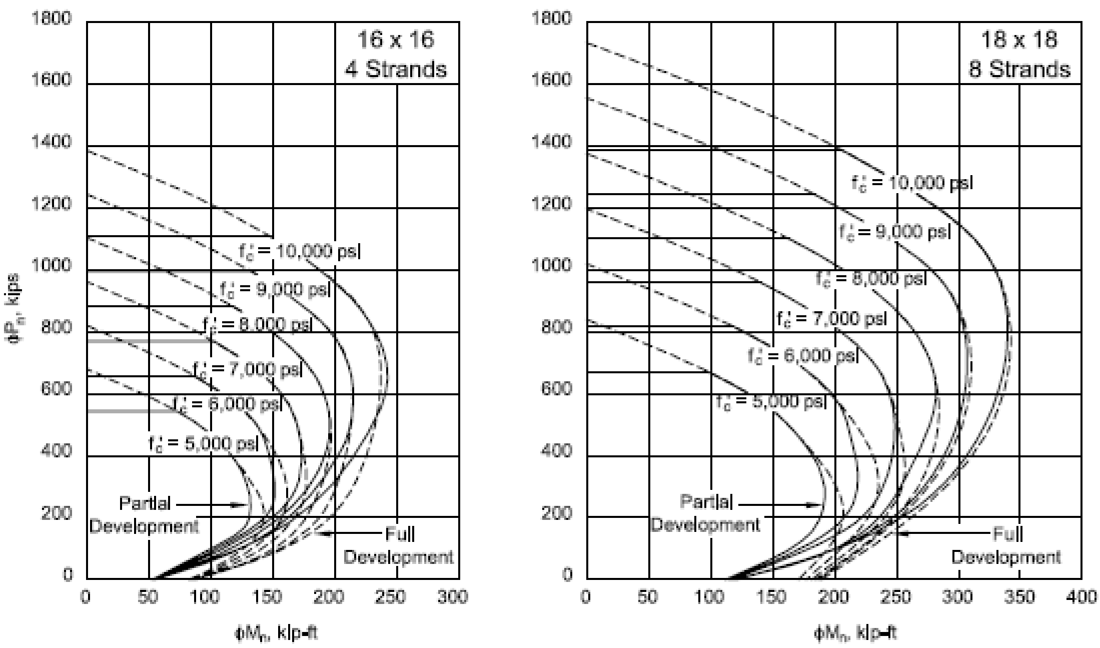


USE OF CURVES

1. Enter at left with applied factored axial load, P_u
2. Enter at bottom with applied magnified factored moment, δM_u
3. Intersection point must be to the left of curve indicating required concrete strength.

NOTATION

ϕP_n = Design axial strength
ϕM_n = Design flexural strength
ϕP_c = Design axial strength at zero eccentricity
A_g = Gross area of column
δ = Moment magnifier (Section 10.11–10.13 ACI 318-02)



2–48

Specification for Precast Column

Penthouse/Roof					
Mechanical Equipment	160 kips	160 kips			
Roof					
Roof Meadow DL =	70 psf x 14600 sf =	1022 kips			
Roof Garden LL with Assembly	100 psf x 14600 sf =	1460 kips			
1.2DL + 1.6LL =	1.2(160) + 1.6(1460) =	166 psf		<------------------------	Hollow-Core
		22600 sf			8" thick
					NWC
					4HC6 + 2" topping
					96-S
3rd Floor					
Roof Slab	74 psf x 22500 sf	1665 kips			
		2687 kips			
Roof Column DL	145 pcf x 1 ft^2 x 18.58 ft x 86 columns	232 kips			
Lab LL	70 psf x 19000 sf	1330 kips			
Corridor LL	80 psf x 3500 sf	280 kips			
1.2DL + 1.6LL		4852	216 psf	<----------	Hollow-Core
					10" thick
					4HC8 + 2" topping
					58-s
2nd Floor					
Weight from Above		2919 kips			
3rd Floor slab	81 psf x 22500 sf	1823 kips			
		4742 kips			
3rd Column DL	145 pcf x 1ft^2 x 16 ft x 86 columns	200 kips			
Lab LL	70 psf x 19000 sf	1330 kips			
Corridor LL	80 psf x 3500 sf	280 kips			
1.2DL + 1.6LL		5002	222 psf	<----------	Hollow-Core
					10" thick
					4HC8 + 2" topping
					58-s
1st Floor					
Weight from Above		4941 kips			
2nd Floor Slab	81 psf x 22500 sf	1823 kips			
		6764 kips			
2nd Column DL	145 pcf x 1 ft^2 x 16 ft x 103 columns	239 kips			
Lab LL	70 psf x 19000 sf	1330 kips			
Corridor LL	100 psf x 3500 sf	350 kips			
1.2DL + 1.6LL		5162	229 psf	<----------	Hollow-Core
					10" thick
					4HC8 + 2" topping
					58-s
Foundations					
Weight from Above		7002 kips			
1st Floor Slab	81 psf x 22500 sf	1823 kips			
1st Column DL	145 pcf x 1 ft^2 x 18 ft x 103 columns	269 kips			
Weight from SOG	145 pcf x 22600 sf x 6 in	1639 kips			

Precast Slab Loading

Foam Core SIPs

06 12 00/MUR
BuyLine 1605

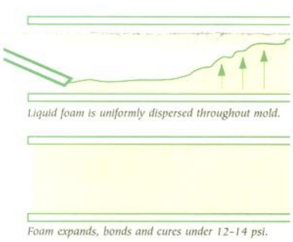
THE MURUS OSB-2100PUR STRUCTURAL INSULATING PANEL

Dimensions and Weights			
Series	**2145**	**2155**	**2165**
OVERALL THICKNESS:	4-5/8"	5-5/8"	6-5/8"
THICKNESS TOLERANCE:	+/- 1/8"	*	*
WIDTH:	48"	*	*
WIDTH TOLERANCE: (Finish Size)	+0", -1/8"	*	*
STANDARD LENGTHS: (Feet)	4', 6', 8', 9', 10', 12', 14', 16', 18', 20', 22', 24'	*	*
LENGTH TOLERANCE:	+/- 1/4"	*	*
WEIGHT:	3.95 lb./sq. ft.	4.15 lb./sq. ft.	4.35 lb./sq. ft.
Insulating Core			
TYPE:	Polyurethane Closed Cell Foam		
THICKNESS:	3-11/16"	4-11/16"	5-11/16"
DENSITY:	2.2 lb./cu. ft.	*	*
R-VALUE:	6.76 per in. thickness	*	*
System R-VALUE:	26	33	40

Insulating Core Properties	[4]Design Values	
K FACTOR: (aged foam)	.148	ASTM C-518
COMPRESSIVE STRENGTH:	23 psi	ASTM D1621
COMPRESSIVE [1]MOE:	682 psi	ASTM D1621
SHEAR STRENGTH:	31 psi	ASTM C-273
SHEAR MODULUS:	203 psi	ASTM C-273
FLEXURE [2]MOR:	52 psi	ASTM C203
FLEXURE MODULUS ([3]MD):	587 psi	ASTM C203
TENSILE STRENGTH:	37 psi	ASTM D1623
TENSILE MODULUS:	611 psi	ASTM D1623
WVT/PERM INCHES:	1.0	ASTM E-96
FOAM FIRE RATING:	Class 1	**UL723
FLAME SPREAD:	20	**UL723
SMOKE DEVELOPED:	300	**UL723

[1]MOE: Modulus of Elasticity. [2]MOR: Modulus of Rupture. [3]MD: Machine Direction.
[4]Design Values are mean derived from multiple specimens.
*Specification or value is the same as the OSB-2145 Panel.
**UL723 is not necessarily a representation of performance in an actual fire.
Class 1 is the highest rating available for combustible materials.

Outside Skins	
TYPE:	APA or equivalent rated oriented strand board (OSB)
GRADE:	Exposure-1
THICKNESS:	7/16"



Other Panel Systems Available:

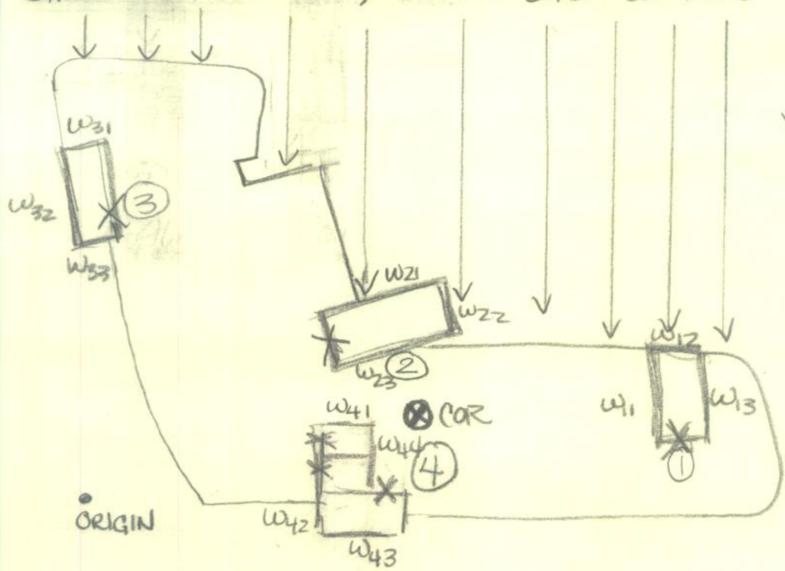
CLAD-2100 (OSB/OSB/PC)	**Exterior Skin.** 7/16" Exposure-1, APA or equivalent rated oriented strandboard (OSB). **Interior Skin (exposed).** 3/4" Standard Grade (kiln dried), WP4-Eastern White Pine, T&G with V-groove face pattern.
PTP-2100 (PT/PT) **(Subject to Availability)**	**Exterior and Interior Skins.** 1/2" CA .10 - CDX Grade, APA or equivalent rated pressure treated plywood.
CB-2100 (CB/CB)	**Exterior and Interior Skins.** 10 mm (also available in 8 and 12 mm) Cement bonded particle board comprised of wood particles and cement.
BB-2100 (OSB/BB) **(Roof Applications Only)**	**Exterior Skin.** 7/16" Exposure-1, APA or equivalent rated oriented strandboard (OSB). **Interior Skin.** 1/2" Veneer Base (Blueboard) Gypsum Wall Board.
T-1-11-2100 (OSB/OSB/T-1-11)	**Exterior Skin.** 7/16" Exposure-1, APA or equivalent rated oriented strandboard (OSB). **Interior Skin (exposed).** 5/8" 303-6 Grade (8 in. on center face pattern), T-1-11 pine plywood.
FB-2100 (OSB/FB)	**Exterior Skin.** 7/16" Exposure-1, APA or equivalent rated oriented strandboard (OSB). **Interior Skin.** 1/2" Gypsum Wallboard - Fiber Reinforced.
PTP/FB-2100 (PT/FB) **(Subject to Availability)**	**Exterior Skin.** 1/2" CA .10 - CDX Grade, APA or equivalent rated pressure treated plywood. **Interior Skin.** 1/2" Gypsum Wallboard - Fiber Reinforced.
CP-2100 (OSB/SB)	**Exterior Skin.** 1/4" Oriented Strand Board (OSB)(7/16" Exposure-1 optional for nailbase). **Interior Skin.** 1/2" Low Density Wood Fiber Composite (Sound Board), Fiber Board Insulating Sheathing.

APPLICATION / **SKINS**	OSB-2100 (OSB/OSB)	CLAD-2100 (OSB/OSB/PC)	PTP-2100 (PT/PT)	CB-2100 (CB/CB)	BB-2100 (OSB/BB)	T-1-11-2100 (OSB/OSB/T-1-11)	FB-2100 (OSB/FB)	PTP/FB-2100 (PT/FB)	CP-2100 (OSB/SB)
LOAD BEARING	•		•						
CURTAIN WALL	•	•	•	•		•	•	•	
ROOF SPANS UP TO 4FT.	•	•	•	•	•	•	•	•	
ROOF SPANS OVER 4FT.	•	•	•	•		•			
RESIDENTIAL CONSTRUCTION	•	•	•						•
COMMERCIAL CONSTRUCTION	•	•	•	•		•	•	•	
STRUCTURAL STEEL FRAMING	•		•	•			•	•	
INSULATED GARAGES	•		•	•					
INSULATED WAREHOUSES	•		•	•			•	•	
TIMBER FRAME STRUCTURES	•	•	•		•	•	•	•	
HEAVY TIMBER RAFTER SYSTEMS	•	•	•		•	•	•	•	
GLUE LAMINATED STRUCTURES	•	•	•			•		•	
MANUFACTURED ROOF TRUSSES	•	•	•			•	•	•	•
TROPICAL CLIMATES			•	•				•	
POOL ENCLOSURES	•		•	•					

Specification for SIPs

GEN*NY*SIS | CFG | SHEAR WALLS

BASED ON ASCE 7-05, SEISMIC LOAD CONTROLS



$V_{DIAPH} = 1810^k$

* ASSUME ALL HAVE STIFFNESS FACTOR K

h = 87.00 ft COR: (90.24, 67.53) → RAM OUTPUT, ORIGIN @ A1.B1

COR

$$\bar{X}: \frac{(-21.16)(30\,ft) + (61.97)(21') + (73.97)(18') + (90.4)(14') + (248.55)(27') + (259.22)(27.5')}{30 + 21 + 18 + 14 + 27.5 + 27.5}$$

$\bar{X}$: 124.84

$$\bar{Y}: \frac{(174.5)(10.5') + (145.5)(10.5') + (16.5)(21.7) + (46.5)(12) + (98.05)(27) + (84.15)(27) + (84.17)(10.7)}{(10.5 + 10.5 + 21.7 + 12 + 27 + 27 + 10.7)}$$

$\bar{Y}$: 84.56

MY CALCULATED COR: (124.84, 84.56)
($\bar{X}$, $\bar{Y}$)

ECCENTRICITY

1-1 e(123.71, 0)
1-2 e(0, -0.39)
1-3 e(134.38, 0)

2-1 e(0, 13.49)
2-2 e(-34.44, 0)
2-3 e(0, -0.41)

3-1 e(0, 89.94)
3-2 e(-146, 0)
3-3 e(0, 20.66)

4-1 e(0, -38.06)
4-2 e(-62.87, 0)
4-3 e(0, -68.56)
4-4 e(-56.87, 0)

Shear Wall Calculations

GEN*NY*SIS | CFG | SHEAR WALLS | 2

POLAR MOMENT OF INERTIA

$$J = \Sigma K_i y_i^2 + K_i x_i^2$$

$$= (27')(123.7)^2 + (10.7')(0.39)^2 + (27')(134.38)^2 + (27.5')(13.8)^2 + (14.1')(6.44)^2 + (27.5')(1.06)^2 + (10.4')(89.94)^2 + (30.1')(-146.84)^2 + (10.4')(60.44)^2 + (12.0')(38.06)^2 + (12.5)(63.34)^2 + (22.7')(68.56)^2 + (18')(50.87)^2 + (12.5)(40.7)^2$$

$$= 1919050$$

TORSIONAL SHEARS

$$F_{w_{11}} = \frac{(27')(124.84')(1810^k)(123.71')}{1919050} = 394^k$$

$$F_{w_{12}} = \frac{(10.7')(84.56')(1810^k)(0.39)}{1919050} = 0.33^k$$

$$F_{w_{13}} = \frac{(27')(124.84')(1810^k)(134.38)}{1919050} = 428^k$$

$$F_{21} = \frac{(27')(13.49')(1810^k)(84.56')}{1919050} = 30^k$$

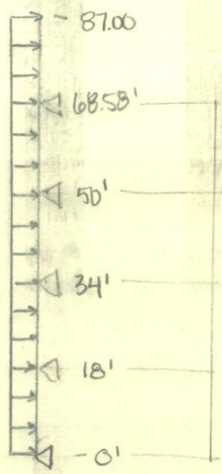
$$F_{22} = \frac{(14.5')(124.84')(1810^k)(34.44)}{1919050} = 60^k$$

$$F_{23} = \frac{(27')(84.56^k)(1810^k)(0.41)}{1919050} = 0.88^k$$

$$F_{31} = \frac{(10.7')(84.56^k)(1810^k)(89.94)}{1919050} = 78^k$$

Shear Wall Calculations

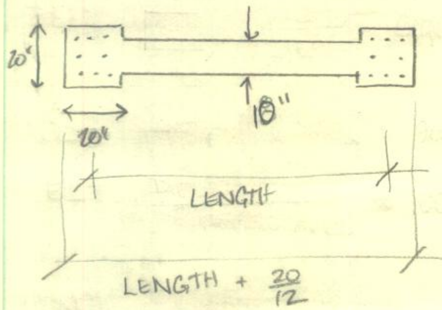
GEN*NY*SIS CFG SHEAR WALLS 3



ORDINARY CONCRETE SHEAR WALL

$f'_c = 5$ ksi

$f_y = 60$ ksi



$b_w = 8$ in

$h_w = (20/12 \text{ ft}) + L$

$A_g = (20/12 \text{ ft})(20/12 \text{ ft} + L)$

$I_y = (1/12)(20/12 \text{ ft})(20/12 + L)^3$

CONFINEMENT REINFORCEMENT

S_{max} | 1/4 (20") = 5"

MIN | 4" ← GOVERNS

ASSUME #5@9" o.c.

SEE EXCEL SPREADSHEET FOR REINFORCEMENT JUSTIFICATION

Shear Wall Calculations

	ex	ey	length	Torsional Shear (kips)	Direct Shear, Vu (kips)
wall 1-1	123.71	0	27.00	87.784	85.55
wall 1-2	0	0.39	10.67	0.074	36.01
wall 1-3	134.38	0	27.00	95.356	85.55
wall 2-1	0	13.49	27.00	6.484	91.15
wall 2-2	34.44	0	14.50	13.124	45.95
wall 2-3	0	0.41	27.00	0.197	91.15
wall 3-1	0	89.94	10.67	17.078	36.01
wall 3-2	146	0	29.00	111.276	91.89
wall 3-3	0	20.66	10.67	3.923	36.01
wall 4-1	0	38.06	12.00	8.130	40.51
wall 4-2	62.87	0	12.00	19.828	38.02
wall 4-3	0	68.56	21.67	26.444	73.15
wall 4-4	56.87	0	18.00	26.903	57.04
		Total Lx	119.67		404.00
		Total Ly	127.50	kips	
			247.17		

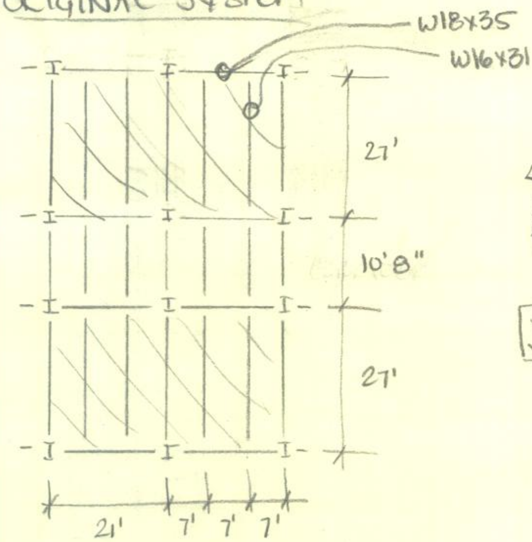
Direct Shear Calculations

	Surface Area (SF)	tw (in)	w (ksf)	Moment (ft-kips)	hw (ft)	Gross Area, Ag (SF)	Ig (ft^4)	fc (ksi)	0.2f'c (ksi)
wall 1-1	2349.00	10.00	0.0364	7443.11	28.67	23.89	1635.95	65.2127	1.0
wall 1-2	927.94	10.00	0.0388	3132.80	12.33	10.28	130.26	148.3032	1.0
wall 1-3	2349.00	10.00	0.0364	7443.11	28.67	23.89	1635.95	65.2127	1.0
wall 2-1	2349.00	10.00	0.0388	7930.39	28.67	23.89	1635.95	69.4820	1.0
wall 2-2	1261.50	10.00	0.0364	3997.22	16.17	13.47	293.43	110.1159	1.0
wall 2-3	2349.00	10.00	0.0388	7930.39	28.67	23.89	1635.95	69.4820	1.0
wall 3-1	927.99	10.00	0.0388	3132.97	12.33	10.28	130.28	148.2972	1.0
wall 3-2	2523.00	10.00	0.0364	7994.45	30.67	25.56	2002.80	61.2051	1.0
wall 3-3	927.99	10.00	0.0388	3132.97	12.33	10.28	130.28	148.2972	1.0
wall 4-1	1044.00	10.00	0.0388	3524.62	13.67	11.39	177.27	135.8686	1.0
wall 4-2	1044.00	10.00	0.0364	3308.05	13.67	11.39	177.27	127.5202	1.0
wall 4-3	1884.99	10.00	0.0388	6363.87	23.33	19.44	882.19	84.1594	1.0
wall 4-4	1566.00	10.00	0.0364	4962.07	19.67	16.39	528.24	92.3706	1.0
	21503.42							Boundary Element Needed	

Acv (ft^2)	Acv (in^2)	2Acv(f'c^0 .5) (kips)	Vu (kips)	Acv (in^2 /ft)	Spacing (in)	Alpha c	rho t	Normal Shear Capactiy (kips)	Phi Vn (kips)	Direct Shear, Vu (kips)	Pu (lbs)	Ast (in^2)
21.250	3060	432.7494	85.55	0.30	12.4	3.03	0.0026	1271	762.9	85.55	275671	6.460
7.638	1100	155.5522	36.01	0.30	12.4	7.05	0.0026	968	580.6	36.01	293718	7.082
21.250	3060	432.7494	85.55	0.30	12.4	3.03	0.0026	1271	762.9	85.55	275671	6.460
21.250	3060	432.7494	91.15	0.30	12.4	3.03	0.0026	1271	762.9	91.15	293718	7.082
10.833	1560	220.6173	45.95	0.30	12.4	5.38	0.0026	1039	623.4	45.95	275671	6.460
21.250	3060	432.7494	91.15	0.30	12.4	3.03	0.0026	1271	762.9	91.15	293718	7.082
7.639	1100	155.5624	36.01	0.30	12.4	7.05	0.0026	968	580.6	36.01	293718	7.082
22.917	3300	466.6905	91.89	0.30	12.4	2.84	0.0026	1309	785.2	91.89	275671	6.460
7.639	1100	155.5624	36.01	0.30	12.4	7.05	0.0026	968	580.6	36.01	293718	7.082
8.750	1260	178.1909	40.51	0.30	12.4	6.37	0.0026	992	595.5	40.51	293718	7.082
8.750	1260	178.1909	38.02	0.30	12.4	6.37	0.0026	992	595.5	38.02	275671	6.460
16.806	2420	342.2386	73.15	0.30	12.4	3.73	0.0026	1172	703.3	73.15	293718	7.082
13.750	1980	280.0143	57.04	0.30	12.4	4.42	0.0026	1104	662.4	57.04	275671	6.460
		CAN USE 1 CURTAIN		ASSUME	2 CURTAINS				8758.282			(9) #8s
				(1) #5	#5 HORIZ							EQ. SPACEI
					#5 VERT							
					AT 15" o.c.							

GEN* NY * SIS | CFG | VIBRATION ANALYSIS | 1

ORIGINAL SYSTEM



4.5" NWC
2" COMPOSITE METAL DECK
$f'_c = 3500$ psi

▨ = LABORATORY SPACE

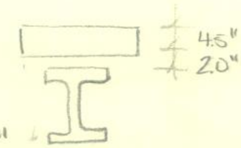
BEAM PROPERTIES → W16x31

$$b = \min\begin{cases} 0.4(27\times12) = 129.6'' \\ 7'\times 12 = 84'' \leftarrow \end{cases}$$

$A = 9.13\ in^2$
$I_x = 375\ in^4$
$d = 15.9\ in$
$w = 31\ plf$
$C_b = 1.0$

$$E_c = 33\,(145)^{1.5}\sqrt{3.5} = 3409\ ksi$$

$$n = \frac{29000\ ksi}{1.35\ (3409\ ksi)} = 6.301$$



$$\bar{y} = \frac{\left(\frac{84}{6.301}\right)\frac{(4.5)^2}{2} + (9.13\ in^2)\left(\frac{15.9''}{2} + 4.5'' + 2''\right)}{\left(\frac{84}{6.301}\right)(4.5) + 9.13} = 3.86''$$

$$I_j = 375 + (9.13)\left(2 + \frac{15.9}{2} - 3.86\right)^2 + \left(\frac{84}{6.301}\right)\frac{(4.5)^3}{12} + \left(\frac{84}{6.301}\right)(4.5)\left(3.86 + \frac{4.5}{2}\right)^2 = 3055\ in^4$$

$$w_j = 7'(65\ psf + 11 + 4) + 31\ plf = 591\ plf$$

$$\Delta_j = \frac{5\,(591\ plf)(27')^4\,(1728)}{384\,(29000000)\,3055} = 0.080\ in$$

$$D_s = (5.5)^3/6.301 = 26.405$$
$$D_j = 3055/7 = 436.428$$

$$B_j = \min\begin{cases} \tfrac{2}{3}(64.667) = 43.11 \\ 2\left(\frac{26.405}{436.428}\right)^{0.25}(27) = 26.782 \leftarrow \end{cases}$$

$$W_j = \left(\frac{591}{7}\right) 26.782\,(21) = 47.5$$

Original System Vibration Calculations

GEN*NY*SIS | CFG | VIBRATION ANALYSIS | 2

GIRDER PROPERTIES — W18x35

$b_g = \begin{cases} 0.4(21')\times 12 = 101'' \leftarrow \\ 27\times 12 = 324'' \end{cases}$ MIN

$A = 10.3\ in^2$
$I_x = 510\ in^4$
$d = 17.7\ in$

$$\bar{y} = \frac{\left(\frac{101}{6.301}\right)\frac{(4.5)^2}{2} + \frac{101}{6.301}(5.5) + (10.3)\left(6.5 + \frac{17.7}{2}\right)}{\left(\frac{101}{6.301}\right)(4.5) + \left(\frac{101}{6.301}\right) + 10.3} = 4.15''$$

$$I_g = 510 + \left(\frac{101}{6.301}\right)\frac{(4.5)^3}{12} + \left(\frac{101}{6.301}\right)\frac{2^3}{24} + 10.3\left(6.5 + \frac{17.7}{2} - 4.15\right)^2 + \left(\frac{101}{6.301}\right)(4.5)\left(\frac{4.5}{2} - 4.15\right)^2 + \frac{101}{2(6.301)}(2)(5.5 - 4.15)^2 = 2219\ in^4$$

$$w_g = \left(\frac{591\ plf}{7\ ft}\right)(21\ ft) + 35 = 1808\ plf$$

$$\Delta_g = \frac{5(1808)(21)^4(1728)}{384(29000000)2219} = 0.123''$$

$$\frac{L_g}{B_g} = \frac{21\times 12}{101} = 3.208$$

$$\Delta_2 = (0.123'')(3.208) = 0.423''$$

$$f_g = 0.18\sqrt{\frac{386.4}{0.123}} = 10.09\ Hz$$

$$D_g = \frac{2219\ in^4}{27\times 12} = 6.849\ in,\ 82.185\ in^4/ft$$

$$D_j = \frac{3055\ in^4}{7\ ft} = 436.429\ in^4/ft$$

$$B_g = 1.8\left(\frac{436.429}{82.185}\right)^{0.25}(21) = 57.38\ ft$$

$$W_g = \left(\frac{1808}{27}\right)(57.38)(21) = 80.689^k$$

$$W_c = \left(\frac{(47.5)(.08)}{.08 + .423} + \frac{(80.689)(.423)}{.08 + .423}\right)\times 1000 = 75410$$

$$f_n = 0.18\sqrt{\frac{386.4}{.08 + .423}} = 4.99\ Hz$$

BAY FREQUENCY $= f_n = 0.18\sqrt{\frac{386.4}{.08 + .123}} = 7.85\ Hz$

Original System Vibration Calculations

GEN*NY*SIS CFG — VIBRATION ANALYIS — 3

DEFLECTION DUE TO UNIT LOAD AT MID-BAY

$$\Delta_{oj} = \frac{1^k (27ft)^3 (1728)}{96 (29000000)(3055)} = 4.00 \times 10^{-6} \text{ in/lb}$$

$$0.018 \le \frac{d_e}{S} = \frac{5.5}{7 \times 12} = 0.065 \le 0.208 \checkmark \longrightarrow \frac{d_e}{S} = 0.065$$

$$4.5 \times 10^6 \le \frac{L_j^4}{I_t} = \frac{(27 \times 12)^4}{1775} = 6.21 \times 10^6 \le 257 \times 10^6 \checkmark \longrightarrow \frac{L_j^4}{I} = 6.21 \times 10^6$$

$$2.0 \le \frac{L_j}{S} = \frac{(27 \times 12)}{7 \times 12} = 3.86 \le 30 \checkmark \longrightarrow \frac{L_j}{S} = 3.86$$

$$N_{eff} = 0.49 + 34.2(0.065) + 9 \times 10^{-9}(6.21 \times 10^6) - 0.0059(3.86)^2 = 2.681$$

$$\Delta_{jp} = \frac{\Delta_{oj}}{n_{eff}} = \frac{4 \times 10^{-6}}{2.681} = 1.49 \times 10^{-6} \text{ in/lb}$$

$$\Delta_{gp} = \frac{(1 \text{ lb})(21')^3 (1728)}{96 (29000000 \text{ psi})(2219 \text{ in}^4)} = 2.59 \times 10^{-6} \text{ in/lb}$$

$$\Delta_p = \Delta_{jp} + \frac{\Delta_{gp}}{2} = 1.49 \times 10^{-6} + \frac{2.59 \times 10^{-6}}{2} = 2.785 \times 10^{-6} \text{ in/lb}$$

EVALUATE PREDICTED VELOCITY

$f_n = 7.85$ Hz , 4.99 Hz

FAST WALKING (100 bpm)

$$U_v = 25000 \longrightarrow V_p = \frac{(25000 \text{ lb Hz}^2)(2.785 \times 10^{-6} \text{ in/lb})}{7.85 \text{ Hz}} = 8870 \ \mu\text{in/sec}$$

MODERATE WALKING (75 bpm)

$$U_v = 5500 \longrightarrow V_p = \frac{(5500 \text{ lb Hz}^2)(2.785 \times 10^{-6} \text{ in/lb})}{7.85 \text{ Hz}} = 1951 \ \mu\text{in/sec}$$

SLOW WALKING (50 bpm)

$$U_v = 1500 \longrightarrow V_p = \frac{(1500 \text{ lb Hz}^2)(2.785 \times 10^{-6} \text{ in/lb})}{7.85 \text{ Hz}} = 532 \ \mu\text{in/sec}$$

Original System Vibration Calculations

GEN*NY*SIS | CFG | VIBRATION ANALYSIS | 4

EVALUATE PREDICTED VELOCITY

$f_n = 5.0 \text{ Hz}$

FAST WALKING (100 bpm)

$U_v = 25000 \longrightarrow V_p = \frac{(25000 \text{ lb Hz}^2)(2.785\times10^{-6} \text{ in/lb})}{5 \text{ Hz}} = 13925 \frac{\mu\text{in}}{\text{sec}}$

MODERATE WALKING (75 bpm)

$U_v = 5500 \longrightarrow V_p = \frac{(5500 \text{ lb Hz}^2)(2.785\times10^{-6} \text{ in/lb})}{5 \text{ Hz}} = 3064 \frac{\mu\text{in}}{\text{sec}}$

SLOW WALKING (50 bpm)

$U_v = 1500 \longrightarrow V_p = \frac{(1500 \text{ lb}\cdot\text{Hz}^2)(2.785\times10^{-6} \text{ in/lb})}{5 \text{ Hz}} = 836 \frac{\mu\text{in}}{\text{sec}}$

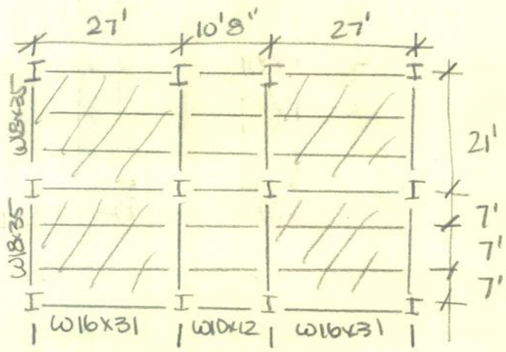
MASS SPECTROMETER REQUIRES 250 μin/sec

$\therefore$ NOT ACCEPTABLE

Original System Vibration Calculations

GEN* NY* SIS | CFG | VIBRATION ANALYSIS 5

ORIGINAL SYSTEM



4.5" NWC
2" COMP METAL DECK
f'c = 3500 psi

[hatched box] = LABORATORY SPACE

DECK PROPERTIES

CONCRETE w_c = 145 pcf
$f'c$ = 3500 psi

t_d = 2"
t_c = 4.5"
d_e = 5.5"

SLAB + DECK WEIGHT = 72 psf

BEAM PROPERTIES – W16x31
A = 9.13 in²
d = 15.9 in
I = 375 in⁴

W10x12
A = 3.54 in²
d = 9.87 in
I = 53.8 in⁴

GIRDER PROPERTIES – 18x35
A = 10.3 in²
d = 17.7 in
I = 510 in⁴

BEAM MODE (W16x31)

b = MIN | 0.4(27x12) = 130" ←
21x12 = 252"

$E_c = (145)^{1.5}\sqrt{3.5} = 3267$ ksi

$n = 29000/(1.35)(3267) = 6.575$

Original System Vibration Calculations

GEN*NY*SIS CFG STRUCTURAL DEPTH VIBRATION ANALYSIS

$\bar{y} = \frac{(9.13)(2+\frac{15.9}{2}) - (\frac{130}{6.575})(4.5)(4.5/2)}{9.13 + (130/6.575)(4.5)} = 1.115$ in BELOW TOP OF FORM DECK

$I_j = 375 + (9.13)(2+\frac{15.9}{2}-1.15)^2 + (\frac{130}{6.575})(4.5)^3(1/12)$
$+ (130/6.575)(4.5)(1.115 + \frac{4.5}{2})^2$
$= 375 + 707 + 150 + 1008 = 2240\ in^4$

$w_j = 7'(11+4+72) + 31 = 640$ plf

$\Delta_j = \frac{5(640)(27)^4(1728)}{384(29000000)(2240)} = 0.118$ in

$f_j = 0.18\sqrt{\frac{386.4}{0.118}} = 10.3$ Hz

$D_s = \frac{12(5.5)^3}{12(6.575)} = 25.304$

$D_j = \frac{2240}{7} = 320$

$B_j = 2.0\left(\frac{25.304}{320}\right)^{0.25}(27) = 28.635$ ft $< 2/3(27+27+10.67) = 43.1$

$W_j = \frac{640}{7}(28.635)(27) = 70.7^k$

BEAM MODE (W10x12)

$b = \min \begin{cases} 0.4(10.67 \times 12) = 51'' \leftarrow \\ 21 \times 12 = 252'' \end{cases}$

$\bar{y} = \frac{(3.54)(2+\frac{9.87}{2}) - (\frac{130}{6.575})(4.5)(4.5/2)}{3.54 + (130/6.575)(4.5)} = 1.899''$ BELOW TOP OF FORM DECK

$I_j = 53.8 + (3.54)(2+\frac{9.87}{2} - 1.899)^2 + (130/6.575)(4.5)^3(1/12)$
$+ (130/6.575)(4.5)(1.899 + \frac{4.5}{2})^2$
$= 53.8 + 25.36 + 150.14 + 1531.61 = 1761\ in^4$

$w_j = 7'(20+4+72) + 12 = 684$

$\Delta_j = \frac{5(684)(10.667)^4(1728)}{384(29000000)(1761)} = 0.0039''$

$f_j = 0.18\sqrt{\frac{386.4}{0.0039}} = 57$ Hz

Original System Vibration Calculations

GEN*NY*SIS CFG | STRUCTURAL DEPTH | VIBRATION ANALYSIS

$D_s = \frac{12(5.5)^3}{12(6.575)} = 25.304$

$D_j = \frac{1761}{7} = 251.571$

$B_j = 2.0\left(\frac{25.304}{251.571}\right)^{0.25}(10.667) = \underline{12.014 ft} < 43.1 ft$

$W_j = \frac{684}{7}(12.014)(10.6667) = 12.5^k$

GIRDER MODE (W18x35)

(JOIST = W16x31)

$b = \min \begin{cases} 0.4(21\times12) = 101'' \leftarrow \\ 27\times12 = 324'' \end{cases}$

(JOIST = W10x12)

$b = \min \begin{cases} 0.4(21\times12) = 101'' \leftarrow \\ 10.6667\times12 = 128'' \end{cases}$

$\bar{y} = \frac{(10.3)(1+\frac{17.7}{2}) - (\frac{101}{6.575})(5.5)^2(1/2)}{10.3 + (\frac{101}{6.575})(5.5)} = 1.381''$ BELOW EFFECTIVE SLAB ←

$\bar{y} = \frac{(\frac{101}{6.575})(4.5)^2(1/2) + (\frac{15.361}{2})(2)(5.5) + (10.3)(6.5+\frac{17.7}{2})}{(15.361)(4.5) + (\frac{15.361}{2})(2) + 10.3} = 4.200''$

$I_g = 510 + 10.3(1+\frac{17.7}{2} - 1.381)^2 + (15.361)(5.5)^3/12 + (15.361)(5.5)(1.381+\frac{5.5}{2})^2$
$= 2904\ in^4$

$W_g = 27\frac{(640)}{7} + 35 = 2504\ plf$

$\Delta_g = \frac{5(2504)(21)^4(1728)}{384(29000000)2904} = 0.130''$

$f_g = 0.18\sqrt{\frac{386.4}{0.130}} = 9.81\ Hz$

$D_j = 320$

$D_g = 2904/27 = 107.56$

$B_g = 1.8\left(\frac{320}{107.56}\right)^{0.25}(21) = 49.6 > \frac{2}{3}(63) = 42$

$B_g = 42$

$W_g = \left(\frac{2504}{27}\right)(42)(21) = 82^k$

$W_g = \frac{10.6667(684)}{7} + 35 = 1043\ plf$

$\Delta_g = \frac{5(1043)(21)^4(1728)}{384(29000000)2904} = 0.0542''$

$f_g = 0.18\sqrt{\frac{386.4}{0.0542}} = 15.20\ Hz$

$D_j = 252$

$D_g = 2904/10.67 = 272.25$

$B_g = 1.8\left(\frac{252}{272.25}\right)^{0.25}(21) = 37.077 < 42$

$B_g = 37.077$

$W_g = \left(\frac{1043}{10.6667}\right)(37.077)(21) = 76^k$

Original System Vibration Calculations

GEN*NY*SIS CFG | STRUCTURAL DEPTH | VIBRATION ANALYSIS

COMBINED MODE

GIRDER SPAN = 21'

$21 < 28.635$

$\Delta g' = \frac{21}{28.635}(0.130) = 0.0953''$

$W = \frac{0.118(70.7)}{(0.118+0.0953)} + \frac{(0.0953)(82^k)}{(0.118+0.0953)}$

$W = 75.7^k$

$\beta = 0.02$

$\beta W = 1.514^k$

$f_n = 0.18\sqrt{\frac{386.4}{.118+.0953}} = 7.66\ Hz$

$\frac{a_p}{g} = \frac{65\,e(-0.35 \times 7.66)}{1514} = 0.294g$

OK FOR OFFICES

$21 > 12.014\ ft$

$\Delta g' = \Delta g = 0.0542$

$W = \frac{0.0039(125)}{(.0039+.0542)} + \frac{(0.0542)(76)}{(.0039+.0542)}$

$W = 71.7^k$

$\beta = 0.01$

$\beta W = 0.717^k$

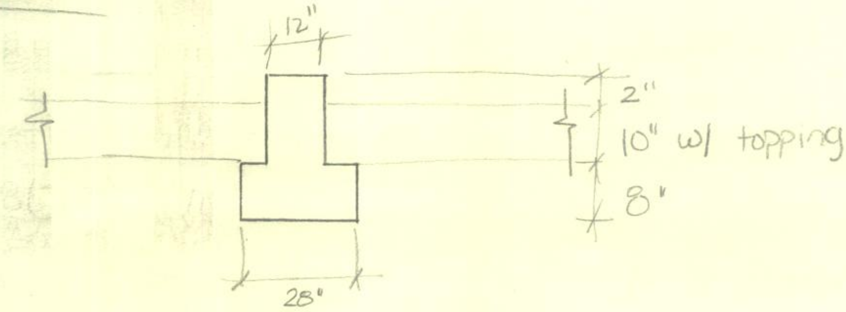
$f_n = 0.18\sqrt{\frac{386.4}{.0039+.0542}} = 14.68\ Hz$

$\frac{a_p}{g} = \frac{65e(-0.35 \times 14.68)}{717} = 0.053g$

Original System Vibration Calculations

GEN*NY*SIS CEG | STRUCTURAL DEPTH | VIBRATION ANALYSIS | 1

NEW SYSTEM



LIVE LOAD = 11 psf
DEAD LOAD = 145.0 psf (12" SLAB)
96.67 psf (8" BEAM)
4 psf (MECH LOAD)

W_{slab} = (4 psf)(336/12 ft) = 112 plf
(120.83)(336/12) = 3384 plf
(96.67)(28/12) = 225.56 plf
(11 psf)(336/12 ft) = 308 plf

3722 plf DEAD, 380 plf LIVE

$b_{f\,MIN}$ | 0.4(21) = 100.8" ; 4' = 48" ←

I_g = (4×12)(12)³ /12 = 6912 in⁴

A_g = 576 in²

E_{c_t} = 1.35(145^1.5 √5) = 5271 ksi

	SPAN 1	SPAN 2
W_{dead} = (145 psf)(336/12)	= 4060	3480

W_{live} = 380 plf

$\Delta_g = \frac{5(380\ plf)(21)^4\ 1728}{384(5271000\ psi)(6912)}$ = 0.333" ; 0.264"

b_{MIN} | 0.4(29) = 139.2" ← ; 21 = 252" | 0.4(336) 134.4 ← ; 252 | 0.4(288) = 115.2 ← ; 252

$I_g = \frac{(139.2)(20)^3}{12}$ = 92800 ; I_g = 89600 ; 76800

A_g = (28)(20) = 560 in²

New System Vibration Calculations

GEN*NY*SIS | CFG | VIBRATION ANALYSIS 3

$$A_p = \Delta_{jp} + \frac{\Delta_{gp}}{2} = 0.00000915 + \frac{0.00000167}{2} = 0.00000999$$

ASSUME 185 lb PERSON

FAST WALKING

$F_m = 315$, $f_0 = 5.0\ Hz$, $U_v = 25000$

$$V_{fast} = \frac{(25000)(0.00000999)}{4.20} = 59500\ \mu in/sec$$

New System Vibration Calculations

GEN*NY*SIS CFG | VIBRATION ANALYSIS

ASSUME SIMPLY SUPPORTED

$$W_g = \frac{40604}{4}(29') + (96.67\,psf \times 4) = 24921\,plf$$

$$\Delta_g = \frac{5(3722\,plf)(29')^4(1728)}{384(5271000\,psi)(18667\,in^4)} = 0.602''$$

$$\Delta_{jp} = \frac{21^3(1728)}{48(5271000)(4000)} = 0.0000158\,in/lb$$

$$\Delta_{gp} = \frac{(29)^3(1728)}{48(5271000)(18667)} = 0.0000802\,in/lb$$

$$\Delta_p = \Delta_{jp} + \frac{\Delta_{gp}}{2} = 0.0000158 + \frac{0.0000802}{2} = 0.0000560\,in/lb$$

$$f_n = 0.18\sqrt{\frac{386}{0.781 + 0.602}} = 3.01\,Hz$$

FAST WALKING

New System Vibration Calculations

GEN*NY*SIS CFG — VIBRATION ANALYSIS 2

ASSUME SIMPLY SUPPORTED

SPAN 1

$$w_g = \frac{4060\text{ plf}}{4'}(28') + (96.67\text{ psf} \times 21) = 30451\text{ plf}$$

$$\Delta_{g_1} = \frac{5(30451)(28)^4(1728)}{384(5271000)(89600)} = 0.178\text{ in}$$

SPAN 2

$$w_g = \frac{3480}{4'}(24) + (96.67\text{ psf} \times 21) = 22911\text{ plf}$$

$$\Delta_{g_2} = \frac{5(22911)(24)^4(1728)}{384(5271000)(76800)} = 0.422''$$

$$\Delta_{jp_1} = \frac{21^3(1728)}{48(5271000)(6912)} = 0.00000915\text{ in/sec}$$

$$\Delta_{gp_1} = \frac{28^3(1728)}{48(5271000)(89600)} = 0.00000167\text{ in/sec}$$

$$\Delta_{gp_2} = \frac{24^3(1728)}{48(5271000)(76800)} = 0.00000123\text{ in/sec}$$

$$f_{n_1} = 0.18\sqrt{\frac{386.4}{0.333+0.178}} = 4.95\text{ Hz}$$

$$f_{n_2} = 0.18\sqrt{\frac{386.4}{0.264+0.422}} = 4.27\text{ Hz}$$

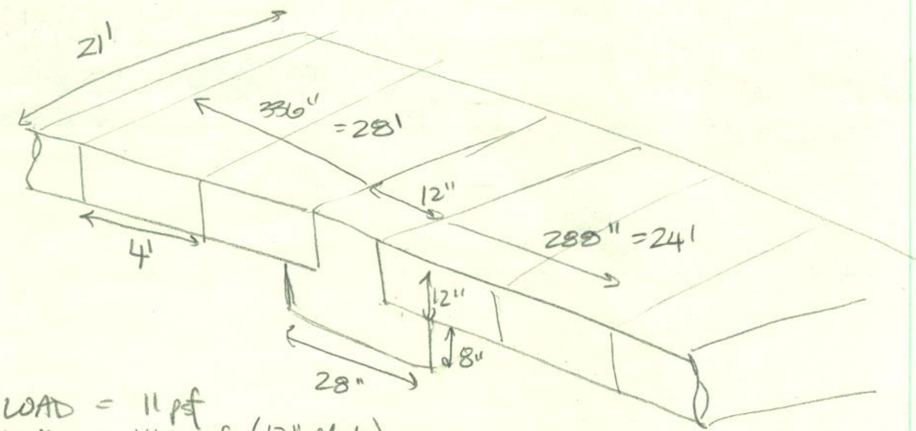
$f_0 \leq 5.0$ Hz

$$\frac{f_{n_1}}{f_0} = \frac{4.95}{5.0} = 0.99 >> 0.5$$

$$\frac{f_{n_2}}{f_0} = \frac{4.27}{5.0} = 0.85 >> 0.5$$

New System Vibration Calculations

GEN*NY*SIS CFG VIBRATION ANALYSIS 1



LIVE LOAD = 11 psf
~~DEAD LOAD~~ = 145 psf (12" slab)
96.67 (8" beam)
4 psf (MECH)

$b_{MIN} = \begin{cases} 4' = 48" \leftarrow \\ 0.4(21') = 101" \end{cases}$

$I_j = \frac{(48)(12)^3}{12} = 6912\ in^4$

$A_j = (48)(12) = 576\ in^2$

$E_c = 145^{1.5}\sqrt{5} = 5271\ ksi$

$w_{dead} = (145\ psf) + 4\ psf = 149\ psf\ (48") = 596\ plf$

$w_{live} = 11\ psf\ (48") = 44\ plf$

$\Delta_j = \frac{5(596 + 44\ plf)(21')^4(1728)}{384\ (5271000\ psi)(6912\ in^4)} = 0.0769"$

$I_g = \frac{(28)(20)^3}{12} = 18667\ in^4$

$w_{g_1} = \frac{640\ plf}{4'}(28') + 383\ plf = 4863\ plf$

$\Delta_{g_1} = \frac{5\ (4863)(28)^4(1728)}{384\ (5271000)(18667)} = 0.684$

New Vibration Calculations

GEN*NY*SIS | CFG | VIBRATION ANALYSIS 2

$$w_{g2} = \frac{640 \text{ plf}}{4'}(24') + 383 \text{ plf} = 4223$$

$$\Delta_{g2} = \frac{5(4223)(24)^4(1728)}{384(5271000)(18667)} = 0.320$$

$$\Delta_{jp} = \frac{(21)^3 1728}{48(5271000)(6912)} = 0.00000915 \text{ in/lb}$$

$$\Delta_{gp_1} = \frac{(28)^3 1728}{48(5271000)(18667)} = 0.00000803 \text{ in/lb}$$

$$\Delta_{gp_2} = \frac{(24)^3(1728)}{48(5271000)(18667)} = 0.00000506 \text{ in/lb}$$

$$\Delta_{p_1} = 0.00000915 + \frac{0.00000803}{2} = 0.0000132 \text{ in/lb}$$

$$\Delta_{p_2} = 0.00000915 + \frac{0.00000506}{2} = 0.0000117 \text{ in/lb}$$

$$f_{n_1} = 0.18\sqrt{\frac{386.4}{.0769 + .684}} = 4.06 \text{ Hz}$$

$$f_{n_2} = 0.18\sqrt{\frac{386.4}{.0769 + .320}} = 5.62 \text{ Hz}$$

$$5 \text{ Hz} \geq f_0 \geq 0 \text{ Hz}$$

$$\frac{f_{n_1}}{f_0} = \frac{4.06}{5.00} >> 0.5$$

$$\frac{f_{n_2}}{f_0} = \frac{5.62}{5.00} >> 0.5$$

New Vibration Calculations

GEN*NY*SIS | CFG | VIBRATION ANALYSIS 3

FAST WALKING (100 bpm)

$U_V = 25000$

$V_p = \frac{25000(0.0000132)}{4.06} = 81281\ \mu in/sec$

MODERATE WALKING (75 bpm)

$U_V = 5500$

$V_p = \frac{5500(0.0000132)}{4.06} = 17882\ \mu in/sec$

SLOW WALKING (50 bpm)

$U_V = 1500$

$V_p = \frac{1500(0.0000132)}{406} = 4877\ \mu in/sec < 8000\ \mu in/sec$

FAST WALKING (100 bpm)

$V_p = \frac{25000(0.0000117)}{5.62} = 52046\ \mu in/sec$

MODERATE WALKING (75 bpm)

$V_p = \frac{5500(0.0000117)}{5.62} = 11450\ \mu in/sec$

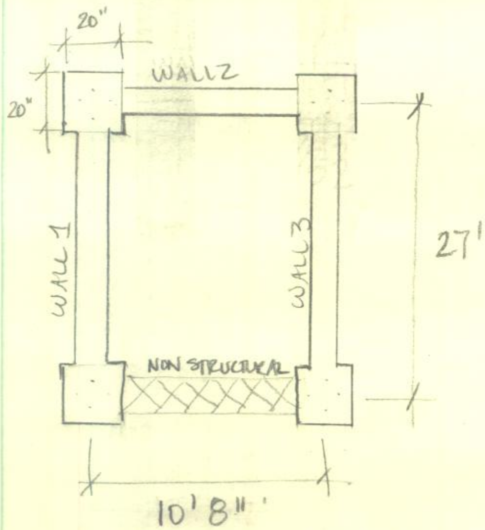
SLOW WALKING (50 bpm)

$V_p = \frac{1500(0.0000117)}{5.62} = 3123\ \mu in/sec < 8000\ \mu in/sec$

New Vibration Calculations

GEN*NY*SIS CFG FOUNDATIONS 1

FOUNDATION FOR SHEAR WALL #1



DAUPHIN COUNTY, PA
"LEWISBERRY" LrC2

http://soildatamart.nrcs.usda.gov/Manuscripts/PA133/0/PA_York.pdf

ALLOWABLE FOUNDATION PRESSURE → 2000 psf
LATERAL BEARING (psf/ft BELOW NATURAL GRADE) → 150 psf/ft
LATERAL SLIDING, COEFFICIENT OF FRICTION → 0.25

DEAD LOAD: $\left(\frac{20 \times 20}{144}\right)(145)(87) + (145)(72.6)(1) + (145)\left(\frac{10}{12}\right)(87)\left(\frac{27}{2}\right) = 46520$

LIVE LOAD: $(100\ psf)(72.6)(1) = 7260$

$P = 46.5^k + 7.3^k = 53.8^k$

$q_a = 2000 = \frac{53.8}{B^2}$

$B \geq 5.2\ ft \rightarrow$ USE $B = 6\ ft$

$P_u = 1.2(46.5) + 1.6(7.3) = 68^k$

$q = \frac{P_u}{A} = \frac{68^k}{6^2} = 1.89\ ksf = 13.12\ psi$

$V_c = \phi 4\sqrt{f'c} = 0.75(4)\sqrt{5000\ psi} = 212\ psi$

New Foundation Calculations

GEN*NY*SIS CFG — FOUNDATIONS — 2

$d^2(v_c + \frac{q}{4}) + d(v_c + \frac{q}{2})w = \frac{q}{4}(BL - w^2)$

$d^2(212 + \frac{13.12}{4}) + d(212 + \frac{13.12}{2})(24) = \frac{13.12}{4}((36)^2 - (24)^2)$

$215.3d^2 + 5245.4d = 2361.6$

$d = 6.96 \text{ in}$

$h = 6.96 + 3 + 0.625 = 10.6'' \rightarrow h = 12''$

$d = 12 - 3 - 0.625 = 8.375'$

$l = \frac{6' - 2'}{2} = 2'$

$M_U = \frac{1.89(2')^2}{2} = 3.78'^{k}$

$a = \frac{A_s(60\text{ ksi})}{0.85(5\text{ksi})(12)} = 1.18A_s$

$M_U = \phi M_n = A_s f_y (d - a/2)$

$3.78(12) = 0.9A_s(60)(8.375 - \frac{1.18A_s}{2})$

$45.4 = 452.3A_s - 31.9A_s^2$

$A_s = 0.12$

USE #4 @ 12" o.c. $A_s = 0.20\text{ in}^2$

$\rho = \frac{0.20}{(12)(12)} = 0.0013 < 0.0018$ ∴ USE #5 @ 12" o.c. $A_s = 0.31\text{ in}^2$

$a = 1.96A_s = 1.96(0.31\text{ in}^2) = 0.608''$

$c = \frac{0.608}{0.85} = 0.715''$

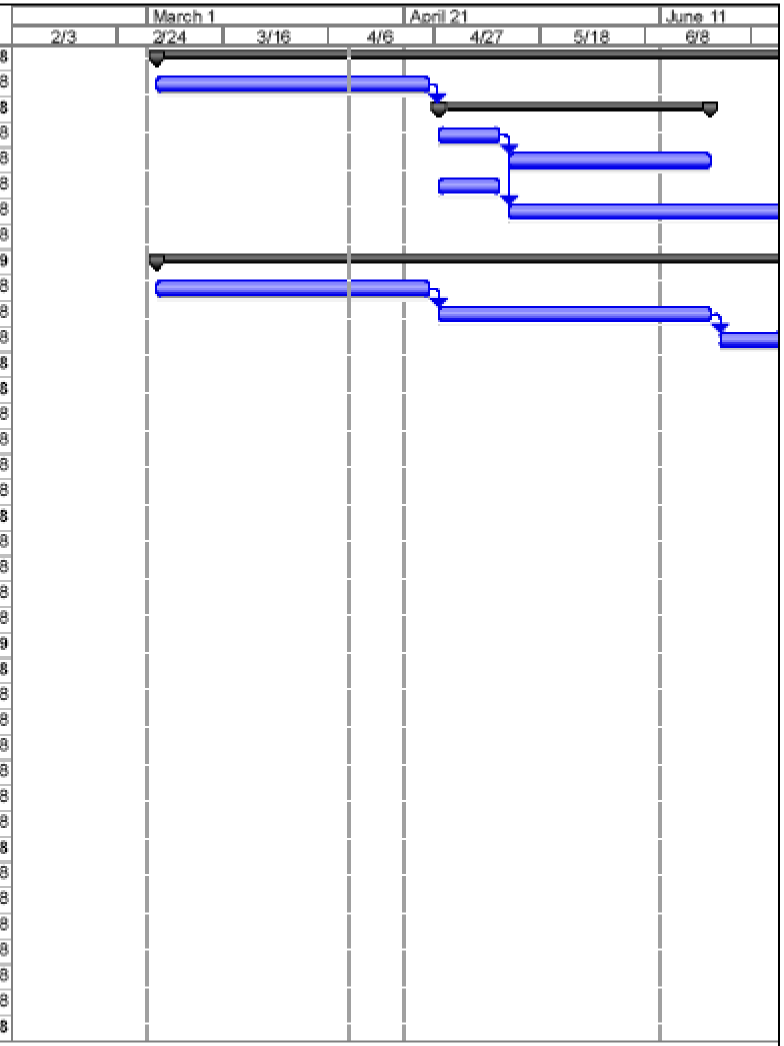
$\varepsilon_s = \frac{0.003}{0.715}(8.375 - 0.715) = 0.032\text{ in/in} > 0.005\text{ in/in}$ ✓ ∴ $\phi = 0.9$

$\phi B_n = (0.65)(0.85)(5\text{ksi})(24'')^2 = 1592\text{ k}$

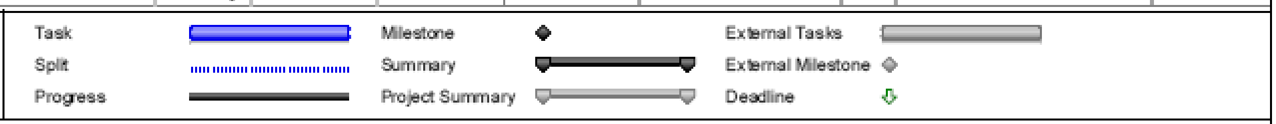
$\phi B_n = 1592^k > P_u$ $A_{s,min} = 0.005(24)^2 = 2.88\text{ in}^2 \rightarrow$ (8) #6

New Foundation Calculations

ID	Task Name	Duration	Start	Finish
1	**STEEL CONSTRUCTION**	**130 days**	**Mon 3/3/08**	**Fri 8/29/08**
2	Site Work	40 days	Mon 3/3/08	Fri 4/25/08
3	**Foundation**	**40 days**	**Mon 4/28/08**	**Fri 6/20/08**
4	Retaining Walls	10 days	Mon 4/28/08	Fri 5/9/08
5	Footings	30 days	Mon 5/12/08	Fri 6/20/08
6	SOG	10 days	Mon 4/28/08	Fri 5/9/08
7	Steel Erection	50 days	Mon 5/12/08	Fri 7/18/08
8	FRP	30 days	Mon 7/21/08	Fri 8/29/08
9	**PRECAST CONSTRUCTION**	**284 days**	**Mon 3/3/08**	**Thu 4/2/09**
10	Site Work	40 days	Mon 3/3/08	Fri 4/25/08
11	Foundation	40 days	Mon 4/28/08	Fri 6/20/08
12	SOG	10 days	Mon 6/23/08	Fri 7/4/08
13	**Section I**	**14 days**	**Mon 7/7/08**	**Thu 7/24/08**
14	**1st**	**7 days**	**Mon 7/7/08**	**Tue 7/15/08**
15	1st Erect Columns	2 days	Mon 7/7/08	Tue 7/8/08
16	1st Erect Beams	2 days	Wed 7/9/08	Thu 7/10/08
17	1st 4HC8	2 days	Fri 7/11/08	Mon 7/14/08
18	2" Topping	1 day	Tue 7/15/08	Tue 7/15/08
19	**2nd**	**7 days**	**Wed 7/16/08**	**Thu 7/24/08**
20	2nd Erect Columns	2 days	Wed 7/16/08	Thu 7/17/08
21	2nd Erect Beams	2 days	Fri 7/18/08	Mon 7/21/08
22	2nd 4HC8	2 days	Tue 7/22/08	Wed 7/23/08
23	2" Topping	1 day	Thu 7/24/08	Thu 7/24/08
24	**Section 2**	**137 days**	**Tue 7/15/08**	**Wed 1/21/09**
25	**1st Floor**	**26 days**	**Tue 7/15/08**	**Tue 8/19/08**
26	Column	2 days	Tue 7/15/08	Wed 7/16/08
27	Beam	2 days	Thu 7/17/08	Fri 7/18/08
28	Plank	2 days	Mon 7/21/08	Tue 7/22/08
29	FR Shear	4 days	Wed 7/23/08	Mon 7/28/08
30	P Shear	15 days	Tue 7/29/08	Mon 8/18/08
31	2" Topping	1 day	Tue 8/19/08	Tue 8/19/08
32	**2nd Floor**	**27 days**	**Wed 8/20/08**	**Thu 9/25/08**
33	Column	2 days	Wed 8/20/08	Thu 8/21/08
34	Beam	2 days	Fri 8/22/08	Mon 8/25/08
35	Plank	2 days	Tue 8/26/08	Wed 8/27/08
36	FR Shear	4 days	Thu 8/28/08	Tue 9/2/08
37	P Shear	16 days	Wed 9/3/08	Wed 9/24/08
38	2" Topping	1 day	Thu 9/25/08	Thu 9/25/08
39	**3rd Floor**	**27 days**	**Fri 9/26/08**	**Mon 11/3/08**



Project: schedule
Date: Thu 4/10/08



Page 1

ID	Task Name	Duration	Start	Finish
40	Columns	2 days	Fri 9/26/08	Mon 9/29/08
41	Beams	2 days	Tue 9/30/08	Wed 10/1/08
42	Plank	2 days	Thu 10/2/08	Fri 10/3/08
43	FR Shear	4 days	Mon 10/6/08	Thu 10/9/08
44	P Shear	16 days	Fri 10/10/08	Fri 10/31/08
45	2" Topping	1 day	Mon 11/3/08	Mon 11/3/08
46	**Roof**	**34 days**	**Tue 11/4/08**	**Fri 12/19/08**
47	Columns	3 days	Tue 11/4/08	Thu 11/6/08
48	Beams	2 days	Fri 11/7/08	Mon 11/10/08
49	Plank	4 days	Tue 11/11/08	Fri 11/14/08
50	FR Shear	4 days	Mon 11/17/08	Thu 11/20/08
51	P Shear	20 days	Fri 11/21/08	Thu 12/18/08
52	2" Topping	1 day	Fri 12/19/08	Fri 12/19/08
53	**Penthouse**	**23 days**	**Mon 12/22/08**	**Wed 1/21/09**
54	FR Shear	2 days	Mon 12/22/08	Tue 12/23/08
55	P Shear	21 days	Wed 12/24/08	Wed 1/21/09
56	**Section 3**	**182 days**	**Wed 7/23/08**	**Thu 4/2/09**
57	**1st**	**37 days**	**Wed 7/23/08**	**Thu 9/11/08**
58	Column	2 days	Wed 7/23/08	Thu 7/24/08
59	Beam	2 days	Fri 7/25/08	Mon 7/28/08
60	Plank	2 days	Tue 7/29/08	Wed 7/30/08
61	FR Shear	4 days	Thu 7/31/08	Tue 8/5/08
62	P Shear	26 days	Wed 8/6/08	Wed 9/10/08
63	Topping	1 day	Thu 9/11/08	Thu 9/11/08
64	**2nd**	**37 days**	**Fri 9/12/08**	**Mon 11/3/08**
65	Columns	2 days	Fri 9/12/08	Mon 9/15/08
66	Beams	2 days	Tue 9/16/08	Wed 9/17/08
67	Plank	2 days	Thu 9/18/08	Fri 9/19/08
68	FR Shear	4 days	Mon 9/22/08	Thu 9/25/08
69	P Shear	26 days	Fri 9/26/08	Fri 10/31/08
70	Topping	1 day	Mon 11/3/08	Mon 11/3/08
71	**3rd**	**37 days**	**Tue 11/4/08**	**Wed 12/24/08**
72	Columns	2 days	Tue 11/4/08	Wed 11/5/08
73	Beams	2 days	Thu 11/6/08	Fri 11/7/08
74	Plank	2 days	Mon 11/10/08	Tue 11/11/08
75	FR Shear	4 days	Wed 11/12/08	Mon 11/17/08
76	P Shear	26 days	Tue 11/18/08	Tue 12/23/08
77	Topping	1 day	Wed 12/24/08	Wed 12/24/08
78	**Roof**	**39 days**	**Thu 12/25/08**	**Tue 2/17/09**

March 1 | April 21 | June 11

2/3 | 2/24 | 3/16 | 4/6 | 4/27 | 5/18 | 6/8

Project: schedule
Date: Thu 4/10/08

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

Page 2

ID		Task Name	Duration	Start	Finish
79		Columns	3 days	Thu 12/25/08	Mon 12/29/08
80		Beams	2 days	Tue 12/30/08	Wed 12/31/08
81		Plank	2 days	Thu 1/1/09	Fri 1/2/09
82		FR Shear	2 days	Mon 1/5/09	Tue 1/6/09
83		P Shear	28 days	Wed 1/7/09	Fri 2/13/09
84		Topping	2 days	Mon 2/16/09	Tue 2/17/09
85		**Penthouse**	**32 days**	**Wed 2/18/09**	**Thu 4/2/09**
86		FR Shear	4 days	Wed 2/18/09	Mon 2/23/09
87		P Shear	28 days	Tue 2/24/09	Thu 4/2/09
88		**Section 4**	**42 days**	**Thu 7/31/08**	**Fri 9/26/08**
89		**1st**	**10 days**	**Thu 7/31/08**	**Wed 8/13/08**
90		Column	3 days	Thu 7/31/08	Mon 8/4/08
91		Beam	2 days	Tue 8/5/08	Wed 8/6/08
92		Plank	3 days	Thu 8/7/08	Mon 8/11/08
93		Topping	2 days	Tue 8/12/08	Wed 8/13/08
94		**2nd**	**10 days**	**Thu 8/14/08**	**Wed 8/27/08**
95		Column	3 days	Thu 8/14/08	Mon 8/18/08
96		Beam	2 days	Tue 8/19/08	Wed 8/20/08
97		Plank	3 days	Thu 8/21/08	Mon 8/25/08
98		Topping	2 days	Tue 8/26/08	Wed 8/27/08
99		**3rd**	**10 days**	**Thu 8/28/08**	**Wed 9/10/08**
100		Column	3 days	Thu 8/28/08	Mon 9/1/08
101		Beam	2 days	Tue 9/2/08	Wed 9/3/08
102		Plank	3 days	Thu 9/4/08	Mon 9/8/08
103		Topping	2 days	Tue 9/9/08	Wed 9/10/08
104		**Roof**	**12 days**	**Thu 9/11/08**	**Fri 9/26/08**
105		Column	3 days	Thu 9/11/08	Mon 9/15/08
106		Beam	2 days	Tue 9/16/08	Wed 9/17/08
107		Plank	5 days	Thu 9/18/08	Wed 9/24/08
108		Topping	2 days	Thu 9/25/08	Fri 9/26/08
109		**Section 5**	**121 days**	**Tue 8/12/08**	**Tue 1/27/09**
110		**1st**	**23 days**	**Tue 8/12/08**	**Thu 9/11/08**
111		Column	2 days	Tue 8/12/08	Wed 8/13/08
112		Beam	2 days	Thu 8/14/08	Fri 8/15/08
113		Plank	2 days	Mon 8/18/08	Tue 8/19/08
114		FR Shear	2 days	Wed 8/20/08	Thu 8/21/08
115		P Shear	14 days	Fri 8/22/08	Wed 9/10/08
116		Topping	1 day	Thu 9/11/08	Thu 9/11/08
117		**2nd**	**25 days**	**Fri 9/12/08**	**Thu 10/16/08**

Timeline: March 1, April 21, June 11 — 2/3, 2/24, 3/16, 4/6, 4/27, 5/18, 6/8

Project: schedule
Date: Thu 4/10/08

Legend: Task; Split; Progress; Milestone; Summary; Project Summary; External Tasks; External Milestone; Deadline

Page 3

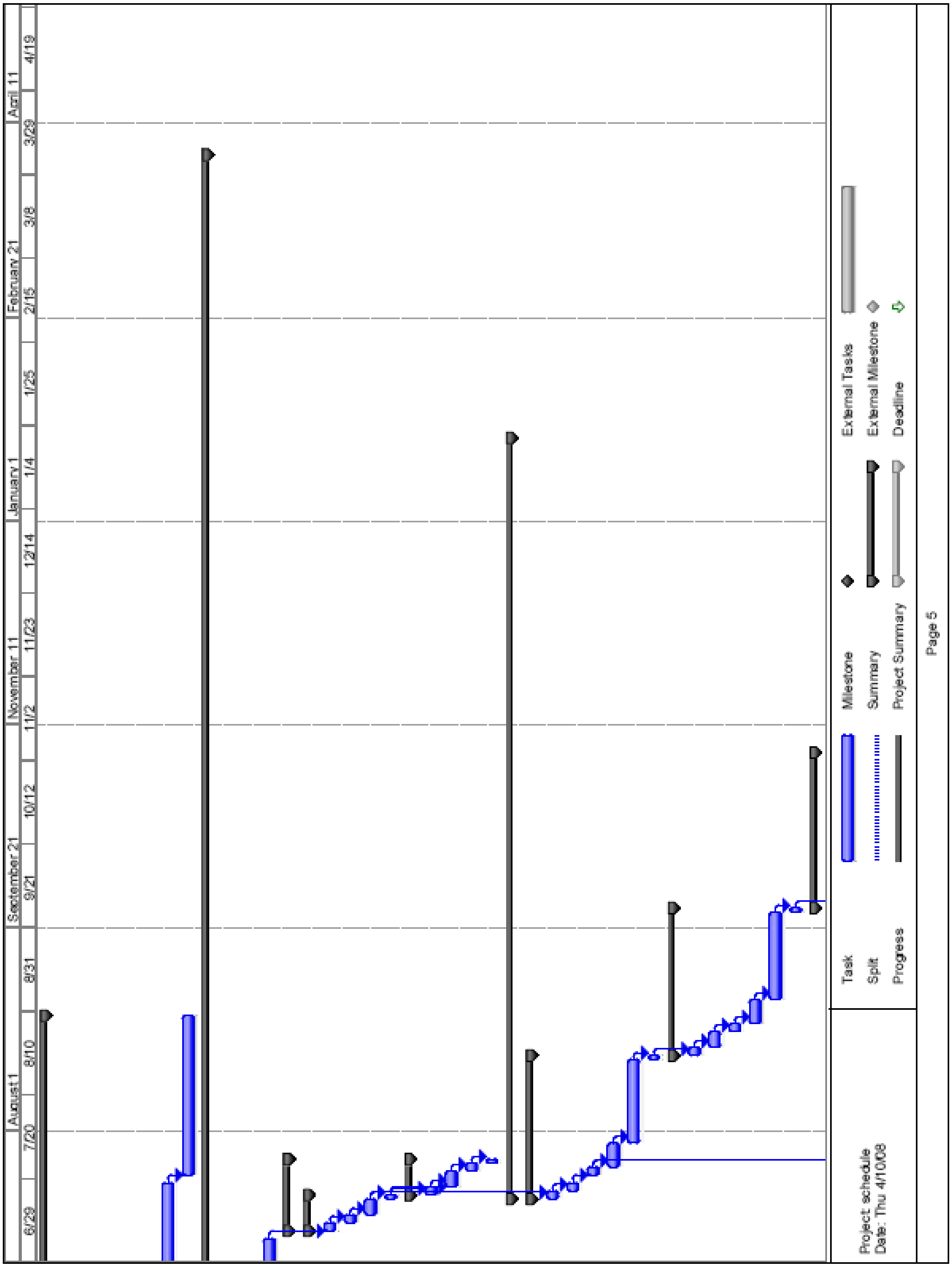
ID		Task Name	Duration	Start	Finish
118		Column	2 days	Fri 9/12/08	Mon 9/15/08
119		Beam	2 days	Tue 9/16/08	Wed 9/17/08
120		Plank	2 days	Thu 9/18/08	Fri 9/19/08
121		FR Shear	2 days	Mon 9/22/08	Tue 9/23/08
122		P Shear	16 days	Wed 9/24/08	Wed 10/15/08
123		Topping	1 day	Thu 10/16/08	Thu 10/16/08
124		**3rd**	**25 days**	**Fri 10/17/08**	**Thu 11/20/08**
125		Column	2 days	Fri 10/17/08	Mon 10/20/08
126		Beam	2 days	Tue 10/21/08	Wed 10/22/08
127		Plank	2 days	Thu 10/23/08	Fri 10/24/08
128		FR Shear	2 days	Mon 10/27/08	Tue 10/28/08
129		P Shear	16 days	Wed 10/29/08	Wed 11/19/08
130		Topping	1 day	Thu 11/20/08	Thu 11/20/08
131		**Roof**	**27 days**	**Fri 11/21/08**	**Mon 12/29/08**
132		Column	2 days	Fri 11/21/08	Mon 11/24/08
133		Beam	2 days	Tue 11/25/08	Wed 11/26/08
134		Plank	2 days	Thu 11/27/08	Fri 11/28/08
135		FR Shear	2 days	Mon 12/1/08	Tue 12/2/08
136		P Shear	18 days	Wed 12/3/08	Fri 12/26/08
137		Topping	1 day	Mon 12/29/08	Mon 12/29/08
138		**Penthouse**	**21 days**	**Tue 12/30/08**	**Tue 1/27/09**
139		FR Shear	2 days	Tue 12/30/08	Wed 12/31/08
140		P Shear	18 days	Thu 1/1/09	Mon 1/26/09
141		Topping	1 day	Tue 1/27/09	Tue 1/27/09

Timescale: March 1, April 21, June 11 — 2/3, 2/24, 3/16, 4/6, 4/27, 5/18, 6/8

Project: schedule
Date: Thu 4/10/08

Legend: Task, Split, Progress, Milestone, Summary, Project Summary, External Tasks, External Milestone, Deadline

Page 4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November 11
January 1
February 21
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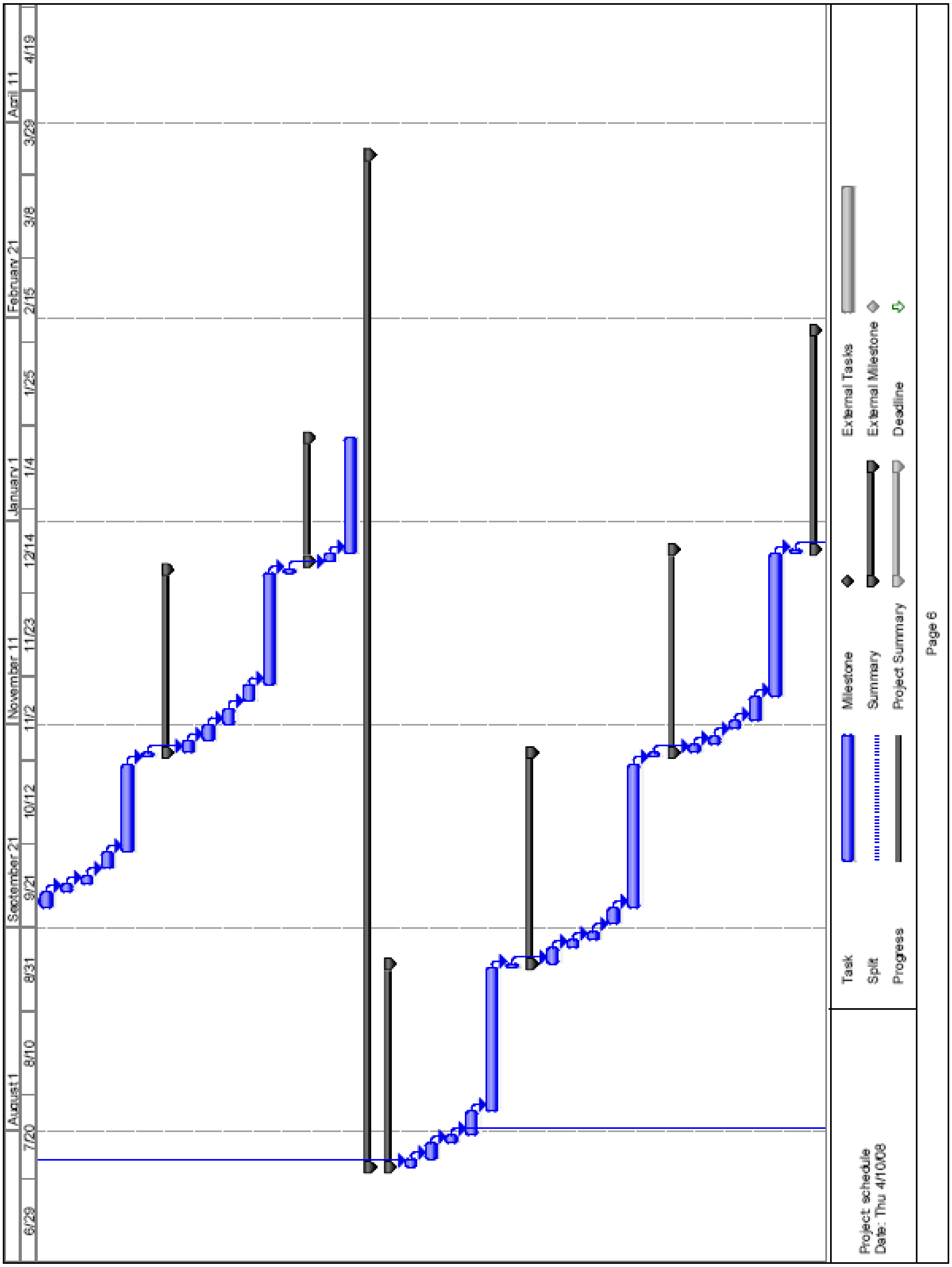
Project: schedule
Date: Thu 4/10/08
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 5



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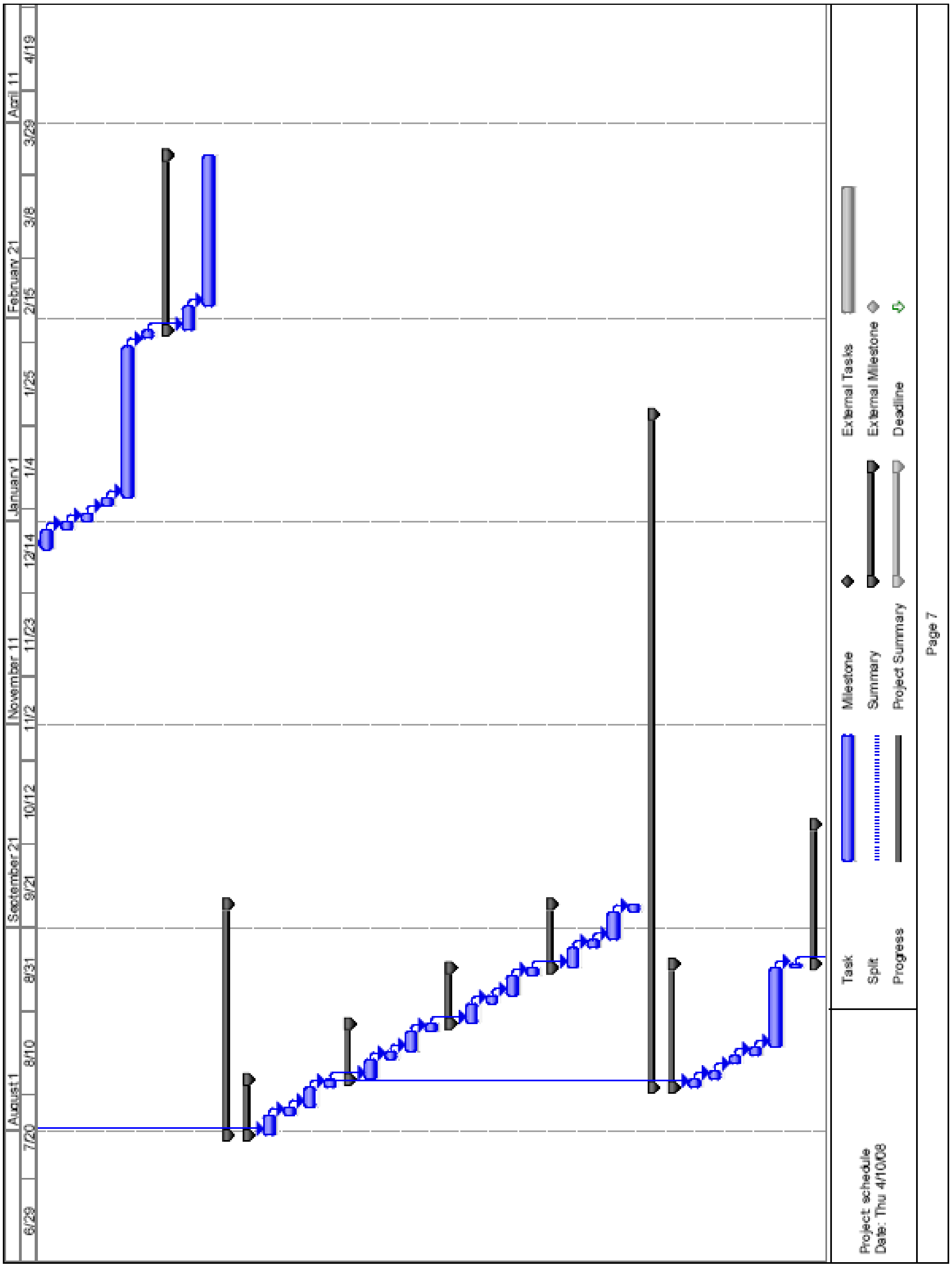
Project: schedule
Date: Thu 4/10/08
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 6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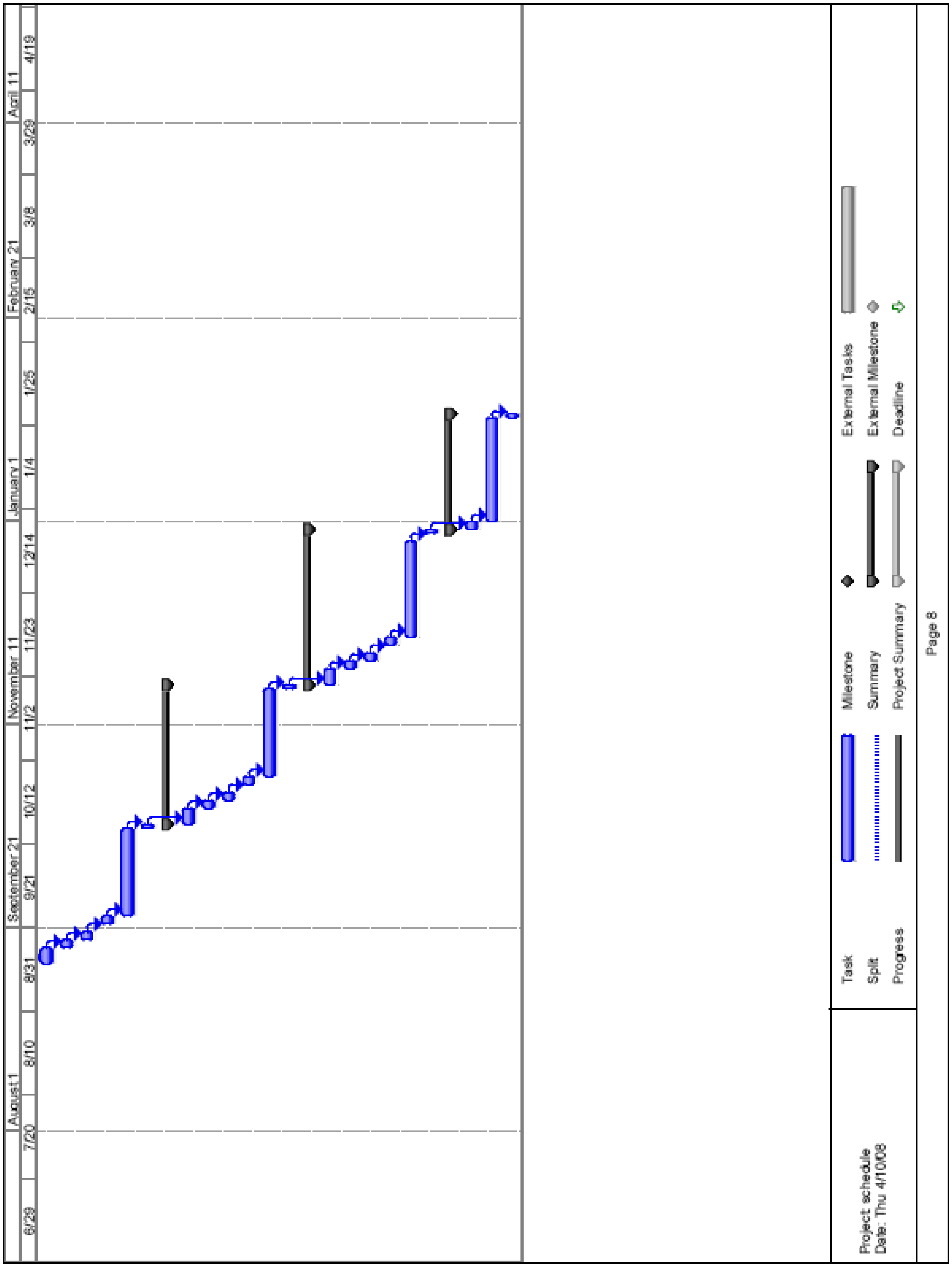
Project: schedule
Date: Thu 4/10/08
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 7


August 1
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Project schedule
Date: Thu 4/10/08
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 8

CSI Division	CSI Subdivision	Description	Crew	Daily Output	Labor-Hours	Unit of Measure	Quantity	Unit Mat'l Cost	Mat'l Cost	Unit Labor Cost	Labor Cost	Unit Equip/Sub Cost	Equip/Sub Cost	Item Cost	Total Item Cost
03310-220		Concrete, ready mix													
	400	Regular weight				C.Y.	190720	$ 77.00	$ 14,685,440.00					$ 77.00	$ 16,153,984.00
05120-260		Columns													
	4550	HSS6x6x1/4"x12'-0"	E-2	54	1.037	Each	34	$ 165.00	$ 5,610.00	$ 34.50	$ 1,173.00	$ 26.50	$ 901.00	$ 226.00	$ 7,684.00
	4600	HSS8x8x3/8"x14'-0"	E-2	50	1.12	Each	34	$ 360.00	$ 12,240.00	$ 37.00	$ 1,258.00	$ 28.50	$ 969.00	$ 425.50	$ 14,467.00
	6850	W8x31	E-2	1080	0.052	L.F.	420	$ 21.00	$ 8,820.00	$ 1.72	$ 722.40	$ 1.32	$ 554.40	$ 24.04	$ 10,096.80
	7150	W12x50	E-2	1032	0.054	L.F.	6245	$ 33.50	$ 209,207.50	$ 1.80	$ 11,241.00	$ 1.38	$ 8,618.10	$ 36.68	$ 229,066.60
	7200	W12x87	E-2	984	0.057	L.F.	50	$ 58.50	$ 2,925.00	$ 1.89	$ 94.50	$ 1.44	$ 72.00	$ 61.83	$ 3,091.50
05120-640		Structural Steel Members													
	600	W10x12	E-2	600	0.093	L.F.	180	$ 8.10	$ 1,458.00	$ 3.10	$ 558.00	$ 2.37	$ 426.60	$ 13.57	$ 2,442.60
	1900	W14x26	E-2	990	0.057	L.F.	120	$ 17.50	$ 2,100.00	$ 1.88	$ 225.60	$ 1.44	$ 172.80	$ 20.82	$ 2,498.40
	2320	W14x43	E-2	810	0.069	L.F.	120	$ 29.00	$ 3,480.00	$ 2.29	$ 274.80	$ 1.75	$ 210.00	$ 33.04	$ 3,964.80
	2700	W16x26	E-2	1000	0.056	L.F.	240	$ 17.50	$ 4,200.00	$ 1.86	$ 446.40	$ 1.42	$ 340.80	$ 20.78	$ 4,987.20
	3300	W18x35	E-5	960	0.083	L.F.	325	$ 23.50	$ 7,637.50	$ 2.81	$ 913.25	$ 1.57	$ 510.25	$ 27.88	$ 9,061.00
	4100	W21x44	E-5	1064	0.075	L.F.	275	$ 29.50	$ 8,112.50	$ 2.53	$ 695.75	$ 1.42	$ 390.50	$ 33.45	$ 9,198.75
	4900	W24x55	E-5	1110	0.072	L.F.	120	$ 37.00	$ 4,440.00	$ 2.43	$ 291.60	$ 1.36	$ 163.20	$ 40.79	$ 4,894.80
05210-600		Open Web Joists													
	2200	18LH04, 12 lb/lf	E-7	1400	0.057	L.F.	225	$ 5.95	$ 1,338.75	$ 1.93	$ 434.25	$ 1.14	$ 256.50	$ 9.02	$ 2,029.50
	2320	28LH60, 16 lb/lf	E-7	1800	0.044	L.F.	490	$ 7.95	$ 3,895.50	$ 1.50	$ 735.00	$ 0.89	$ 436.10	$ 10.34	$ 5,066.60
	2360	32LH08, 17 lb/lf	E-7	1800	0.044	L.F.	380	$ 12.45	$ 4,731.00	$ 1.50	$ 570.00	$ 0.89	$ 338.20	$ 14.84	$ 5,639.20
05310-300		Metal Decking													
	5300	Non-cellular comp deck, galv. 2" deep 20 gauge	E-4	3600	0.009	S.F.	117400	$ 0.95	$ 111,530.00	$ 0.31	$ 36,394.00	$ 0.02	$ 2,348.00	$ 1.28	$ 150,272.00
															$ 16,618,444.75

Original System Cost Analysis

CSI Division	CSI Subdivision	Description	Crew	Daily Output	Labor-Hours	Unit of Measure	Quantity	Unit Mat'l Cost	Mat'l Cost	Unit Labor Cost	Labor Cost	Unit Equip/Sub Cost	Equip/Sub Cost	Item Cost	Total Item Cost
03110-410		Forms In Place, Columns													
	6500	24"x24" columns, 4 use	C-1	238	0.134	SFCA	342	$ 0.63	$ 215.46	$ 3.81	$ 1,303.02			$ 4.44	$ 1,518.48
03110-455		Forms In Place, Walls													
	2850	Over 16' high, 4 use	C-2	330	0.145	SFCA	304	$ 0.69	$ 209.76	$ 4.25	$ 1,292.00			$ 4.94	$ 1,501.76
03210-600		Reinforcing in place A615 Grade 60													
	250	Columns, #8 to 18	4 Rodm	2.3	13.913	Ton	30	$ 550.00	$ 16,500.00	$ 475.00	$ 14,250.00			$ 1,025.00	$ 30,750.00
	700	Walls, #3 to #7	4 Rodm	3	10.667	Ton	75	$ 535.00	$ 40,125.00	$ 365.00	$ 27,375.00			$ 900.00	$ 67,500.00
03310-220		Concrete, ready mix													
	400	Regular weight				C.Y.	161120	$ 77.00	$ 12,406,240.00					$ 77.00	$ 12,406,240.00
03310-700		Placing Concrete													
	650	Columns, 24", crane and bucket	C-7	55	1.309	C.Y.	190			$ 33.50	$ 6,365.00	$ 19.40	$ 3,686.00	$ 52.90	$ 10,051.00
	5200	12" thick, crane and bucket	C-7	90	0.8	C.Y.	420			$ 20.50	$ 8,610.00	$ 11.85	$ 4,977.00	$ 32.35	$ 13,587.00
03410-100		Beams, "L" shaped													
	11	20' span, 12"x20"	C-11	32	2.25	Ea.	240	$ 1,400.00	$ 336,000.00	$ 75.00	$ 18,000.00	$ 53.00	$ 12,720.00	$ 1,528.00	$ 366,720.00
	2200	30' span, 12"x36"	C-11	24	3	Ea.	220	$ 3,750.00	$ 825,000.00	$ 109.00	$ 23,980.00	$ 77.00	$ 16,940.00	$ 3,886.00	$ 854,920.00
03410-210		Rectangular Columns													
	300	24' high, small	C-11	192	0.375	L.F.	6462.12	$ 104.00	$ 672,060.48	$ 12.55	$ 81,099.61	$ 8.80	$ 56,866.66	$ 125.35	$ 810,026.74
03410-620		Prestressed slabs													
	50	6" thick	C-11	1800	0.026	S.F.	22500	$ 4.57	$ 102,825.00	$ 0.86	$ 19,350.00	$ 0.60	$ 13,500.00	$ 6.03	$ 135,675.00
	100	8"thick	C-11	3200	0.023	S.F.	22600	$ 5.00	$ 113,000.00	$ 0.75	$ 16,950.00	$ 0.53	$ 11,978.00	$ 6.28	$ 141,928.00
															$ 14,840,417.98

New System Cost Analysis

CSI Division	CSI Subdivision	Description	Crew	Daily Output	Labor-Hours	Unit of Measure	Quantity	Unit Mat'l Cost	Mat'l Cost	Unit Labor Cost	Labor Cost	Unit Equip/Sub Cost	Equip/Sub Cost	Item Cost	Total Item Cost
05120-260		Columns													
	4600	HSS8x8x3/8	E-2	38	1.12	Each	2803	$ 360.00	$ 1,009,080.00	$ 37.00	$ 103,711.00	$ 28.50	$ 79,885.50	$ 425.50	$ 1,192,676.50
	6850	W8x31	E-2	38	0.052	L.F.	420	$ 21.00	$ 8,820.00	$ 1.72	$ 722.40	$ 1.32	$ 554.40	$ 24.04	$ 10,096.80
	7150	W12x50	E-2	2095.34	0.054	L.F.	6245	$ 33.50	$ 209,207.50	$ 1.80	$ 11,241.00	$ 1.38	$ 8,618.10	$ 36.68	$ 229,066.60
	7200	W12x87	E-2	36	0.057	L.F.	50	$ 58.50	$ 2,925.00	$ 1.89	$ 94.50	$ 1.44	$ 72.00	$ 61.83	$ 3,091.50
05120-640		Structural Steel Members													
	2700	W16x26	E-2	1000	0.056	L.F.	1170	$ 17.50	$ 20,475.00	$ 1.86	$ 2,176.20	$ 1.42	$ 1,661.40	$ 20.78	$ 24,312.60
	3300	W18x35	E-5	960	0.083	L.F.	914	$ 23.50	$ 21,479.00	$ 2.81	$ 2,568.34	$ 1.57	$ 1,434.98	$ 27.88	$ 25,482.32
	4900	W24x55	E-5	1110	0.072	L.F.	216	$ 37.00	$ 7,992.00	$ 2.43	$ 524.88	$ 1.36	$ 293.76	$ 40.79	$ 8,810.64
															$ 1,493,536.96

Lateral Brace Cost Analysis

CSI Division	CSI Subdivision	Description	Crew	Daily Output	Labor-Hours	Unit of Measure	Quantity	Unit Mat'l Cost	Mat'l Cost	Unit Labor Cost	Labor Cost	Unit Equip/Sub Cost	Equip/Sub Cost	Item Cost	Total Item Cost
03110-410		Forms In Place, Columns													
	6500	24"x24" columns, 4 use	C-1	238	0.134	SFCA	342	$ 0.63	$ 215.46	$ 3.81	$ 1,303.02			$ 4.44	$ 1,518.48
03110-455		Forms In Place, Walls													
	2850	Over 16' high, 4 use	C-2	330	0.145	SFCA	304	$ 0.69	$ 209.76	$ 4.25	$ 1,292.00			$ 4.94	$ 1,501.76
03210-600		Reinforcing in place A615 Grade 60													
	250	Columns, #8 to 18	4 Rodm	2.3	13.913	Ton	30	$ 550.00	$ 16,500.00	$ 475.00	$ 14,250.00			$ 1,025.00	$ 30,750.00
	700	Walls, #3 to #7	4 Rodm	3	10.667	Ton	75	$ 535.00	$ 40,125.00	$ 365.00	$ 27,375.00			$ 900.00	$ 67,500.00
03310-220		Concrete, ready mix													
	400	Regular weight				C.Y.	161120	$ 77.00	$ 12,406,240.00					$ 77.00	$ 12,406,240.00
03310-700		Placing Concrete													
	650	Columns, 24", crane and bucket	C-7	55	1.309	C.Y.	190			$ 33.50	$ 6,365.00	$ 19.40	$ 3,686.00	$ 52.90	$ 10,051.00
	5200	12" thick, crane and bucket	C-7	90	0.8	C.Y.	420			$ 20.50	$ 8,610.00	$ 11.85	$ 4,977.00	$ 32.35	$ 13,587.00
															$ 12,531,148.24

Shear Wall Cost Analysis

List of Websites Used for Sustainability Breadth

http://www.greencontractors.us/how/leedguide/LEEDNC2-EAC2.pdf

http://depts.washington.edu/urbhort/html/education/StormwaterChallenges&Solutions.pdf

http://www.archenergy.com/_edr-leed/html-pages/SSpages/LEEDSSc61.htm

http://www.greeninfrastructurewiki.com/page/3Bs:+Bioswale?t=anon

http://www.skykeepers.org/odlight.html

http://www.csemag.com/article/CA504173.html

http://www.cambridgearchitectural.com/System.aspx?ID=21#

http://leedbootcamp.blogspot.com/2006/09/ea-energy-and-atmosphere.html

http://www.archenergy.com/_edr-leed/html-pages/EApages/LEEDEAc4.htm

http://www.nitterhouse.com/CompanyInfo/CompanyInfoSub/CompanyInfoOverview.html

http://www.archenergy.com/_edr-leed/html-pages/IEQpages/LEEDIEQc1.htm

http://www.roofmeadow.com/

Sections of Green Roofs