April 7th, 2011

UNIT 5 APPENDICES: STRUCTURAL

KGB Maser
Management. Engineering. Consulting.

IPD/BIM TEAM #3

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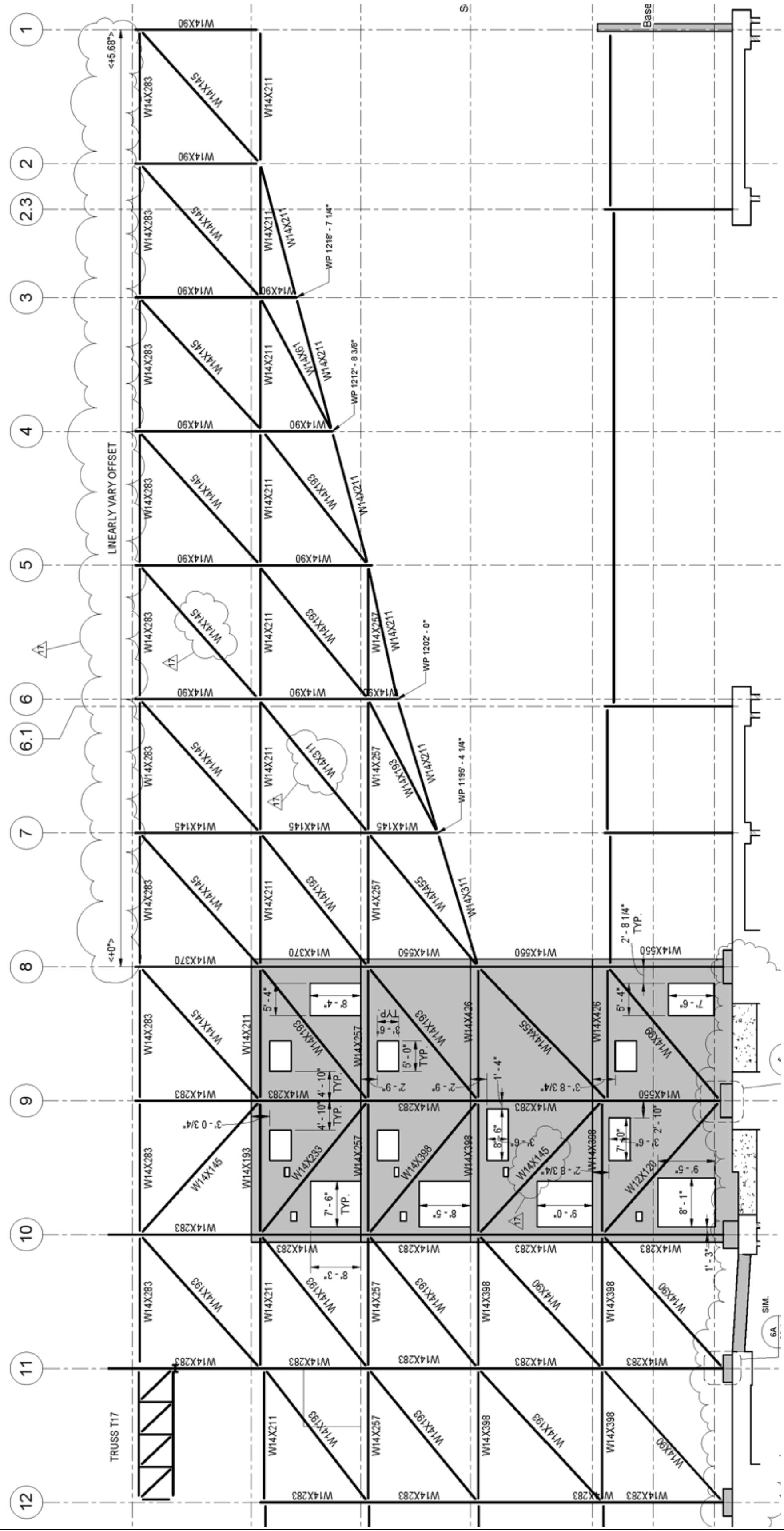
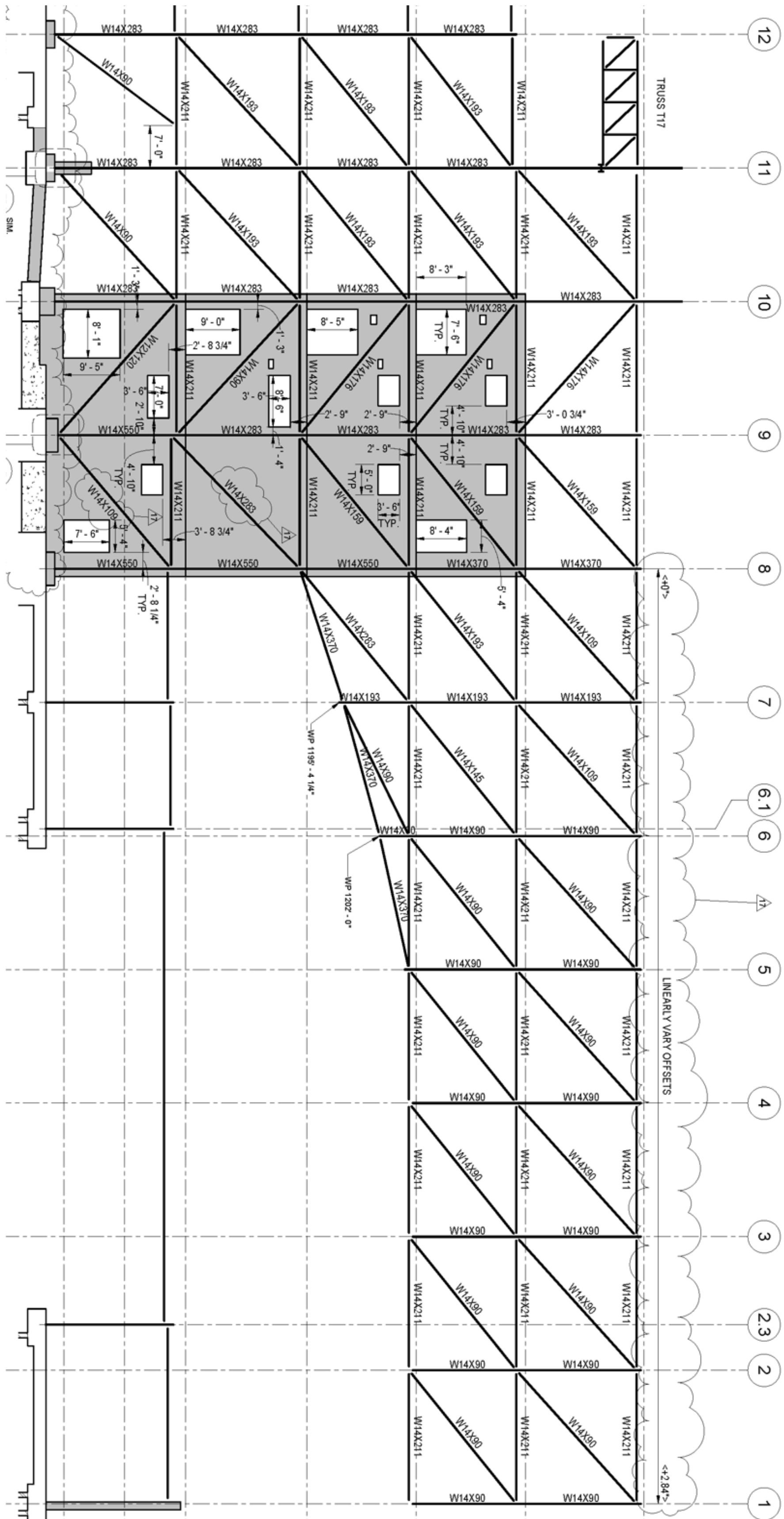
APPENDIX 5.A: ELEVATIONS OF EXISTING SYSTEM


LINEARLY VARY OFFSET
TRUSS T17


TRUSS T17
LINEARLY VARY OFFSETS
12
11
10
9
8
7
6.1
6
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3
2.3
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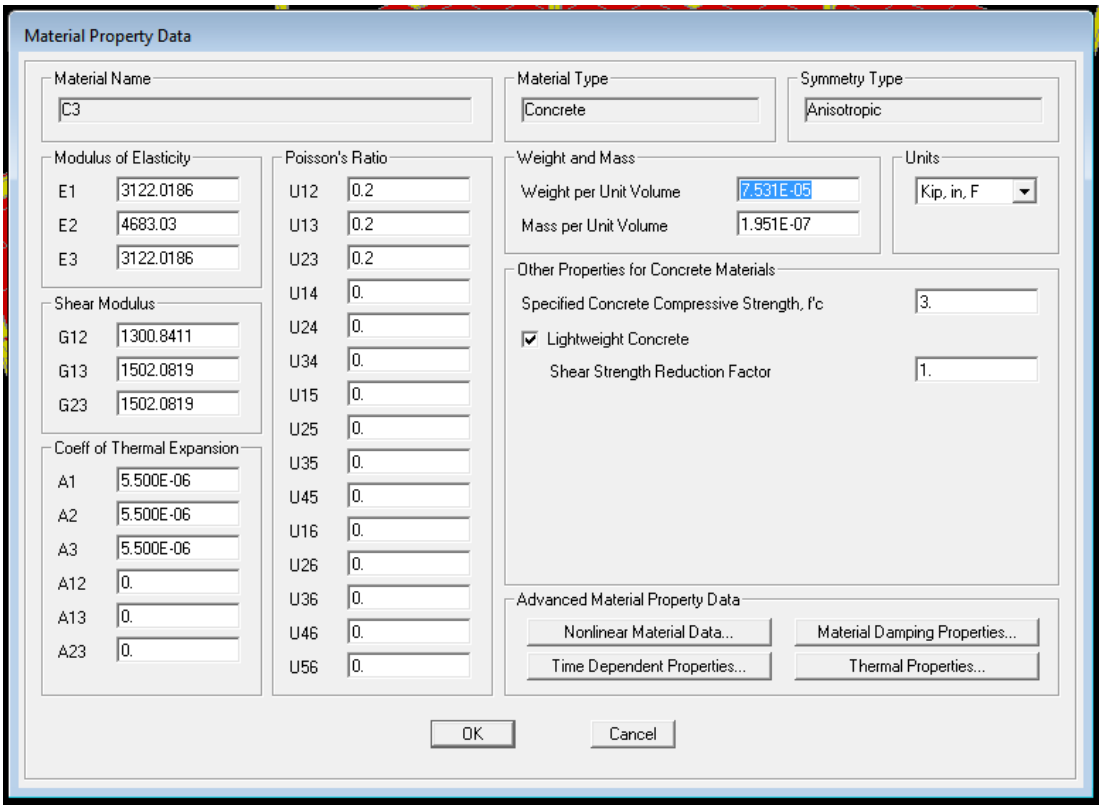
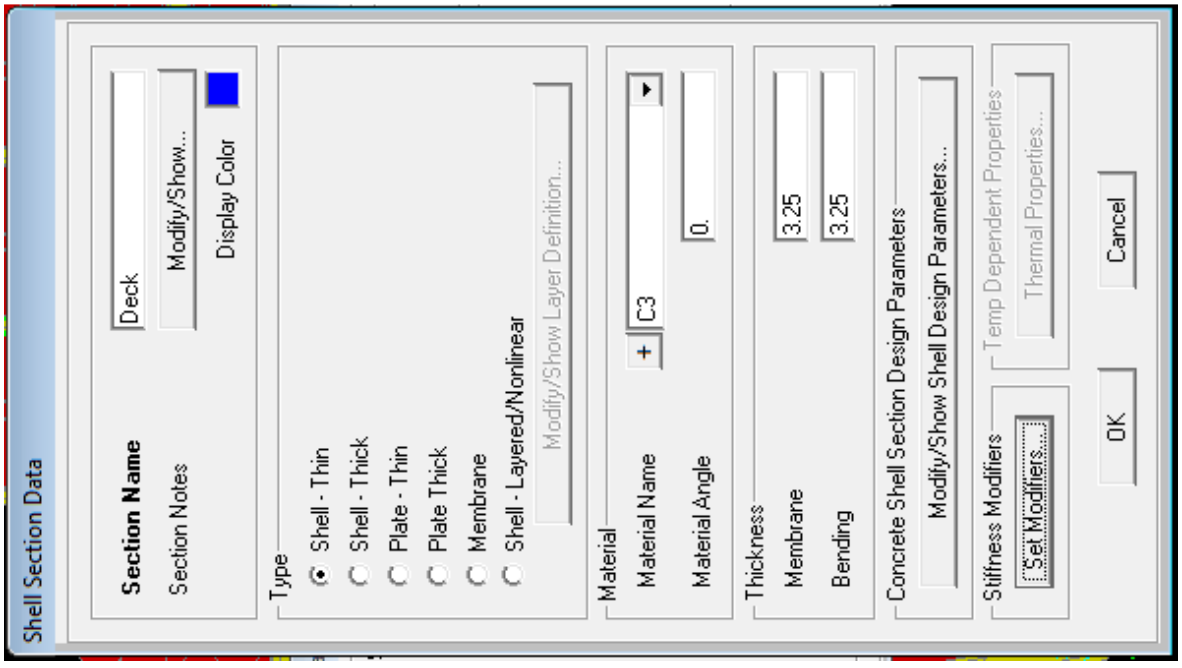
1

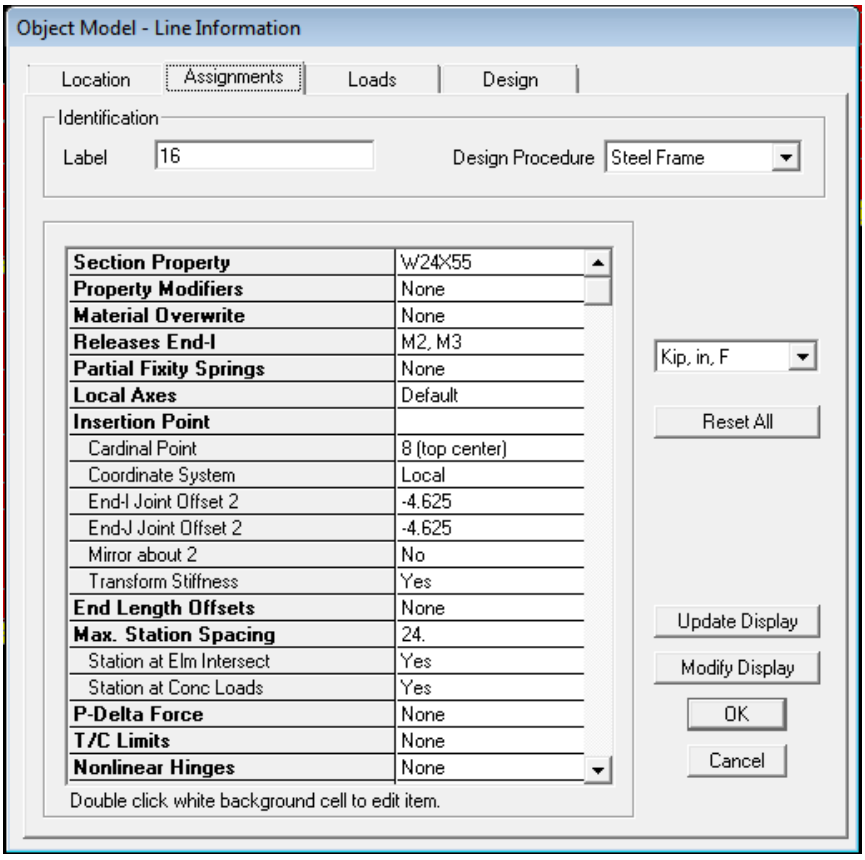
APPENDIX 5.B: FLOOR SYSTEM



SAP Composite Deck Properties: Stiffness Increased by a Factor of 1.5



SAP Concrete Deck Properties: Shell Section Data



SAP Member Properties: Example of Typical Wide Flange Properties in Existing Conditions Model

W21x44			3" NWC Slab		
Inertia Beam			***Inertia Slab***		
Depth	20.7	in.	topping	3	in.
Area	13	in.2	rib height	3	in.
tw	0.35	in.	trib width	96	in.
tf	0.45	in.	Area (t)	35.80	in.2
bf	6.5	in.	y(slab)	25.2	
T	19.8	in.			
yfb	0.225		n=Ec/Es	0.124310225	
yft	20.475				
N.A.	21.29	in.			
I_o	843	in.4	I_o	26.85	in.4
I_{tot}	2973.1	in.4			

nt Load Deflect	0.3340	in.	Dist. Load Deflection	0.20876931	in.
P	100	k	w	5	k/ft
L	20	ft	L	20	ft

Meshed Areas/ Meshed Beam			
1)Horizontal grid modeled at center of slab top			
Insert Off.	14.85	in	
SAP Deflection	0.3563	in	
% diff	-6.67	%	
2) Horizontal grid modeled at bottom of slab to			
Insert Off.	13.35	in	
SAP Deflection	0.3569	in	
% diff	-6.85	%	
3) Horizontal grid modeled at center of decking			
Insert Off.	11.85	in	
SAP Deflection	0.3578	in	
% diff	-7.12	%	
4)Horizontal grid modeled at Top of Beam Flan			
Insert Off.	10.35	in	
SAP Deflection	0.3584	in	
% diff	-7.30	%	

Excel Analysis of SAP Data: Comparison of Insertion Points and Shell Offsets in SAP

SPAN	Lx	Ly	w	Wslab	Wbeams	NODE	Wi	Δ	Wi.Δ^2	P.Δ	Tcalc	T(SAP)	Vel
	ft	ft	ksf	kip	kip		kip	in		P=100 k	sec	sec	μ in/sec
SPAN-A	22.0	22.0	0.049	23.619	4.103	1	0.533	0.0012	0.0000	178.6212	0.0639		3916
						2	0.902	-0.0195	0.0003				
- due to load at A13						3	0.902	-0.0330	0.0010				
						4	0.902	-0.0195	0.0003				
						5	0.533	0.0012	0.0000				
						A1	0.902	0.0551	0.0027				
						A2	1.640	0.0596	0.0058				
						A3	1.640	0.0774	0.0098				
						A4	1.640	0.0596	0.0058				
						A5	0.902	0.0552	0.0027				
						A6	0.902	0.0913	0.0075				
						A7	1.640	0.2216	0.0805				
						A8	1.640	0.2886	0.1366				
						A9	1.640	0.2217	0.0806				
						A10	0.902	0.0914	0.0075				
						A11	0.902	0.0614	0.0034				
						A12	1.640	0.6814	0.7615				
						A13	1.640	1.7862	5.2335				
						A14	1.640	0.6818	0.7624				
						A15	0.902	0.0614	0.0034				
						A16	0.533	0.0052	0.0000				
						A17	0.902	0.0818	0.0060				
						A18	0.902	0.1219	0.0134				
						A19	0.902	0.0826	0.0062				
						A20	0.533	0.0051	0.0000				
SPAN-B	22.0	22.0	0.049	23.619	4.840	A16	0.563	0.0012	0.0000	164.6979	0.0601		3317
						A17	0.932	-0.0031	0.0000				
- due to load at B13						A18	0.932	-0.0053	0.0000				
						A19	0.932	-0.0031	0.0000				
						A20	0.563	0.0012	0.0000				
						B1	0.932	0.0327	0.0010				
						B2	1.670	-0.0334	0.0019				
						B3	1.670	-0.0755	0.0095				
						B4	1.670	-0.0336	0.0019				
						B5	0.932	0.0311	0.0009				
						B6	0.932	0.0581	0.0031				
						B7	1.670	0.1380	0.0318				
						B8	1.670	0.1785	0.0532				
						B9	1.670	0.1375	0.0315				
						B10	0.932	0.0554	0.0029				
						B11	0.932	0.0402	0.0015				
						B12	1.670	0.5821	0.5657				
						B13	1.670	1.6470	4.5294				
						B14	1.670	0.5817	0.5651				
						B15	0.932	0.0386	0.0014				
						B16	0.563	0.0043	0.0000				
						B17	0.932	0.0678	0.0043				
						B18	0.932	0.1011	0.0095				
						B19	0.932	0.0678	0.0043				
						B20	0.563	0.0042	0.0000				
SPAN-C	22.0	22.0	0.049	23.619	5.192	B16	0.577	0.0040	0.0000	183.7910	0.0649		4063
						B17	0.946	0.0406	0.0016				
- due to load at C7						B18	0.946	0.0558	0.0029				
						B19	0.946	0.0313	0.0009				
						B20	0.577	0.0011	0.0000				
						C1	0.946	0.0801	0.0061				
						C2	1.684	0.6990	0.8228				
						C3	1.684	0.1769	0.0527				
						C4	1.684	-0.0226	0.0009				
						C5	0.946	-0.0025	0.0000				
						C6	0.946	0.1221	0.0141				
						C7	1.684	1.8379	5.6880				
						C8	1.684	0.2341	0.0922				
						C9	1.684	-0.0622	0.0065				
						C10	0.946	-0.0044	0.0000				
						C11	0.946	0.0801	0.0061				
						C12	1.684	0.6988	0.8224				
						C13	1.684	0.1769	0.0527				
						C14	1.684	-0.0225	0.0009				
						C15	0.946	-0.0025	0.0000				
						C16	0.577	0.0040	0.0000				
						C17	0.946	0.0406	0.0016				
						C18	0.946	0.0558	0.0029				
						C19	0.946	0.0313	0.0009				
						C20	0.577	0.0011	0.0000				

Velocity Evaluation from SAP Deflection Data: Existing Conditions. Please see SAP plan view in Appendix A for node designations.

CELLULAR BEAM INFORMATION		
Job Name	TEST	
Beam Mark #	LB1	
Span	22.000	ft
Spac. Left	11.000	ft
Spac. Right	11.000	ft
Mat. Strength-Fy	50	ksi
Cellular Beam	LB30X73	
Root Beams (T/B)	W21X73	W21X73
d	21.24	21.24
bf	8.295	8.295
tf	0.74	0.74
tw	0.455	0.455

CELLULAR PARAMETERS:		
Min. Hole Diameter	16.13	in
Max. Hole Diameter	28.21	in
STD Hole Diameter Do	20.75	in
STD Hole Spacing S	29.500	in
Web Post Width "e"	8.750	in
S / Do	1.42	
Gross Depth "dg"	30.65	in
dg / Do	1.477	
Cutting Loss	0.968	
dt top	4.949	in
dt bot	4.949	in

CMC Steel Products

LOADING INFORMATION				
Uniform Distributed Loads				
Live Load	0	plf	Pre-comp %	0%
Dead Load	73	plf	Pre-comp %	85%
Concentrated Point Loads				
Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Percent DL (%)	Percent Pre-Comp.
P1	81.31	11.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION			
Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	3/4"
conc. wt. - wc (pcf)	115	stud ht. (in)	5
conc. above deck - tc (in)	3 1/4	studs per rib	1
rib height - hr (in)	3	composite %	100%
rib width - wr (in)	6	STUD SPACING:	
		32 | 32	

RESULTS			WARNINGS
Failure Mode	Interaction	Status	
Bending	0.988	OK	
Web Post	0.654	OK	
Shear	0.467	OK	
Concrete	0.418	OK	
Pre-Comp.	0.467	OK	
Overall	0.988	OK	

DEFLECTION		
Pre-Composite Deflection	0.008	=L/31919
Live Load Deflection	0.182	=L/1450

EXPAND'D. SXN. PROP'S		
Avg. wt.	73.00	plf
Anet	16.18	in^2
Agross	25.63	in^2
Ix net	3364	in^4
Ix gross	3703	in^4
Ix critical	3462	in^4
Min Sx net	220	in^3
Min Sx gross	242	in^3
Min Sx critical	226	in^3
rx min	12.02	in
Iy net	70	in^4
Sy net	16.99	in^3

COMPOSITE SXN. PROP'S		
n	11.758	
beffec.	66.000	in
Actr	18.243	in^2
N.A. ht.	25.594	In Steel
Itr	7000	in^4
Ieffec.	7000	in^3
Sxconc	619.272	in^3
Sxsteel	273.514	in^3

CONSTRUCTION BRIDGING	
End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging. Spacing (ft)	47

Stnd " Do " & " S "
To Help Sheet
Find Lightest Cellular Beam

RAM Smartbeam Section Properties of a Cellular Beam: Girder on the Third Floor Subjected to a Point Load

CELLULAR BEAM INFORMATION		
Job Name	TEST	
Beam Mark #	LB1	
Span	22.000	ft
Spac. Left	11.000	ft
Spac. Right	11.000	ft
Mat. Strength-Fy	50	ksi
Cellular Beam	LB30X44	
Root Beams (T/B)	W21X44	W21X44
d	20.66	20.66
bf	6.5	6.5
tf	0.45	0.45
tw	0.35	0.35

CELLULAR PARAMETERS:		
Min. Hole Diameter	15.69	in
Max. Hole Diameter	27.44	in
STD Hole Diameter Do	20.75	in
STD Hole Spacing S	29.250	in
Web Post Width "e"	8.500	in
S / Do	1.41	
Gross Depth "dg"	30.12	in
dg / Do	1.452	
Cutting Loss	0.910	
dt top	4.687	in
dt bot	4.687	in

CMC Steel Products

LOADING INFORMATION				
Uniform Distributed Loads				
Live Load	1650	plf	Pre-comp %	0%
Dead Load	953	plf	Pre-comp %	85%
Concentrated Point Loads				
Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Percent DL (%)	Percent Pre-Comp.
P1	0.00	11.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION			
Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	3/4"
conc. wt. - wc (pcf)	115	stud ht. (in)	5
conc. above deck - tc (in)	3 1/4	studs per rib	1
rib height - hr (in)	3	composite %	100%
rib width - wr (in)	6	STUD SPACING:	
		22 | 22	

RESULTS			WARNINGS
Failure Mode	Interaction	Status	
Bending	0.402	OK	
Web Post	0.507	OK	
Shear	0.380	OK	
Concrete	0.178	OK	
Pre-Comp.	0.380	OK	
Overall	0.507	OK	

DEFLECTION		
Pre-Composite Deflection	0.099	=L/2675
Live Load Deflection	0.091	=L/2914

EXPAND'D. SXN. PROP'S		
Avg. wt.	44.00	plf
Anet	8.89	in^2
Agross	16.16	in^2
Ix net	1772	in^4
Ix gross	2032	in^4
Ix critical	1847	in^4
Min Sx net	118	in^3
Min Sx gross	135	in^3
Min Sx critical	123	in^3
rx min	11.22	in
Iy net	21	in^4
Sy net	6.35	in^3

COMPOSITE SXN. PROP'S		
n	11.758	
beffec.	66.000	in
Actr	18.243	in^2
N.A. ht.	27.929	In Steel
Itr	4312	in^4
Ieffec.	4312	in^3
Sxconc	510.623	in^3
Sxsteel	154.404	in^3

CONSTRUCTION BRIDGING	
End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging. Spacing (ft)	38

Stnd " Do " & " S "
To Help Sheet
Find Lightest Cellular Beam

RAM Smartbeam Section Properties of a Cellular Beam: Beam on the Third Floor Subjected to a Distributed Load

CELLULAR BEAM INFORMATION		
Job Name	TEST	
Beam Mark #	LB1	
Span	22.000	ft
Spac. Left	11.000	ft
Spac. Right	11.000	ft
Mat. Strength-Fy	50	ksi
Cellular Beam	LB30X57	
Root Beams (T/B)	W21X57	W21X57
d	21.06	21.06
bf	6.555	6.555
tf	0.65	0.65
tw	0.405	0.405

CELLULAR PARAMETERS:		
Min. Hole Diameter	15.99	in
Max. Hole Diameter	27.97	in
STD Hole Diameter Do	20.75	in
STD Hole Spacing S	29.250	in
Web Post Width "e"	8.500	in
S / Do	1.41	
Gross Depth "dg"	30.52	in
dg / Do	1.471	
Cutting Loss	0.910	
dt top	4.887	in
dt bot	4.887	in

CMC Steel Products

LOADING INFORMATION				
Uniform Distributed Loads				
Live Load	0	plf	Pre-comp %	0%
Dead Load	57	plf	Pre-comp %	85%
Concentrated Point Loads				
Load # (#)	Magnitude (kips)	Dist from Lft. End (ft)	Percent DL (%)	Percent Pre-Comp.
P1	68.53	11.00	0%	0%
P2	0.00	0.00	0%	0%
P3	0.00	0.00	0%	0%
P4	0.00	0.00	0%	0%

COMPOSITE INFORMATION			
Concrete & Deck:		Shear Studs:	
conc. strength - fc' (psi)	4000	stud dia. (in)	3/4"
conc. wt. - wc (pcf)	115	stud ht. (in)	5
conc. above deck - tc (in)	3 1/4	studs per rib	1
rib height - hr (in)	3	composite %	100%
rib width - wr (in)	6	STUD SPACING:	
		29 | 29	

RESULTS		
Failure Mode	Interaction	Status
Bending	0.993	OK
Web Post	0.659	OK
Shear	0.446	OK
Concrete	0.387	OK
Pre-Comp.	0.446	OK
Overall	0.993	OK

WARNINGS

DEFLECTION		
Pre-Composite Deflection	0.009	=L/29971
Live Load Deflection	0.195	=L/1357

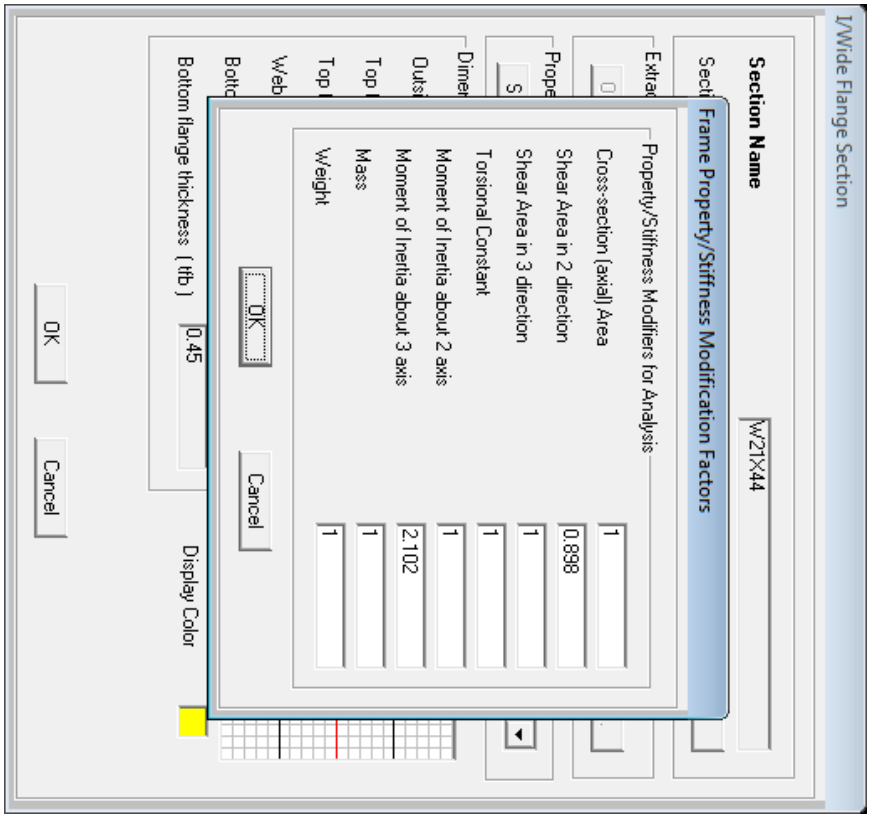
EXPAND'D. SXN. PROP'S		
Avg. wt.	57.00	plf
Anet	12.03	in^2
Agross	20.43	in^2
Ix net	2459	in^4
Ix gross	2760	in^4
Ix critical	2546	in^4
Min Sx net	161	in^3
Min Sx gross	181	in^3
Min Sx critical	167	in^3
rx min	11.62	in
Iy net	31	in^4
Sy net	9.33	in^3

COMPOSITE SXN. PROP'S		
n	11.758	
beffec.	66.000	in
Actr	18.243	in^2
N.A. ht.	26.901	In Steel
Itr	5554	in^4
Ieffec.	5554	in^3
Sxconc	562.546	in^3
Sxsteel	206.478	in^3

CONSTRUCTION BRIDGING	
End Connection type	Double clip
Min. No. Of Bridging Rows	0
Max. Bridging. Spacing (ft)	41

Stnd " Do " & " S "
To Help Sheet
Find Lightest Cellular Beam

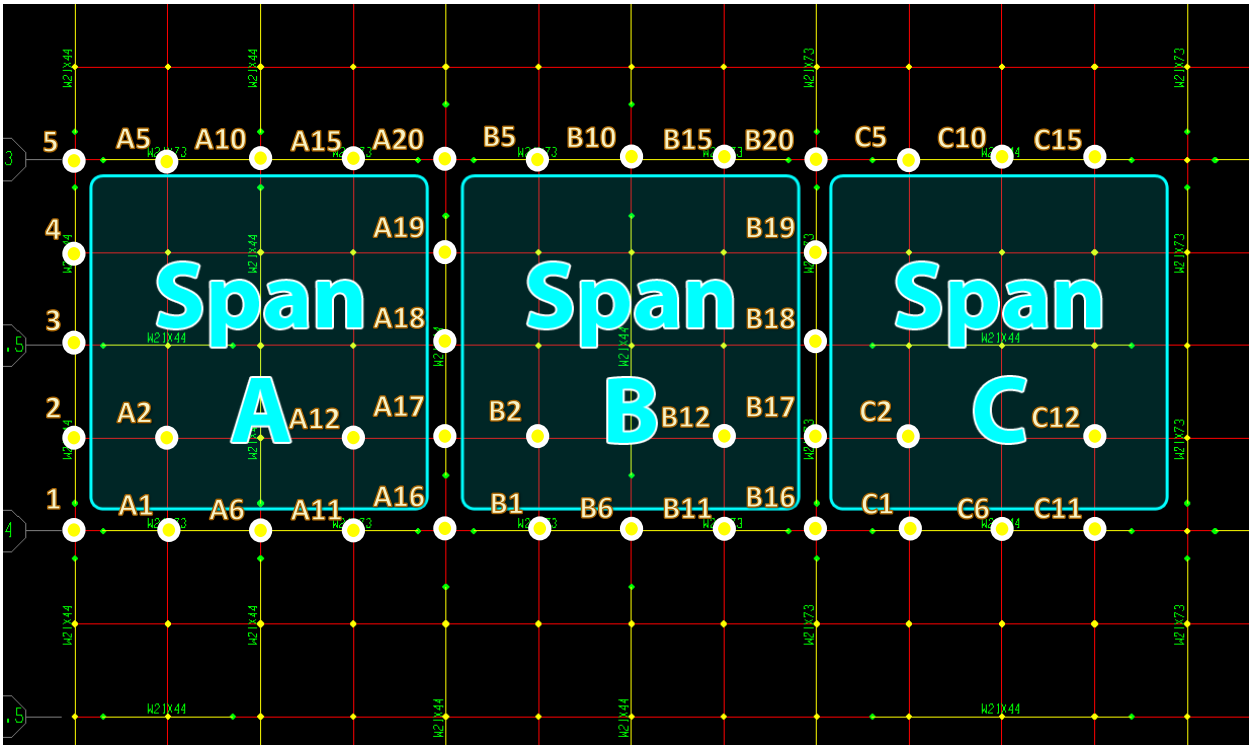
RAM Smartbeam Section Properties of a Cellular Beam: Girder on the Fourth Floor Subjected to a Point Load



SAP Section Property Modifiers: W21x44 Modified to Imitate an LB30x44 in Redesign Model

FLOOR LOADING SCHEDULE

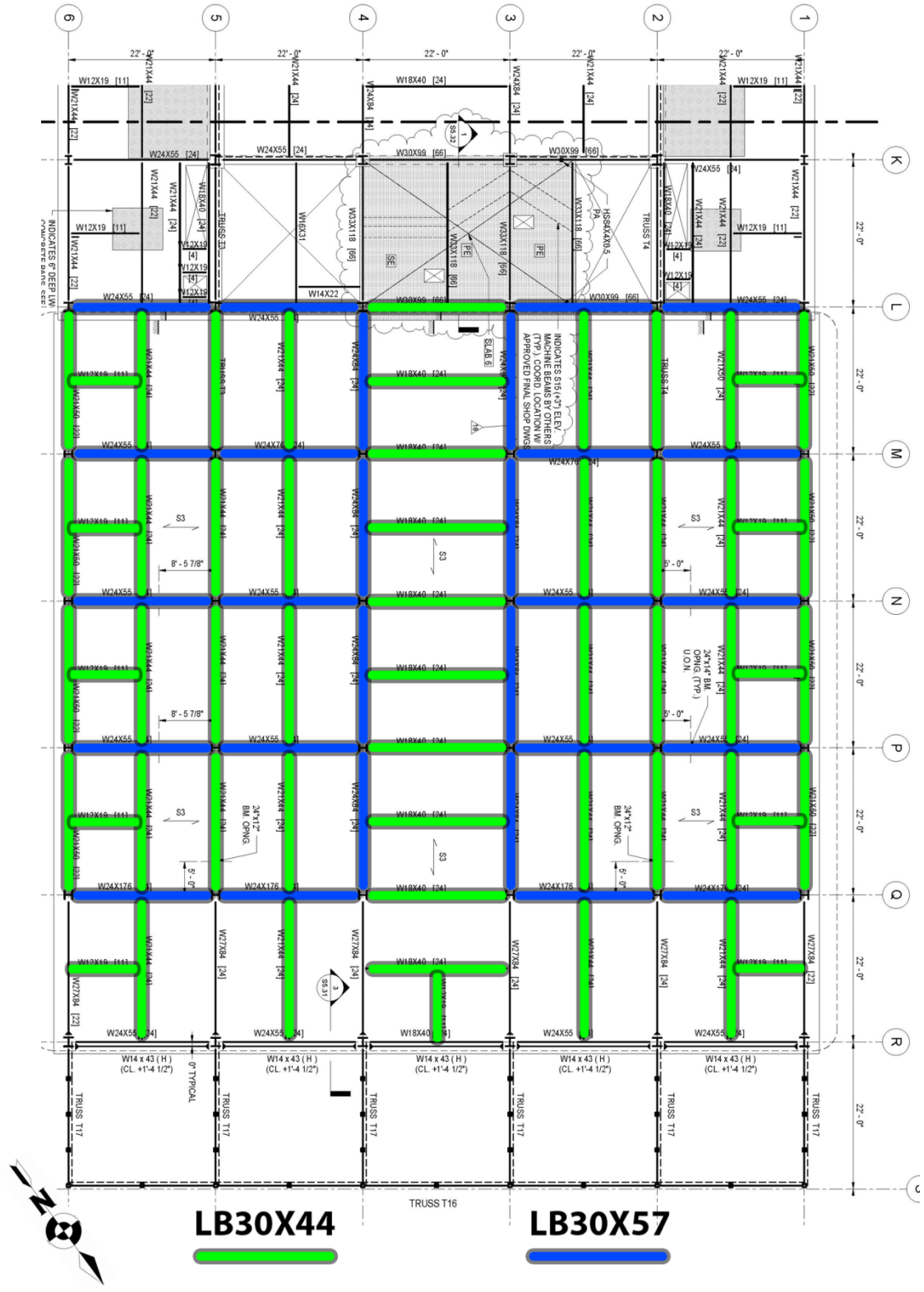
FLOOR	ELEVATION (ft-in.)	OCCUPANCY	SLAB TYPE	LOADS		
				SLAB (PSF)	SDL (PSF)	LL (PSF)
LEVEL ROOF	1245'-6"	ROOF	S1	50.00	25.00	30.00
MECHANICAL PENTHOUSE	1226'-0"	MECHANICAL	S2	110.00	25.00	150.00
THIRD FLOOR	1208'-0"	GREEN ROOF	S3	76.00	120.00	30.00
		OFFICE	S1	50.00	30.00	50.00
		MATERIAL SCIENCE LABS	S1	50.00	30.00	150.00
		LIFE SCIENCE LABS	S1	50.00	30.00	100.00
		CORRIDORS	S1	50.00	30.00	AREA SERVED
		ELEVATOR LOBBIES	S1	50.00	30.00	100.00
SECOND FLOOR	1190'-0"	GREEN ROOF	S3	76.00	120.00	30.00
		OFFICE	S1	50.00	30.00	50.00
		MATERIAL SCIENCE LABS	S1	50.00	30.00	150.00
		LIFE SCIENCE LABS	S1	50.00	30.00	100.00
		CORRIDORS	S1	50.00	30.00	AREA SERVED
		ELEVATOR LOBBIES	S1	50.00	30.00	100.00
FIRST FLOOR	1170'-0"	PLAZA LANDSCAPE	S2	110.00	300.00	100.00
		OFFICE	S1	50.00	30.00	50.00
		MATERIAL SCIENCE LABS	S1	50.00	30.00	150.00
		LIFE SCIENCE LABS	S1	50.00	30.00	100.00
		CORRIDORS	S1	50.00	30.00	100.00
		MECHANICAL MEZZANINE	GRATING	10.00	10.00	150.00
		ELEVATOR LOBBIES	S1	50.00	30.00	100.00
BASEMENT MEZZANINE	1160'-0"	Retail	S1	50.00	30.00	50.00



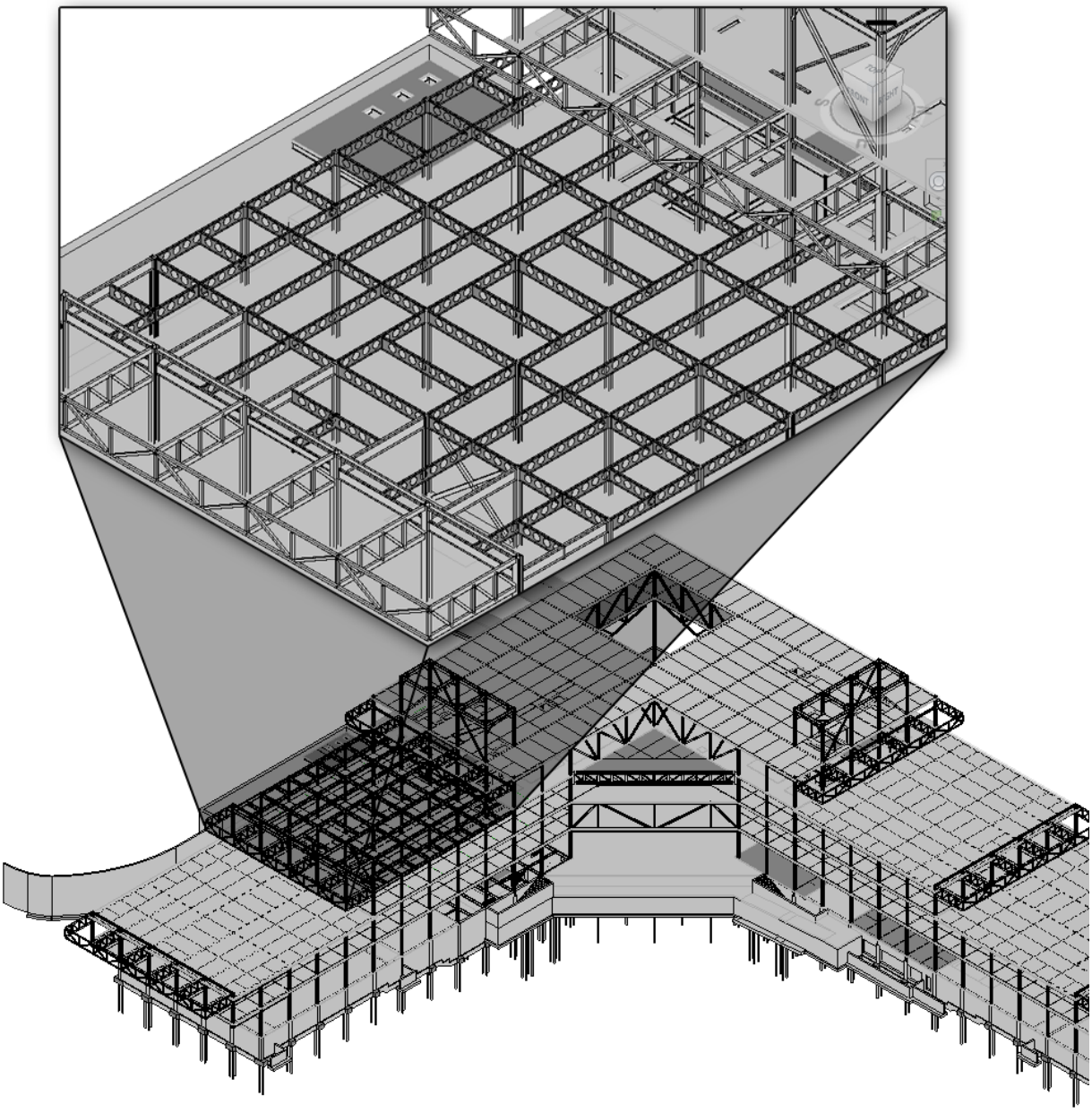
SPAN	Lx	Ly	w	Wslab	Wbeams	NODE	Wi	Δ	Wi.Δ^2	P.Δ	Tcalc	T(SAP)	Vel
	ft	ft	ksf	kip	kip		kip	in		P=100 k	sec	sec	μ in/sec
SPAN-A	22.0	22.0	0.049	23.619	4.510	1	0.549	0.0013	0.0000	160.6674	0.0609		3099
						2	0.919	-0.0175	0.0003				
- due to load at A13						3	0.919	-0.0295	0.0008				
						4	0.919	-0.0175	0.0003				
						5	0.549	0.0013	0.0000				
						A1	0.919	0.0470	0.0020				
						A2	1.657	0.0640	0.0068				
						A3	1.657	0.0981	0.0160				
						A4	1.657	0.0640	0.0068				
						A5	0.919	0.0470	0.0020				
						A6	0.919	0.0773	0.0055				
						A7	1.657	0.1908	0.0603				
						A8	1.657	0.2487	0.1025				
						A9	1.657	0.1908	0.0603				
						A10	0.919	0.0774	0.0055				
						A11	0.919	0.0525	0.0025				
						A12	1.657	0.6123	0.6212				
						A13	1.657	1.6067	4.2763				
						A14	1.657	0.6122	0.6209				
						A15	0.919	0.0526	0.0025				
						A16	0.549	0.0050	0.0000				
						A17	0.919	0.0907	0.0076				
						A18	0.919	0.1352	0.0168				
						A19	0.919	0.0905	0.0075				
						A20	0.549	0.0050	0.0000				
SPAN-B	22.0	22.0	0.049	23.619	3.861	A16	0.523	0.0012	0.0000	152.4988	0.0577		2737
						A17	0.893	-0.0046	0.0000				
- due to load at B13						A18	0.893	-0.0075	0.0001				
						A19	0.893	-0.0046	0.0000				
						A20	0.523	0.0012	0.0000				
						B1	0.893	0.0318	0.0009				
						B2	1.631	-0.0408	0.0027				
						B3	1.631	-0.0891	0.0129				
						B4	1.631	-0.0407	0.0027				
						B5	0.893	0.0318	0.0009				
						B6	0.893	0.0565	0.0028				
						B7	1.631	0.1468	0.0351				
						B8	1.631	0.1927	0.0605				
						B9	1.631	0.1468	0.0351				
						B10	0.893	0.0565	0.0028				
						B11	0.893	0.0393	0.0014				
						B12	1.631	0.5547	0.5018				
						B13	1.631	1.5250	3.7922				
						B14	1.631	0.5547	0.5018				
						B15	0.893	0.0393	0.0014				
						B16	0.523	0.0042	0.0000				
						B17	0.893	0.0735	0.0048				
						B18	0.893	0.1091	0.0106				
						B19	0.893	0.0735	0.0048				
						B20	0.523	0.0042	0.0000				
SPAN-C	22.0	22.0	0.049	23.619	3.542	B16	0.511	0.0039	0.0000	173.4116	0.0626		3458
						B17	0.880	0.0436	0.0017				
- due to load at C7						B18	0.880	0.0601	0.0032				
						B19	0.880	0.0337	0.0010				
						B20	0.511	0.0010	0.0000				
						C1	0.880	0.0835	0.0061				
						C2	1.618	0.6843	0.7575				
						C3	1.618	0.1884	0.0574				
						C4	1.618	-0.0308	0.0015				
						C5	0.880	-0.0036	0.0000				
						C6	0.880	0.1270	0.0142				
						C7	1.618	1.7341	4.8652				
						C8	1.618	0.2482	0.0997				
						C9	1.618	-0.0791	0.0101				
						C10	0.880	-0.0062	0.0000				
						C11	0.880	0.0835	0.0061				
						C12	1.618	0.6842	0.7574				
						C13	1.618	0.1884	0.0574				
						C14	1.618	-0.0308	0.0015				
						C15	0.880	-0.0036	0.0000				
						C16	0.511	0.0039	0.0000				
						C17	0.880	0.0436	0.0017				
						C18	0.880	0.0601	0.0032				
						C19	0.880	0.0337	0.0010				
						C20	0.511	0.0010	0.0000				

Velocity Evaluation from SAP Deflection Data: Redesign. Please see SAP plan view in Appendix A for node designations.

Plan View of Fourth Floor of the Life Sciences Wing: Redesign scheme with Cellular Beams



Plan View of Fourth Floor of the Material Sciences Wing: Redesign scheme with Cellular Beams



The area shown above was chosen for Structural and MEP coordination. Cellular beams are used only in certain areas of each floor. The Fourth floor section you see above is one of two places on the Fourth floor where cellular beams are present; in this case, cellular beams are are used to support the green roof at the end of each wing.

SAMPLE CALCULATIONS: VIBRATIONS FOR BAY A, NODE A13

$Bay\ Size = 484ft.^2$ $w = 48.8lb/ft.^2$ $w = 48.8lb/ft.^2$

$64\ Subdivided\ Areas/Bay$ $25\ Joints/Bay$ $Beam\ Weight/Bay = 4510lb.$

$P = 100k.$ $U_v = 5500lb.Hz.^2$

$W_i = (48.8lb./ft.^2 * 484ft.^2)/64 * 4 + 4510lb./25 = 1.657k.$

$W_i\Delta^2 = 1.657k.(1.6067in.)^2 = 4.2763k.in.^2$

$P\Delta = 100k.(1.6067in.) = 160.67k.in.$

$$T_{calc} = 2\pi\sqrt{{\Delta^2 m}/{P\Delta}} = 2\pi\sqrt{{[\sum_{n=1}^{25} W_i\Delta^2/(386.4\frac{in.}{s^2})]}/{160.67k.in.}} = 0.0609s.$$

$$V = \frac{U_v\Delta_P}{f_n} = 5.5k./s.^2(4 * 1.6067in. + 2 * 0.6123in. + 2 * 0.6122in. + 0.2487in. + 0.1352in.)/10/100k. * 1000000\mu.in./in.(0.0609s.) = 3099in./s.$$

***These calculations refer to the included Excel table above, in Appendix A.**

SAMPLE CALCULATIONS: CELLULAR BEAM POINT LOAD LB30X73

***This beam acts as a girder on the third floor transferring loads from a mid-span point load, produced by the beams framing into it, to the columns which the girder itself frames into. This calculation refers to the Excel spreadsheet used for cellular beam strength design included in Appendix A. Quantities are taken from the included table of loads per floor.**

$$P = 1.2[(11ft. * 11ft.)80lb./ft.^2] * 2 + 1.6(11ft. * 11ft.)(150lb./ft.^2) * 2 = 81.31k.$$

SAMPLE CALCULATION: COLUMN CHECK AT GRID 9 & C

$${kl}/{r} = {1.0(20ft. * 12in./ft.)}/{3.7in.} = 64.9$$

$$F_e = \frac{\pi^2 E}{{kl}/{r}} = \frac{\pi^2(29000k./in.^2)}{(64.9)^2} = 68k./in.^2$$

$$F_{cr} = 0.658^{{F_y}/{F_e}}(F_y) = 0.658^{{50ksi.}/{68ksi.}}(50ksi.) = 36.8ksi.$$

$$\varphi P_n = 0.9A_gF_{cr} = 0.9(26.5in.^2)(36.8ksi.) = 876.7k.$$

***These calculations refer to the included Excel table below, in Appendix A.**

Column Check: Grid 9,C Interior Column								
	Occupancy	Area	Dead Load (lbs.)				Live Load (lbs.)	Totals (lbs.)
			Slab	Beams	Panels & Column	SDL		
Roof	Roof	484	24200	1804	0	12100	8580	59452.8
Floor 4	Mechanical	484	53240	3817	1755	12100	72600	201254.4
Floor 3	Green Roof	0	0	4559.5	1620	0	0	131319.4
	Office	0	0			0	0	
	M.S. Labs	0	0			0	0	
	L.S. Labs	484	24200			14520	48400	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 2	Green Roof	0	0	6303	1620	0	0	78851.6
	Office	484	24200			14520	14300	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 1	Plaza Landscape	242	26620	3476	1800	72600	24200	231875.2
	Office	0	0			0	0	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	242	16940			7260	24200	
	Mech. Mezzanine	0	0			0	0	
	Elevator Lobbies	0	0			0	0	

Floors Three and Four

	W14X61	392.0 k
A=	17.9	in.2
k=	1.0	
l=	18.0	ft.
r=	2.5	in.
E=	29000.0	ksi.
Fy=	50.0	ksi.
k*l/r=	88.2	
Fe=	36.8	ksi.
Fcr=	28.3	ksi.
ϕPn=	456.3 k.	OK

Floors One Two and Three

	W14X90	702.8 k
A=	26.5	in.2
k=	1.0	
l=	20.0	ft.
r=	3.7	in.
E=	29000.0	ksi.
Fy=	50.0	ksi.
k*l/r=	64.9	
Fe=	68.0	ksi.
Fcr=	36.8	ksi.
ϕPn=	876.7 k.	OK

Column Check: Interior Column in the Life Sciences Wing

Column Check: Grid 9,A Exterior Column								
	Occupancy	Area	Dead Load (lbs.)				Live Load (lbs.)	Totals (lbs.)
			Slab	Beams	Panels & Column	SDL		
Roof	Roof	242	12100	968	32520	6050	5857	72293.2
Floor 4	Mechanical	242	26620	2266	32135	6050	36300	138565.2
Floor 3	Green Roof	0	0	2266	32000	0	0	79968.95
	Office	242	12100			7260	9761	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 2	Green Roof	0	0	2464	41010	0	0	91018.55
	Office	242	12100			7260	9761.097	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 1	Plaza Landscape	121	13310	0	26490	36300	12100	131976
	Office	121	6050			3630	6050	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Mech. Mezzanine	0	0			0	0	
	Elevator Lobbies	0	0			0	0	

Floors Three and Four

	W14X61	290.8 k
A=	17.9	in.2
k=	1.0	
l=	18.0	ft.
r=	2.5	in.
E=	29000.0	ksi.
Fy=	50.0	ksi.
k*l/r=	88.2	
Fe=	36.8	ksi.
Fcr=	28.3	ksi.
ϕPn=	456.3 k.	OK

Floors One Two and Three

	W14X82	513.8 k
A=	24.0	in.2
k=	1.0	
l=	20.0	ft.
r=	2.5	in.
E=	29000.0	ksi.
Fy=	50.0	ksi.
k*l/r=	96.8	
Fe=	30.6	ksi.
Fcr=	25.2	ksi.
ϕPn=	544.5 k.	OK

Column Check: Exterior Column in the Life Sciences Wing

Column Check: Grid N,3 Interior Column								
	Occupancy	Area	Dead Load (lbs.)				Live Load (lbs.)	Totals (lbs.)
			Slab	Beams	Panels & Column	SDL		
Roof	Roof	0	0	0	0	0	0	0
Floor 4	Green Roof	484	36784	3817	1755	58080	8580	140610.4
Floor 3	Green Roof	0	0	5104	1620	0	0	170692.8
	Office	0	0			0	0	
	M.S. Labs	484	24200			14520	72600	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 2	Green Roof	0	0	5104	1620	0	0	170692.8
	Office	0	0			0	0	
	M.S. Labs	484	24200			14520	72600	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 1	Plaza Landscape	0	0	6187.5	1800	0	0	152849
	Office	0	0			0	0	
	M.S. Labs	242	12100			7260	36300	
	L.S. Labs	0	0			0	0	
	Corridors	242	12100			7260	24200	
	Mech. Mezzanine	0	0			0	0	
	Elevator Lobbies	0	0			0	0	

Floors Three and Four

	W14X61	311.3	k
A=	17.9	in.2	
k=	1.0		
l=	18.0	ft.	
r=	2.5	in.	
E=	29000.0	ksi.	
Fy=	50.0	ksi.	
k*l/r=	88.2		
Fe=	36.8	ksi.	
Fcr=	28.3	ksi.	
ϕPn=	456.3	k.	OK

Floors One Two and Three

	W14X90	634.8	k
A=	26.5	in.2	
k=	1.0		
l=	20.0	ft.	
r=	3.7	in.	
E=	29000.0	ksi.	
Fy=	50.0	ksi.	
k*l/r=	64.9		
Fe=	68.0	ksi.	
Fcr=	36.8	ksi.	
ϕPn=	876.7	k.	OK

Column Check: Interior Column in the Material Sciences Wing

Column Check: Grid N,1 Exterior Column								
	Occupancy	Area	Dead Load (lbs.)				Live Load (lbs.)	Totals (lbs.)
			Slab	Beams	Panels & Column	SDL		
Roof	Roof	0	0	0	0	0	0	0
Floor 4	Green Roof	242	18392	2398	31215	29040	5857	113463
Floor 3	Green Roof	0	0	2266	31040	0	0	78816.95
	Office	242	12100			7260	9761.097	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 2	Green Roof	0	0	2266	37140	0	0	86136.95
	Office	242	12100			7260	9761.097	
	M.S. Labs	0	0			0	0	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Elevator Lobbies	0	0			0	0	
Floor 1	Plaza Landscape	0	0	0	17310	0	0	102084
	Office	0	0			0	0	
	M.S. Labs	242	12100			7260	36300	
	L.S. Labs	0	0			0	0	
	Corridors	0	0			0	0	
	Mech. Mezzanine	0	0			0	0	
	Elevator Lobbies	0	0			0	0	

Floors Three and Four

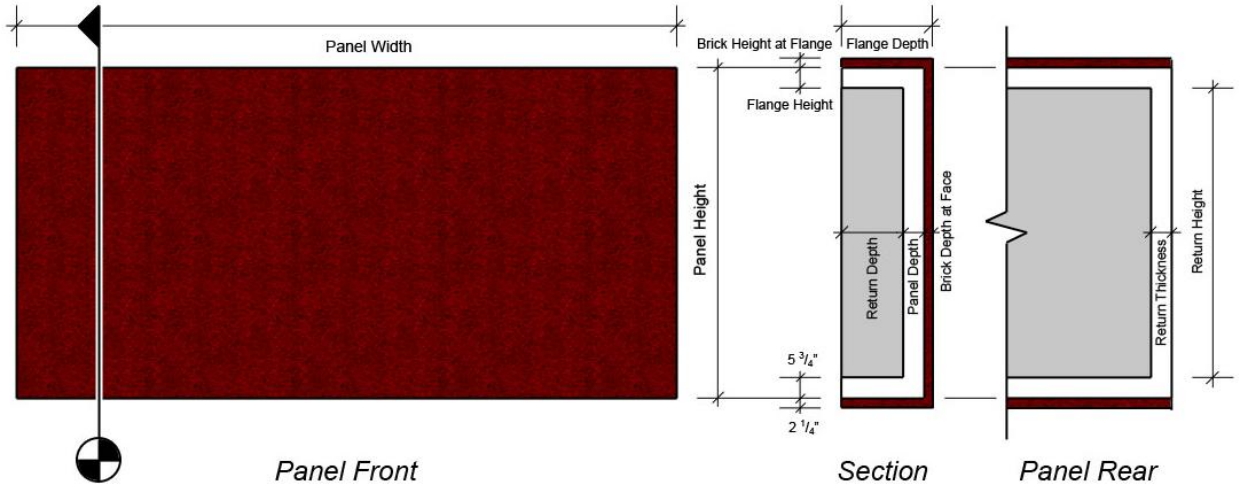
	W14X61	192.3	k
A=	17.9	in.2	
k=	1.0		
l=	18.0	ft.	
r=	2.5	in.	
E=	29000.0	ksi.	
Fy=	50.0	ksi.	
k*l/r=	88.2		
Fe=	36.8	ksi.	
Fcr=	28.3	ksi.	
ϕPn=	456.3	k.	OK

Floors One Two and Three

	W14X61	380.5	k
A=	17.9	in.2	
k=	1.0		
l=	20.0	ft.	
r=	2.5	in.	
E=	29000.0	ksi.	
Fy=	50.0	ksi.	
k*l/r=	98.0		
Fe=	29.8	ksi.	
Fcr=	24.8	ksi.	
ϕPn=	399.3	k.	OK

Column Check: Exterior Column in the Material Sciences Wing

APPENDIX 5.C: FAÇADE



	Precast Panel Dimensions		
	Panel Height	141.125	in.
	Panel Depth	5	in.
	Brick Depth at Face	0.75	in.
	Flange Height	10	in.
	Brick Height at Flange	0.5	in.
	Flange Depth	15.75	in.
	Panel Width	263.25	in.
	Return Thickness	14	in.
	Return Depth	10	in.
	Return Height	121.125	in.
	Volume Concrete	157.593	ft.3
	Weight Concrete	23638.96	lb.
	Volume Brick	18.52405	ft.3
	Weight Brick	2222.886	lb.
(factored)	Total	36206.58	lb.
(factored)	Total with Planters	43930.29	lb.

	Wind Force	
(factored)	50.992	psf.

Self Weight Check Upright			
Weight/in.	137.5369	lb./in.	
Inertia of Panel	2032473	in.4	
Moment	1191423	lb.in.	
Stress	41.36329	psi.	OK

Planter Gravity Check Upright			
Weight/in.	166.8767	lb./in.	
Inertia of Panel	2032473	in.4	
Moment	1445581	lb.in.	
Stress	50.18705	psi.	OK

Wind Check On Face			
Weight/in.	4.249333	lb./in.	
Inertia of Strip	125	in.4	
Moment	10578.86	lb.in.	
Stress	211.58	psi.	OK

Wind Check On Flange			
Weight/in.	24.98697	lb./in.	
Inertia of Flange	2812.5	in.4	
Moment	172855.3	lb.in.	
Stress	460.9476	psi.	OK

Panel Strength Checks: Wind

Self Weight Check Prostrate		(factored)
Weight/in.	8.16667	lb./in.
Inertia of Strip	125	in.4
Moment	14730.64	lb.in.
Stress	294.6128	psi.
		OK

Planter Gravity Check Prostate		(factored)
Weight/in.	10.79167	lb./in.
Inertia of Strip	125	in.4
Moment	19465.49	lb.in.
Stress	389.3098	psi.
		OK

Cantilever Check on Flange Self Weight		
Weight/in.	15.16667	lb./in.
Inertia of Flange	1000	in.4
Moment	758.3333	lb.in.
Stress	3.791667	psi.

Cracking Stress		(factored)
	477.2971	psi

Panel Strength Checks: Gravity

SAMPLE CALCULATIONS: SELF WEIGHT CHECK UPRIGHT

$$Weight/in. = Total\ Weight/Panel\ Width = 36206.58lb./263.25in. = 137.5lb./in.$$

$$Inertia = \frac{(5in.)(141.125in.)^3}{12} + 2\left[\frac{(15.75in. - 0.75in. - 5in.)(10in.)^3}{12} + (15.75in. - 0.75in. - 5in.)(10in.)\left(\frac{141.125in.}{2} + \frac{10in.}{2}\right)^2\right] = 2032473in.^4$$

$$Moment = \frac{wl^2}{8} = \frac{(137.5lb./in.)(236.25in.)^2}{8} = 1191423lb.in.$$

$$Stress = \frac{Mc}{I} = \frac{(1191423lb.in.)(141.125in.)}{2032473in.^4} = 41.36psi.$$

$$Cracking\ Stress = \varphi 7.5\sqrt{f'_c} = 0.9(7.5)\sqrt{5000psi.} = 477.3psi.$$

Corbel Dimensions		
L1=	6	in.
L2=	6	in.
b=	14	in.
h=	18	in.
d=	16.5	in.
a=	5.5	in.
λ=	1	
μ=	1.4	
β=	1	
ϕ=	0.75	
f'c=	5000	psi.
fy=	60000	psi.
Vu=	36.2	k.
Nu=	7.2	k.

Required Steel		
Vu.max=	189	k.
As.req=	0.44	in.2
μe=	3.4	
As.req=	0.32	in.2
As.min=	0.77	in.2
As=	0.77	in.2
Ah=	0.30	in.2
Ldh=	0.00	in.

Results			
As.prov=	0.88	in.2	OK
Bar Size=	6		
(#) Bars=	2		
Ah.prov=	0.4	in.2	OK
Bar Size=	4		
(#) Bars=	2		

Panel Strength Checks: Corbel Connection Rebar Check

SAMPLE CALCULATIONS: CORBEL CHECK

$$V_{u,max} = \varphi 1000psi.\lambda^2 hb = 0.75(1000psi.)(1)^2(18in.)(14in.) = 189k.$$

$$A_{s,req1} = \frac{1}{\varphi f_y}\left(V_u\frac{a}{d} + N_u\frac{h}{d}\right) = \frac{1}{0.75(60ksi.)}\left((36.2k.)\frac{5.5in.}{16.5in.} + (0.2 * 36.2k.)\frac{18in.}{16.5in.}\right) = 0.44in.^2$$

$$\mu_e = min.\left(\frac{1000psi.\lambda bh\mu}{V_u}, 3.4\right) = min.\left(\frac{1000psi.(1)(14in.)(18in.)(1.4)}{36.2k.}, 3.4\right) = 3.4$$

$$A_{s,req2} = \frac{1}{\varphi f_y}\left(\frac{2V_u}{3\mu_e} + N_u\right) = \frac{1}{0.75(60ksi.)}\left(\frac{2(36.2k.)}{3(3.4)} + (0.2 * 36.2k.)\right) = 0.32in.^2$$

$$A_{s,min.} = 0.04bd\left(\frac{f'_c}{f_y}\right) = 0.04(14in.)(16.5in.)\left(\frac{5ksi.}{60ksi.}\right) = 0.77in.^2$$

$$A_s = max.\left(A_{s,min.}, A_{s,req.1}, A_{s,req.2}\right) = 0.77in.^2$$

$$A_{h,req.} = 0.5\left(A_s - \frac{N_u}{\varphi f_y}\right) = 0.5\left(0.77in.^2 - \frac{(0.2 * 36.2k.)}{0.75(60ksi.)}\right) = 0.30in.^2$$

$$L_{dh} = \frac{0.02\beta\lambda f_y}{\sqrt{f'_c}} d_b f_a = \frac{0.02(1)(1)(60ksi.)}{\sqrt{5000psi.}}(0.75in.)(0.7) = 8.91in.$$

All equations were taken from PCI Design Handbook, 6th Edition

Connection Dimensions				Required Steel				Results			
b=	14	in.		As.1=	0.33	in.2		As.prov=	0.4	in.2	OK
h=	36	in.		μe=	3.4			Bar Size=	4		
d=	35	in.		As.2=	0.32	in.2		(#) Bars=	2		
a=	7	in.		As.req=	0.33	in.2		Ash.prov=	0.88	in.2	OK
λ=	1			Ash.req=	0.805	in.2		Bar Size=	6		
μ=	1.4			An=	0.161	in.2		(#) Bars=	2		
ϕ=	0.75			Ah.req=	0.083	in.2		Av.prov=	0.11	in.2	OK
f'c=	5000	psi.		Vc=	69.3	k.		Bar Size=	3		
fy=	60000	psi.		Av.min=	0.001	in.2		(#) Bars=	1		
Vu=	36.2	k.		ϕVn=	61.87	k.	OK	Ah.prov=	0.11	in.2	OK
Nu=	7.2	k.		Ld.As=	16.97	in.		Bar Size=	3		
								(#) Bars=	1		

Panel Strength Checks: Dap Steel Connection Rebar Check

SAMPLE CONNECTIONS: DAP STEEL

$$A_{s1} = \frac{1}{\varphi f_y}\left(V_u\frac{a}{d} + N_u\frac{h}{d}\right) = \frac{1}{0.75(60ksi.)}\left((36.2k.)\frac{7in.}{35in.} + (7.2k.)\frac{36in.}{35in.}\right) = 0.33in.^2$$

$$\mu_e = min.\left(\frac{1000psi.\,\lambda bh\mu}{V_u}, 3.4\right) = min.\left(\frac{1000psi.\,(1)(14in.)(36in.)(1.4)}{36.2k.}, 3.4\right) = 3.4$$

$$A_{s2} = \frac{1}{\varphi f_y}\left(\frac{2V_u}{3\mu_e} + N_u\right) = \frac{1}{0.75(60ksi.)}\left(\frac{2(36.2k.)}{3(3.4)} + (7.2k.)\right) = 0.32in.^2$$

$$A_{s,req.} = max.(A_{s1}, A_{s2}) = 0.33in.^2$$

$$A_{sh,req.} = \frac{V_u}{\varphi f_y} = \frac{36.2k.}{0.75(60ksi.)} = 0.805in.^2$$

$$A_n = \frac{N_u}{\varphi f_y} = \frac{7.2k.}{0.75(60ksi.)} = 0.16in.^2$$

$$A_{h,req.} = 0.5\left(A_{s,req.} - \frac{N_u}{\varphi f_y}\right) = 0.5\left(0.33in.^2 - \frac{(7.2k.)}{0.75(60ksi.)}\right) = 0.083in.^2$$

$$V_c = 2bd\lambda\sqrt{f'_c} = 2(14in.)(35in.)(1)\sqrt{5000psi.} = 69.3k.$$

$$A_{v,req.} = if\left[V_c < \frac{V_u}{\varphi}, \frac{1}{2f_y}\left(\frac{V_u}{\varphi} - V_c\right), 0.001in.^2\right] = 0.001in.^2$$

$$\varphi V_n = \varphi\left(A_{v,prov.}f_y + A_{h,prov.}f_y + V_c\right) = 0.75[(0.11in.^2)(60ksi.) + (0.11in.^2)(60ksi.) + 69.3k.] = 61.87k.$$

All equations were taken from PCI Design Handbook, 6th Edition

APPENDIX 5.D: CANTILEVER

SAMPLE CALCULATIONS: INTERACTION EQUATION FOR CANTILEVER COLUMN CL(T2)1

***All equations can be found in the AISC Steel Manual, Chapters E, F, and H of the Specifications.**

$$F_e = \frac{\pi^2 29000ksi.}{\left(\frac{240in.}{4.17in.}\right)} = 86.4ksi.$$

$$F_{cr} = \left[0.658^{\frac{50ksi.}{86.4ksi.}}\right](50ksi.) = 39.2ksi.$$

$$\varphi P_n = 0.9(39.2ksi.)(83.3in.^2) = 2942k.$$

$$p = \frac{1}{2942k.} = 0.340\text{x}10^{-3}k.^{-1}$$

$$\varphi M_p = \frac{0.9(50ksi.)(542in.^3)}{12in./ft.} = 2032.5k.ft.$$

$$\varphi M_r = \frac{0.9(0.7)(50ksi.)(459in.^3)}{12in./ft.} = 1204.9k.ft.$$

$$h_0 = 16.7in. - 2.07in. = 14.6in.$$

$$\lambda_{pf} = 0.38\sqrt{\frac{29000ksi.}{50ksi.}} = 9.2$$

$$\lambda_{rf} = \sqrt{\frac{29000ksi.}{50ksi.}} = 24.1$$

$$r_{ts} = \sqrt{\frac{(1440in.^4)(14.6in.)}{2(459in.^3)}} = 4.79in.$$

$$L_p = 1.76(4.17in.)\sqrt{\frac{29000ksi.}{50ksi.}} = 14.73ft.$$

$$L_r = 1.95(4.79in.)\left(\frac{29000ksi.}{0.7(50ksi.)}\right)\sqrt{\frac{(104in.^4)(1)}{(459in.^3)(14.6in.)}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7(50ksi.)}{29000ksi.}\frac{(459in.^3)(14.6in.)}{(104in.^4)(1)}\right)^2}}$$
$$= 114.1ft.$$

$$k_c = \frac{4}{\sqrt{8.84}} = 1.345$$

$$BF = \frac{-(2032.5k.ft. - 1204.9k.ft.)}{(14.73ft. - 114.1ft.)} = 8.33k.$$

$$\varphi M_n = 2032.5k.ft. - 8.33k.(20ft. - 14.73ft.) = 1989k.ft.$$

$$b_x = \frac{8}{9}\left(\frac{1}{1989k.ft.}\right) = 0.447\text{x}10^{-3}k.^{-1}$$

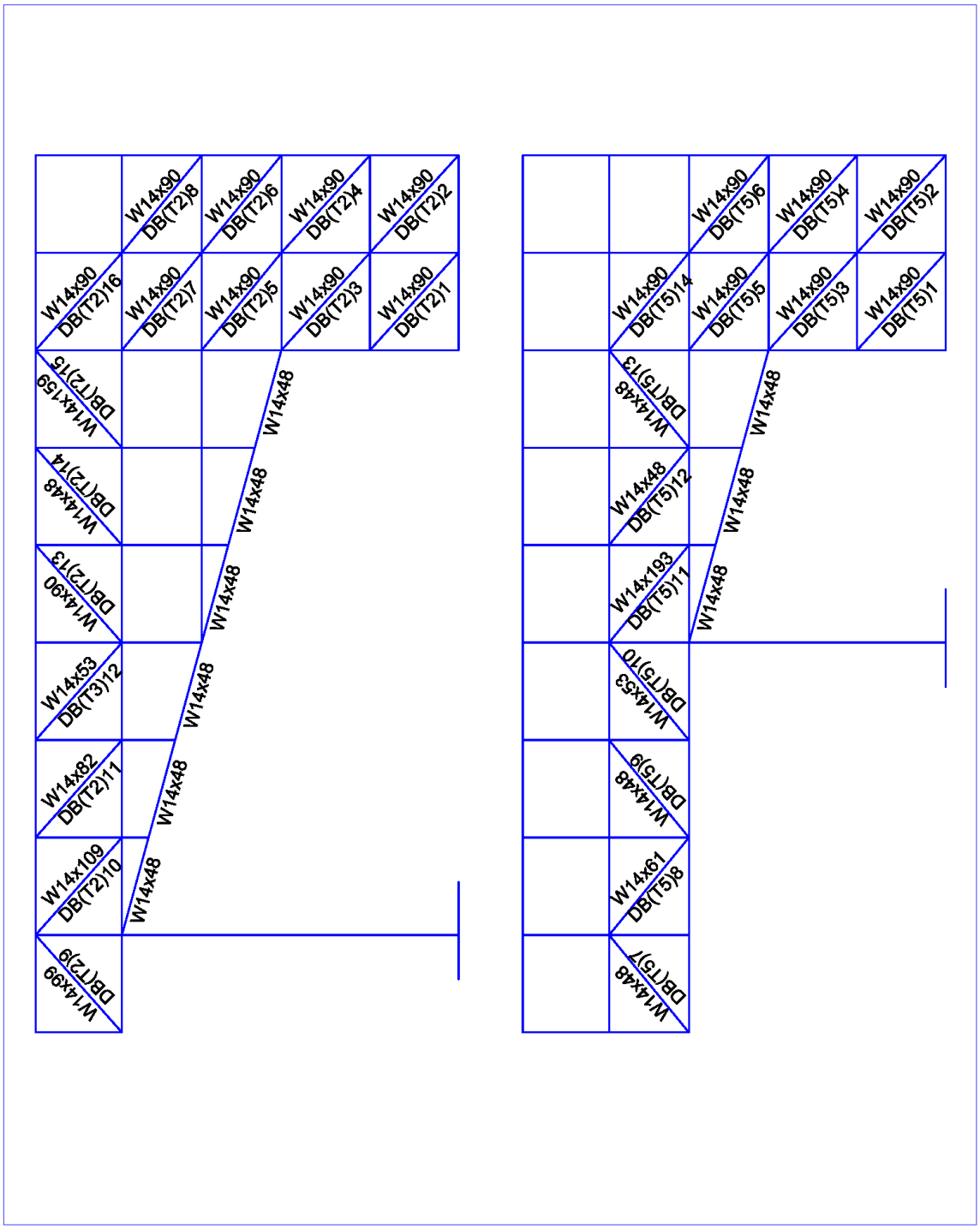
$$b_y = \frac{8}{9}\left(\frac{12in./ft.}{0.9(274in.^3)(50ksi.)}\right) = 0.865\text{x}10^{-3}k.^{-1}$$

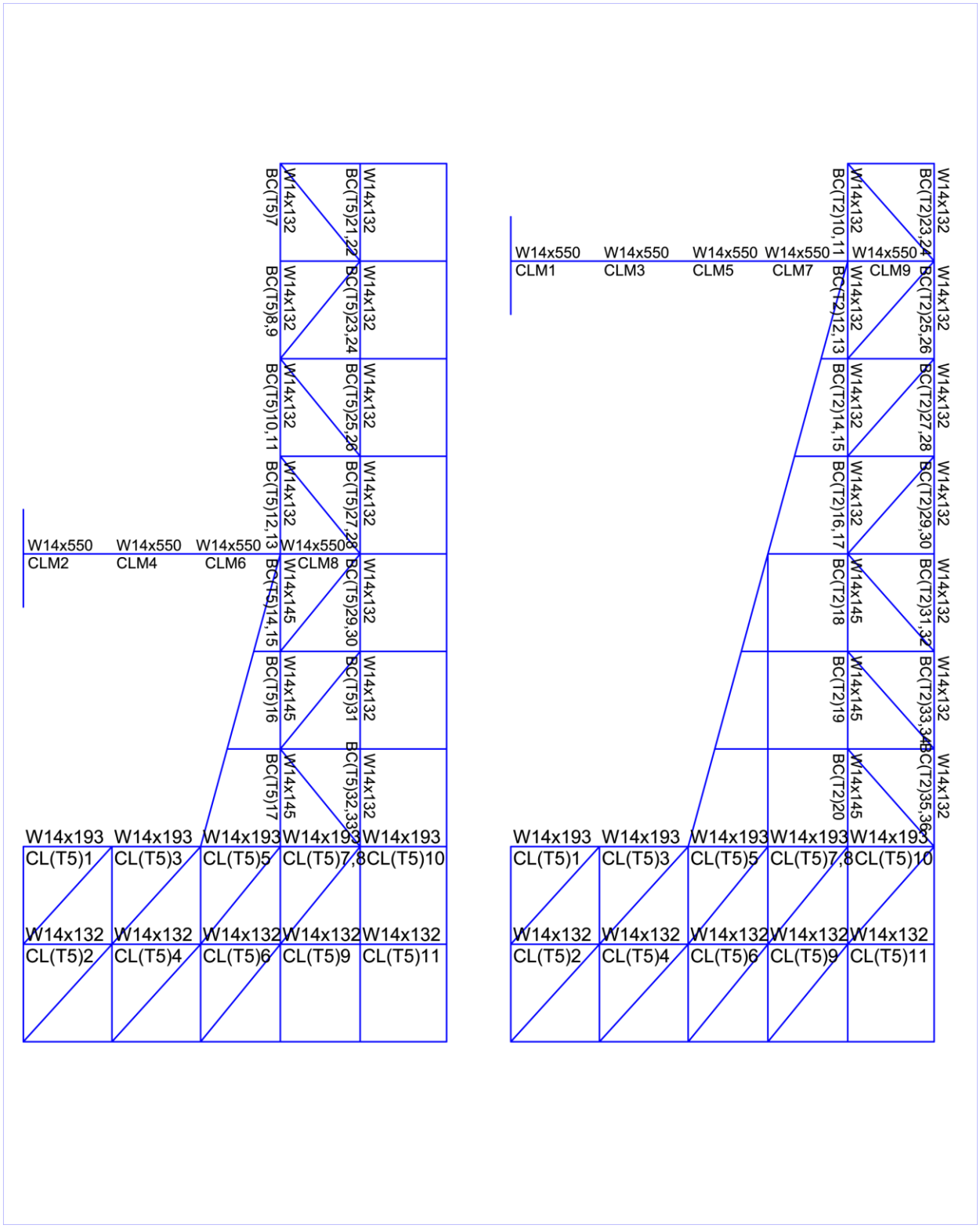
$$t_r = \frac{1}{0.75(0.75)(65ksi.)(83.3in.^2)} = 0.328\text{x}10^{-3}k.^{-3}$$

$$t_y = \frac{1}{0.9(50ksi.)(83.3in.^2)} = 0.267\text{x}10^{-3}k.^{-3}$$

$$1 \geq (2477.8k.)(0.340\text{x}10^{-3}k.^{-1}) + \frac{[(522.2k.ft.)(0.447\text{x}10^{-3}k.^{-1}) + (86.73k.ft.)(0.865\text{x}10^{-3}k.^{-1})]}{12in./ft.}$$

$$= 0.87$$


W14x90 DB(T2)8
W14x90 DB(T2)6
W14x90 DB(T2)4
W14x90 DB(T2)2
W14x90 DB(T2)16
W14x90 DB(T2)7
W14x90 DB(T2)5
W14x90 DB(T2)3
W14x90 DB(T2)1
W14x159 DB(T2)15
W14x48 DB(T2)14
W14x90 DB(T2)13
W14x53 DB(T3)12
W14x82 DB(T2)11
W14x109 DB(T2)10
W14x99 DB(T2)9
W14x48
W14x48
W14x48
W14x48
W14x48
W14x48
W14x90 DB(T5)6
W14x90 DB(T5)4
W14x90 DB(T5)2
W14x90 DB(T5)14
W14x90 DB(T5)5
W14x90 DB(T5)3
W14x90 DB(T5)1
W14x48 DB(T5)13
W14x48 DB(T5)12
W14x193 DB(T5)11
W14x53 DB(T5)10
W14x48 DB(T5)9
W14x61 DB(T5)8
W14x48 DB(T5)7
W14x48
W14x48
W14x48


W14x550 CLM1
W14x550 CLM3
W14x550 CLM5
W14x550 CLM7
W14x550 CLM9
W14x550 CLM2
W14x550 CLM4
W14x550 CLM6
W14x550 CLM8
W14x193 CL(T5)1
W14x193 CL(T5)3
W14x193 CL(T5)5
W14x193 CL(T5)7,8
W14x193 CL(T5)10
W14x132 CL(T5)2
W14x132 CL(T5)4
W14x132 CL(T5)6
W14x132 CL(T5)9
W14x132 CL(T5)11
W14x132 BC(T5)7
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W14x132 BC(T5)12,13
W14x132 BC(T5)27,28
W14x145 BC(T5)14,15
W14x132 BC(T5)29,30
W14x145 BC(T5)16
W14x132 BC(T5)31
W14x145 BC(T5)17
W14x132 BC(T5)32,33
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W14x132 BC(T2)23,24
W14x132 BC(T2)12,13
W14x132 BC(T2)25,26
W14x132 BC(T2)14,15
W14x132 BC(T2)27,28
W14x132 BC(T2)16,17
W14x132 BC(T2)29,30
W14x145 BC(T2)18
W14x132 BC(T2)31,32
W14x145 BC(T2)19
W14x132 BC(T2)33,34
W14x145 BC(T2)20
W14x132 BC(T2)35,36

TABLE: Element Forces - Frames

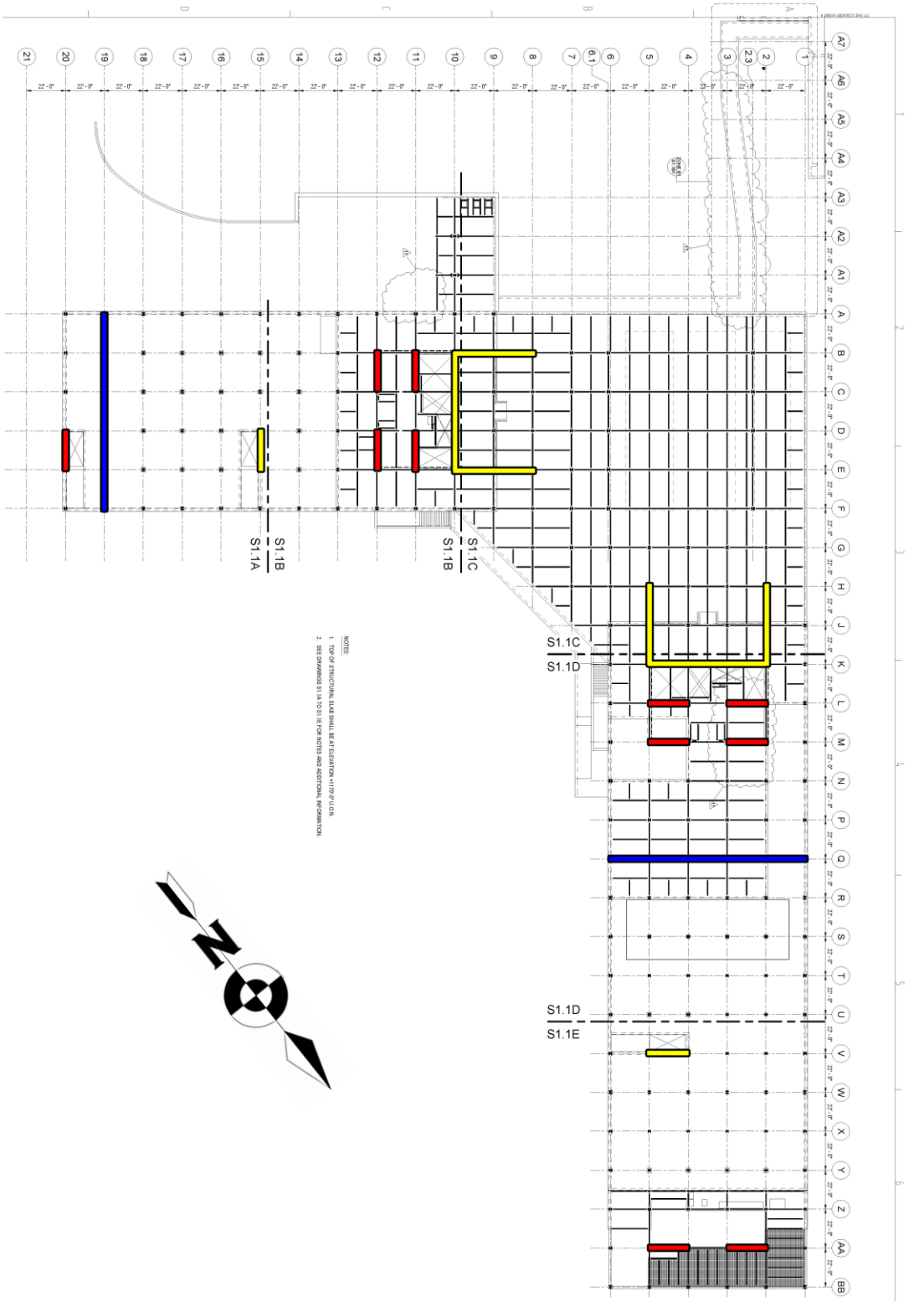
Frame	Station	OutputCase	P	V2	V3	M2	M3	Section	Length	Length	Interaction
Text	in	Text	Kip	Kip	Kip	Kip-in	Kip-in		in	ft	
CL(T2)1	0	All Factored Loads	-2566.34	2.013	-0.485	-1.1E-14	-2.3E-13	W14X283	240	20	0.87
CL(T2)1	120	All Factored Loads	-2562.6	2.013	-0.485	58.154	-241.525	W14X283	240	20	0.88
CL(T2)1	240	All Factored Loads	-2558.87	2.013	-0.485	116.307	-483.049	W14X283	240	20	0.90
CL(T2)2	0	All Factored Loads	-763.225	-0.891	0.158	-1.4E-14	-1.1E-13	W14X132	240	20	0.59
CL(T2)2	120	All Factored Loads	-761.641	-0.891	0.158	-18.934	106.876	W14X132	240	20	0.60
CL(T2)2	240	All Factored Loads	-760.057	-0.891	0.158	-37.868	213.751	W14X132	240	20	0.61
CL(T2)3	0	All Factored Loads	-2577.54	-1.544	-0.485	116.307	-35.398	W14X283	240	20	0.89
CL(T2)3	120	All Factored Loads	-2573.8	-1.544	-0.485	174.461	149.839	W14X283	240	20	0.89
CL(T2)3	240	All Factored Loads	-2570.07	-1.544	-0.485	232.615	335.076	W14X283	240	20	0.90
CL(T2)4	0	All Factored Loads	-677.764	-2.592	1.081	155.089	-482.068	W14X132	240	20	0.59
CL(T2)4	120	All Factored Loads	-676.18	-2.592	1.081	25.314	-170.969	W14X132	240	20	0.54
CL(T2)4	240	All Factored Loads	-674.596	-2.592	1.081	-104.46	140.13	W14X132	240	20	0.55
CL(T2)5	0	All Factored Loads	-2460.79	-14.624	29.091	2470.084	-1847.08	w14x311	216	18	0.95
CL(T2)5	108	All Factored Loads	-2457.43	-14.624	29.091	-671.753	-267.677	w14x311	216	18	0.78
CL(T2)5	216	All Factored Loads	-2454.07	-14.624	29.091	-3813.59	311.725	w14x311	216	18	0.98
CL(T2)6	0	All Factored Loads	-565.966	-8.097	7.933	824.811	-605.656	W14X132	216	18	0.61
CL(T2)6	108	All Factored Loads	-564.54	-8.097	7.933	-31.908	268.841	W14X132	216	18	0.44
CL(T2)6	216	All Factored Loads	-563.114	-8.097	7.933	-888.628	1143.338	W14X132	216	18	0.67
CL(T2)7	0	All Factored Loads	-1915.77	36.244	99.693	5802.812	1608.581	w14x311	216	18	1.00
CL(T2)7	60	All Factored Loads	-1913.91	36.244	99.693	821.252	1433.913	w14x311	216	18	0.67
CL(T2)7	120	All Factored Loads	-1912.04	36.244	99.693	-5160.31	-740.755	w14x311	216	18	0.92
CL(T2)9	0	All Factored Loads	-1882.35	36.248	-35.599	-1872.73	-741.223	W14X283	216	18	0.77
CL(T2)9	48	All Factored Loads	-1880.99	36.248	-35.599	-163.957	-2481.15	W14X283	216	18	0.71
CL(T2)9	96	All Factored Loads	-1879.63	36.248	-35.599	1544.815	-4221.07	W14X283	216	18	0.88
CL(T5)1	0	All Factored Loads	-1414.11	1.585	0.718	0	0	W14X193	240	20	0.72
CL(T5)1	120	All Factored Loads	-1411.79	1.585	0.718	-86.17	-190.251	W14X193	240	20	0.73
CL(T5)1	240	All Factored Loads	-1409.47	1.585	0.718	-172.341	-380.502	W14X193	240	20	0.75
CL(T5)2	0	All Factored Loads	-655.756	0.125	-0.391	0	-2.8E-14	W14X132	240	20	0.51
CL(T5)2	120	All Factored Loads	-654.172	0.125	-0.391	46.917	-15.051	W14X132	240	20	0.51
CL(T5)2	240	All Factored Loads	-652.587	0.125	-0.391	93.835	-30.102	W14X132	240	20	0.52
CL(T5)3	0	All Factored Loads	-1427.49	1.585	0.91	132.815	-380.502	W14X193	240	20	0.76
CL(T5)3	120	All Factored Loads	-1425.17	1.585	0.91	23.632	-570.753	W14X193	240	20	0.76
CL(T5)3	240	All Factored Loads	-1422.85	1.585	0.91	-85.55	-761.004	W14X193	240	20	0.77
CL(T5)4	0	All Factored Loads	-594.613	1.15	-1.923	-257.585	-36.686	W14X132	240	20	0.51
CL(T5)4	120	All Factored Loads	-593.028	1.15	-1.923	-26.81	-174.703	W14X132	240	20	0.48
CL(T5)4	240	All Factored Loads	-591.444	1.15	-1.923	203.965	-312.719	W14X132	240	20	0.52
CL(T5)5	0	All Factored Loads	-1415.93	5.159	2.656	161.916	339.342	W14X193	216	18	0.72
CL(T5)5	108	All Factored Loads	-1413.84	5.159	2.656	-124.905	-217.873	W14X193	216	18	0.71
CL(T5)5	216	All Factored Loads	-1411.75	5.159	2.656	-411.726	-775.088	W14X193	216	18	0.77
CL(T5)6	0	All Factored Loads	-488.02	-9.024	-2.167	-239.194	-994.785	W14X132	216	18	0.49
CL(T5)6	108	All Factored Loads	-486.594	-9.024	-2.167	-5.173	-20.209	W14X132	216	18	0.36
CL(T5)6	216	All Factored Loads	-485.168	-9.024	-2.167	228.847	954.366	W14X132	216	18	0.48
CL(T5)7	0	All Factored Loads	-1107.45	66.178	9.212	888.74	5109.692	W14X193	216	18	0.92
CL(T5)7	60	All Factored Loads	-1106.29	66.178	9.212	336.034	1138.994	W14X193	216	18	0.63
CL(T5)7	120	All Factored Loads	-1105.13	66.178	9.212	-216.671	-2831.7	W14X193	216	18	0.72
CL(T5)9	0	All Factored Loads	-1082.56	5.602	9.207	-217.209	-418.783	W14X193	216	18	0.57
CL(T5)9	48	All Factored Loads	-1081.63	5.602	9.207	-659.13	-687.657	W14X193	216	18	0.63
CL(T5)9	96	All Factored Loads	-1080.71	5.602	9.207	-1101.05	-956.532	W14X193	216	18	0.70

TABLE: Element Forces - Frames											
Frame	Station	OutputCase	P	V2	V3	M2	M3	Section	Length	Length	Interaction
Text	in	Text	Kip	Kip	Kip	Kip-in	Kip-in		in	ft	
DB(T2)7	0	All Factored Loads	-422.924	-1.19	0	0	0	W14X90	341.104	28.42533	0.66
DB(T2)7	170.6	All Factored Loads	-423.898	0	0	0	101.503	W14X90	341.104	28.42533	0.68
DB(T2)7	341.1	All Factored Loads	-424.872	1.19	0	0	0	W14X90	341.104	28.42533	0.66
DB(T2)8	0	All Factored Loads	-270.112	-1.19	0	0	0	W14X90	341.104	28.42533	0.42
DB(T2)8	170.6	All Factored Loads	-271.086	0	0	0	101.503	W14X90	341.104	28.42533	0.44
DB(T2)8	341.1	All Factored Loads	-272.06	1.19	0	0	0	W14X90	341.104	28.42533	0.42
DB(T2)9	0	All Factored Loads	1040.622	-1.307	0	0	0	w14x99	352.778	29.39817	0.98
DB(T2)9	176.4	All Factored Loads	1039.463	-1.1E-15	0	0	115.277	w14x99	352.778	29.39817	0.99
DB(T2)9	352.8	All Factored Loads	1038.305	1.307	0	0	3.98E-13	w14x99	352.778	29.39817	0.98
DB(T5)8	0	All Factored Loads	-80.243	-0.804	0	0	0	W14X61	341.104	28.42533	0.38
DB(T5)8	170.6	All Factored Loads	-80.901	0	0	0	68.563	W14X61	341.104	28.42533	0.41
DB(T5)8	341.1	All Factored Loads	-81.559	0.804	0	0	0	W14X61	341.104	28.42533	0.39
DB(T5)9	0	All Factored Loads	345.642	-0.633	0	0	0	W14X48	341.104	28.42533	0.67
DB(T5)9	170.6	All Factored Loads	346.16	-2.2E-16	0	0	54.007	W14X48	341.104	28.42533	0.70
DB(T5)9	341.1	All Factored Loads	346.678	0.633	0	0	7.82E-14	W14X48	341.104	28.42533	0.67
BC(T2)12	0	All Factored Loads	-441.462	33.821	9.395	205.523	224.961	W14X132	132	11	0.33
BC(T2)12	22	All Factored Loads	-441.462	34.111	9.395	-1.172	-522.287	W14X132	132	11	0.32
BC(T2)12	44	All Factored Loads	-441.462	34.401	9.395	-207.867	-1275.93	W14X132	132	11	0.42
BC(T2)12	44	All Factored Loads	-546.3	37.242	11.169	279.009	10.585	W14X132	132	11	0.39
BC(T2)12	66	All Factored Loads	-546.3	37.533	11.169	33.288	-811.943	W14X132	132	11	0.42
BC(T2)12	88	All Factored Loads	-546.3	37.823	11.169	-212.433	-1640.86	W14X132	132	11	0.52
BC(T2)12	88	All Factored Loads	-758.848	21.615	17.251	759.033	963.837	W14X132	132	11	0.69
BC(T2)12	110	All Factored Loads	-758.848	21.905	17.251	379.516	485.113	W14X132	132	11	0.58
BC(T2)12	132	All Factored Loads	-758.848	22.196	17.251	3.64E-12	-7E-13	W14X132	132	11	0.48
BC(T2)13	0	All Factored Loads	-319.393	17.16	-1.275	-162.921	1528.04	W14X132	132	11	0.36
BC(T2)13	22	All Factored Loads	-319.393	17.45	-1.275	-134.874	1147.328	W14X132	132	11	0.32
BC(T2)13	44	All Factored Loads	-319.393	17.741	-1.275	-106.826	760.226	W14X132	132	11	0.28
BC(T2)13	44	All Factored Loads	-318.618	19.055	2.043	11.014	693.666	W14X132	132	11	0.17
BC(T2)13	66	All Factored Loads	-318.618	19.345	2.043	-33.928	271.266	W14X132	132	11	0.13
BC(T2)13	88	All Factored Loads	-318.618	19.636	2.043	-78.87	-157.525	W14X132	132	11	0.13
BC(T2)13	88	All Factored Loads	-364.596	24.533	7.493	172.378	385.577	W14X132	132	11	0.29
BC(T2)13	110	All Factored Loads	-364.596	24.823	7.493	7.535	-157.335	W14X132	132	11	0.24
BC(T2)13	132	All Factored Loads	-364.596	25.114	7.493	-157.307	-706.637	W14X132	132	11	0.32

TABLE: Element Forces - Frames											
Frame	Station	OutputCase	P	V2	V3	M2	M3	Section	Length	Length	Interaction
Text	in	Text	Kip	Kip	Kip	Kip-in	Kip-in		in	ft	
BC(T2)18	0	All Factored Loads	391.795	-31.721	-0.915	-21.649	-329.976	W14X132	264	22	0.31
BC(T2)18	22	All Factored Loads	391.795	-31.43	-0.915	-1.519	364.69	W14X132	264	22	0.31
BC(T2)18	44	All Factored Loads	391.795	-31.14	-0.915	18.611	1052.966	W14X132	264	22	0.38
BC(T2)18	44	All Factored Loads	457.489	-21.294	-0.907	-30.82	379.939	W14X132	264	22	0.36
BC(T2)18	66	All Factored Loads	457.489	-21.004	-0.907	-10.859	845.214	W14X132	264	22	0.40
BC(T2)18	88	All Factored Loads	457.489	-20.713	-0.907	9.101	1304.099	W14X132	264	22	0.44
BC(T2)18	88	All Factored Loads	499.88	-7.631	-0.893	-21.624	849.016	W14X132	264	22	0.43
BC(T2)18	110	All Factored Loads	499.88	-7.341	-0.893	-1.984	1013.708	W14X132	264	22	0.45
BC(T2)18	132	All Factored Loads	499.88	-7.05	-0.893	17.656	1172.009	W14X132	264	22	0.46
BC(T2)18	132	All Factored Loads	504.882	7.274	-0.938	-36.463	1104.117	W14X132	264	22	0.46
BC(T2)18	154	All Factored Loads	504.882	7.565	-0.938	-15.823	940.888	W14X132	264	22	0.44
BC(T2)18	176	All Factored Loads	504.882	7.855	-0.938	4.816	771.269	W14X132	264	22	0.43
BC(T2)18	176	All Factored Loads	475.734	21.819	-1.826	-49.334	1044.075	W14X132	264	22	0.44
BC(T2)18	198	All Factored Loads	475.734	22.11	-1.826	-9.171	560.856	W14X132	264	22	0.39
BC(T2)18	220	All Factored Loads	475.734	22.4	-1.826	30.992	71.246	W14X132	264	22	0.35
BC(T2)18	220	All Factored Loads	426.059	41.535	-5.092	-89.808	502.995	W14X132	264	22	0.36
BC(T2)18	242	All Factored Loads	426.059	41.826	-5.092	22.217	-413.979	W14X132	264	22	0.34
BC(T2)18	264	All Factored Loads	426.059	42.116	-5.092	134.241	-1337.34	W14X132	264	22	0.45
BC(T5)13	0	All Factored Loads	-465.063	27.937	7.293	192.427	393.272	W14X132	132	11	0.36
BC(T5)13	22	All Factored Loads	-465.063	28.228	7.293	31.989	-224.539	W14X132	132	11	0.32
BC(T5)13	44	All Factored Loads	-465.063	28.518	7.293	-128.45	-848.74	W14X132	132	11	0.39
BC(T5)13	44	All Factored Loads	-553.865	30.466	9.737	279.377	201.44	W14X132	132	11	0.41
BC(T5)13	66	All Factored Loads	-553.865	30.757	9.737	65.155	-472.016	W14X132	132	11	0.40
BC(T5)13	88	All Factored Loads	-553.865	31.047	9.737	-149.067	-1151.86	W14X132	132	11	0.47
BC(T5)13	88	All Factored Loads	-765.643	30.25	12.765	561.676	1343.796	W14X132	132	11	0.69
BC(T5)13	110	All Factored Loads	-765.643	30.541	12.765	280.838	675.093	W14X132	132	11	0.59
BC(T5)13	132	All Factored Loads	-765.643	30.831	12.765	2.27E-13	1.52E-12	W14X132	132	11	0.48
BC(T5)14	0	All Factored Loads	-874.276	-47.002	0.965	0	0	W14X145	132	11	0.49
BC(T5)14	22	All Factored Loads	-874.276	-46.682	0.965	-21.222	1030.521	W14X145	132	11	0.57
BC(T5)14	44	All Factored Loads	-874.276	-46.362	0.965	-42.444	2054.009	W14X145	132	11	0.66
BC(T5)14	44	All Factored Loads	-546.553	-46.594	-1.861	-70.161	-1780.22	W14X145	132	11	0.45
BC(T5)14	66	All Factored Loads	-546.553	-46.274	-1.861	-29.225	-758.672	W14X145	132	11	0.37
BC(T5)14	88	All Factored Loads	-546.553	-45.954	-1.861	11.71	255.84	W14X145	132	11	0.33
BC(T5)14	88	All Factored Loads	-430.454	-39.839	-7.969	-99.6	-1104.29	W14X145	132	11	0.34
BC(T5)14	110	All Factored Loads	-430.454	-39.519	-7.969	75.728	-231.351	W14X145	132	11	0.27
BC(T5)14	132	All Factored Loads	-430.454	-39.2	-7.969	251.056	634.559	W14X145	132	11	0.33

The preceding results are part of a larger pool of data from a SAP analysis of the redesigned cantilever system. The included data is meant to be representative of the process used in checking strength in the cantilever.

APPENDIX 5.E: LATERAL SYSTEM



Existing Lateral System: Moment Frames are in Blue, Braced Frames are Red, and Shear Walls are in Yellow

SEISMIC CALCULATIONS

Design Seismic Base Shear (ASCE7-05)

V= CsW 12.8-1

W: Effective Weight- 12.7.2

Cs: Seismic Coeff.- 12.8.1.1

$$Cs = \text{Min}\begin{cases} S_{ds}/(R/I) \\ S_{D1}/(T*R/I) \\ S_{D1}*TI/(T^2*R/I) \end{cases} > 0.01$$

In addition, where S1 > 0.6

$Cs > 0.5S_1/(R/I)$ Eq. 12.8-6

Fa,Fv- Table 11.4-1, 11.4-2

Ss, S1- USGS website, using long./lat. of site location

R: Response Mod. Coeff.- Table 12.2-1

I: Importance Factor- 11.5

Occ. Cat.- Table 1-1

$$T = \text{Min}\begin{cases} Cu*Ta \\ Tb \end{cases} \qquad S_{ds} = 2/3(S_{MS}) \qquad S_{MS} = Fa*Ss$$

$$S_{D1} = 2/3(S_{M1}) \qquad S_{M1} = Fv*S1$$

Cu- Table 12.8-1

Ta- 12.8.2.1

Tb- Fundamental Mode of Vibration from Modal Analysis w/Mass input

Design Seismic Base Shear- MSC Complex, University Park, PA

Latitude: 40.802 Site Class: D

Longitude: -77.86 Occ. Cat: III

Ss = 0.147 g (Site Class B)

S1= 0.049 g (Site Class B)

Fa= 1.6

Fv= 2.4

S_{MS}= 0.2352 g S_{DS}= 0.1568 g

S_{M1}= 0.1176 g S_{D1}= 0.0784 g

Lateral Force Resisting System: Ordinary Steel Concentrically Braced Frames

R= 3.25
I= 1.25
SDC: B (No Limitations)
Tl= 6 s (Fig. 22-15)

Design Base Shear

Ta= 0.512 s
Cu= 1.7
Cu*Ta= 0.871 s

Cs= Min 0.0603 = 0.0346
0.0346
0.2386

Building Weight Calculation (above ground)

Frame Weights

	Columns	Beams	Braces	
	Weight(K)	W (K)	# braces	W (K)
1st Floor	503.31	770.26	32	358.35
2nd Floor	440.87	889.46	72	806.28
3rd Floor	325.36	1011.99	95	1063.84
Mech.	234.69	762.95	88	985.45
Roof	59.93	481.01	24	268.76
		Total	311	3482.68

Superimposed Dead Loads

	psf	Area (SF)	W (K)
Roof	25	33202.82	830.07
Pent	25	40174.27	1004.36
Third	30	53742.49	1612.27
Second	30	64818.42	1944.55
Green Roofs	120	63584.00	7630.08
	Total	255522.00	13021.33

Floor Weights (slabs, beams, columns, façade)

	slabs(K)	columns(K)	beams(K)	braces(K)	façade(K)	W(K)
Level-2	4186.6	472.09	889.46	582.3126	1331	7461.03
Level-3	4670.6	383.12	1011.99	935.0597	1890	8890.80
Mech.	6258.12	280.02	762.95	1024.646	2213	10538.70
Roof	1771.44	147.31	481.01	761.4857	2590	5751.22
					Total	32641.75

V= CS*W

Cs= 0.0346
W= 45663 K

V= **1581** **K**

1771.44
3944.4
6823.4
3779

Seismic Load Distribution

X/Y-Direction Loading

T=	0.871	s
k=	1.185	
V_b=	1581	kips

i (Level)	Story Height h_i (ft)	Effective Height h (ft)	Story Weight w (K)	$w*h^k$	C_{vx}	Lateral Force f_i (K)	Story Shear V_i (K)	Moment M_i (K-ft)
Roof	19.5	75.5	5751	968094	0.309	488	488	36849
Mech.	18.0	56.0	10539	1244874	0.397	628	1116	35146
3	18.0	38.0	8891	663207	0.211	334	1450	12706
2	20.0	20.0	7461	260056	0.083	131	1581	2622.1
Totals	75.5	75.5	32642	3136231	1.000	1581	1581	87323

WIND CALCULATIONS

MWFRS Wind Analysis (ASCE7-05)- MSC Complex

Location: University Park, PA

Topography: Campus Setting. Buildings to North, North West, West, and South. Mostly open terrain to East with small obstructions

Bulding Dimensions: L-Shaped. North Wing outside dimension = 550 ft, West Wing outside dimension = 440 ft. Building Heights (From Pollock Road): 85'-6" ft to Roof level, 66 ft to Mechanical Penthouse, 48 ft to Third Floor, 30 ft to second floor, 10 ft to first floor. Roof Step Backs: Roof steps to: North Wing- Steps Down to Mech. Penthouse level at 220 ft, Third Floor at 330 ft, and Second Floor at 440 ft. - Same on West Wing except the last step down does not exist

Framing: Primarily Steel Framing- W-Flange columns, beams, and cross-bracing. The floor system is a composite beam and concrete slab on metal deck.

Cladding: Alternate horizontal strips of precast concrete panels and exterior glazing for each floor of elevation. Assume no debris resistant glazing.

Roof Top: Primary Roof consists of EPDM Walkway Pads and EODM Fooring Membrane tapered. The lower roofs are all green roofs. All roofs flat.

a) Basic Wind Speed (Fig. 6-1): V = 90mph

b) Exposure: (6.5.2.3) Exposure B: Urban/Suburban, wooded, numerous closely spaced obstructions- single family dwellings and larger.

c)Building Classification: Construction Type IIIB, Occ. Cat: B with special Occ. areas of H-5

d) Velocity Pressure: $q_z = 0.000256 k_z k_{zt} k_d V^2 I$

kz (Table 6-3) =	15	20	39	57	75.75	87	(ft)
	0.575	0.624	0.755	0.842	0.913	0.950	

kzt (Fig. 6-4) =	1	, assume homo-topo
kd (Table 6-4) =	0.85	, buildings
$V^2 = 90^2$ =	8100	
I (Table 6-1) =	1.15	
qz =	**20.27**	*kz **psf** *depends on height

e) Gust Effect Factor: G= 0.85 (Rigid Structure T< 1.0s, refer to Seismic Analysis)

f) Internal Pressure Coefficient: GCpi = +/- 0.18 (assume Enclosed Building)

g) Design Wind Pressures: P = qGCp - qi(Gcpi)

q = qz (windward, depends on height)
q = qh (leeward, taken at height-h)
G = 0.85
qi = qh (windward, leeward, and roofs for enclosed buildings)
GCpi = +/- 0.18

Cp values determined:

h) Wall Cp: (Fig. 6-6 cont'd)

Cpw =	0.8	(windward, with qz)
Cpsw =	-0.07	(side walls, with qh)
Cpl=	-0.5	L/B = 0-1 (Leeward, with qh)
	-0.3	L/B = 2
	-0.2	L/B = > 4

i) Roof Cp: (Fig. 6-6 cont'd)

angle < 10deg., h/L < 0.5

Hor. Dist. From Wind. Edge	Cp (1st)	Cp (2nd)
0-h/2, h/2-h	-0.9	-0.18
h-2h	-0.5	-0.18
> 2h	-0.3	-0.18

j) MWFRS Pressures P = qGCp - qi(Gcpi)

Terrain Exposure Constants

Exposure	α	Zg(ft)	â	b^	α–	b-	c
B	7.00	1200.00	0.14	0.84	0.25	0.45	0.30

l (ft)	Ɛ	Zmin (ft)
320.00	0.33	30.00

Windward Walls	qz	G	Cp	qzGCp
Height				
z= 15ft	11.65	0.85	0.8	7.92
z= 20ft	12.65	0.85	0.8	8.60
z= 39ft	15.31	0.85	0.8	10.41
z= 57ft	17.06	0.85	0.8	11.60
z= 75.75ft	18.50	0.85	0.8	12.58
z= 87ft	19.25	0.85	0.8	13.09

Leeward Walls	qh	G	Cp	qhGCp
Wind- short side	19.25	0.85	-0.2	-3.27
Wind-Long Side	19.25	0.85	-0.5	-8.18
Side Walls	19.25	0.85	-0.7	-11.45

Roof- First Value	qh	G	Cp	qzGCp
Length				
0-h	19.25	0.85	-0.9	-14.73
h-2h	19.25	0.85	-0.5	-8.18
>2h	19.25	0.85	-0.3	-4.91

Roof- Second Value	qh	G	Cp	qzGCp
all lengths	19.25	0.85	-0.18	-2.95

Wall Areas

	Windward			Leeward-Long Side		Leeward-Short Side
Height	E/W(SF)	N/S(SF)		E/W(SF)	N/S(SF)	E/W=N/S(SF)
z= 0-15ft	6398	8335		4638	6571	1760
z= 15-20ft	2136	2778		1549	2195	587
z= 20-39ft	8444	10141		6215	7911	2229
z= 39-57ft	7564	7564		5452	5452	2112
z= 57-75.75ft	5753	5753		3553	3553	2200
z= 75.75-87ft	2740	2740		1420	1420	1320

Floor Loads by Area

	Windward		Leeward-Long Side		Leeward-Short Side
Floor Level	E/W(K)	N/S(K)	E/W(K)	N/S(K)	E/W=N/S(SK)
First Floor	52.2	67.9	38.0	53.8	5.8
Second Floor	87.9	105.5	50.8	64.7	7.3
Third Floor	87.7	87.7	44.6	44.6	6.9
Mech. Pent.	72.4	72.4	29.1	29.1	7.2
Roof	35.9	35.9	11.6	11.6	4.3

Final Story Forces y x

	Load		Shear		Moment	
Floor Level	E/W(K)	N/S(K)	E/W(K)	N/S(K)	E/W(K-ft)	N/S(K-ft)
First Floor	153	204	867	968	117814.6	203993.9
Second Floor	234	284	713	764	191627.7	294721.3
Third Floor	223	223	480	480	187014.5	187014.5
Mech. Pent.	174	174	257	257	111496.1	111496.1
Roof	83	83	83	83	36754.47	36754.47
Totals*(1.6)			**867**	**968**	**644707**	**833980**

Components and Cladding Wall Panels p = q(GCp) – qh (GCpi) (lb/ft2)

Windward

					Area 4/5		
Floor Level	Wall Area	h	qz	qh	GCp	Gcpi	P(psf)
First Floor	440	20	12.65	19.25	0.638	0.18	11.53
Second Floor	418	39	15.31	19.25	0.651	0.18	13.43
Third Floor	396	57	17.06	19.25	0.665	0.18	14.81
Mech. Pent.	412.5	75.75	18.50	19.25	0.655	0.18	15.58
Roof	214.5	87	19.25	19.25	0.778	0.18	18.45

Leeward

					Area 4	Area 5			
Floor Level	Wall Area	h	qz	qh	GCp	GCp	Gcpi	P4(psf)	P5(psf)
First Floor	440	20	12.65	19.25	-0.725	-1.100	0.18	-17.42	-24.64
Second Floor	418	39	15.31	19.25	-0.734	-1.137	0.18	-17.60	-25.35
Third Floor	396	57	17.06	19.25	-0.743	-1.173	0.18	-17.77	-26.05
Mech. Pent.	412.5	75.75	18.50	19.25	-0.736	-1.146	0.18	-17.64	-25.52
Roof	214.5	87	19.25	19.25	-0.819	-1.476	0.18	-19.23	-31.87

RESULTS

NS-Load Direction

Frame	Total	Col	Brace	S-Wall
A	0	0	0	0
B	395.0119	5.6586	30.3466	359.0067
C	0.0457	0.0457	0	0
D	0.1928	0.1928	0	0
E	352.1036	5.5897	31.4656	315.0483
F	0.132	0.0335	0	0.0985
G	0	0	0	0
H	0.429	0.429	0	0
J	0.48	0.48	0	0
K	687.2726	4.686	6.271	676.3156
L	11.2206	0.031	0	11.1896
M	6.6218	0.2942	0	6.3276
N	0.1065	0.0102	0	0.0963
P	0.0675	0.0675	0	0
Q	0.6474	0.6474	0	0
R	0.5752	0.0027	0	0.5725
S	0	0	0	0
T	0.0023	0.0023	0	0
U	0.0178	0.0178	0	0
V	106.8865	1.8679	0	105.0186
W	0.022	0.022	0	0
X	0.0005	0.0005	0	0
Y	0.0003	0.0003	0	0
Z	0	0	0	0
AA	5.6249	0.5613	5.0637	
BB	0	0	0	0
Radial	0.7654	0.7654	0	0
Total	1568.2263			
Applied	1581			
% diff	0.81			

EW-Load Direction

Frame	Total	Col	Brace	S-Wall
1	0.4053	0.1355	0	0.2698
2	393.6461	5.2453	13.1252	375.2756
3	0.0374	0.0374	0	0
4	0.2228	0.2228	0	0
5	316.6231	4.9592	28.0517	283.6122
6	4.6241	0.0207	0	4.6034
7	0	0	0	0
8	0.1356	0.1356	0	0
9	0.3765	0.3765	0	0
10	666.1471	4.8363	5.5675	655.7433
11	7.4544	0.4752	6.9792	0
12	3.2325	0.0622	3.1703	0
13	0.0201	0.001	0	0.0191
14	0.0285	0.0285	0	0
15	83.525	2.2138	0	81.3112
16	0.07	0.07	0	0
17	0.00833	0.00833	0	0
18	0.00078	0.00078	0	0
19	0.0012	0.0012	0	0
20	15.7909	0.1521	0	15.6388
21	0	0	0	0
Radial	21.9897			21.9897
Total	1514.34			
Applied	1581			
% diff	4.22			

Check of Wall on Frame 2					
Check Concrete Wall					
Vu =	375	K	lw =	44	ft
Vc =	1603	K	hw =	56	ft
Ø =	0.75		tw =	30	in
ØVc =	1202	**>Vu, OK**			
Check Braces					
Vu =	13.13	K			
	ØVn				
W14x90	185	K			
W14x99	206	K			
W14x120	256	K			
Total =	647	**> Vu, OK**			
Check Columns					
Vu =	5.25	K			
	ØVn				
W14X550	1450	K			
W14X550	1450	K			
W14x283	648	K			
W14x283	648	K			
W14x283	648	K			
Total =	4844	**> Vu, OK**			

Check of Wall on Frame 15					
Check Concrete Wall					
Vu =	81	K	lw =	22	ft
Vc =	481	K	hw =	20	ft
Ø =	0.75		tw =	18	in
ØVc =	361	**>Vu, OK**			
Check Columns					
Vu =	2.21	K			
	ØVn				
W14X99	206	K			
W14X99	206	K			
Total =	412	**> Vu, OK**			

Check of Wall on Frame 10					
Check Concrete Wall					
Vu =	666	K	lw =	66	ft
Vc =	1282	K	hw =	56	ft
Ø =	0.75		tw =	16	in
ØVc =	962	**>Vu,OK**			
Check Braces					
Vu =	5.57	K			
	ØVn				
HSS10X8X0.5	262	K			
HSS10X8X0.5	262	K			
HSS10X8X0.5	262	K			
Total =	786	**>Vu,OK**			
Check Columns					
Vu =	4.84	K			
	ØVn				
W14x283	648	K			
W14x283	648	K			
W14x90	185	K			
W14x90	185	K			
Total =	1666	**>Vu,OK**			