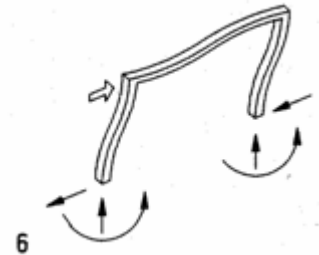
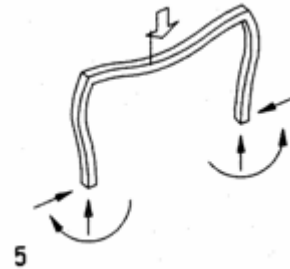
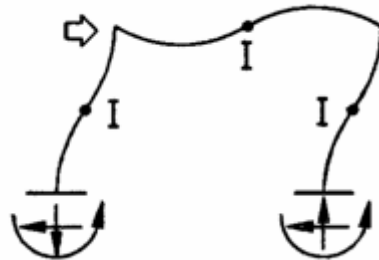
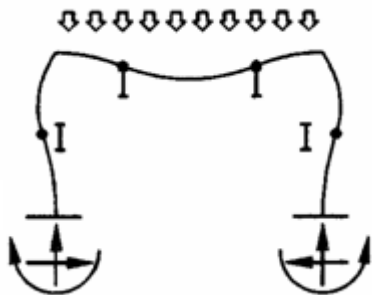


Moment frame



Eight-story steel moment frame

Assume

Live load 50 psf

Live load reduction

$$R = 0.08 (A-150)$$

where

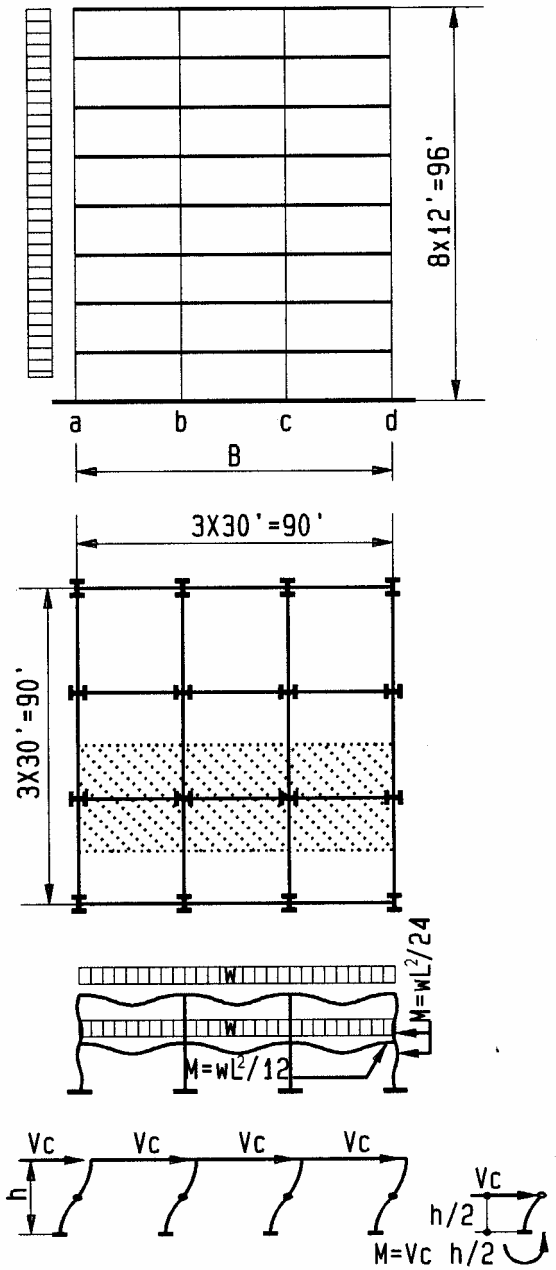
R = LL reduction in percent

A = tributary area

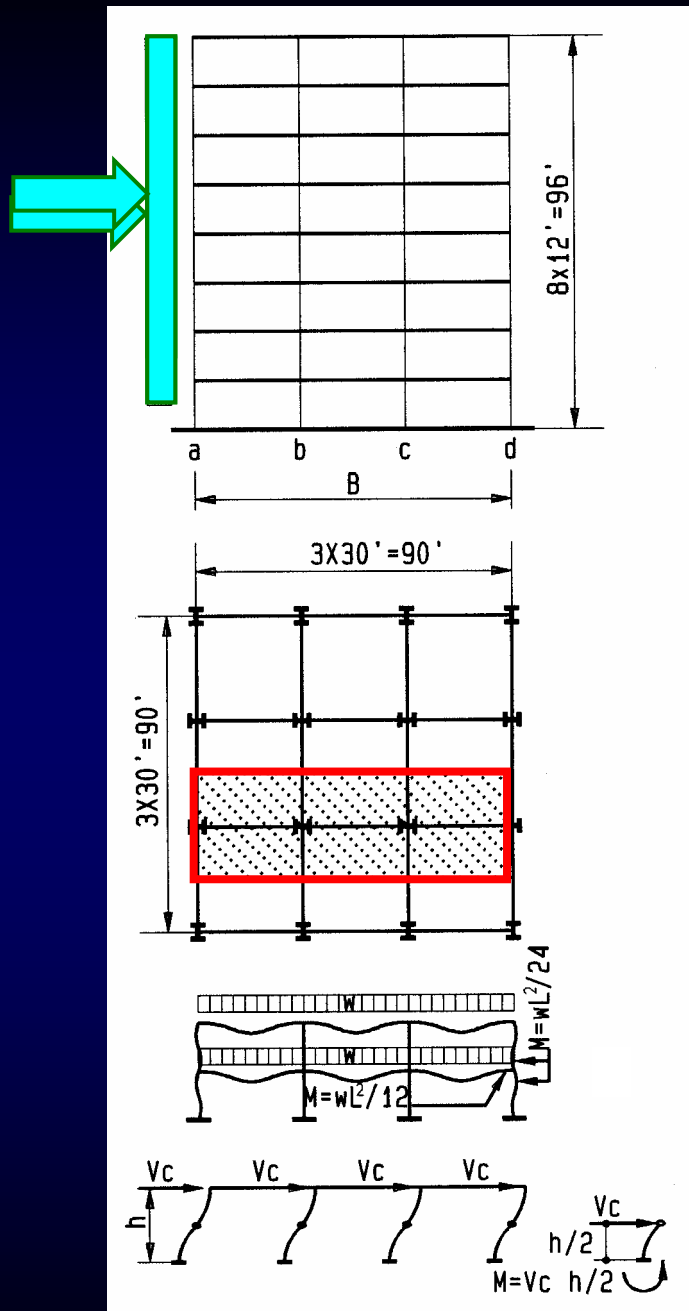
Reduction shall not exceed:

40% for members supporting a single level

60% for other members



Gravity load	Beam	Column
Framing	10	10
Concrete slab	37	37
Partitions	20	20
Floor/ceiling	3	3
DL	70	70
LL	$50 \times 0.6 = 30$	$50 \times 0.4 = 20$
Total DL+LL	100	90



Assume

Average wind pressure

$$P = 30 \text{ psf}$$

Gravity load

Beams = 100 psf

Columns = 90 psf

Design ground floor beams and columns

Uniform beam load

$$w = 100 \text{ psf} \times 30' / 1000$$

$$w = 3 \text{ klf}$$

Uniform column load (distributed on beam)

$$w = 90 \text{ psf} \times 30' / 1000$$

$$w = 2.7 \text{ klf}$$

Base shear

$$V = 30 \text{ psf} \times 30' \times 7.5 \times 12' / 1000$$

$$V = 81 \text{ k}$$

Overturn moments

Ground floor M_0

$$M_0 = 30 \text{ psf} \times 30' \times (7.5 \times 12')^2 / 2 / 1000$$

$$M_0 = 3,645 \text{ k'}$$

First floor M_1

$$M_1 = 30 \text{ psf} \times 30' \times (6.5 \times 12')^2 / 2 / 1000$$

$$M_1 = 2,738 \text{ k'}$$

Column shear

Column	$V_c = L_{trib} V/B$	V_c
a & d	$15 \times 81 / 90$	13.5k
b & c	$30 \times 81 / 90$	27.0k

Column bending

Col.	$M_{lateral} = V_c h/2$	$M_{gravity} = wL^2/24$	ΣM
a & d	$13.5 \times 6 = 81k'$	$3 \times 30^2 / 24 = 113$	194k'
b & c	$27 \times 6 = 162k'$	0	162k'

Column axial force (n = # of stories)

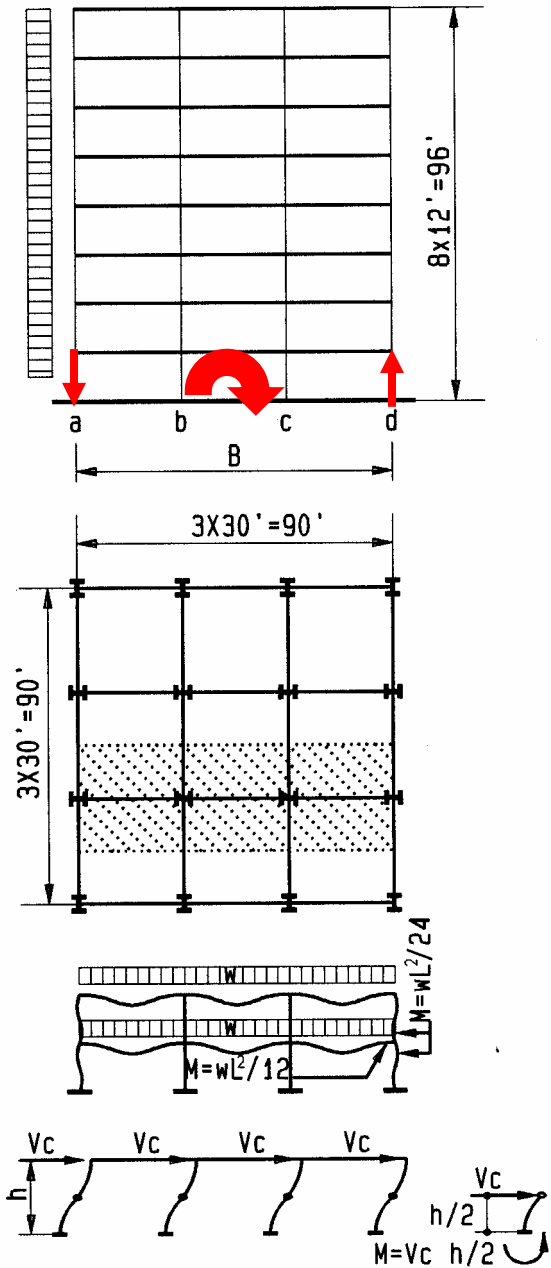
Col.	$P_{lateral} = M_0/B$	$P_{gravity} = n w L_{tributary}$	ΣP
a & d	$3645/90 = 41k$	$8 \times 2.7 \times 15 = 324$	365k
b & c	0	$8 \times 2.7 \times 30 = 648$	648k

Combined axial + bending ($\Sigma P = P + M Bx$)

Col.	P	M Bx (Bx assumes M in k-in)	ΣP
a & d	365k	$194k' \times 12'' \times 0.184 = 428$	793k
b & c	648k	$162k' \times 12'' \times 0.184 = 358$	1006k

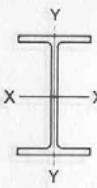
Column design (assume $KL = 1.2 \times 12' = 14'$)

Col.	Use	$P_{allowable}$ vs. P	$Bx_{estimate}$ vs. Bx
a & d	W14x145	$812 > 793$	$0.184 = 0.184$
b & c	W14x193	$1083 > 1006$	$0.184 > 0.183$



$F_y = 36$ ksi
 $F_y = 50$ ksi

COLUMNS
W shapes
 Allowable axial loads in kips



Col.	Use	$P_{allowable}$ vs. P	$Bx_{estimate}$ vs. Bx
a & d	W14x145	812 > 793	0.184 = 0.184
b & c	W14x193	1083 > 1006	0.184 > 0.183

Designation	W14								
	193		176		159		145		
	36	50	36	50	36	50	36	50	
Wt./ft	1227	1704	1119	1554	1009	1401	922	1281	
F_y	36	50	36	50	36	50	36	50	
Effective length in ft KL with respect to least radius of gyration r_y	0	1227	1704	1119	1554	1009	1401	922	1281
	6	1178	1620	1074	1477	968	1331	884	1217
	7	1167	1603	1064	1461	959	1317	877	1203
	8	1157	1584	1054	1444	950	1301	869	1189
	9	1146	1565	1044	1426	941	1285	860	1174
	10	1134	1545	1034	1407	931	1268	851	1159
	11	1122	1524	1022	1388	921	1250	842	1142
	12	1110	1502	1011	1368	911	1232	832	1125
	13	1097	1479	999	1347	900	1213	823	1108
	14	1083	1455	987	1325	889	1193	812	1090
	15	1069	1431	974	1302	877	1173	801	1071
	16	1055	1406	961	1279	865	1152	790	1051
	17	1040	1380	947	1255	853	1130	779	1031
	18	1025	1353	933	1231	840	1107	767	1011
	19	1010	1326	919	1205	827	1085	755	990
	20	994	1298	904	1179	814	1061	743	968
	22	961	1239	874	1125	786	1012	718	923
	24	927	1178	842	1069	758	960	691	875
	26	891	1113	809	1009	727	906	663	825
	28	853	1046	775	947	696	850	634	773
30	814	976	739	882	663	791	604	719	
32	774	902	701	815	629	729	573	662	
34	732	826	662	744	594	665	540	603	
36	688	745	622	670	558	598	507	541	
38	643	669	580	601	520	537	472	486	
40	596	604	537	543	480	484	435	438	
Properties									
U	2.29	2.29	2.31	2.31	2.32	2.32	2.34	2.34	
P_{wo} (kips)	340	473	299	415	251	349	214	298	
P_{wi} (kips/in.)	32	45	30	42	27	37	24	34	
P_{wb} (kips)	1542	1817	1250	1474	904	1066	688	810	
P_{rb} (kips)	467	648	386	536	319	443	267	371	
L_c (ft)	16.6	14.1	16.5	14.0	16.4	13.9	16.4	13.9	
L_u (ft)	68.1	49.0	62.6	45.0	57.2	41.2	52.6	37.9	
A (in. ²)	56.8		51.8		46.7		42.7		
I_x (in. ⁴)	2400		2140		1900		1710		
I_y (in. ⁴)	931		838		748		677		
r_x (in.)	4.05		4.02		4.00		3.98		
Ratio r_x/r_y	1.60		1.60		1.60		1.59		
B_x } Bending	0.183		0.184		0.184		0.184		
B_y } factors	0.477		0.484		0.485		0.489		
$a_x/10^6$	358		319		283		255		
$a_y/10^6$	139		125		111		101		
F_{ox} ($K_x L_x$) ² /10 ² (kips)	438		429		422		416		
F_{oy} ($K_y L_y$) ² /10 ² (kips)	170		168		166		164		

Designation	W14									
	132		120		109		99		90	
	36	50	36	50	36	50	36	50†	36	50†
Wt./ft	838	1164	762	1059	691	960	629	873	572	795
F_y	36	50	36	50	36	50	36	50†	36	50†
Effective length in ft KL with respect to least radius of gyration r_y	0	838	1164	762	1059	691	960	629	873	795
	6	801	1101	729	1002	661	908	600	825	751
	7	794	1088	722	990	654	897	595	815	742
	8	786	1074	714	977	647	885	589	805	732
	9	777	1060	707	963	640	873	582	793	722
	10	768	1044	699	949	633	860	575	782	711
	11	759	1028	690	935	626	847	568	769	700
	12	750	1011	682	919	618	833	561	757	689
	13	740	994	673	903	609	818	554	743	676
	14	730	976	663	887	601	803	546	730	664
	15	719	958	654	870	592	788	538	715	651
	16	708	938	644	852	583	772	529	701	637
	17	697	919	633	834	574	755	521	685	624
	18	686	898	623	815	564	738	512	670	609
	19	674	877	612	796	554	721	503	654	595
	20	662	856	601	776	544	703	494	637	580
	22	637	811	578	735	523	665	475	603	548
	24	610	764	554	692	501	626	454	567	515
	26	583	714	528	647	478	585	433	529	481
	28	554	663	502	599	454	541	411	489	444
30	524	608	475	549	429	496	388	448	406	
32	493	551	446	497	403	449	365	404	366	
34	461	492	416	443	376	399	340	359	325	
36	427	439	385	395	348	356	314	320	290	
38	392	394	353	355	319	320	287	288	261	
Properties										
U	2.47	2.47	2.48	2.48	2.49	2.49	2.50	2.28	2.52	2.29
P_{wo} (kips)	196	272	173	240	148	205	125	174	109	151
P_{wi} (kips/in.)	23	32	21	30	19	26	17	24	16	22
P_{wb} (kips)	587	692	449	529	316	373	249	294	186	220
P_{rb} (kips)	239	332	199	276	166	231	137	190	113	158
L_c (ft)	15.5	13.2	15.5	13.1	15.4	13.1	15.4	13.0	15.3	13.0
L_u (ft)	47.7	34.4	44.1	31.7	40.6	29.2	37.0	26.7	34.0	24.5
A (in. ²)	38.8		35.3		32.0		29.1		26.5	
I_x (in. ⁴)	1530		1380		1240		1110		999	
I_y (in. ⁴)	548		495		447		402		362	
r_x (in.)	3.76		3.74		3.73		3.71		3.70	
Ratio r_x/r_y	1.67		1.67		1.67		1.66		1.66	
B_x } Bending	0.186		0.186		0.185		0.185		0.185	
B_y } factors	0.521		0.523		0.523		0.527		0.531	
$a_x/10^6$	228.0		204.8		184.5		165.1		148.9	
$a_y/10^6$	81.7		73.6		66.3		59.7		54.1	
F_{ox} ($K_x L_x$) ² /10 ² (kips)	409		404		401		395		391	
F_{oy} ($K_y L_y$) ² /10 ² (kips)	147		145		144		143		142	

†Flange is noncompact; see discussion preceding column load tables.

Beam design

From previous page:

Uniform beam load

$$w = 3 \text{ klf}$$

Overturn moments

Ground floor M_0

$$M_0 = 3,645 \text{ k'}$$

First floor M_1

$$M_1 = 2,738 \text{ k'}$$

Column a & d axial load

$$N_0 = M_0 / B = 3645 / 90$$

$$N_0 = 41 \text{ k}$$

$$N_1 = M_1 / B = 2738 / 90$$

$$N_1 = 30 \text{ k}$$

Beam shear

$$V = N_0 - N_1$$

$$V = 11 \text{ k}$$

Beam bending

$$M_{\text{lateral}} = V L / 2 = 11 \times 30 / 2$$

$$M_{\text{lateral}} = 165 \text{ k'}$$

$$M_{\text{gravity}} = wL^2 / 12 = 3 \times 30^2 / 12$$

$$M_{\text{gravity}} = 225 \text{ k'}$$

$$\Sigma M = 165 + 225$$

$$\Sigma M = 390 \text{ k'}$$

Section modulus required

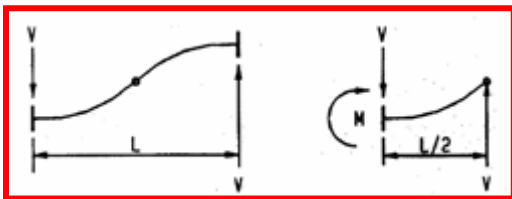
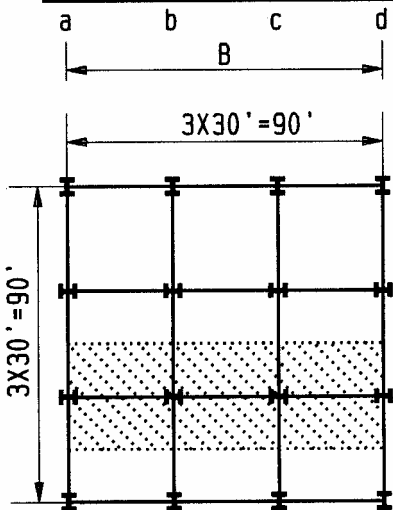
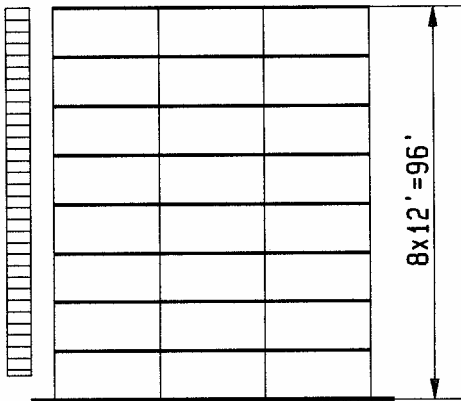
$$S_x = M / F_b = 390 \text{ k' } \times 12 \text{''} / 22 \text{ ksi}$$

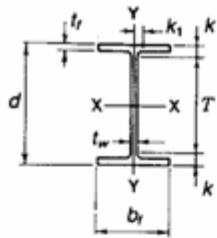
$$S_x = 213 \text{ in}^3$$

Use

W18x119

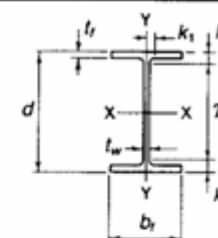
Note: W18 beam has optimal ratio $L/d = 20$





W SHAPES
Dimensions

W SHAPES
Properties



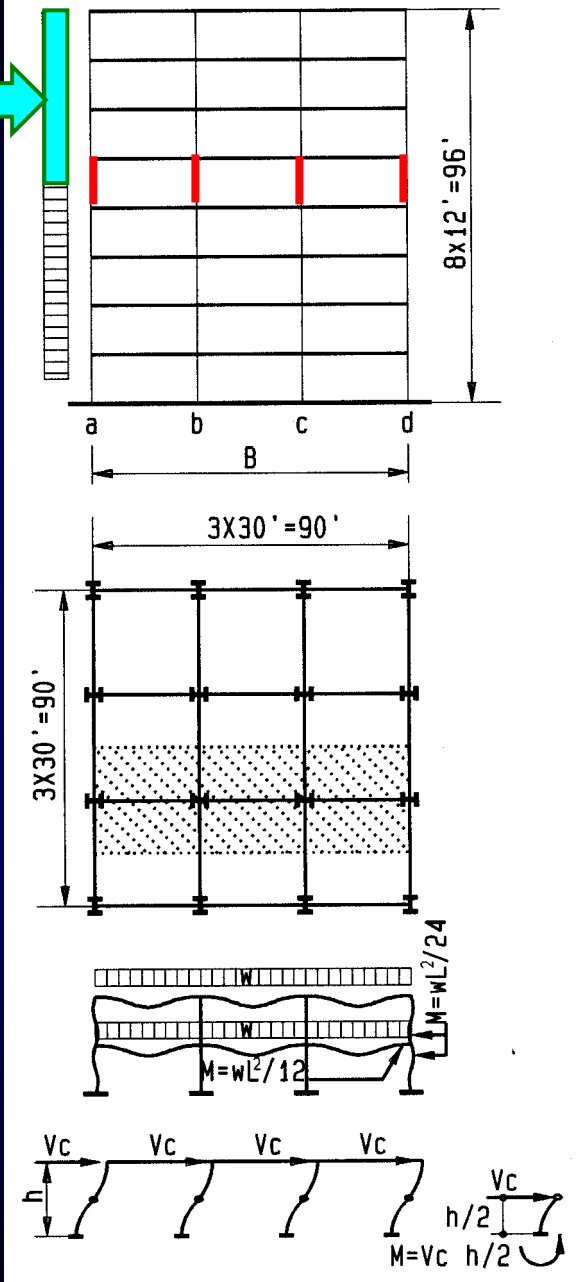
Required
 $S_x \geq 213$
Use
W18x119
 $S_x = 231$

Designation	Area A In. ²	Depth d In.	Web		Flange		Distance					
			Thickness t_w In.	$\frac{t_w}{2}$ In.	Width b_f In.	Thickness t_f In.	T In.	k In.	k_1 In.			
W 18x311*	91.5	22.32	22%	1.520	1 1/2	12.005	12	2.740	2%	15 1/2	3 3/8	1 3/8
x283*	83.2	21.85	21%	1.400	1%	11.890	11 1/2	2.500	2 1/2	15%	3 3/8	1 3/8
x258*	75.9	21.46	21 1/2	1.280	1 1/4	11.770	11 1/2	2.300	2 3/8	15 1/2	3	1 1/2
x234*	68.8	21.06	21	1.160	1 3/8	11.650	11 1/2	2.110	2 1/2	15%	2 3/4	1
x211*	62.1	20.67	20%	1.060	1 1/8	11.555	11 1/2	1.910	1 1/8	15%	2 3/8	1
x192	56.4	20.35	20%	0.960	1	11.455	11 1/2	1.750	1%	15 1/2	2 1/8	1 3/8
x175	51.3	20.04	20	0.890	3/4	11.375	11 1/2	1.590	1%	15%	2 1/4	3/4
x158	46.3	19.72	19%	0.810	1 3/8	11.300	11 1/2	1.440	1 3/8	15%	2 1/8	3/4
x143	42.1	19.49	19 1/2	0.730	3/4	11.220	11 1/2	1.320	1%	15 1/2	2	1 3/8
x130	38.2	19.25	19%	0.670	1 1/8	11.160	11 1/2	1.200	1 3/8	15%	1 3/4	1 3/8
W 18x119	35.1	18.97	19	0.855	3/4	11.265	11 1/4	1.060	1 1/8	15 1/2	1 3/4	1 3/8
x106	31.1	18.73	18%	0.590	3/8	11.200	11 1/4	0.940	1 3/8	15%	1 3/4	1 3/8
x 97	28.5	18.59	18%	0.535	3/8	11.145	11 1/4	0.870	3/4	15%	1 3/4	3/4
x 86	25.3	18.39	18%	0.480	1/2	11.090	11 1/4	0.770	3/4	15%	1 3/4	3/4
x 76	22.3	18.21	18%	0.425	3/8	11.035	11	0.680	1 3/8	15 1/2	1 3/4	1 3/8
W 18x 71	20.8	18.47	18%	0.495	1/2	7.635	7%	0.810	1 3/8	15 1/2	1 1/2	3/4
x 65	19.1	18.35	18%	0.450	3/8	7.590	7%	0.750	3/4	15%	1 1/8	3/4
x 60	17.6	18.24	18%	0.415	3/8	7.555	7%	0.695	1 3/8	15%	1 1/8	1 3/8
x 55	16.2	18.11	18%	0.390	3/8	7.530	7%	0.630	3/4	15%	1 1/8	1 3/8
x 50	14.7	17.99	18	0.355	3/8	7.495	7 1/2	0.570	3/8	15 1/2	1 1/4	1 3/8
W 18x 46	13.5	18.06	18	0.380	3/8	6.060	6	0.605	3/8	15%	1 1/4	1 3/8
x 40	11.8	17.90	17 1/2	0.315	3/8	6.015	6	0.525	1/2	15%	1 1/8	1 3/8
x 35	10.3	17.70	17 1/2	0.300	3/8	6.000	6	0.425	3/8	15%	1 1/4	3/4
W 16x100	29.4	16.97	17	0.585	3/8	10.425	10%	0.985	1	13%	1 1/8	1 3/8
x 89	26.2	16.75	16%	0.525	1/2	10.365	10%	0.875	3/4	13%	1 1/8	3/4
x 77	22.6	16.52	16 1/2	0.455	3/8	10.295	10%	0.760	3/4	13%	1 1/8	3/4
x 67	19.7	16.33	16%	0.395	3/8	10.235	10%	0.665	1 1/8	13%	1 1/8	1 3/8
W 16x 57	16.8	16.43	16%	0.430	3/8	7.120	7 1/2	0.715	1 1/8	13%	1 1/8	3/4
x 50	14.7	16.26	16%	0.380	3/8	7.070	7 1/2	0.630	3/4	13%	1 1/8	1 3/8
x 45	13.3	16.13	16%	0.345	3/8	7.035	7	0.565	3/8	13%	1 1/4	1 3/8
x 40	11.8	16.01	16	0.305	3/8	6.995	7	0.505	1/2	13%	1 1/8	1 3/8
x 36	10.6	15.86	15%	0.295	3/8	6.985	7	0.430	3/8	13%	1 1/4	3/4

*For application refer to Notes in Table 2.

Nominal Wt. per Ft	Compact Section Criteria					Elastic Properties						Plastic Modulus		
	$\frac{b_f}{2t_f}$	F_y	$\frac{d}{t_w}$	F_y	r_f	Axis X-X			Axis Y-Y			Z_x	Z_y	
						I	S	r	I	S	r			
	lb.	Ksi	Ksi	In.	In. ⁴	In. ³	In.	In. ⁴	In. ³	In.	In. ³	In. ³		
311	2.2	—	14.7	—	3.26	0.68	6960	624	6.72	795	132	2.95	753	207
283	2.4	—	15.6	—	3.23	0.74	6160	564	8.61	704	118	2.91	676	185
258	2.6	—	16.8	—	3.19	0.79	5510	514	8.53	628	107	2.88	611	166
234	2.8	—	18.2	—	3.16	0.86	4900	466	8.44	558	95.8	2.85	549	149
211	3.0	—	19.5	—	3.13	0.94	4330	419	8.35	493	85.3	2.82	490	132
192	3.3	—	21.2	—	3.10	1.02	3870	380	8.28	440	76.8	2.79	442	119
175	3.6	—	22.5	—	3.07	1.11	3450	344	8.20	391	68.8	2.76	398	106
158	3.9	—	24.3	—	3.05	1.21	3060	310	8.12	347	61.4	2.74	356	94.8
143	4.2	—	26.7	—	3.03	1.32	2750	282	8.09	311	55.5	2.72	322	85.4
130	4.6	—	28.7	—	3.01	1.44	2460	256	8.03	278	49.9	2.70	291	76.7
119	5.3	—	29.0	—	3.02	1.59	2190	231	7.90	253	44.9	2.69	261	69.1
106	6.0	—	31.7	—	3.00	1.78	1910	204	7.84	220	39.4	2.66	230	60.5
97	6.4	—	34.7	54.7	2.99	1.92	1750	188	7.82	201	36.1	2.65	211	55.3
86	7.2	—	38.3	45.0	2.97	2.15	1530	166	7.77	175	31.6	2.63	186	48.4
76	8.1	64.2	42.8	36.0	2.95	2.43	1330	146	7.73	152	27.6	2.61	163	42.2
71	4.7	—	37.3	47.4	1.98	2.99	1170	127	7.50	60.3	15.8	1.70	145	24.7
65	5.1	—	40.8	39.7	1.97	3.22	1070	117	7.49	54.8	14.4	1.69	133	22.5
60	5.4	—	44.0	34.2	1.96	3.47	984	108	7.47	50.1	13.3	1.69	123	20.6
55	6.0	—	46.4	30.6	1.95	3.82	890	98.3	7.41	44.9	11.9	1.67	112	18.5
50	6.6	—	50.7	25.7	1.94	4.21	800	88.9	7.38	40.1	10.7	1.65	101	16.6
46	5.0	—	50.2	26.2	1.54	4.93	712	78.8	7.25	22.5	7.43	1.29	90.7	11.7
40	5.7	—	56.8	20.5	1.52	5.67	612	68.4	7.21	19.1	6.35	1.27	78.4	9.95
35	7.1	—	59.0	19.0	1.49	6.94	510	57.6	7.04	15.3	5.12	1.22	66.5	8.06
100	5.3	—	29.0	—	2.81	1.65	1490	175	7.10	186	35.7	2.51	198	54.9
89	5.9	—	31.9	64.9	2.79	1.85	1300	155	7.05	163	31.4	2.49	175	48.1
77	6.8	—	36.3	50.1	2.77	2.11	1110	134	7.00	138	26.9	2.47	150	41.1
67	7.7	—	41.3	38.6	2.75	2.40	954	117	6.96	119	23.2	2.46	130	35.5
57	5.0	—	38.2	45.2	1.86	3.23	758	92.2	6.72	43.1	12.1	1.60	105	18.9
50	5.6	—	42.8	36.1	1.84	3.65	659	81.0	6.68	37.2	10.5	1.59	92.0	16.3
45	6.2	—	46.8	30.2	1.83	4.06	586	72.7	6.65	32.8	9.34	1.57	82.3	14.5
40	6.9	—	52.5	24.0	1.82	4.53	518	64.7	6.63	28.9	8.25	1.57	72.9	12.7
36	8.1	64.0	53.8	22.9	1.79	5.28	448	56.5	6.51	24.5	7.00	1.52	64.0	10.8

5th floor Columns



5th floor shear $V = 30 \times 30 \times 3.5 \times 12 / 1000$

$V = 38 \text{ k}$

Column shear

Column shear	$V_c = L_{trib} V/B$	V_c
a & d	$15 \times 38 / 90$	6.3k
b & c	$30 \times 38 / 90$	12.6k

Column bending

Col.	$M_{lateral} = V_c h/2$	$M_{gravity} = wL^2/24$	ΣM
a & d	$6.3 \times 6 = 38k'$	$3 \times 30^2 / 24 = 113$	151k'
b & c	$12.6 \times 6 = 76k'$	0	76k'

Column axial force (n = # of stories above)

Col.	$P_{lateral} = M_4/B$	$P_{gravity} = nwL_{tributary}$	ΣP
a & d	$794/90 = 9k$	$4 \times 2.7 \times 15 = 162$	171k
b & c	0	$4 \times 2.7 \times 30 = 324$	324k

Combined axial + bending ($\Sigma P = P + M Bx$)

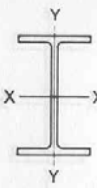
Col.	P	M Bx (Bx assumes M in k-in)	ΣP
a & d	171k	$151k' \times 12'' \times 0.186 = 337$	508k
b & c	324k	$76k' \times 12'' \times 0.186 = 170$	494k

Column design (assume $KL = 1.2 \times 12' = 14'$)

Col.	Use	$P_{allowable}$ vs. P	$Bx_{estimate}$ vs. Bx
a & d	W14x99	$546 > 508$	$0.186 > 0.185$
b & c	W14x90	$497 > 494$	$0.186 > 0.185$

$F_y = 36 \text{ ksi}$
 $F_y = 50 \text{ ksi}$

COLUMNS
W shapes
 Allowable axial loads in kips



Col.	Use	$P_{\text{allowable}}$ vs. P	B_x estimate vs. B_x
a & d	W14x99	546 > 508	0.186 > 0.185
b & c	W14x90	497 > 494	0.186 > 0.185

Designation	W14								
	193		176		159		145		
	36	50	36	50	36	50	36	50	
F_y	36	50	36	50	36	50	36	50	
Effective length in ft KL with respect to least radius of gyration r_y	0	1227	1704	1119	1554	1009	1401	922	1281
	6	1178	1620	1074	1477	968	1331	884	1217
	7	1167	1603	1064	1461	959	1317	877	1203
	8	1157	1584	1054	1444	950	1301	869	1189
	9	1146	1565	1044	1426	941	1285	860	1174
	10	1134	1545	1034	1407	931	1268	851	1159
	11	1122	1524	1022	1388	921	1250	842	1142
	12	1110	1502	1011	1368	911	1232	832	1125
	13	1097	1479	999	1347	900	1213	822	1108
	14	1083	1455	987	1325	889	1193	812	1090
	15	1069	1431	974	1302	877	1173	801	1071
	16	1055	1406	961	1279	865	1152	790	1051
	17	1040	1380	947	1255	853	1130	779	1031
	18	1025	1353	933	1231	840	1107	767	1011
	19	1010	1326	919	1205	827	1085	755	990
	20	994	1298	904	1179	814	1061	743	968
	22	961	1239	874	1125	786	1012	718	923
	24	927	1178	842	1069	758	960	691	875
	26	891	1113	809	1009	727	906	663	825
	28	853	1046	775	947	696	850	634	773
30	814	976	739	882	663	791	604	719	
32	774	902	701	815	629	729	573	662	
34	732	826	662	744	594	665	540	603	
36	688	745	622	670	558	598	507	541	
38	643	669	580	601	520	537	472	486	
40	596	604	537	543	480	484	435	438	
Properties									
U	2.29	2.29	2.31	2.31	2.32	2.32	2.34	2.34	
P_{wo} (kips)	340	473	299	415	251	349	214	298	
P_{wi} (kips/in.)	32	45	30	42	27	37	24	34	
P_{wb} (kips)	1542	1817	1250	1474	904	1066	688	810	
P_{rb} (kips)	467	648	386	536	319	443	267	371	
L_c (ft)	16.6	14.1	16.5	14.0	16.4	13.9	16.4	13.9	
L_u (ft)	68.1	49.0	62.6	45.0	57.2	41.2	52.6	37.9	
A (in. ²)	56.8		51.8		46.7		42.7		
I_x (in. ⁴)	2400		2140		1900		1710		
I_y (in. ⁴)	931		838		748		677		
r_y (in.)	4.05		4.02		4.00		3.98		
Ratio r_x/r_y	1.60		1.60		1.60		1.59		
B_x } Bending factors	0.183		0.184		0.184		0.184		
B_y }	0.477		0.484		0.485		0.489		
$a_x/10^6$	358		319		283		255		
$a_y/10^6$	139		125		111		101		
$F_{ox} (K_x L_x)^2/10^2$ (kips)	438		429		422		416		
$F_{oy} (K_y L_y)^2/10^2$ (kips)	170		168		166		164		

Designation	W14										
	132		120		109		99		90		
	36	50	36	50	36	50	36	50	36	50	
F_y	36	50	36	50	36	50	36	50	36	50	
Effective length in ft KL with respect to least radius of gyration r_y	0	838	1164	762	1059	691	960	629	873	572	795
	6	801	1101	729	1002	661	908	600	825	547	751
	7	794	1088	722	990	654	897	595	815	541	742
	8	786	1074	714	977	647	885	589	805	536	732
	9	777	1060	707	963	640	873	582	793	530	722
	10	768	1044	699	949	633	860	575	782	524	711
	11	759	1028	690	935	626	847	568	769	517	700
	12	750	1011	682	919	618	833	561	757	511	689
	13	740	994	673	903	609	818	554	743	504	676
	14	730	976	663	887	601	803	546	730	497	664
	15	719	958	654	870	592	788	538	715	489	651
	16	708	938	644	852	583	772	529	701	482	637
	17	697	919	633	834	574	755	521	685	474	624
	18	686	898	623	815	564	738	512	670	466	609
	19	674	877	612	796	554	721	503	654	458	595
	20	662	856	601	776	544	703	494	637	449	580
	22	637	811	578	735	523	665	475	603	432	548
	24	610	764	554	692	501	626	454	567	413	515
	26	583	714	528	647	478	585	433	529	394	481
	28	554	663	502	599	454	541	411	489	374	444
30	524	608	475	549	429	496	388	448	353	406	
32	493	551	446	497	403	449	365	404	331	366	
34	461	492	416	443	376	399	340	359	308	325	
36	427	439	385	395	348	356	314	320	285	290	
38	392	394	353	355	319	320	287	288	260	261	
Properties											
U	2.47	2.47	2.48	2.48	2.49	2.49	2.50	2.28	2.52	2.29	
P_{wo} (kips)	196	272	173	240	148	205	125	174	109	151	
P_{wi} (kips/in.)	23	32	21	30	19	26	17	24	16	22	
P_{wb} (kips)	587	692	449	529	316	373	249	294	186	220	
P_{rb} (kips)	239	332	199	276	166	231	137	190	113	158	
L_c (ft)	15.5	13.2	15.5	13.1	15.4	13.1	15.4	13.0	15.3	13.0	
L_u (ft)	47.7	34.4	44.1	31.7	40.6	29.2	37.0	26.7	34.0	24.5	
A (in. ²)		38.8		35.3		32.0		29.1		26.5	
I_x (in. ⁴)		1530		1380		1240		1110		999	
I_y (in. ⁴)		548		495		447		402		362	
r_y (in.)		3.76		3.74		3.73		3.71		3.70	
Ratio r_x/r_y		1.67		1.67		1.67		1.66		1.66	
B_x } Bending factors		0.186		0.186		0.185		0.185		0.185	
$a_x/10^6$		228.0		204.8		184.5		165.1		148.9	
$a_y/10^6$		81.7		73.6		66.3		59.7		54.1	
$F_{ox} (K_x L_x)^2/10^2$ (kips)		409		404		401		395		391	
$F_{oy} (K_y L_y)^2/10^2$ (kips)		147		145		144		143		142	

†Flange is noncompact; see discussion preceding column load tables.

Compare columns

4th floor columns

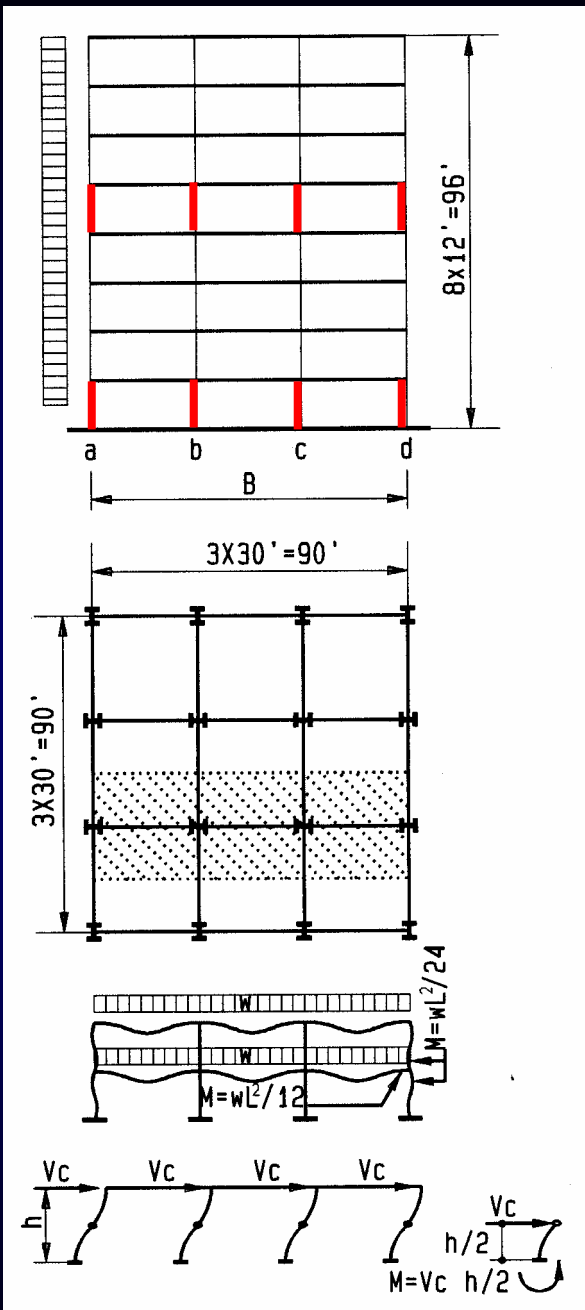
Col.	Use	$P_{\text{allowable}}$ vs. P	Bx_{estimate} vs. Bx
a & d	W14x99	546 > 508	0.186 > 0.185
b & c	W14x90	497 = 494	0.186 > 0.185

Ground floor columns

Col.	Use	$P_{\text{allowable}}$ vs. P	Bx_{estimate} vs. Bx
a & d	W14x145	812 > 793	0.184 = 0.184
b & c	W14x193	1083 > 1006	0.184 > 0.183

Difference between 5th floor and ground floor

Col.	\$/column	weight/foot	weight/column
a & d	\$552	145-99 = 46 #	46x12 = 552 #
b & c	\$1236	193-90 = 103 #	103x12 = 1236 #



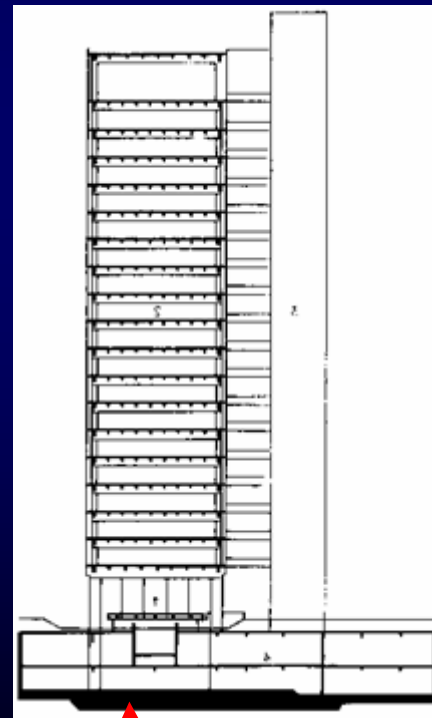


**Crown Zellerbach building
San Francisco**

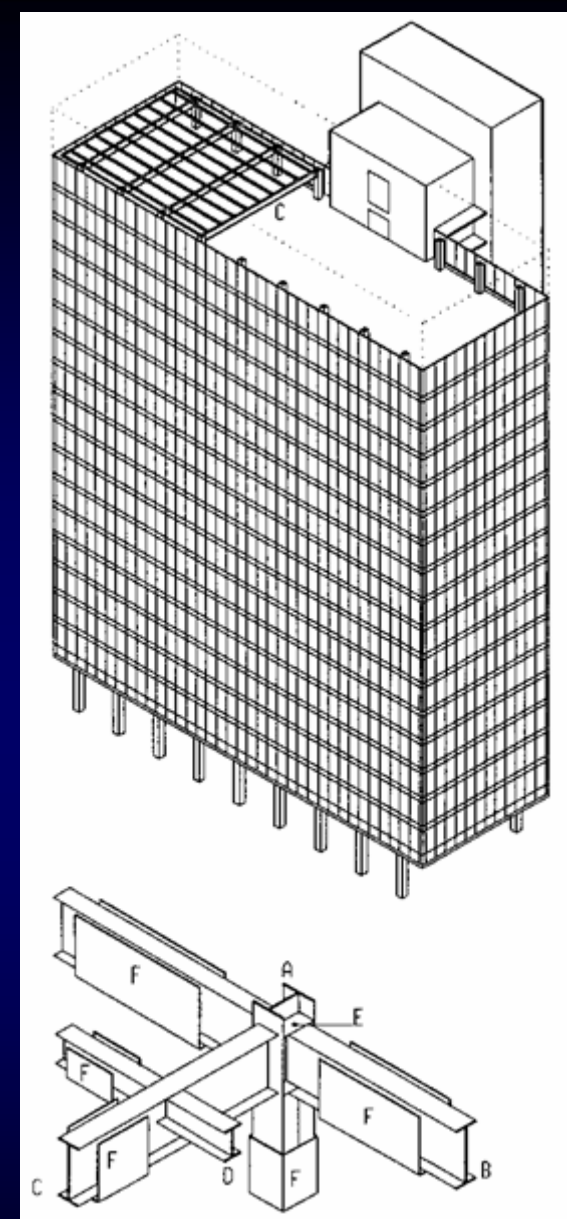
Architect: SOM & Hertzka and Knowles
Engineer: H J Brunnier

The 19-story building has an external core and column-free, moment frame, office wing

Size: 201x69'
Height: 285'
Story height: 13.7'
Height/width ratio 4.1



8' deep mat footing



- A Column
- B Spandrel beam
- C Girder
- D Joist @ 7'
- E Gusset plate
- F Fire proofing

Width direction lateral load

Shear

Bending

Axial

Deflection

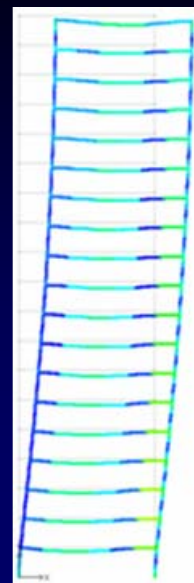
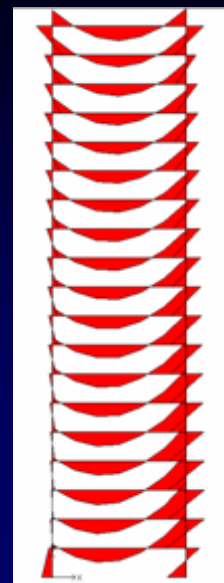
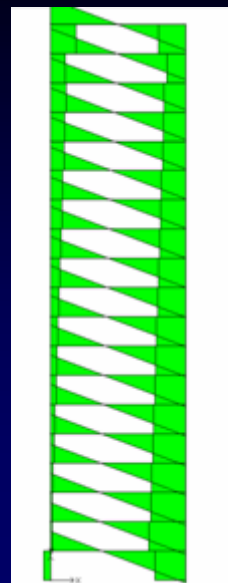
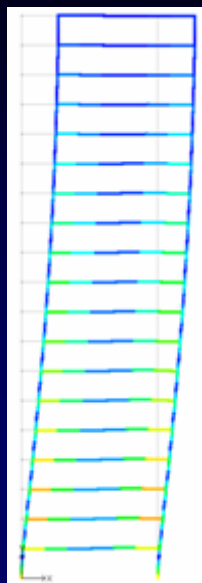
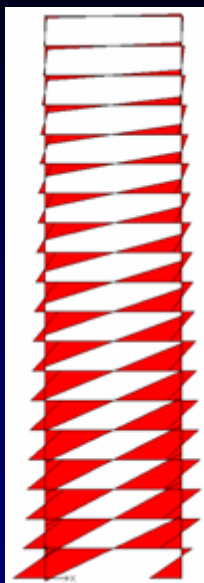
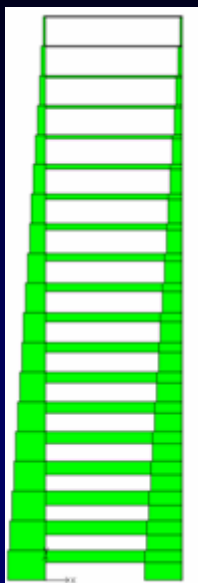
Width direction combined gravity and lateral load

Shear

Bending

Axial

Deflection



Length direction lateral load

Shear

Bending

Axial

Deflection

