APPENDIX A: LATERAL LOAD CALCULATIONS

Seismic Load Calculations

Level 2

Slab:					48	psf	*	25368	sq ft			=	**1218**	k
Framing:												=	**115**	k
Ext. Wall:		44	psf	*	644	ft perimeter	*	19.5	ft height			=	**553**	k
Partition:		20	psf				*	25368	sq ft			=	**507**	k
Columns:					70	lb/ft	*	19.5	ft height	*	44	=	**60**	k
											TOTAL	=	**2453**	k

Level 3

Slab:					48	psf	*	18547	sq ft			=	**890**	k
Framing:												=	**112**	k
Ext. Wall:		44	psf	*	644	ft perimeter	*	17.33	ft height			=	**491**	k
Partition:		20	psf				*	18547	sq ft			=	**371**	k
Columns:					70	lb/ft	*	17.33	ft height	*	42	=	**51**	k
Storage:		250	psf	*	800	sq ft	*	25	%			=	**50**	k
Roof:					48	psf	*	3500	sq ft			=	**168**	k
											TOTAL	=	**2133**	k

Level 4

Slab:					48	psf	*	21700	sq ft			=	**1042**	k
Framing:												=	**97**	k
Ext. Wall:		44	psf	*	644	ft perimeter	*	16.17	ft height			=	**458**	k
Partition:		20	psf				*	21700	sq ft			=	**434**	k
Columns:					60	lb/ft	*	16.17	ft height	*	42	=	**41**	k
											TOTAL	=	**2072**	k

Level 5

Slab:					48	psf	*	21810	sq ft			=	**1047**	k
Framing:												=	**200**	k
Ext. Wall:		44	psf	*	644	ft perimeter	*	16.17	ft height			=	**458**	k
Partition:		20	psf				*	21810	sq ft			=	**436**	k
Columns:					60	lb/ft	*	16.17	ft height	*	42	=	**41**	k
Storage:		250	psf	*	600	sq ft	*	25	%			=	**38**	k
											TOTAL	=	**2220**	k

Penthouse

Slab:					48	psf	*	8400	sq ft			=	**403**	k
Framing:												=	**91**	k
Ext. Wall:		44	psf	*	644	ft perimeter	*	7.84	ft height			=	**222**	k
Columns:		150	pcf	*	4	sq ft	*	7.84	ft height	*	42	=	**198**	k
Equip:								318	k			=	**318**	k
Roof:					48	psf	*	13600	sq ft			=	**653**	k
											TOTAL	=	**1885**	k

Roof

Framing:		10	psf	*	10000	sq ft						=	**100**	k
Roofing:		17	psf	*	10000	sq ft						=	**170**	k
											TOTAL	=	**270**	k

W = 11032 k

$$Cvx = \frac{w_x h_x^k}{\Sigma w_i h_i^k} \qquad k = 1.1$$

S_S =	0.169	S_1 =	0.051
Fa =	1.2	Fv =	1.7
S_{DS} =	0.135	S_{D1} =	0.059

Ordinary Concentric Steel Braced Frames

R = 3.25

Occupancy Category IV - I = 1.5

$Ta = C_t h_n^x = 0.02(110)^{0.75} =$ 0.679

$T_L = 6$

Cu = 1.7

CuTa = 1.15

Cs = MIN	$S_{DS}/(R/I)$	0.062308
	$S_{D1}/[T(R/I)]$	0.023679
	$(S_{D1}T_L)/[T^2(R/I)]$	0.123542

$V = C_s * W$ $\qquad C_s =$ 0.023679

$F_x = C_{vx} * V$

V = 261.22 k

	h_x	$w_x h_x^k$
Level 2	21	69835
Level 3	40	123396
Level 4	55.67	172376
Level 5	72.33	246326
Penthouse	88	259524
Roof	111	47998
	Σ =	919454

	Cvx	Fx	
Level 2	0.0760	19.84	k
Level 3	0.1342	35.06	k
Level 4	0.1875	48.97	k
Level 5	0.2679	69.98	k
Penthouse	0.2823	73.73	k
Roof	0.0522	13.64	k
Σ =	1.0000	261.22	k

Wind Load Calculations

V =	90	mph	
K_{zt} =	1		

I =	1.15
K_d =	0.85

$g_a = g_v = 3.4$

$Q = \sqrt{(1/(1+0.63((B+h)/Lz)^{0.63}))}$

$$G = 0.925 \frac{(1+1.7 g_a I_z Q)}{(1+1.7 g_v I_z)}$$

I_z =	$c*(33/z)^{1/6}$	= 0.18
L_z =	$I*(z/33)^{\varepsilon}$	= 569
c = 0.2	z = 63	ε = 0.2

Q_{N-S}=	0.841
Q_{E-W}=	0.856

G_{N-S} =	0.85
G_{E-W} =	0.86

$q = 0.00256*K_zK_dV^2I$

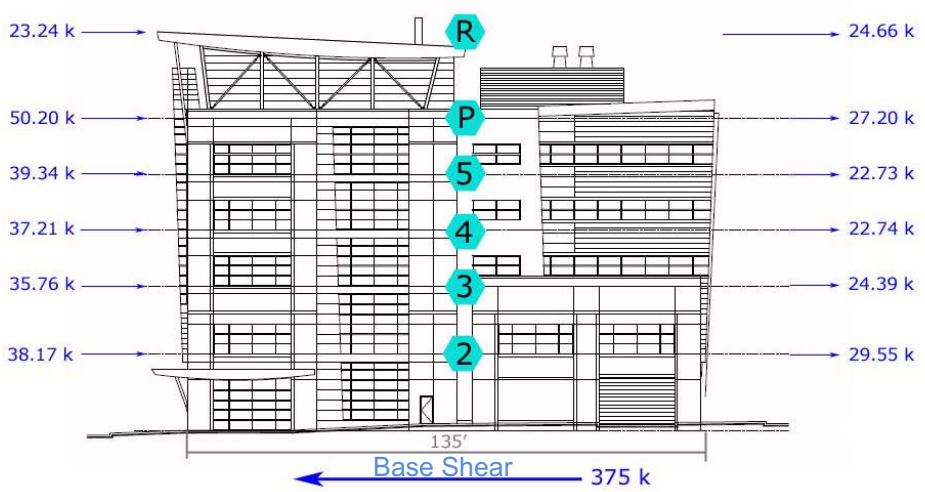
$p = qGC_p$

(Table 6.3)

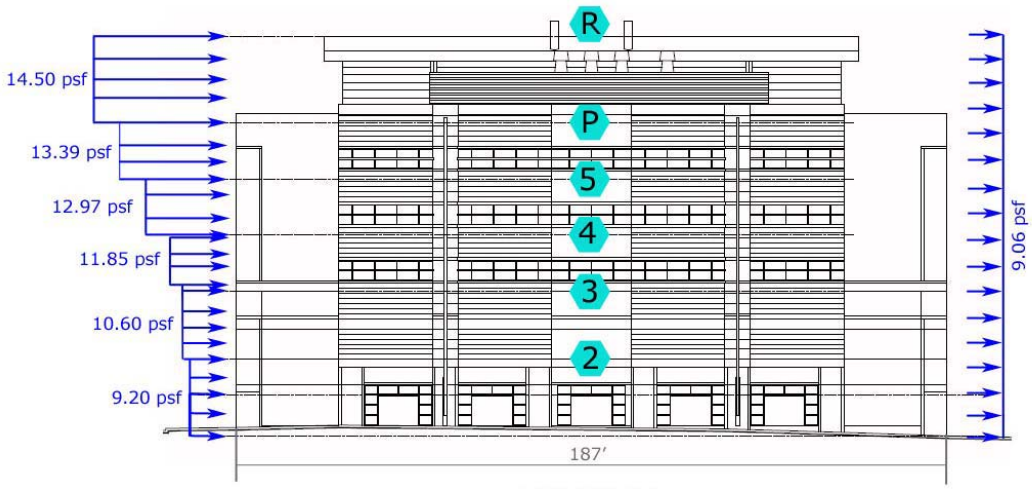
STORY	Start Height (ft.)	End Height (ft.)	Kz	q	Cp	Wind Pressures (psf) N-S WW 0.8	N-S LW -0.42	E-W WW 0.8	E-W LW -0.5
Pent.	88	111	1.04	21.08		14.33	-7.53	14.50	-9.06
5	72.33	88	0.96	19.46		13.23	-7.53	13.39	-9.06
4	55.67	72.33	0.93	18.85		12.82	-7.53	12.97	-9.06
3	40	55.67	0.85	17.23		11.72	-7.53	11.85	-9.06
2	21	40	0.76	15.40		10.48	-7.53	10.60	-9.06
1	0	21	0.66	13.38		9.10	-7.53	9.20	-9.06

LEVEL	Trib. Height (ft.)	Wind Forces (k) N-S Width (ft.)	N-S WW	N-S LW	E-W Width (ft.)	E-W WW	E-W LW
Roof	11.5	141	23.24	-24.66	122	20.35	-12.72
Pent.	11.5 7.83	187	50.20	-27.20	135	36.67	-23.65
5	7.83 8.33	187	39.34	-22.74	135	28.74	-19.78
4	8.33 7.83	187	37.12	-22.74	135	27.11	-19.78
3	7.83 9.5	187	35.76	-24.39	135	26.12	-21.21
2	9.5 11.5	187	38.17	-29.55	135	27.88	-25.70
1	0	187	0.00	0.00	135	0.00	0.00
Base Shear:			**375.14**			**289.70**	

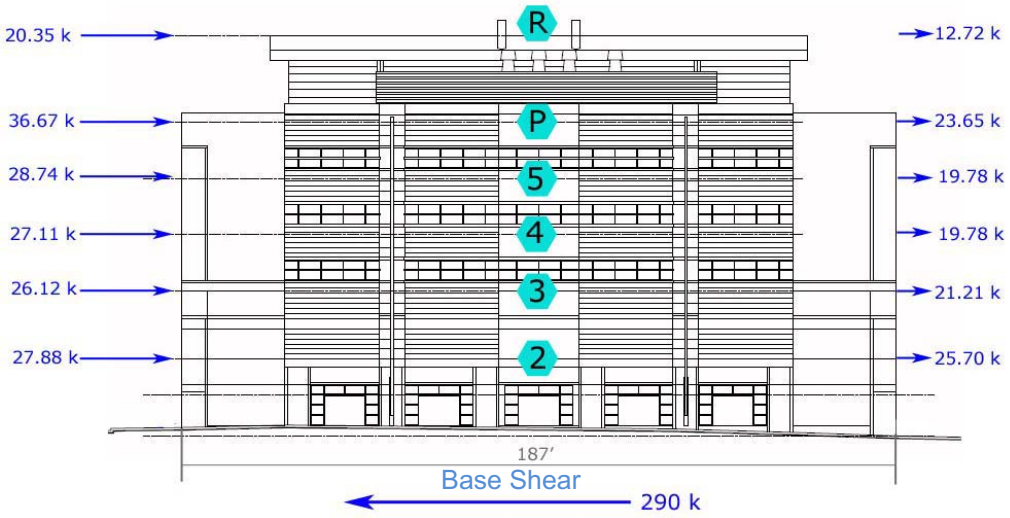
Level	Diaph. #	Centers of Rigidity Xr ft	Yr ft	Centers of Mass Xm ft	Ym ft
Penthouse	1	91.62	70.05	91.07	62.92
Fifth	1	91.60	69.32	91.49	59.50
Fourth	1	91.57	68.21	91.57	59.69
Third	1	91.55	59.29	93.55	74.40
Second	1	91.54	67.56	91.59	65.76



North-South Wind Story Forces

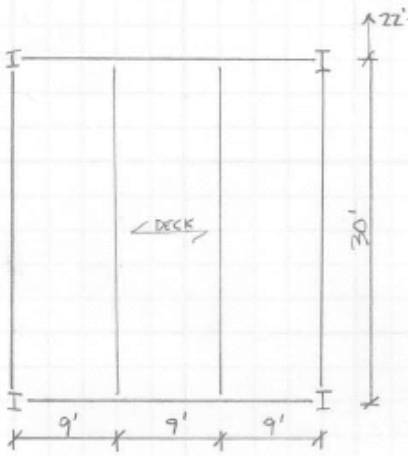


East-West Wind Pressures



East-West Wind Story Forces

APPENDIX B: FLOOR FRAMING CALCULATIONS



LIGHTWEIGHT CONCRETE
110 pcf, $f'_c = 5$ ksi

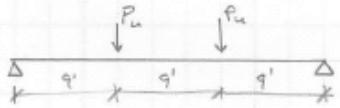
2" LOK-FLOOR 19 gage DECK w/ 4" SLAB
48 psf, MAX. UNSHORED SPAN: 9.64'

TOTAL DL: 60 psf
TOTAL LL: 80 psf

GIRDER DESIGN: TRIB AREA: $\left(\frac{30'+22.5'}{2}\right) \times 27' = 709\ ft^2$

INFLUENCE AREA: $2A_T = 1418\ ft^2$

$$LL = L_o\left(0.25 + \frac{15}{\sqrt{1418}}\right) = 0.65L_o \Rightarrow LL = 52\ psf$$



P_u: DEAD: $60\ psf \times 9' \times \left(\frac{30+22.5}{2}\right) = 14.2\ k$
LIVE: $52\ psf \times 9' \times \left(\frac{30+22.5}{2}\right) = 12.3\ k$

STRENGTH: $1.2D + 1.6L = 36.7\ k = P_u$

$M_u = P_u \times 9' = 331\ ft \cdot k$

DEFLECTION: $\Delta_{LL} \le \frac{27\times12}{360} = 0.9" = \frac{12.3 \times (27\times12)^3}{28(29000) I_{req}} \Rightarrow I_{REQ} = 573\ in^4$ (LB)

$\Delta_T \le \frac{27\times12}{240} = 1.35" = \frac{26.5 \times (27\times12)^3}{28(29000) I_{REQ}} \Rightarrow I_{REQ} = 822\ in^4$ (LB.)

PRE-COMPOSITE DL $48(9')\left(\frac{30+22.5}{2}\right) = 11.3^k$

$\Delta_{PC} \le \frac{27\times12}{360} = 0.9" = \frac{11.3 \times (27\times12)^3}{28(29000) I_{REQ}} \Rightarrow I_{REQ} = 526\ in^4$ (I_x)

TRY W18 x 40

$Y2 = 6" - 2"/2 = 5" \Rightarrow$ USE PNA ⑦

$\phi M_n = 422\ ft \cdot k$ $I_{LB} = 1070\ in^4$ $I_x = 612\ in^4$

$\Sigma Q_n = 147\ k$ $a = \frac{147}{0.85 \times 5 \times 81"} = 0.427" < 2"$ OK

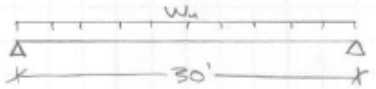
$Q_n = 18.3\ k$ FOR 3/4" ø STUDS, DECK PARALLEL

$147/18.3 \Rightarrow 9$ STUDS/SIDE $\Rightarrow 18$ STUDS

BEAM DESIGN: TRIB AREA: $9' \times 30' = 270\ ft^2$

INFLUENCE AREA: $2A_T = 540\ ft^2$

$$LL = L_o\left(0.25 + \frac{15}{\sqrt{540}}\right) = 0.90 L_o \Rightarrow LL = 72\ psf$$



W_u = DEAD: $60\ psf \times 9' = 0.54\ ^k/_{ft}$

LIVE: $72\ psf \times 9' = 0.65\ ^k/_{ft}$

STRENGTH: $1.2D + 1.6L = 1.69\ ^k/_{ft} = w_u$

$$M_u = \frac{1.69 \times (30)^2}{8} = 190\ ft \cdot k$$

DEFLECTION: $\Delta_{LL} \leq \frac{(30\times12)}{360} = 1'' = \frac{5(0.65/12)(30\times12)^4}{384(29000)(I_{REQ})} \Rightarrow I_{REQ} = 409\ in^4$ (I_{LB})

$\Delta_T \leq \frac{(30\times12)}{240} = 1.5'' = \frac{5(1.19/12)(30\times12)^4}{384(29000)(I_{REQ})} \Rightarrow I_{REQ} = 499\ in^4$ (I_{LB})

PRE-COMPOSITE DL:

$48\ psf \times 9' = 0.43\ ^k/_{ft}$ $\Delta_{PC} \leq \frac{(30\times12)}{360} = 1'' = \frac{5(0.43/12)(30\times12)^4}{384(29000)(I_{REQ})} \Rightarrow I_{REQ} = 270\ in^4$ (I_x)

TRY W16 x 26

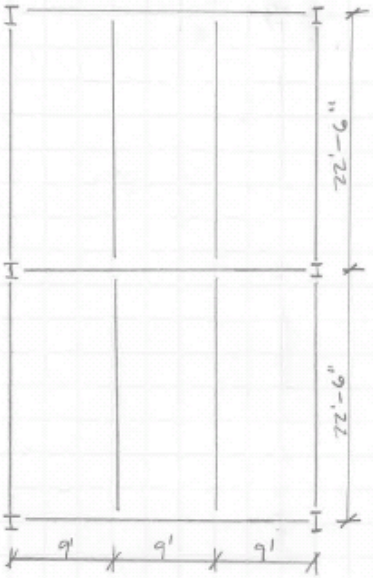
$Y2 = 6'' - 2''/2 = 5'' \Rightarrow$ USE PNA (7)

$\phi M_n = 245\ ft \cdot k$ $I_{LB} = 554\ in^4$ $I_x = 301\ in^4$

$\Sigma Q_n = 96.0\ k$ $a = \frac{96}{0.85 \times 5 \times 90} = 0.25'' < 2''$ OK

$Q_n = 17.2\ k$ FOR $3/4''$ Ø STUDS, DECK PERPENDICULAR, WEAK

$96.0/17.2 \Rightarrow 6$ STUDS/SIDE $\Rightarrow 12$ STUDS



LIGHTWEIGHT CONCRETE
110 pcF, f'_c = 5 ksi

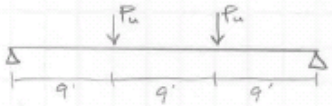
2" LOK-FLOOR, 19 gage DECK w/ 4" SLAB
48 psF, MAX. UNSHORED SPAN: 9.64'

TOTAL DL: 60 psF

TOTAL LL: 80 psF

GIRDER DESIGN: TRIB. AREA: 22'-6" x 27' = 608 ft²
INFLUENCE AREA: 2A_T = 1216 ft²

$$LL = L_o\left(0.25 + \frac{15}{\sqrt{1216}}\right) = 0.68\,L_o \Rightarrow LL = 55 \text{ psF}$$



P_u: DEAD: 60 psF x 22.5' x 9' = 12.2 k
LIVE: 55 psF x 22.5' x 9' = 11.1 k.

STRENGTH: $1.2D + 1.6L = 32.4\text{ k} = P_u$

$M_u = 32.4 \times 9 = 292$ ft·k

DEFLECTION: $\Delta_u \le \frac{27\times12}{360} = 0.9" = \frac{12.2 \times (27\times12)^3}{28(29000)I_{REQ}} \Rightarrow I_{REQ} = 568$ in⁴ (I_{LB})

$\Delta_T \le \frac{27\times12}{240} = 1.35" = \frac{23.3 \times (27\times12)^3}{28(29000)I_{REQ}} \Rightarrow I_{REQ} = 723$ in⁴ (I_{LB})

PRE-COMPOSITE DL:
48(9)(22.5) = 9.72 k $\Delta_{PC} \le \frac{27\times12}{360} = 0.9" = \frac{9.72 \times (27\times12)^3}{28(29000)I_{REQ}} \Rightarrow I_{REQ} = 452$ in⁴ (I_x)

W18x35 OR W18x40

- USE W18x40 FOR CONSISTENCY w/ OTHER BAYS

Y2 = 5" ⇒ USE PNA ③

$\phi M_n = 422$ ft·k $I_{LB} = 1070$ in⁴ $I_x = 612$ in⁴

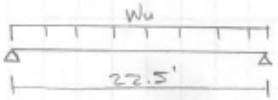
$\Sigma Q_n = 147$ k $a = \frac{147}{0.85 \times 5 \times 81} = 0.427" < 2"$ OK

$Q_n = 18.3$ k ⇒ 147/18.3 = 9 STUDS/SIDE ⇒ 18 STUDS

BEAM DESIGN: TRIB AREA: $9' \times 22.5' = 203\ ft^2$

INFLUENCE AREA: $2A_T = 406\ ft^2$

$$LL = L_o\left(0.25 + \frac{15}{\sqrt{406}}\right) = 0.99L_o \Rightarrow LL = 80\ psf$$



Wu: DEAD: $60\ psf \times 9' = 0.54\ k/ft$

LIVE: $80\ psf \times 9' = 0.72\ k/ft$

STRENGTH: $1.2D + 1.6L = 1.8\ k/ft = w_u$

$$M_u = \frac{1.8(22.5)^2}{8} = 114\ ft\cdot k$$

DEFLECTION:

$$\Delta_{LL} \le \frac{22.5\times12}{360} = 0.75" = \frac{5\left(0.73/12\right)(22.5\times12)^4}{384(29000)I_{REQ}} \Rightarrow I_{REQ} = 191\ in^4\ (I_{LB})$$

$$\Delta_T \le \frac{22.5\times12}{240} = 1.13" = \frac{5\left(1.24/12\right)(22.5\times12)^4}{384(29000)I_{REQ}} \Rightarrow I_{REQ} = 222\ in^4\ (I_{LB})$$

PRE-COMPOSITE DL:
$48 \times 9 = 0.43\ k/ft$

$$\Delta_{PC} \le \frac{22.5\times12}{360} = 0.75" = \frac{5\left(0.43/12\right)(22.5\times12)^4}{384(29000)I_{REQ}} \Rightarrow I_{REQ} = 114\ in^4\ (I_x)$$

LIGHTEST SIZE FOR PRE-COMPOSITE DEFL: W12x19

W12x19: $\bar{Y}2 = 5" \Rightarrow$ USE PNA (7)

$\phi M_n = 143\ ft\cdot k$ $\quad I_{LB} = 267\ in^4$ $\quad I_x = 130\ in^4$

$\Sigma Q_n = 69.7\ k$ $\quad a = \frac{69.7}{0.85\times5\times67.5} = 0.243" < 2"$ OK

$Q_n = 17.2\ k \Rightarrow 69.7/17.2 \Rightarrow 5$ STUDS/SIDE $\Rightarrow$ 10 STUDS

Gridlines A-B Vibration Calculations

VIBRATION CALCULATIONS

LOADS:	Dead:	52	psf	Beam Spacing:				
	Live:	11	psf		6	ft.	9	in.
				Beam Span:				
					30	ft.	0	in.
				Girder Span:				
					27	ft.	0	in.

Slab	wc =	110	pcf			
	f'c =	5	ksi	Ec =	2580	ksi
	tslab=	4	in			
	trib=	2	in	n =	8.33	
	wt=	48	psf			

Beam		W27X129		Girder		W30X191	
	A=	37.8	in2		A=	56.3	in2
	I=	4760	in4		I=	9200	in4
	d=	27.6	in		d=	30.7	in
beff=	81	in		beff=	129	in	

BEAM MODE PROPERTIES:				GIRDER MODE PROPERTIES:			
	ybar=	10.77128	in.		ybar=	10.49202	in.
	Ij=	10886.76	in4		Ig =	20861.28	in4
	wj =	554.25	plf		wg =	2463.333	plf
	Δj =	0.032	in.		Δg =	0.049	in.
	fj =	19.77	Hz		fg =	16.03	Hz
	Ds =	15.01	in^4/ft				
	Dj =	1612.85	in^4/ft		Dg =	695.38	in^4/ft
	Bj =	18.6	ft		Bg =	60.0	ft.
	Wj =	68.9	k		Wg =	133.0	k

COMBINED MODE PROPERTIES:						
	Δg' =	0.07	in	W =	113.0	k
	β =	0.03		P_0=	65	lb
	fn =	11.04	Hz	a_p/g =	0.04%	g

	Δoj =	1.54E-06	in/lb	ΔgP =	5.86E-07	in/lb
			Neff = 2.6033			
	ΔP =	8.84E-07	in/lb			

RESULTS		
a_p/g =	0.04%	g
FAST	2001	μin/sec
MODERATE	440	μin/sec
SLOW	120	μin/sec

Gridlines E-F Vibration Calculations

VIBRATION CALCULATIONS

LOADS:	Dead:	52	psf	Beam Spacing:				
	Live:	11	psf		9	ft.	0	in.
				Beam Span:				
					28	ft.	0	in.
				Girder Span:				
					27	ft.	0	in.

Slab	wc =	110	pcf			
	f'c =	5	ksi	Ec =	2580	ksi
	tslab=	4	in			
	trib=	2	in	n =	8.33	
	wt=	48	psf			

Beam		W27X114		Girder		W30X191	
	A=	**33.5**	in2		A=	**56.3**	in2
	I=	**4080**	in4		I=	**9200**	in4
	d=	**27.3**	in		d=	**30.7**	in
beff=	108	in		beff=	129	in	

BEAM MODE PROPERTIES:				GIRDER MODE PROPERTIES:			
	ybar=	8.925279	in.		ybar=	10.49202	in.
	Ij=	10490.43	in4		Ig =	20861.28	in4
	wj =	681	plf		wg =	2118.667	plf
	Δj =	0.031	in.		Δg =	0.042	in.
	fj =	20.10	Hz		fg =	17.28	Hz
	Ds =	15.01	in^4/ft				
	Dj =	1165.60	in^4/ft		Dg =	745.05	in^4/ft
	Bj =	18.9	ft		Bg =	54.4	ft.
	Wj =	60.0	k		Wg =	111.0	k

COMBINED MODE PROPERTIES:						
	Δg' =	0.06	in	W =	93.6	k
	β =	**0.03**		P_0=	**65**	lb
	fn =	11.73	Hz	a_p/g =	**0.04%**	g

	Δoj =	1.30E-06	in/lb	ΔgP =	5.86E-07	in/lb
			Neff = 2.0786			
	ΔP =	9.18E-07	in/lb			

RESULTS		
a_p/g =	**0.04%**	g
FAST	1956	μin/sec
MODERATE	430	μin/sec
SLOW	117	μin/sec

Gridlines B-E Vibration Calculations

VIBRATION CALCULATIONS

LOADS:	Dead:	52	psf	Beam Spacing:				
	Live:	11	psf		9	ft.	0	in.
				Beam Span:				
					22	ft.	6	in.
				Girder Span:				
					27	ft.	0	in.

Slab	wc =	110	pcf			
	f'c =	5	ksi	Ec =	2580	ksi
	tslab=	4	in			
	trib=	2	in	n =	8.33	
	wt=	48	psf			

Beam		W21X44		Girder		W24X55	
	A=	13	in2		A=	16.3	in2
	I=	843	in4		I=	1360	in4
	d=	20.7	in		d=	23.6	in
beff=	108	in		beff=	129	in	

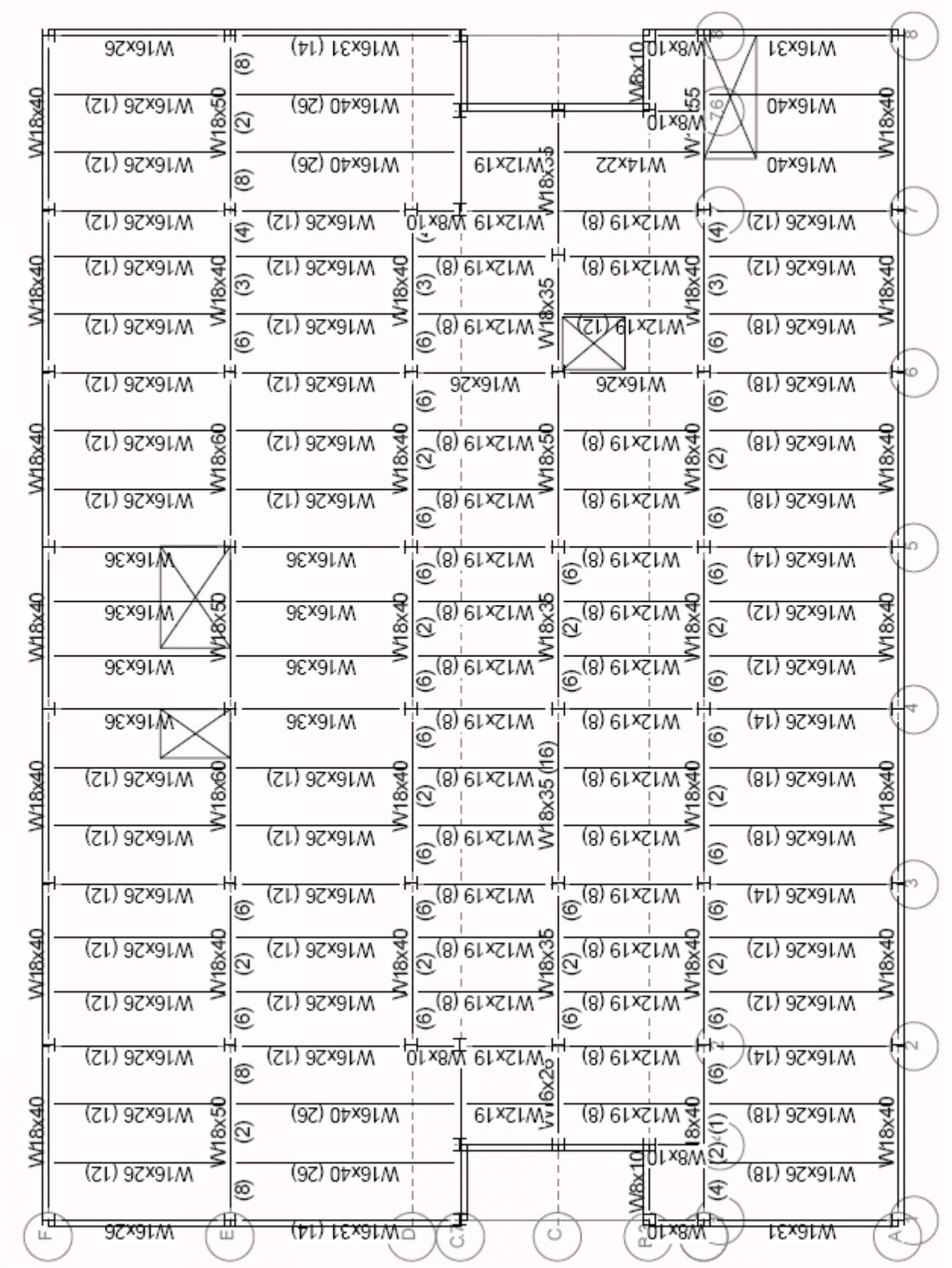
BEAM MODE PROPERTIES:				GIRDER MODE PROPERTIES:		
ybar=	4.875342	in.		ybar=	5.242532	in.
Ij=	3052.77	in4		Ig =	4670.565	in4
wj =	611	plf		wg =	1527.5	plf
Δj =	0.040	in.		Δg =	0.135	in.
fj =	17.73	Hz		fg =	9.63	Hz
Ds =	15.01	in^4/ft				
Dj =	339.20	in^4/ft		Dg =	207.58	in^4/ft
Bj =	20.6	ft		Bg =	54.9	ft.
Wj =	47.3	k		Wg =	100.7	k

COMBINED MODE PROPERTIES:					
Δg' =	0.18	in	W =	90.9	k
β =	0.03		P_0=	65	lb
fn =	7.61	Hz	a_p/g =	0.17%	g

Δoj =	2.32E-06	in/lb	ΔgP =	2.62E-06	in/lb
		Neff = 2.0853			
	ΔP =	2.42E-06	in/lb		

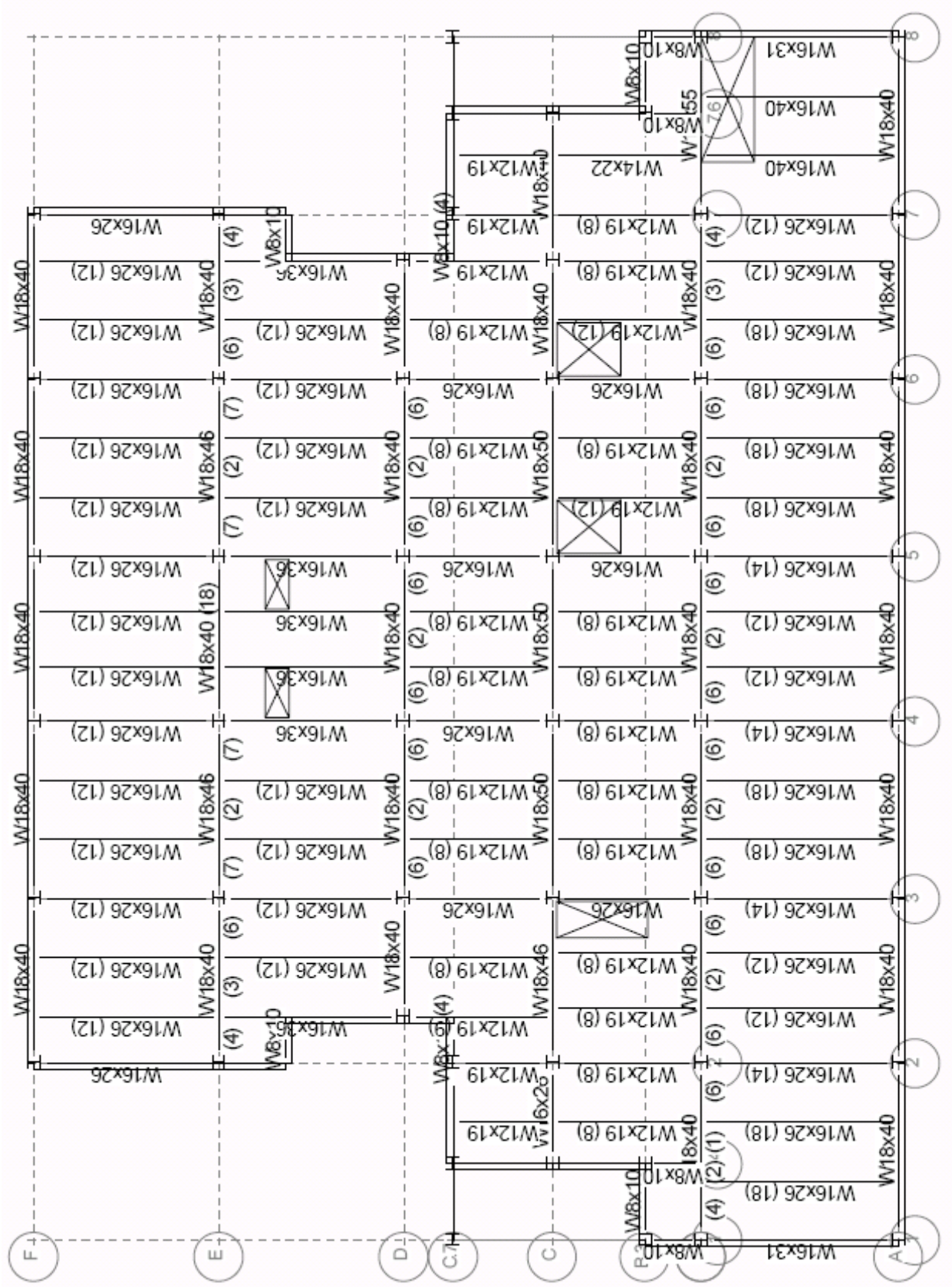
RESULTS		
a_p/g =	0.17%	g
FAST	7950	μin/sec
MODERATE	1749	μin/sec
SLOW	477	μin/sec

APPENDIX C: FLOOR FRAMING PLANS

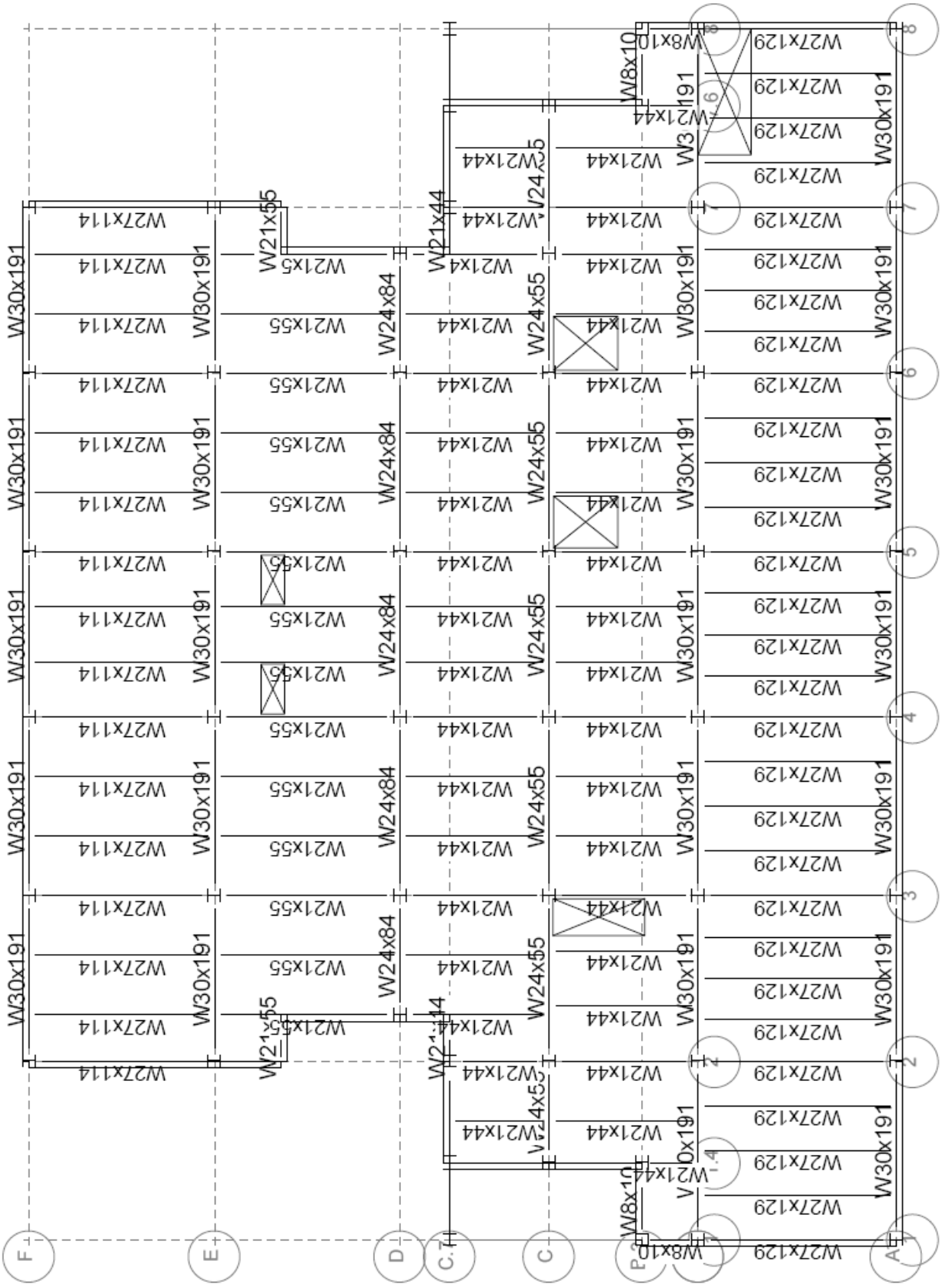


2nd Floor Framing Plan

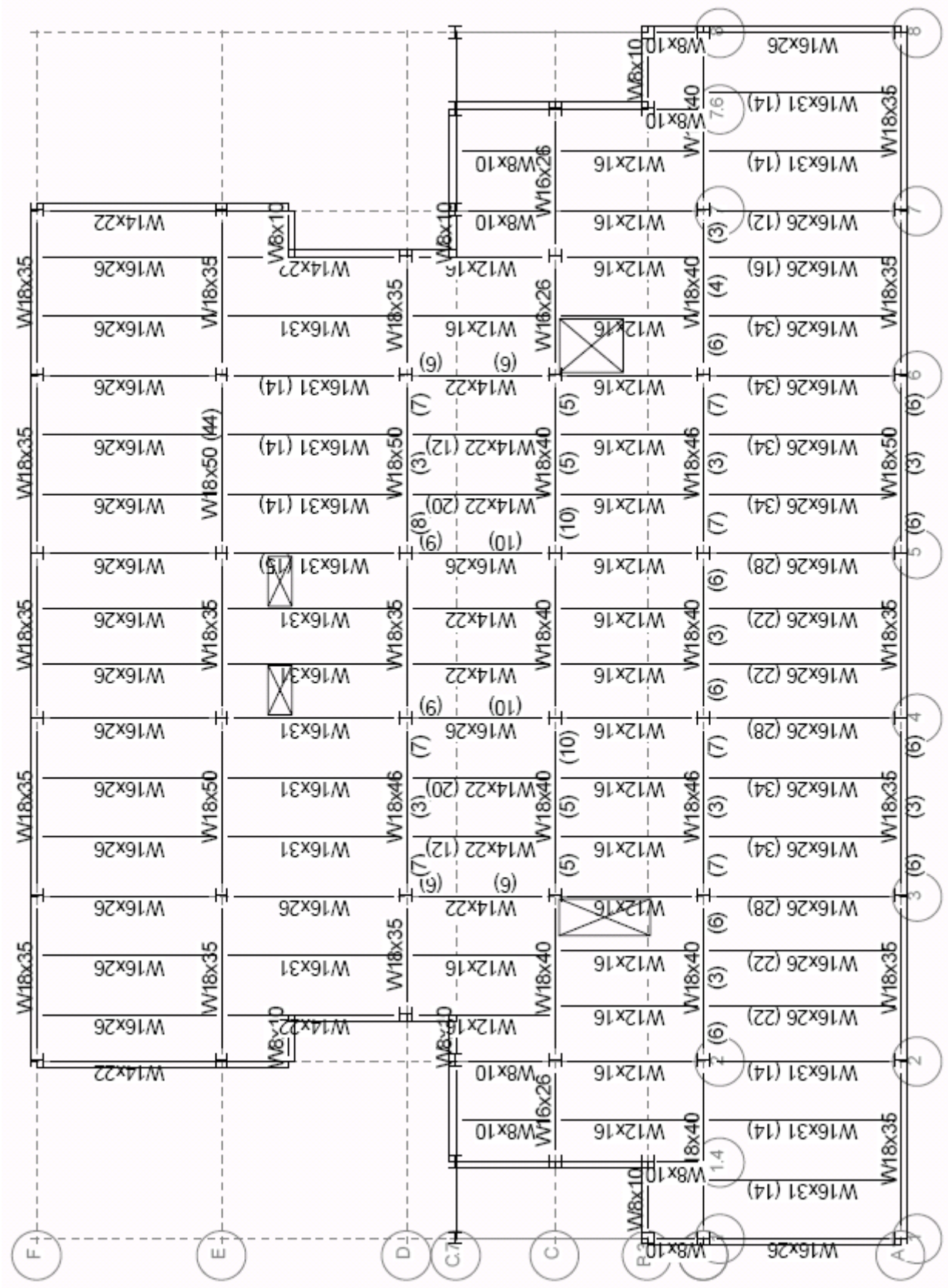
3rd Floor Framing Plan



4th Floor Framing Plan



5th Floor Framing Plan – CLASS A - VIBRATION CRITICAL



Penthouse Floor Framing Plan

APPENDIX D: COLUMN CALCULATIONS AND COLUMN PLANS

COLUMN: E-5 **K_{LL} = 4**

	LOAD (psf)					
STORY	D	L	S	Trib Area	Total Area	LL Red.
Penthouse	60	30	21	585	585	--
5	60	80		585	1170	0.47
4	60	80		585	1755	0.43
3	60	80		585	2340	0.41
2	60	80		585	2925	0.40

Total Area: 2925 ft^2

	TOTAL LOAD (k)				FACTORED LOAD (k)	KL (ft)
STORY	D	L	S	Equip		
Penthouse	35.1	17.6	12.3	45.9	**144.94**	15.67
5	35.1	22.0			**222.19**	16.67
4	35.1	20.1			**296.44**	15.67
3	35.1	19.0			**368.89**	19
2	35.1	18.7			**440.96**	21

Hand Calculation:	4-5-P:	W12X50 @ KL=16:	ΦP_n =	326 k
	2-3:	W12X65 @ KL=22:	ΦP_n =	491 k
RAM Struct. Sys.:	4-5-P:	W12X53		
	2-3:	W12X72		

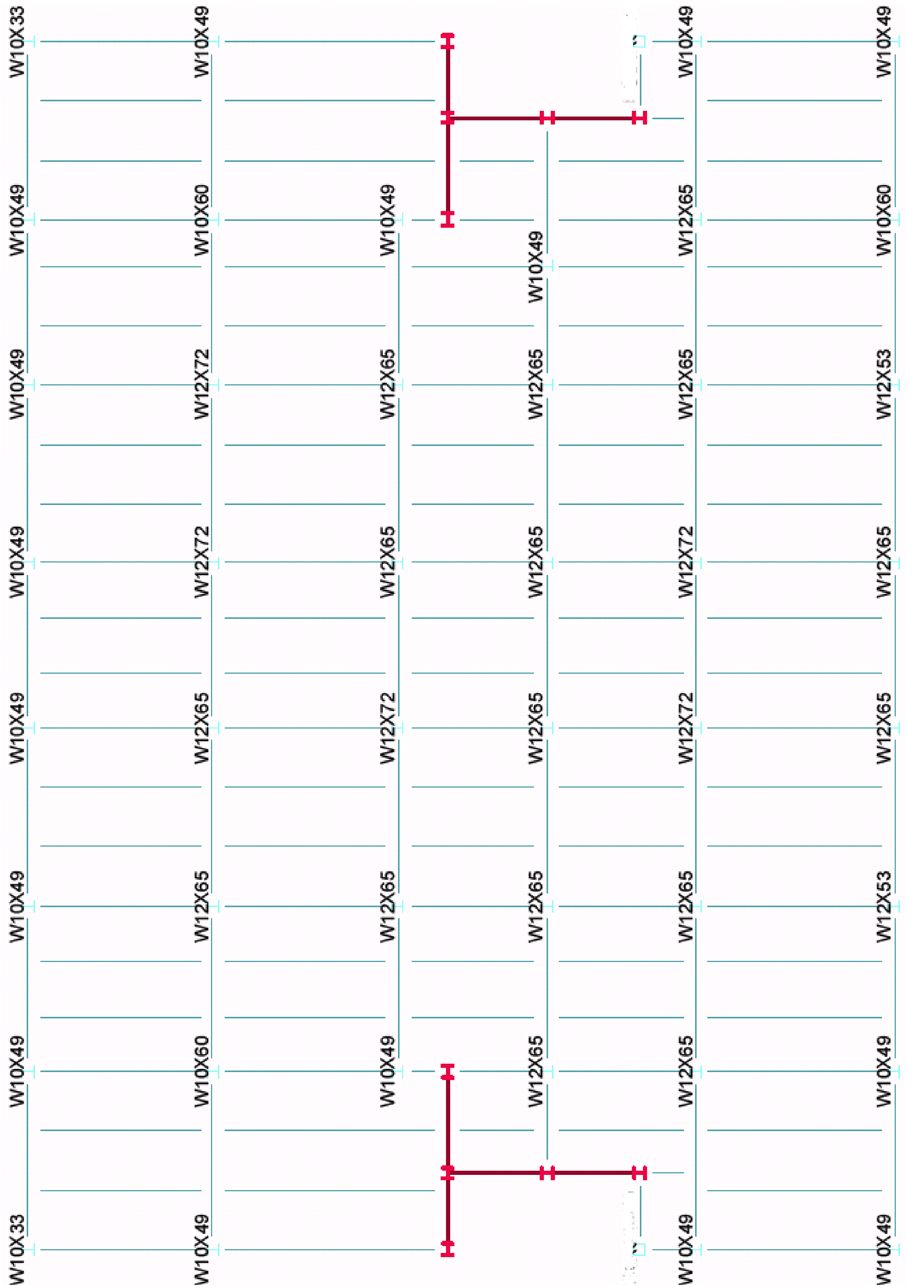
COLUMN: A-1 **K_{LL} = 4**

	LOAD (psf)					
STORY	D	L	S	Trib Area	Total Area	LL Red.
Penthouse	60	30	21	203	203	--
5	60	80		203	406	0.62
4	60	80		203	609	0.55
3	60	80		203	812	0.51
2	60	80		203	1015	0.49

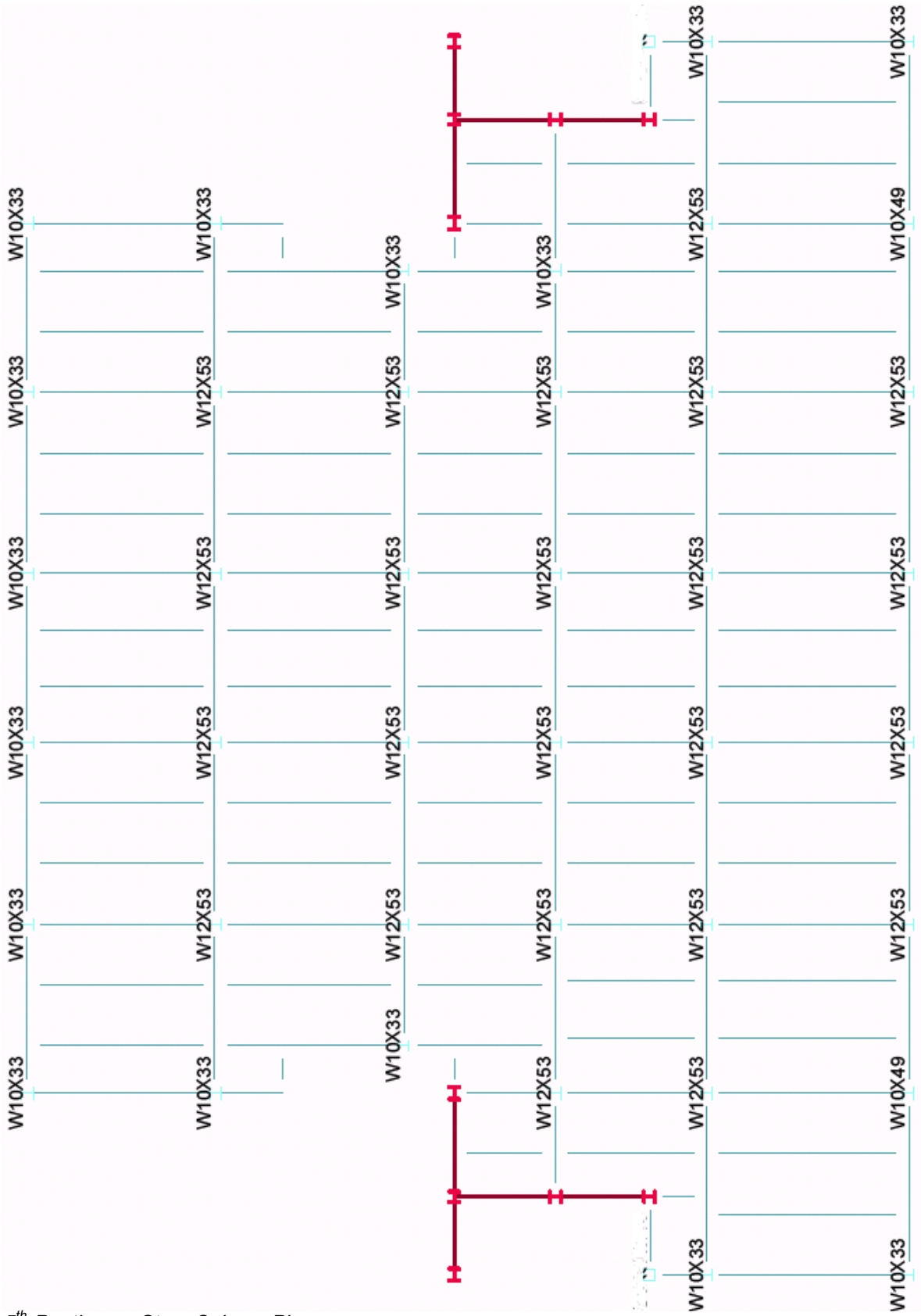
Total Area: 1015 ft^2

	TOTAL LOAD (k)				FACTORED LOAD (k)	KL (ft)
STORY	D	L	S	Equip		
Penthouse	12.2	6.1	4.3		**31.18**	15.67
5	12.2	10.1			**61.96**	16.67
4	12.2	9.0			**90.97**	15.67
3	12.2	8.3			**118.92**	19
2	12.2	7.9			**146.15**	21

Hand Calculation:	4-5-P:	W10X33 @ KL=16:	ΦP_n =	213 k
	2-3:	W10X45 @ KL=22:	ΦP_n =	174 k
RAM Struct. Sys.:	4-5-P:	W10X33		
	2-3:	W10X49		

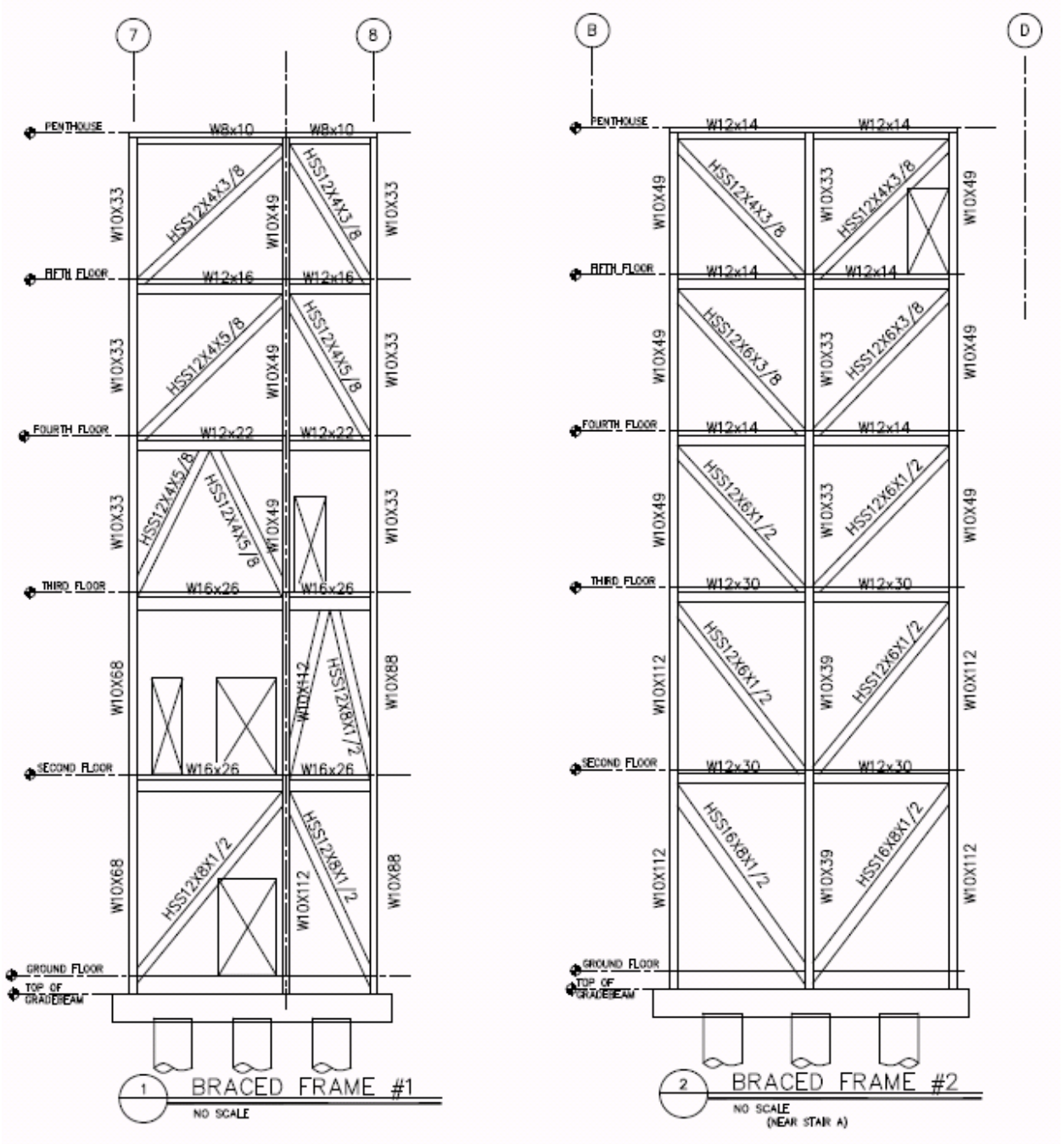


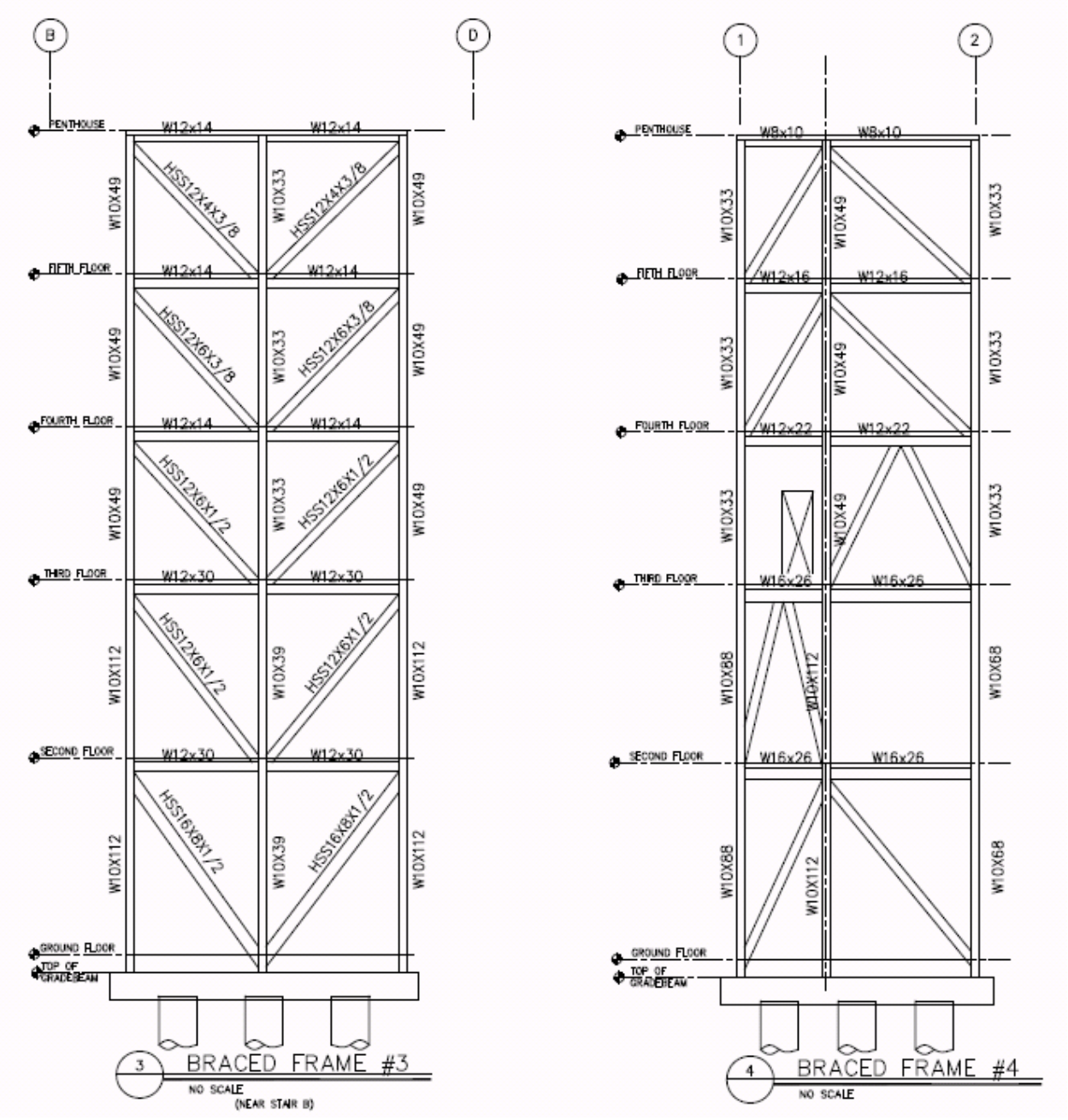
2nd-3rd Story Column Plan



4th-5th-Penthouse Story Column Plan

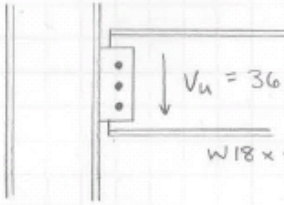
APPENDIX E: BRACED FRAME ELEVATIONS




B
D
PENTHOUSE
FIFTH FLOOR
FOURTH FLOOR
THIRD FLOOR
SECOND FLOOR
GROUND FLOOR
TOP OF GRADEBEAM
W12x14
W12x30
HSS12X4X3/8
HSS12X6X3/8
HSS12X6X1/2
HSS16X8X1/2
W10X49
W10X33
W10X112
W10X39
3
BRACED FRAME #3
NO SCALE
(NEAR STAIR B)
1
2
W8x10
W12x16
W12x22
W16x26
W10X88
W10X68
4
BRACED FRAME #4
NO SCALE

APPENDIX F: CONNECTION DESIGN

SHEAR CONNECTION - TYPICAL (GIRDER - TO - COLUMN)



USE 7/8" ø A325-N BOLTS : ϕr_n = 21.6 k

$n = {}^{36.7}/_{21.6} = 1.7 \Rightarrow$ USE 3 BOLTS (MIN.)

$n \leq 9$: NO ECCENTRICITY

— PLATE THICKNESS :

- MAXIMUM : $t_{PLATE} \leq \frac{d_b}{2} + 1/16" = 0.5"$

TRY 1/4" PLATE

— BOLT BEARING :

- PLATE $\phi r_n = 0.75 \times 2.4 \times (58)(0.875)(0.25) = 22.8$ k > 21.6 k

∴ BOLTS CONTROL

— BLOCK SHEAR :

- BEAM NOT COPED - NO BLOCK SHEAR

- PLATE : TABLE 9-3 : SHEAR YIELD : 121 k/in x 1/4" = 30.3 k ←
  SHEAR RUPTURE : 131 k/in x 1/4" = 32.8 k
  TENSION RUPTURE : 43.5 k/in x 1/4" = 10.9 k ←

ϕR_n = 41.2 k

41.2 k > 36.7 k OK

— SHEAR YIELD : $\phi R_n = 1.0(0.6 F_y) A_g$

$\phi R_n = 1.0(0.6 \times 36)(9 \times 1/4)$

$\phi R_n = 48.6$ k > 36.7 k OK

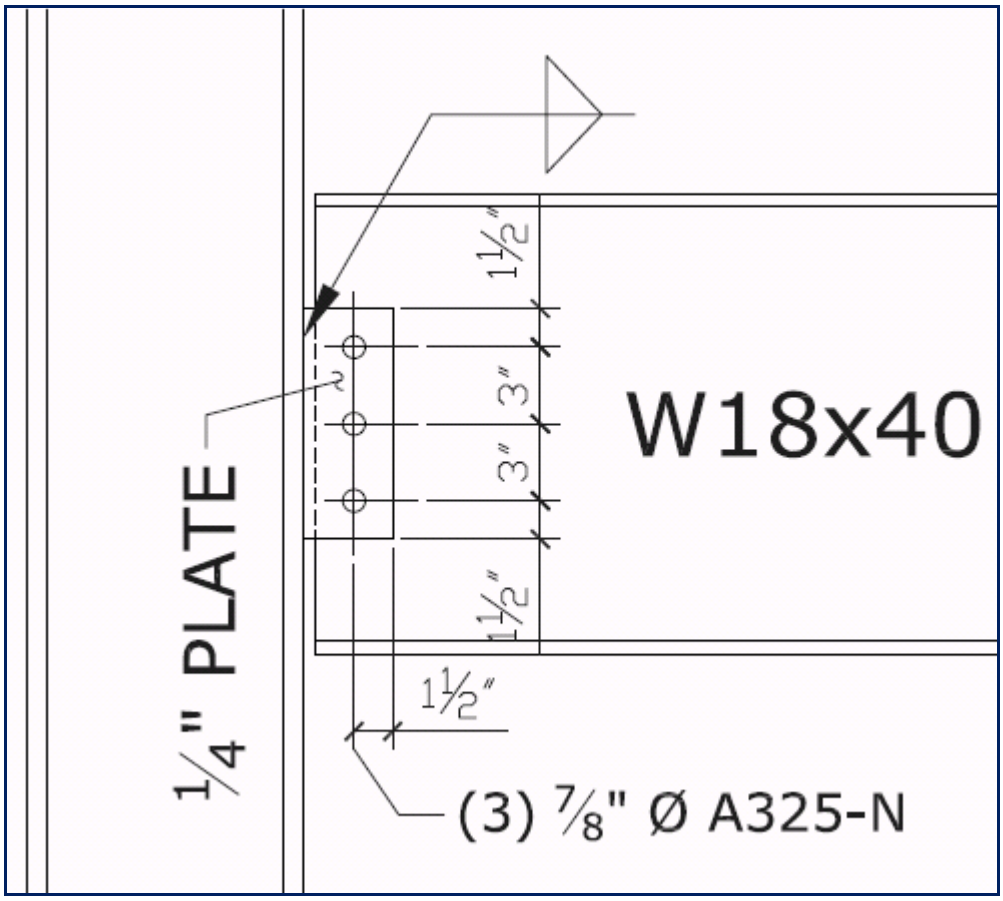
— SHEAR RUPTURE : $\phi R_n = 0.75(0.6 \times F_u) A_n$

$\phi R_n = 0.75(0.6 \times 58)[9" - 3(7/8 + 1/8)](1/4)$

$\phi R_n = 39.2$ k > 36.7k OK

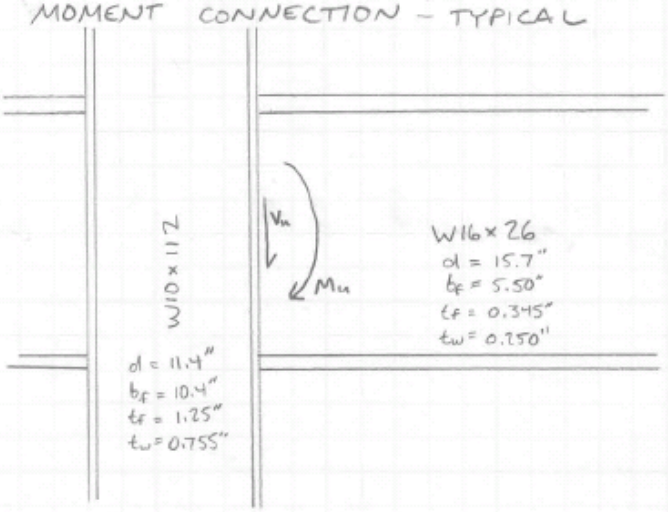
— SIZE WELD : $t_{WELD,MIN} = 1/4(5/8) = 0.16 \Rightarrow {}^{2.5}/_{16}$

$\Rightarrow 3/16"$ WELD, EACH SIDE



Typical Shear Connection

MOMENT CONNECTION - TYPICAL



$V_u = 22.7$ k
$M_u = 78.4$ ft·k
$= 941$ in·k
$F_u = 941/15.7 = 59.9$ k

- FLANGE WELDED / WEB BOLTED

- SHEAR: SHEAR TAB CONNECTION - $t_{WELD} = 5/8\, t_{PLATE} \Rightarrow 3/8$" WELD

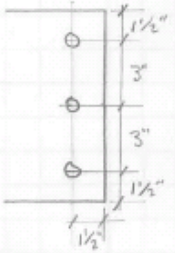
  - NUMBER OF BOLTS
    - USE 7/8" Ø A325-N $\Rightarrow \phi r_n = 21.6$ k

      $\frac{22.7}{21.6} \Rightarrow 1.05$, MINIMUM OF 3 BOLTS - USE 3

  - PLATE THICKNESS
    - MAXIMUM: $t_{PLATE} \le \frac{d_b}{2} + \frac{1}{16} = 0.5$"
      TRY 1/4" PLATE

  - BOLT BEARING
    - PLATE: $\phi r_n = 0.75\,(2.4)(58)(0.875)(0.25) = 22.8$ k < 21.6 k
      - BOLT SHEAR CONTROLS
    - BEAM WEB: SAME THICKNESS, WITH STRONGER MAT'L $\Rightarrow$ PLATE CONTROLS

  - BLOCK SHEAR: FROM TABLE 9-3



SHEAR YIELD: $121\ ^k/_{in} \times 1/4" = 30.3$ k ← CONTROLS

SHEAR RUPTURE: $131\ ^k/_{in} \times 1/4" = 32.8$ k

TENSION RUPTURE: $43.5\ ^k/_{in} \times 1/4" = 10.9$ k

$\phi R_n = 41.2$ k > 22.7 k OK

  - SHEAR YIELD: $\phi R_n = 1.0(0.6F_y)A_g$
    $\phi R_n = 1.0(0.6 \times 36)(9" \times 0.75") = 48.6$ k > 22.7 k OK

  - SHEAR RUPTURE: $\phi R_n = 0.75(0.6F_u)A_n$, $A_n = [9 - 3(0.875 + 1/8)](0.75) = 1.5\ in^2$
    $\phi R_n = 0.75(0.6 \times 58)(1.5) = 39.2$ k > 22.7 k OK

— MOMENT: USE FULL PENETRATION WELDS

— COLUMN SIDE LIMIT STATES:

• LOCAL FLANGE BENDING

$$T_u \leq \phi(6.25 t_{fc}^2 F_{yc})$$

$$59.9 \leq 0.9(6.25 \times 1.25^2 \times 50)$$

$59.9 \leq 439$ k OK NO STIFFENER NEEDED

• LOCAL WEB YIELDING

$$F_u \leq \phi[F_{yc}(5k_{DES} + N)t_{wc}] \quad (N = t_{fb})$$

$$59.9 \leq 1.0[(50)(5 \times 1.75 + 0.345)(0.755)]$$

$59.9 \leq 343$ k OK NO STIFFENER NEEDED

• LOCAL WEB CRIPPLING

$$C_u \leq \phi\left[0.8 t_{wc}^2\left[1 + 3\left(\frac{N}{d}\right)\left(\frac{t_{wc}}{t_{fc}}\right)^{1.5}\right]\right]\sqrt{\frac{EF_{yw}t_{fc}}{t_{wc}}}$$

$$59.9 \leq 0.75\left[0.8(0.755)^2\left[1 + \left(\frac{0.345}{11.4}\right)\left(\frac{0.755}{1.25}\right)^{1.5}\right]\right]\sqrt{\frac{(29000)(50)(1.25)}{0.755}}$$

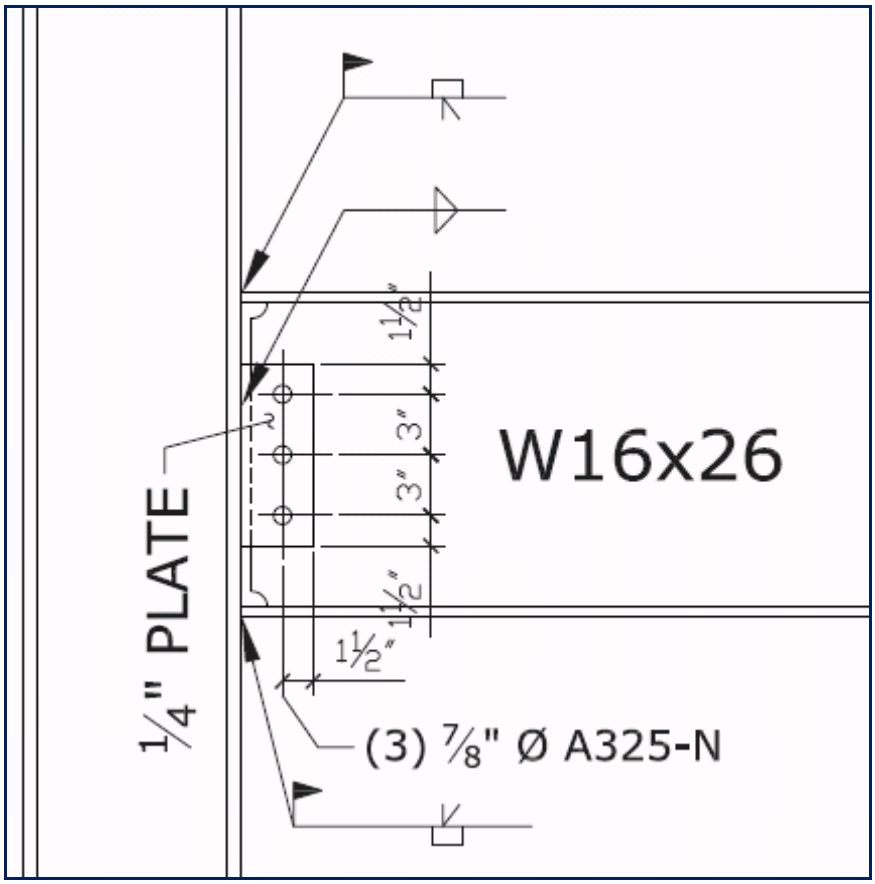
$59.9 \leq 537$ k OK NO STIFFENER NEEDED

• WEB BUCKLING

$$C_u \leq \phi \frac{24 t_{wc}^2 \sqrt{EF_{yc}}}{[h/t_{wc}]}$$

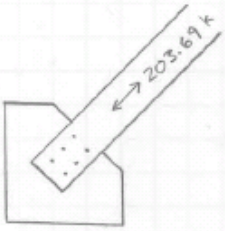
$$59.9 \leq 0.9 \frac{24(0.755)^2\sqrt{29000 \times 50}}{10.4}$$

$59.9 \leq 1426$ k OK NO STIFFENER NEEDED



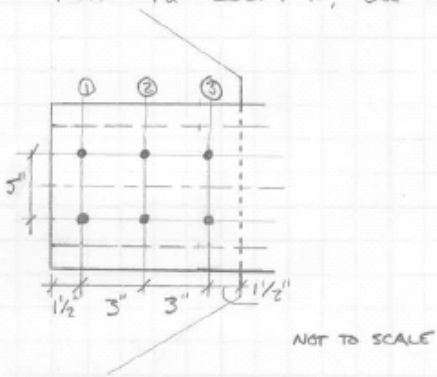
Typical Moment Connection

BRACING CONNECTION – TYPICAL



HSS 16×8×½ (F_y = 46 ksi, F_u = 58 ksi), t = 0.465"
→ WORKABLE FLAT: 13 ¾"
A36 STEEL GUSSET PLATE, ¾" THICK
USE ⅞" Ø A325-N BOLTS: ϕr_n = 43.3 k (DOUBLE SHEAR)

FOR P_u = 203.9 k, USE 6 BOLTS



NOT TO SCALE

BOLT SHEAR: ϕr_n = 43.3 k

BEARING: PLATE: $\phi 2.4 F_u t d_B = (0.75)2.4(58)(3/4)(7/8) =$ 68.5 k
HSS: $2[\phi 2.4 F_u t d_B = 2(0.75)2.4(58)(0.465)(7/8) =$ 85.0 k

TEARout: PLATE EDGE: $\phi 1.2 F_u l_e t = (0.75)1.2(58)\left(1\tfrac{1}{2} - \frac{7/8 + 1/16}{2}\right)(3/4) =$ 40.4 k
HSS EDGE: $2[\phi 1.2 F_u l_e t] = 2(0.75)1.2(58)\left(1\tfrac{1}{2} - \frac{7/8 + 1/16}{2}\right)(0.465) =$ 50.1 k
PLATE INT.: $\phi 1.2 F_u l_e t = (0.75)1.2(58)(3 - 7/8 - 1/16)(3/4) =$ 80.7 k
HSS INT.: $2[\phi 1.2 F_u l_e t] = 2(0.75)1.2(58)(3 - 7/8 - 1/16)(0.465) =$ 100.1 k

BOLT LINE ①: $\phi r_n = \min[43.3, 68.5, 50.1] =$ 43.3 k

BOLT LINE ②: $\phi r_n = \min[43.3, 68.5, 80.7] =$ 43.3 k

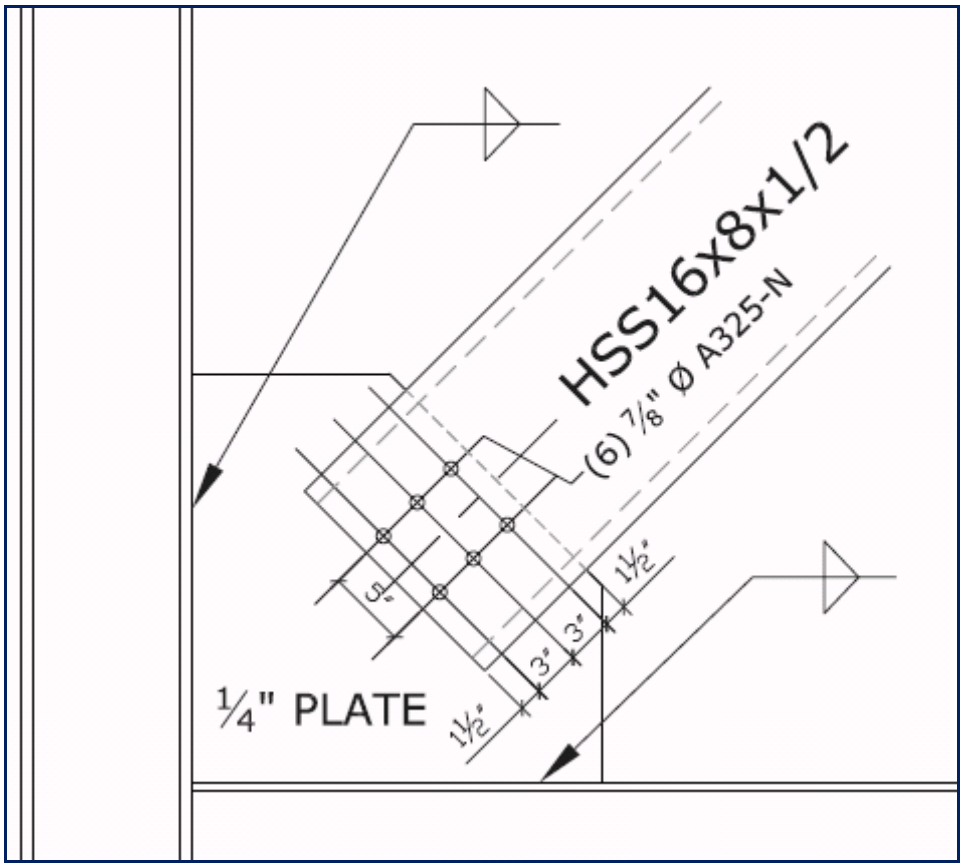
BOLT LINE ③: $\phi r_n = \min[43.3, 68.5, 40.4] =$ 40.4 k

$\phi R_n = 2[43.3 + 43.3 + 40.4] =$ 254 k > 203.7 k OK

WHITMORE SECTION: $l = 2(\tan 30^\circ)(6") + 5" =$ 11.9"
TENSION RUPTURE: $\phi R_n = 0.75 F_u A_e = 0.75(58)(11.9 - 2(7/8 + 1/8))(3/4) =$ 323 k
TENSION YIELD: $\phi R_n = 0.9 F_y A_g = 0.9(36)(11.9)(3/4) =$ 289 k

BLOCK SHEAR: $\phi R_n = \min\begin{cases}(0.75)[(0.6)(58)(7.5 - 2.5(7/8 + 1/8))(2 \times 3/4) + (58)(5 - 7/8 - 1/8)(3/4)] = 326 \text{ k} \\ (0.75)[(0.6)(36)(7.5)(2 \times 3/4) + (58)(5 - 7/8 - 1/8)(3/4)] = 313 \text{ k} \leftarrow \text{OK}\end{cases}$

TENSION RUPTURE OF HSS: A_g = 20.9 in² $A_n = 20.9 - 4(7/8 + 1/8)(0.465) =$ 19.0 in²
$\phi R_n = (0.75)(58)(19.0) =$ 827 k OK



Typical Bracing Connection

APPENDIX G: CONSTRUCTION MANAGEMENT CALCULATIONS

CAST-IN-PLACE CONCRETE SYSTEM - EXISTING CONDITIONS

COLUMNS	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
Formwork	26880	SFCA	C-1	4	800	34	4624	157,216	1.23	33,062		0	190,278
Concrete	598	CY	C-20	1	150	4	2860	11,440	109.00	65,182	600	2,400	79,022
Reinf.	86	Ton	4Rodm	4	11	8	5504	44,032	935.00	80,410		0	124,442

SLABS	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
Formwork	150345	SFCA	C-2	7	3150	48	12474	598,752	1.23	184,924		0	783,676
Concrete	4738	CY	C-20	4	600	8	11440	91,520	109.00	516,442	600	4,800	612,762
Slab Finish	115919	SF	CeFi	8	4000	29	6608	191,632		0		0	191,632
Reinf.	600	Ton	4Rodm	6	16.5	37	8256	305,472	935.00	561,000		0	866,472

SHEARWALLS	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
Formwork	19954	SFCA	C-2	2	900	23	3564	81,972	1.23	24,543		0	106,515
Concrete	370	CY	C-20	1	150	3	2860	8,580	109.00	40,330	600	1,800	50,710
Reinf.	33	Ton	4Rodm	2	5.5	6	2752	16,512	935.00	30,855		0	47,367

CRANE					Days:	135					300	40,500	40,500

COST OF SYSTEM: $ 3,093,377
TIME TO CONSTRUCT: 135 Days

COMPOSITE STEEL SYSTEM - REDESIGN

COLUMNS	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
Steel	1888	CWt	E-6	1	250	8	5091	40,728	53.00	100,064		0	140,792
Baseplates	54		E-6	1	60	1	5091	5,091	45.00	2,430		0	7,521
Fireproofing	22080	SF	G-2	1	1500	15	900	13,500	1.00	22,080		0	35,580

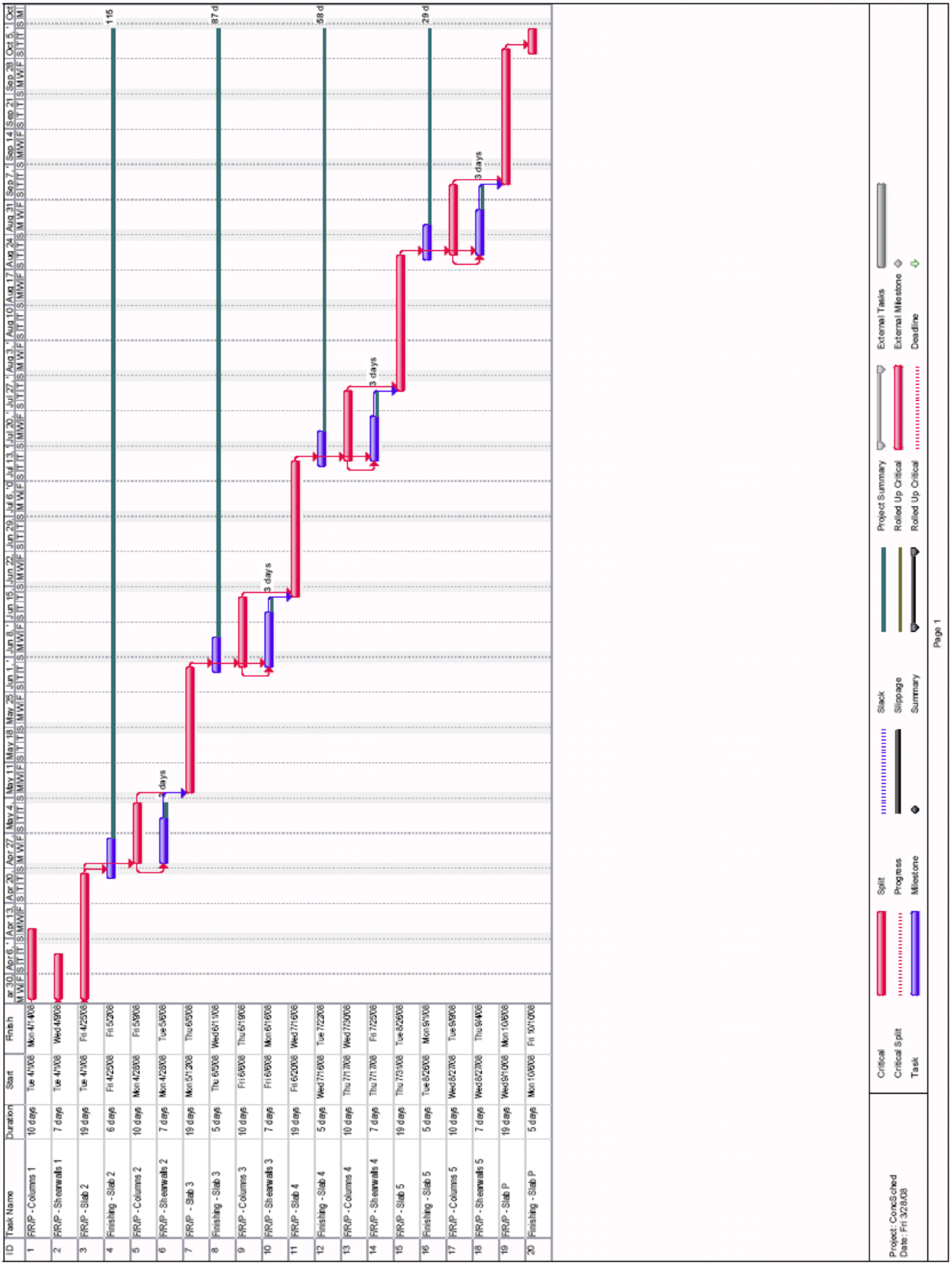
FLOORS	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
Framing	8215	CWt	E-6	1	250	33	5091	168,003	53.00	435,395		0	603,398
Steel Deck	115919	SF	E-4	3	10140	12	7968	95,616	2.00	231,838		0	327,454
Shear Studs	4136	Studs	E-10	1	950	5	1060	5,300	1.00	4,136		0	9,436
Fireproofing	115919	SF	G-2	2	3000	39	1800	70,200	1.00	115,919		0	186,119
Concrete	1800	CY	C-20	2	300	6	5720	34,320	109.00	196,200		0	230,520
WWF	1159	CSF	2Rodm	4	108	11	2752	30,272	29.00	33,611		0	63,883
Slab Finish	115919	SF	CeFi	6	3000	39	4956	193,284		0		0	193,284

BRACES	Amount		Crew	# crews	units/day	Days	Labor cost/day	Labor	Mat'l cost/unit	Mat'l	Equip. cost/day	Equip.	TOTAL COST
HSS Steel	454	CWt	E-6	1	250	2	5091	10,182	59.00	26,786		0	36,968
Fireproofing	3500	SF	G-2	1	1500	3	900	2,700	1.00	3,500		0	6,200

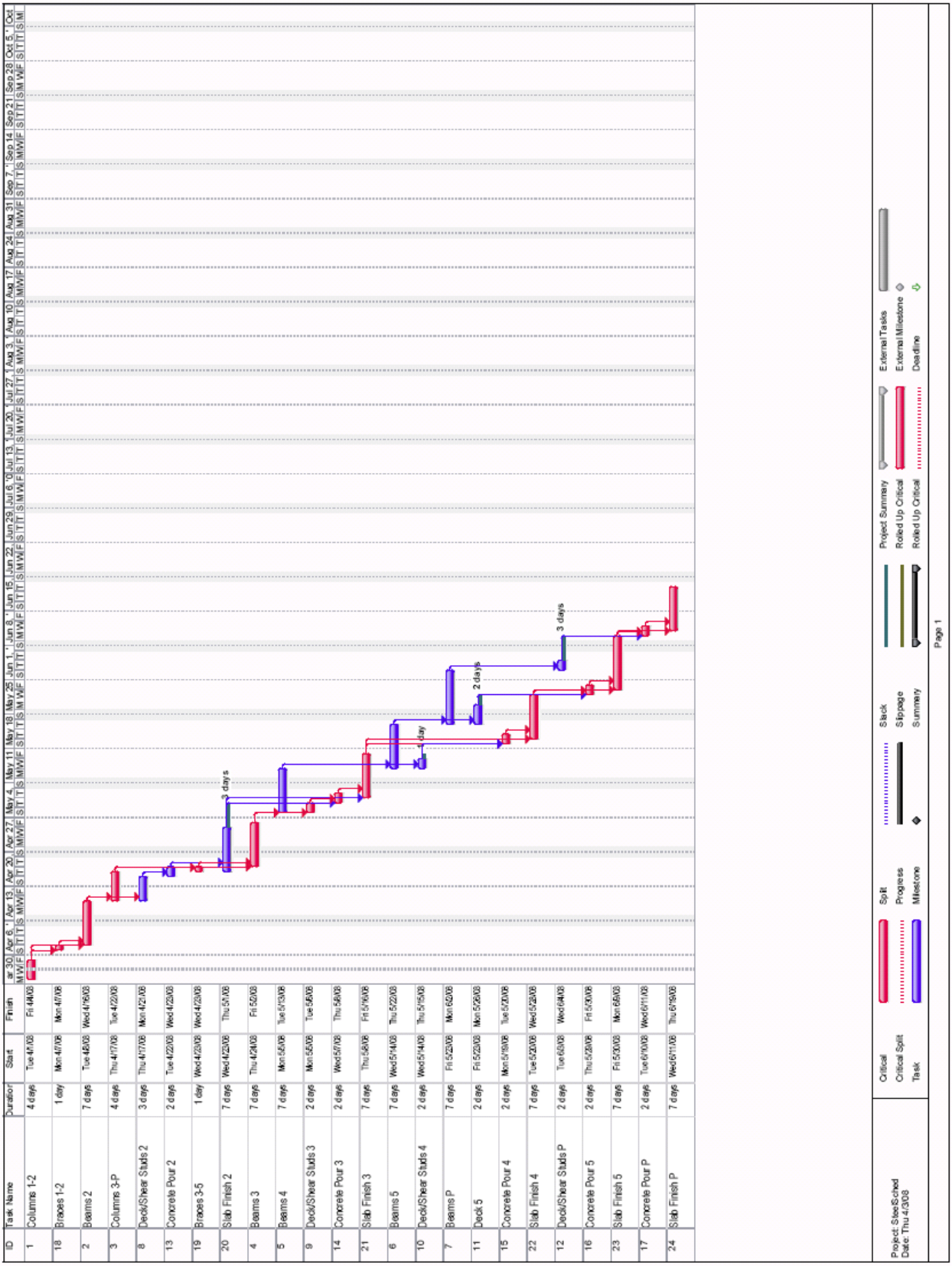
CRANE					Days:	69					300	20,700	20,700

COST OF SYSTEM: $ 1,861,855
TIME TO CONSTRUCT: 69 Days

Concrete Schedule Study



Steel Schedule Study



Floor Framing Takeoffs

SIZE	#	LENGTH (ft)	WEIGHT (lbs)
W8X10	46	458.75	4621
W10X12	9	195.00	2349
W12X14	2	60.00	849
W12X16	22	495.00	7933
W12X19	113	2640.00	50037
W14X22	20	504.50	11141
W16X26	198	5650.38	147663
W16X31	27	783.00	24326
W16X36	22	616.00	22219
W16X40	13	434.00	17426
W16X45	2	71.00	3213
W16X67	2	60.00	4083
W18X35	25	638.38	22374
W18X40	93	2373.75	95313
W18X50	13	347.00	17357
W18X46	8	214.00	9831
W18X55	7	183.00	10088
W18X60	2	54.00	3234
W18X76	2	54.00	4098
W18X65	1	27.00	1755
W21X44	40	810.83	35868
W21X55	16	406.00	22381
W24X55	7	159.75	8861
W24X84	5	115.00	9666
W27X114	16	468.00	53349
W27X129	29	870.00	111904
W30X191	24	624.00	119544
	---		---
	764		**821482**

Total Number of Studs = **4131**

Column Takeoffs

Size	#	Length (ft)	Weight (lbs)
W10X33	17	800.0	26433
W10X49	18	736.0	36064
W12X53	25	1184.0	62851
W10X60	3	120.0	7187
W12X65	15	600.0	38996
W12X72	6	240.0	17232
	106		198217

Lateral Bracing System Takeoffs

Columns:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W10X33	18	288.0	9516	
W10X39	2	40.0	1565	
W10X49	14	232.0	11368	
W10X68	4	80.0	5444	
W10X88	4	80.0	7050	
W10X112	8	160.0	17912	
	50		52855	0.47

Beams:

Wide Flange:

Steel Grade: 50

Size	#	Length ft	Weight lbs	UnitWt psf
W8X10	4	54.0	544	
W12X14	8	116.3	1647	
W12X16	4	54.0	865	
W12X19	4	58.2	1102	
W12X22	4	54.0	1191	
W12X30	8	116.3	3480	
W16X26	8	108.0	2822	
	40		11651	0.10

Braces:

Tube:

Steel Grade: 46

Size	#	Length ft	Weight lbs	UnitWt psf
HSS12X6X3/8	4	88.5	3553	
HSS12X4X3/8	8	168.4	5960	
HSS12X4X5/8	8	155.8	8694	
HSS12X6X1/2	8	181.2	9435	
HSS12X8X1/2	8	179.5	10508	
HSS16X8X1/2	4	102.2	7267	
	40		45417	0.40

APPENDIX H: ALTERNATIVE CARE FACILITY CALCULATIONS

MECHANICAL

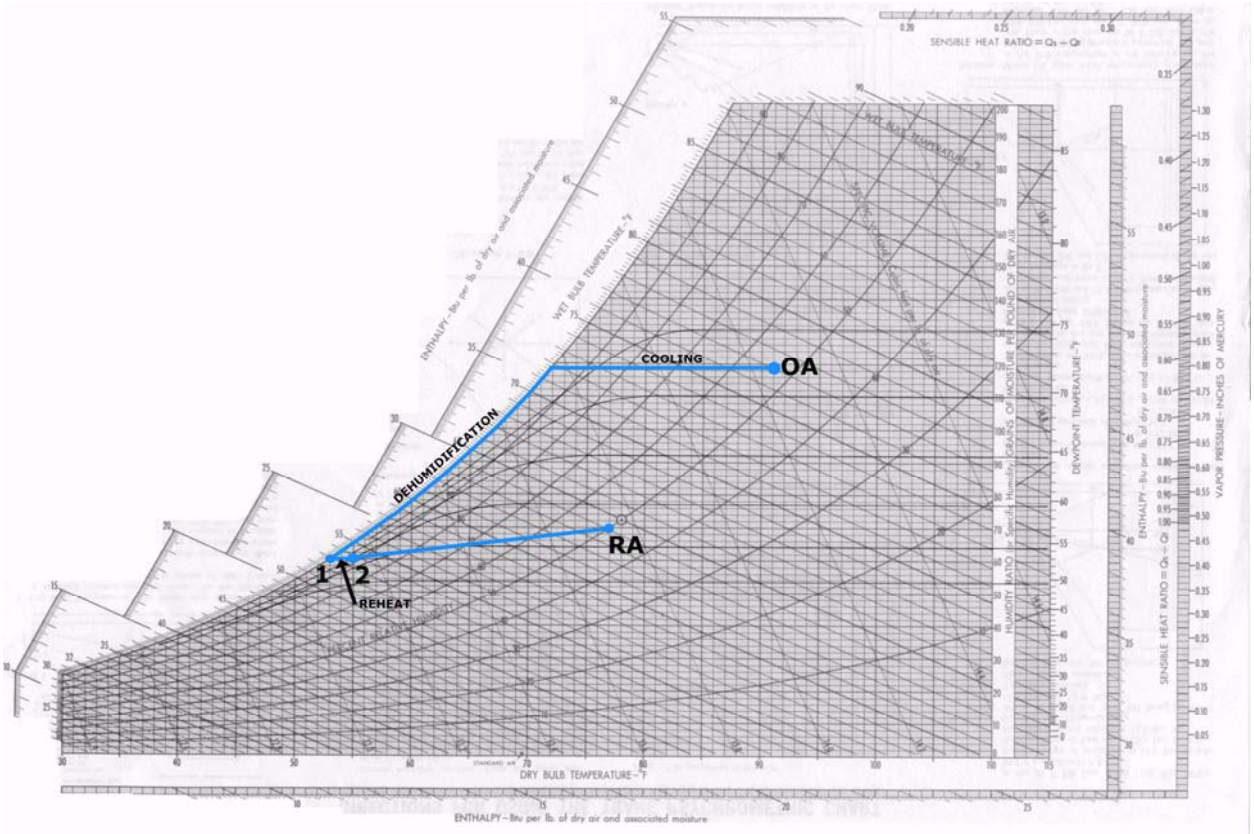
Mechanical Load Calculations

	Cooling	Heating
LOADS		
Sensible	61385	-221874
Latent	82760	
SHF	0.742	1
OUTDOOR DESIGN COND.		
T_{DB} [°F]	91	13
T_{WB} [°F]	77	8
RH [%]	0.54	0
W (lb_W/lb_A)	0.0168	0
Spec. Vol. [ft^3/lb_A]	14.29	11.9
Enthalpy [BTU/lb]	40.3	3.1
PREHEATING		
to T [°F]	-	55
W (lb_W/lb_A)	-	0
Enthalpy [BTU/lb]	-	13.2
Spec. Vol. [ft^3/lb_A]	-	12.99
INDOOR DESIGN CONDITIONS		
T_{DB} [°F]	77	68
RH [%]	50	50
Enthalpy [BTU/lb]	29.3	24.2
AIR SUPPLY TEMPERATURES		
MAX [°F]		140
MIN [°F]	55	
Design [°F]	55	101.9
MINIMUM OUTDOOR AIR		
Fresh Air	100%	100%
MIXING POINT		
Total Mass [lb_A/min]	455.00	455.00
Fresh Air Mass [lb_A/min]	455.00	455.00
Fresh Air Fraction	1	1
T_{DB} [°F]	91	55
Enthalpy [BTU/lb]	40.3	13.2
Spec. Vol. [ft^3/lb_A]	14.29	12.99

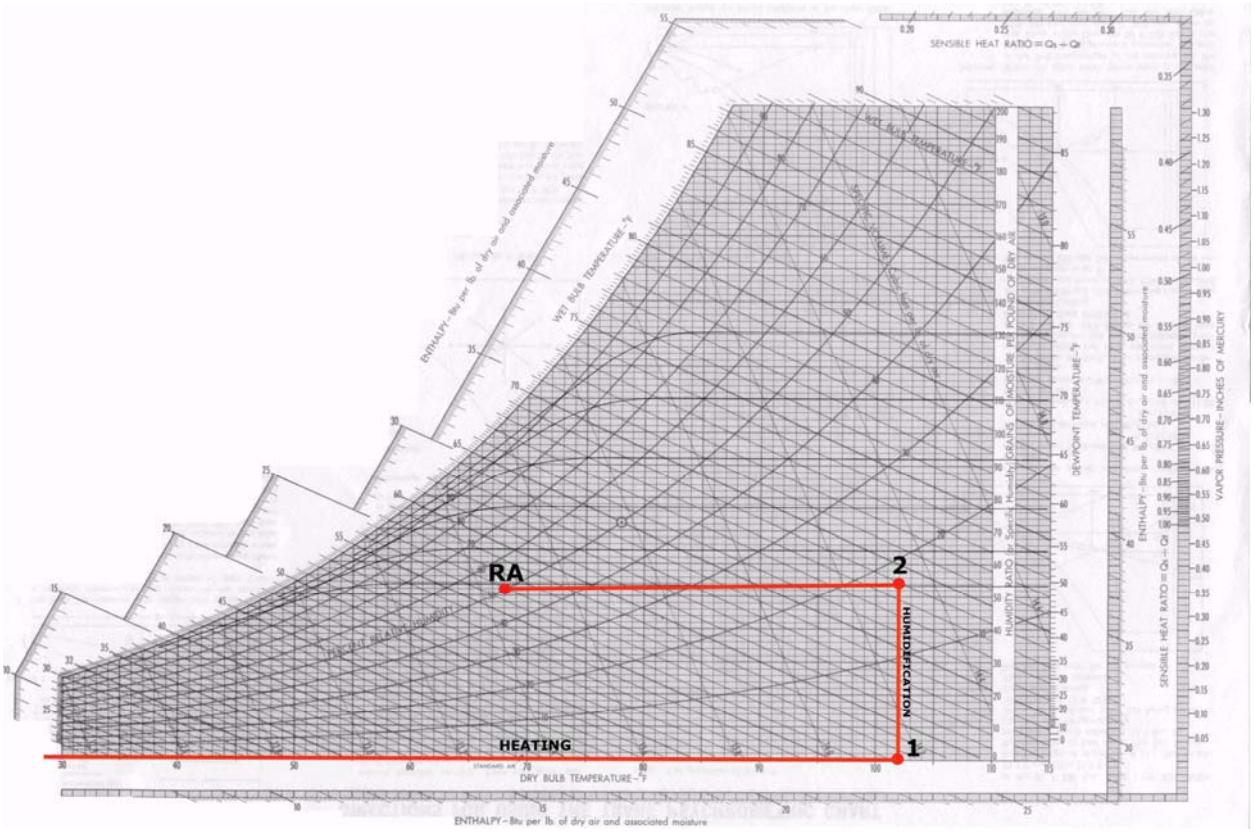
PROCESS 1:	Cooling	Heating
T Supply Air [°F]	53	102
RH Supply Air [%]	100	0
Enthalpy [BTU/lb]	22	24.5
PROCESS 2:	**Reheat**	**Humidify**
T Supply Air [°F]	55	102
RH Supply Air [%]	93	18
Enthalpy [BTU/lb]	22.5	33.1

SUMMER	
Q Cooling [Tons]	-42
Q Reheat [BTU/hr]	13650
Vol. Flow Rate 1 [CFM]	6501.995
Vol. Flow Rate 2 [CFM]	0

WINTER		
Q Preheat [BTU/hr]	275730	
Q Heating [BTU/hr]	308490	819000
Q Humidify [BTU/hr]	234780	
Vol. Flow for Fan [CFM]	5910.45	



Summer Cooling Psychrometric Chart



Winter Heating Psychrometric Chart

LIGHTING/ELECTRICAL
Electrical Calculations

45	luminaires	x	4	lamps/luminaire	=	180	lamps
180	lamps	/	2	lamps/ballast	=	90	ballasts
90	ballasts	x	98 W/ballast / 0.98 PF		=	9000	VA
9000	VA	x 1.25	=	11250	VA		
11250	/	3 x 277	=	13.54	A 3Φ		
4 CCCs:	13.54	A x 1.25	=	16.92	A		
Feeder:	4 #12 Wires	@ 25(0.8)	=	20	A		
Breaker:	20	A					

	50 duplex receptacles	x	180 VA/receptacle	=	9000	VA
				x	1.25	growth
					11250	VA
I =	$\frac{11250}{3 \times 120}$	=	31.3 A (Feeder) -->	40 A Breaker		
		Use	(4) #8 Wire			

Lamp Information

PHILIPS

44 watt 48" T8 Recessed Double Contact R17d Base High Output 4,100K ALTO Fluorescent Philips Light Bulb

Philips F48T8/HO/TL841 ALTO 38810

$16.95

Quantity: 1

ADD TO CART

SHIPPING ALERT

There will be an extra surcharge on this item because extra shipping costs are required.

Our Part #:	PL38810
Manufacturer:	Philips
Manufacturer Code:	F48T8/HO/TL841 ALTO
Case Size:	24 ($406.80/Case)
Light Output:	4,000 lumens
Energy Used:	44 watts
Average Lifetime:	18,000 hours
Bulb Type:	T8
Base Type:	Recessed Double Contact R17d
Color Temperature:	4,100K

Color Temperature is the color of the light coming from the bulb.

CRI:	86
Length:	48 inches

Ballast Information

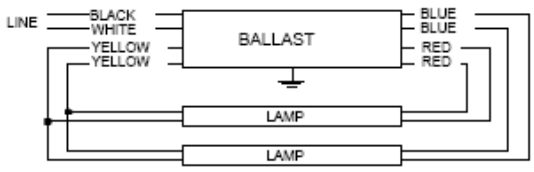
ADVANCE

ICN-2S86@277V	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F48T8/HO	1	44	-20/-29	0.23	59	1.02	20	0.98	1.5	1.73
* F48T8/HO	2	44	-20/-29	0.36	98	0.95	10	0.98	1.5	0.97
F60T8/HO	1	55	-20/-29	0.26	70	1.00	20	0.98	1.5	1.43
F60T8/HO	2	55	-20/-29	0.45	118	0.92	10	0.98	1.4	0.78
F72T8/HO	1	65	-20/-29	0.30	81	1.00	15	0.98	1.5	1.23
F72T8/HO	2	65	-20/-29	0.54	140	0.94	10	0.98	1.4	0.67
F96T8/HO	1	86	-20/-29	0.36	100	1.00	10	0.98	1.5	1.00
F96T8/HO	2	86	-20/-29	0.68	185	0.95	10	0.98	1.4	0.51

Wiring Diagram



Diag. 21

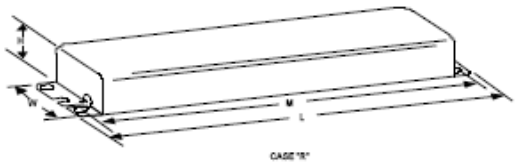
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	22	55.9
White	22	55.9
Blue	46	116.8
Red	46	116.8
Yellow	70	177.8
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White		0
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
11.75 "	2.875 "	1.78125 "	11.14062 "
11 3/4	2 7/8	1 25/32	11 9/64
29.8 cm	7.3 cm	4.5 cm	28.3 cm

Revised 01/26/2004

Data is based upon tests performed by Advance Transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.

ADVANCE
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Corporate Offices: Phone: 800-322-2086

Average Illuminance Calculation Sheet

GENERAL INFORMATION

Project Identification: **Alternative Care Facility**
(give name of area and/or building and room number)

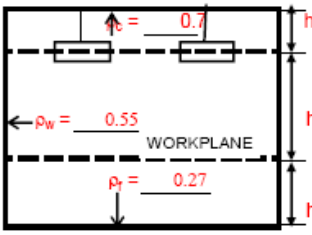
Average maintained Illuminance for design: _____ lux
50 fc

Luminaire Data:
Manufacturer: Corelite Stellar
Catalog number: SB-WB-4T8 DL70

Lamp Data:
Type and Color: F48T8/HO 4100 K
Number per luminaire: 4
Total lumens per lamp: 4000

SELECTION OF COEFFICIENT OF UTILIZATION

Step 1: Fill in sketch at right



Step 2: Determine Cavity Ratios

Ceiling Cavity Ratio, RCR = 0.172
Room Cavity Ratio, CCR = 1.090
Floor Cavity Ratio, FCR = 0.344

Step 3: Obtain Effective Ceiling Cavity Reflectance (ρ_{cc}) — ρ_{cc} = 0.67

Step 4: Obtain Effective Floor Cavity Reflectance (ρ_{fc}) — ρ_{fc} = 0.26

Step 5: Obtain Co-efficient of Utilization (CU) from Manufacturer's Data — CU (67/55/20) = 0.77

Correction for ρ_{fc} = 1.022 x 0.77 = 0.787

SELECTION OF LIGHT LOSS FACTORS

Nonrecoverable		Recoverable	
Luminaire ambient temperature		Room surface dirt depreciation (RSDD)	0.9
Heat extraction thermal factor			
Voltage to luminaire		Lamp lumen depreciation (LLD)	0.9
Ballast factor	0.95		
Ballast-lamp photometric factor		Lamp burnouts factor (LBO)	
Equipment operating factor			
Luminaire surface depreciation		Luminaire dirt depreciation (LDD)	0.9

LLF = 0.69255

CALCULATIONS

(average maintained Illuminance)

$$\text{Number of Luminaires} = \frac{(\text{Illuminance}) \times (\text{Area})}{(\text{Lamps per Luminaire}) \times (\text{Lumens per lamp}) \times (\text{CU}) \times (\text{LLF})}$$

$$= \frac{(50) \times (104 \times 75)}{(4) \times (4000) \times (.787) \times (.721)} = 45 \text{ luminaires}$$

$$\text{Illuminance} = \frac{(\#\text{ luminaires}) \times (\text{Lamps per Luminaire}) \times (\text{Lumens per lamp}) \times (\text{CU}) \times (\text{LLF})}{\text{Area}}$$

$$= \frac{(45) \times (4) \times (4000) \times (.787) \times (.693)}{(104 \times 75)} = 50 \text{ fc}$$