victoria interval

MTOB[pennsylvania]

ae senior thesis [struc]
advisor [dr. boothby]
april 3,2013

MTOB

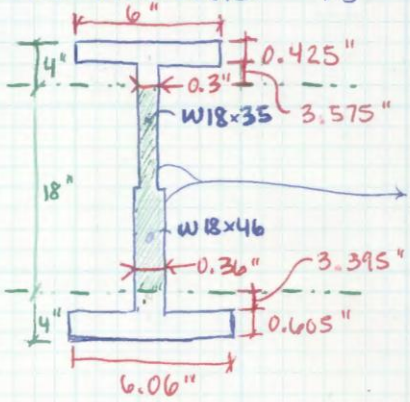
final report

contents

appendix A: cellular beams

A.1 plastic moments

PLASTIC MOMENTS 1/5



TOP TEE SECTION (W18×35)

$A_f = b_f t_f = (6)(0.425) = 2.55\ in^2$
$A_w = h_w t_w = (3.575)(0.3) = 1.0725\ in^2$

AREA FLANGE BELOW PNA:
$\frac{1}{2}(A_f - A_w) = \frac{1}{2}(2.55 - 1.0725) = 0.73875\ in^2 = 0.74\ in^2$

DIST TO PNA
$\frac{A_{BELOW}}{b_f} = \frac{0.74}{6"} = 0.123"$

MOMENTS ABOUT PNA

- FLANGE ABOVE
  $A = 2.55 - 0.74 = 1.81$ ARM $= \frac{1}{2}(0.425 - 0.123) = 0.151$
- FLANGE BELOW
  $A =$ ~~1.0725~~ 0.74 ARM $= \frac{1}{2}(0.123) = 0.615$
- WEB
  $A = 1.0725$ ARM $= \frac{1}{2}(3.575) = 1.7875$

$Z_p = \underbrace{(1.81)(0.151)}_{\text{FL. ABOVE}} + \underbrace{0.74(0.615)}_{\text{FL. BELOW}} + \underbrace{(1.0725)(1.7875)}_{\text{WEB}} = \boxed{2.65\ in^3}$

$\sigma = 50\ ksi$

$M_p = (50\ ksi)(2.65\ in^3) = \boxed{132\ k\text{-}in}$

PLASTIC MOMENTS 2/5

MIDDLE WEB, W18×35 (TOP HALF)

$t_w = 0.30$ in

$M_p = \frac{bh^2}{4} F_y$ (RECTANGULAR SECTION)

$= \frac{(0.3)(5.28)^2}{4} F_y$ ← 50 KSI

$= (2.09\ in^3)(50\ KSI)$

$= \boxed{104.5\ K \cdot in}$

MIDDLE WEB, W18×46 (BOTTOM HALF)

$t_w = 0.36$ in

$M_p = \frac{(0.36)(5.28)^2}{4} (50\ KSI)$

$= (2.5\ in^3)(50\ KSI)$

$= \boxed{125.5\ k\,in}$

PLASTIC MOMENTS 3/5

BOTTOM TEE

$A_f = b_f t_f = (6.06)(0.605) = 3.6663$

$A_w = t_w h_w = (0.36)(3.395) = 1.222$

AREA FL. BELOW PNA =

$\frac{1}{2}(A_f - A_w) = \frac{1}{2}(3.6663 - 1.222) = 1.222$

DIST TO PNA

$\frac{A_{BELOW}}{b_f} = \frac{1.222}{6.06} = 0.202$ in

MOMENTS ABOUT PNA

- FLANGE ABOVE
  A = 3.6663 - 1.222 = 2.4443 ARM = $\frac{1}{2}(0.605 - 0.202) = 0.2015$
- FLANGE BELOW
  A = 1.222 ARM = $\frac{1}{2}(0.202) = 0.101$
- WEB
  A = 1.222 ARM = $\frac{1}{2}(3.395) = 1.6975$

$Z_p = (2.4443)(0.2015) + (1.222)(0.101) + (1.222)(1.6975)$

$= 2.69$ in^3

$\sigma = 50$ KSI

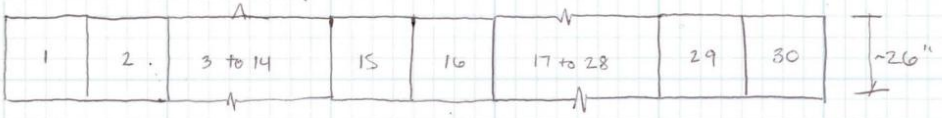
$M_p = (2.69)(50) = \boxed{134.5 \text{ k in}}$

A.2 example plastic analysis calculation

PLASTIC ANALYSIS, UPPERBOUND THM. 1/2

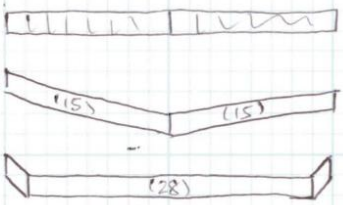
EXAMPLE CALCULATION (SEE SPREADSHEET FOR COMPLETE VERSION)

30-CELL CELLULAR BM:



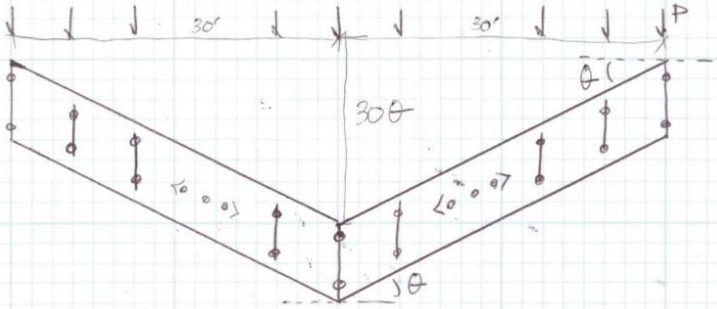
ASSUMING COLLAPSE MECHANISMS WILL ALL BE SYMMETRICAL SINCE THE LOAD IS UNIFORM AND THE SECTIONS ARE SYMMETRICAL

POSSIBLE MECHANISM SHAPES



AND ALL VARIATIONS B/t THESE TWO

WE WILL FIRST CHECK THIS COLLAPSE MECHANISM:



P IS APPLIED @ EVERY PANEL

P IS THE COLLAPSE LOAD

62 TOTAL HINGES

ALSO, NOTE HINGE FORMATION IN THE WEB MEMBERS. THIS IS B/C FOR BOTH W18×35, W18×46, WE HAVE:

$$M_{P,WEB} < M_{P,TEE}$$

$$M_{P,WEB,\,18\times35} = 104.5\ k\cdot in$$

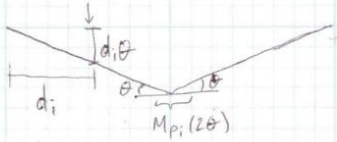
$$M_{P,WEB,\,18\times46} = 125.5\ k\cdot in$$

PLASTIC ANALYSIS, UPPER BOUND THM 2/2

EX CALCULATION

$$\delta W_{EXT} = \delta W_{INT}$$

$$\Sigma P(d_i \theta) = \Sigma M_{P_i}(\theta_i)$$



$$P(2+4+6+\cdots+28+30+28+\cdots+2)\theta = M_{P35}(2\theta) + 30M_{P35}(\theta) + M_{P46}(2\theta) + 30\theta M_{P46}$$

$$450P\theta = 32M_{P35}\theta + 32M_{P46}\theta$$

$$= 32(104.5) + 32(125.5)$$

$$\Rightarrow P = \frac{7360}{450}$$

$$= 16.3556 \text{ K PER PANEL}$$

$$= \boxed{8.18 \text{ K/FT}}$$

THE EXCEL SPREADSHEET WILL CALCULATE THIS FOR ALL SYMMETRICAL COLLAPSE MECHANISMS TO FIND THE LEAST UPPERBOUND, WHICH WILL BE THE CORRECT MECHANISM

A.3 spreadsheet for (plastic) symmetrical failure mechanisms

d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:
0	2	0	2	0	2	0	2	0	2	0		0		0	
2	2	2	2	2	2	2	2	2	2	2		2		2	
4	2	4	2	4	2	4	2	4	2	4		4		4	
6	2	6	2	6	2	6	2	6	2	6		6		6	
8	2	8	2	8	2	8	2	8	2	8		8		8	
10	2	10	2	10	2	10	2	10	2	10		10		10	
12	2	12	2	12	2	12	2	12	2	12		12		12	
14	2	14	2	14	2	14	2	14	2	14		14		14	
16	2	16	2	16	2	16	2	16	2	16		16		16	
18	2	18	2	18	2	18	2	18	2	18		18		16	
20	2	20	2	20	2	20	2	20	2	20		18		16	
22	2	22	2	22	2	22	2	22	2	20		18		16	
24	2	24	2	24	2	24	2	22	0	20		18		16	
26	2	26	2	26	2	24	0	22	0	20		18		16	
28	2	28	2	26	0	24	0	22	0	20		18		16	
30	2	28	0	26	0	24	0	22	0	20		18		16	
28	2	28	2	26	0	24	0	22	0	20		18		16	
26	2	26	2	26	2	24	0	22	0	20		18		16	
24	2	24	2	24	2	24	2	22	0	20		18		16	
22	2	22	2	22	2	22	2	22	2	20		18		16	
20	2	20	2	20	2	20	2	20	2	20		18		16	
18	2	18	2	18	2	18	2	18	2	18		18		16	
16	2	16	2	16	2	16	2	16	2	16		16		16	
14	2	14	2	14	2	14	2	14	2	14		14		14	
12	2	12	2	12	2	12	2	12	2	12		12		12	
10	2	10	2	10	2	10	2	10	2	10		10		10	
8	2	8	2	8	2	8	2	8	2	8		8		8	
6	2	6	2	6	2	6	2	6	2	6		6		6	
4	2	4	2	4	2	4	2	4	2	4		4		4	
2	2	2	2	2	2	2	2	2	2	2		2		2	
0	2	0	2	0	2	0	2	0	2	0		0		0	
	62		**60**		**56**		**52**		**48**		**44**		**40**		**36**
$\delta_{ext} = P*\theta*$	450	$\delta_{ext} = P*\theta*$	448	$\delta_{ext} = P*\theta*$	442	$\delta_{ext} = P*\theta*$	432	$\delta_{ext} = P*\theta*$	418	$\delta_{ext} = P*\theta*$	400	$\delta_{ext} = P*\theta*$	378	$\delta_{ext} = P*\theta*$	352
$\delta_{ext} = \theta*$	7360	$\delta_{ext} = \theta*$	6900	$\delta_{ext} = \theta*$	6440	$\delta_{ext} = \theta*$	5980	$\delta_{ext} = \theta*$	5520	$\delta_{ext} = \theta*$	5060	$\delta_{ext} = \theta*$	4600	$\delta_{ext} = \theta*$	4140
P=	16.35556	P=	15.40179	P=	14.57014	P=	13.84259	P=	13.20574	P=	12.65	P=	12.16931	P=	11.76136
w =	**8.177778**	**w =**	**7.700893**	**w =**	**7.285068**	**w =**	**6.921296**	**w =**	**6.602871**	**w =**	**6.325**	**w =**	**6.084656**	**w =**	**5.880682**

d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:	d	# hinges:
0		0		0		0		0		0		0		0	
2		2		2		2		2		2		2		0	
4		4		4		4		4		4		2		0	
6		6		6		6		6		4		2		0	
8		8		8		8		6		4		2		0	
10		10		10		8		6		4		2		0	
12		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
14		12		10		8		6		4		2		0	
12		12		10		8		6		4		2		0	
10		10		10		8		6		4		2		0	
8		8		8		8		6		4		2		0	
6		6		6		6		6		4		2		0	
4		4		4		4		4		4		2		0	
2		2		2		2		2		2		2		0	
0		0		0		0		0		0		0		0	
	32		28		24		20		16		12		8		4
δ_{ext} = P*θ*	322	δ_{ext} = P*θ*	288	δ_{ext} = P*θ*	250	δ_{ext} = P*θ*	208	δ_{ext} = P*θ*	162	δ_{ext} = P*θ*	112	δ_{ext} = P*θ*	58	δ_{ext} = P*θ*	0
δ_{ext} = θ*	3680	δ_{ext} = θ*	3220	δ_{ext} = θ*	2760	δ_{ext} = θ*	2300	δ_{ext} = θ*	1840	δ_{ext} = θ*	1380	δ_{ext} = θ*	920	δ_{ext} = θ*	460
P=	11.42857	P=	11.18056	P=	11.04	P=	11.05769	P=	11.35802	P=	12.32143	P=	15.86207	P=	#DIV/0!
w =	**5.714286**	**w =**	**5.590278**	**w =**	**5.52**	**w =**	**5.528846**	**w =**	**5.679012**	**w =**	**6.160714**	**w =**	**7.931034**	**w =**	**#DIV/0!**
				***least upper bound**											

appendix A: cellular beams

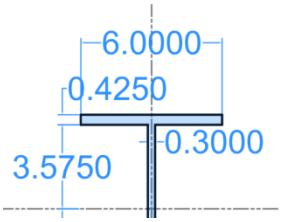
A.4 axial force check on cellular beam

$$w_{failure\ mechanism} = 5.52\frac{k}{ft}\ and\ F = \frac{M}{d}\frac{\left(5.52\frac{k}{ft}\right)(60\ ft)^2}{8} = 95.5\ k$$

top T flange

$$A = (0.425)(6) + (3.575)(0.3) = 3.6225\ in^2$$

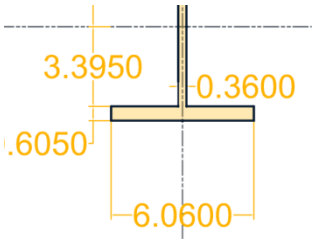
$$\sigma = \frac{F}{A} = \frac{95.5\ k}{3.6225\ in^2} = 26.36\ ksi \leq 50\ ksi$$



Bottom T flange

$$A = (0.605)(6.06) + (3.395)(0.36) = 4.8885\ in^2$$

$$\sigma = \frac{F}{A} = \frac{95.5\ k}{4.8885\ in^2} = 19.54\ ksi \leq 50\ ksi$$



A.5 deflection check on cellular beam

live load deflection

$$\Delta_{LL,allow} = \frac{L}{360} = \frac{(60')\left(12\frac{in}{ft}\right)}{360} = 2\ in$$

$$\Delta_{LL} \approx \frac{5 \cdot w \cdot L^4}{384 \cdot E \cdot I} = \frac{(5)\left(0.281\frac{k}{ft}\right)(60\ ft)^4(12^3)}{(384)(29{,}000\ ksi)(1433\ in^4)} = 1.97\ in \leq 2\ in\ \text{GOOD}$$

$$I = \frac{bh^3}{12} = \left(\frac{(6.03")(26")^3}{12}\right) - 2 \cdot \left(\frac{(2.85")(24.97")^3}{12} + (2.85)(24.97)(0.18")^2\right) = 1433\ in^4$$

total load deflection

$$\Delta_{TL,allow} = \frac{L}{240} = \frac{(60')\left(12\frac{in}{ft}\right)}{240} = 3\ in$$

$$\Delta_{TL} \approx \frac{5 \cdot w \cdot L^4}{384 \cdot E \cdot I} = \frac{(5)\left(0.846\frac{k}{ft}\right)(60\ ft)^4(12^3)}{(384)(29{,}000\ ksi)(1433\ in^4)} = 5.94\ in - (3"\ camber) = 2.94\ in \leq 3\ in\ \text{GOOD}$$

A.6 interaction check

NOTE: these values are taken from the RAM model

Precomposite:
Beam: V = 3.69 kips M = 196.09 kip-ft at 22.125 ft
Top Tee:
fa = 25.68 ksi fb = 3.98 ksi H1-1: 0.869 + 0.113 = 0.982
Fa = 29.54 ksi Fb = 30.00 ksi H1-2: 0.856 + 0.133 = 0.988

Beam: V = 5.79 kips M = 174.76 kip-ft at 17.625 ft
Bot Tee:
fa = 16.89 ksi fb = 6.58 ksi
Ft = 30.00 ksi Fb = 30.00 ksi H2-1: 0.563 + 0.219 = 0.782

Composite: Vc = 10.75 kips
Beam: V = 21.91 kips M = 97.58 kip-ft at 4.125 ft
Top Tee:
fa = 5.63 ksi fb = 12.03 ksi H1-1: 0.191 + 0.341 = 0.532
Fa = 29.54 ksi Fb = 30.00 ksi H1-2: 0.188 + 0.401 = 0.589

Beam: V = 0.95 kips M = 380.50 kip-ft at 28.875 ft
Bot Tee:
fa = 31.88 ksi fb = 0.00 ksi
Ft = 33.00 ksi Fb = 33.00 ksi H2-1: 0.966 + 0.000 = 0.966

A.7 web post buckling

NOTE: these values are taken from the RAM model

Precomposite Max Vh = 12.21 kips at 2.88 ft

	Mmax kip-ft	Mallow kip-ft	Mmax/Mallow
Top:	8.24	12.84	0.642
Bot:	8.24	16.37	0.503

Composite Max Vh = 19.00 kips at 2.88 ft

	Mmax kip-ft	Mallow kip-ft	Mmax/Mallow
Top:	12.82	12.84	0.999
Bot:	12.82	16.37	0.783

Therefore, web post buckling controls the section of cellular beam selected

A.8 cellular beam cost analysis

30'x30' composite beam and slab system = **$17.30**[19]

Assembly B10102564200 **Based on National Average Costs**

Floor, composite metal deck, shear connectors, 5.5" slab, 30'x30' bay, 23.5" total depth, 40 PSF superimposed load, 81 PSF total load

Description	Quantity	Unit	Material	Installation	Total
Shores, vertical members, to 10' high, includes erect and strip by hand	0.01500	Ea.	0.00	0.30	0.30
Welded wire fabric, sheets, 6 x 6 - W1.4 x W1.4 (10 x 10) 121 lb. per C.S.F., A185, incl...	0.01000	C.S.F.	0.15	0.36	0.51
Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes strike...	0.33300	C.F.	0.00	0.51	0.51
Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes local aggre...	0.33300	C.F.	2.41	0.00	2.41
Concrete finishing, floors, for specified Random Access Floors in ACI Classes 1, 2, 3 an...	1.00000	S.F.	0.00	0.86	0.86
Concrete surface treatment, curing, sprayed membrane compound	0.01000	C.S.F.	0.08	0.09	0.17
Weld shear connector, 3/4" dia x 4-7/8" L	0.12600	Ea.	0.09	0.25	0.35
Structural steel project, apartment, nursing home, etc, 100-ton project, 3 to 6 stories,...	4.45400	Lb.	6.24	1.92	8.15
Metal floor decking, steel, non-cellular, composite, galvanized, 3" D, 22 gauge	1.05000	S.F.	2.08	0.98	3.06
Metal decking, steel edge closure form, galvanized, with 2 bends, 12" wide, 18 gauge	0.03300	L.F.	0.13	0.08	0.21
Sprayed fireproofing, cementitious, normal density, beams, 1 hour rated, 1-3/8" thick...	0.50400	S.F.	0.29	0.50	0.79
Total			$11.45	$5.85	$17.30

Assuming that the only change from this system is the replacement of W-shape with cellular beams, we have:

@ 60' span, expect SmartBEAM (LB27x35/46) to cost $150/ton more than traditional W-shape[20]

LB27x35/46 typical beam size, 3 beams per 30'x60' bay

$$\frac{35+46}{2} = 40.5\ PLF\ (60') \cdot (3bms) = 7290\# = 3.65\ tons$$

Since the bay size is double the typical bay (30'x30'), divide tonnage by two

$$\frac{3.65\ tons}{2} = \left(\frac{1.82\ tons}{30'\times30'bay}\right) \times \left(\frac{\$150}{ton}\right) = \frac{\$273}{30'\times30'bay}$$

$$\frac{\$273}{900\ SF} = +\$\mathbf{0.30\ per\ SF} \times (152{,}000\ SF) \approx \$46{,}200\ total\ additional\ cost$$

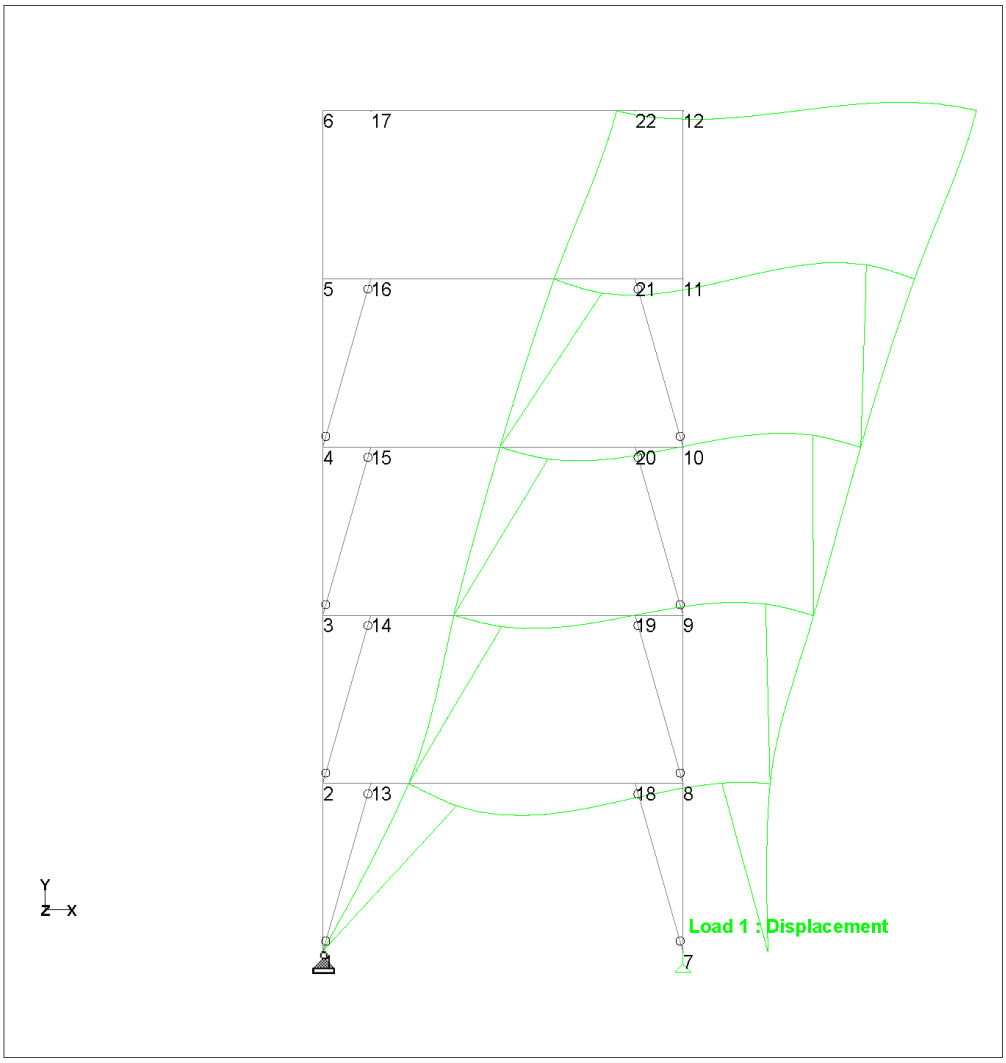
$17.30 + $0.30 = $17.60 Total Cost per SF

[19] "RSMeansOnline," Reed Construction Data Inc., 2013 <meanscostworks.com> (12 October 2012)
[20] Steve Redman, CMC Steel, Personal communication (21 March 2013).

appendix B: lateral analysis

B.1 existing frame stiffness calculation

Academic license user	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref		
	By	Date 19-Feb-13	Chd
Client	File STIFFNESS - existing fra	Date/Time 19-Feb-2013 18:02	



Whole Structure Displacements 0.001in:1in 1 LOAD CASE 1

Print Time/Date: 19/02/2013 18:03 STAAD.Pro V8i (SELECTseries 3)/Academic 20.07.08.22 Print Run 1 of 2

Academic license user	Job No	Sheet No 2	Rev
	Part		
Job Title	Ref		
	By	Date 19-Feb-13	Chd
Client	File STIFFNESS - existing fra	Date/Time 19-Feb-2013 18:02	

Node Displacements

Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
2	1:LOAD CASE	0.086	-0.000	0.000	0.086	0.000	0.000	-0.000
3	1:LOAD CASE	0.131	-0.000	0.000	0.131	0.000	0.000	-0.000
4	1:LOAD CASE	0.177	-0.000	0.000	0.177	0.000	0.000	-0.000
5	1:LOAD CASE	0.231	-0.000	0.000	0.231	0.000	0.000	-0.000
6	1:LOAD CASE	0.294	-0.000	0.000	0.294	0.000	0.000	-0.000
7	1:LOAD CASE	0.085	0.000	0.000	0.085	0.000	0.000	0.000
8	1:LOAD CASE	0.087	-0.000	0.000	0.087	0.000	0.000	-0.000
9	1:LOAD CASE	0.130	-0.001	0.000	0.130	0.000	0.000	-0.000
10	1:LOAD CASE	0.177	-0.000	0.000	0.177	0.000	0.000	-0.000
11	1:LOAD CASE	0.231	-0.000	0.000	0.231	0.000	0.000	-0.000
12	1:LOAD CASE	0.293	-0.000	0.000	0.293	0.000	0.000	-0.000
13	1:LOAD CASE	0.086	-0.023	0.000	0.089	0.000	0.000	-0.000
14	1:LOAD CASE	0.131	-0.012	0.000	0.131	0.000	0.000	-0.000
15	1:LOAD CASE	0.177	-0.012	0.000	0.178	0.000	0.000	-0.000
16	1:LOAD CASE	0.231	-0.015	0.000	0.232	0.000	0.000	-0.000
17	1:LOAD CASE	0.294	-0.008	0.000	0.294	0.000	0.000	-0.000
18	1:LOAD CASE	0.087	0.000	0.000	0.087	0.000	0.000	0.000
19	1:LOAD CASE	0.130	0.011	0.000	0.131	0.000	0.000	-0.000
20	1:LOAD CASE	0.177	0.012	0.000	0.178	0.000	0.000	-0.000
21	1:LOAD CASE	0.231	0.014	0.000	0.232	0.000	0.000	-0.000
22	1:LOAD CASE	0.293	0.007	0.000	0.293	0.000	0.000	-0.000

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	6	1:LOAD CASE	**0.294**	-0.000	0.000	0.294	0.000	0.000	-0.000
Min X	1	1:LOAD CASE	**0.000**	0.000	0.000	0.000	0.000	0.000	-0.001
Max Y	21	1:LOAD CASE	0.231	**0.014**	0.000	0.232	0.000	0.000	-0.000
Min Y	13	1:LOAD CASE	0.086	**-0.023**	0.000	0.089	0.000	0.000	-0.000
Max Z	1	1:LOAD CASE	0.000	0.000	**0.000**	0.000	0.000	0.000	-0.001
Min Z	1	1:LOAD CASE	0.000	0.000	**0.000**	0.000	0.000	0.000	-0.001
Max rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	**0.000**	0.000	-0.001
Min rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	**0.000**	0.000	-0.001
Max rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	**0.000**	-0.001
Min rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	**0.000**	-0.001
Max rZ	18	1:LOAD CASE	0.087	0.000	0.000	0.087	0.000	0.000	**0.000**
Min rZ	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	**-0.001**
Max Rst	17	1:LOAD CASE	0.294	-0.008	0.000	**0.294**	0.000	0.000	-0.000

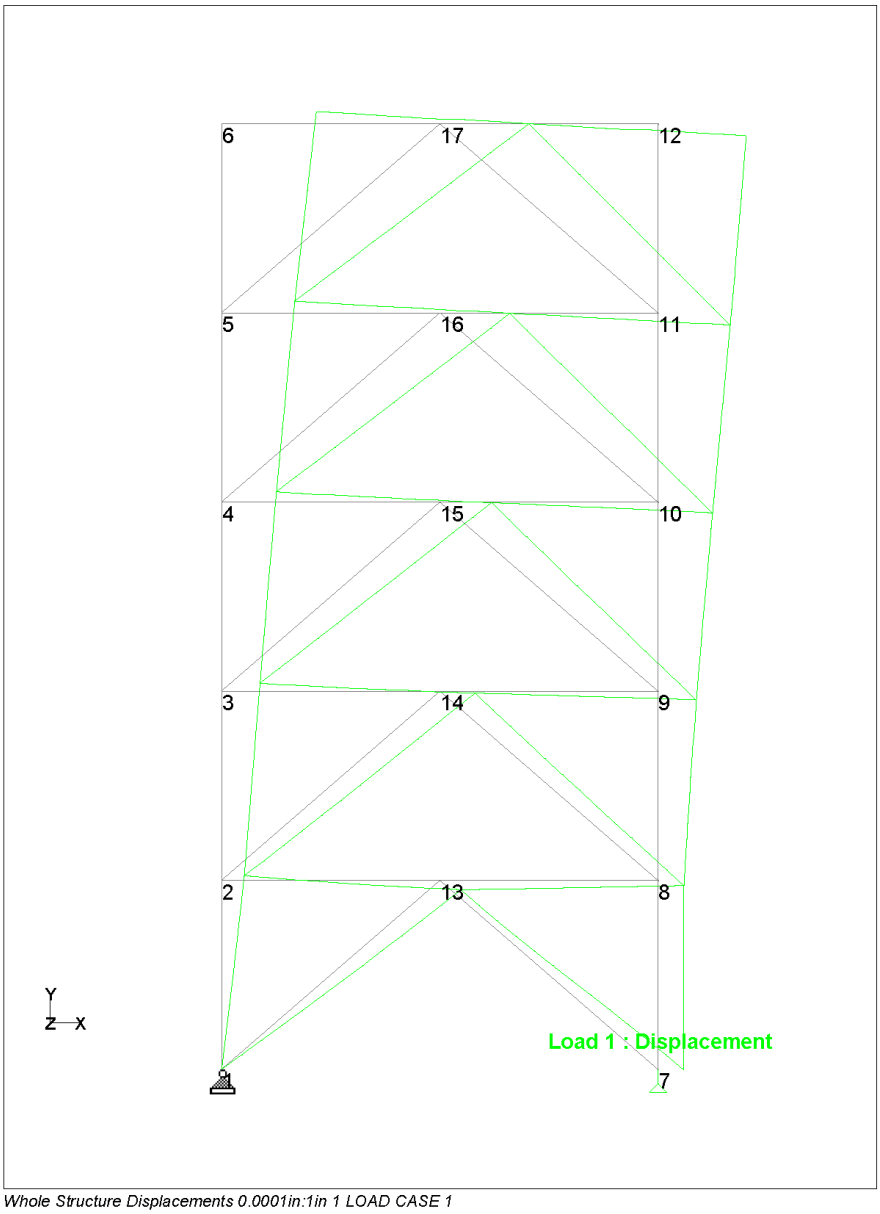
Print Time/Date: 19/02/2013 18:03 STAAD.Pro V8i (SELECTseries 3)/Academic 20.07.08.22 Print Run 2 of 2

Stiffness of original frame

$K = \frac{P}{\Delta} = \frac{1\ k}{0.294\ in} = 3.34\ ksi$ using STAAD values of displacement

B.2 proposed frame stiffness calculation

Academic license user	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref		
	By	Date 19-Feb-13	Chd
Client	File STIFFNESS - new frame.	Date/Time	19-Feb-2013 17:58



Whole Structure Displacements 0.0001in:1in 1 LOAD CASE 1

Print Time/Date: 19/02/2013 18:02 STAAD.Pro V8i (SELECTseries 3)/Academic 20.07.08.22 Print Run 1 of 2

Academic license user	Job No	Sheet No 2	Rev
	Part		
Job Title	Ref		
	By	Date 19-Feb-13	Chd
Client	File STIFFNESS - new frame.	Date/Time 19-Feb-2013 17:58	

Node Displacements

Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
2	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
3	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
4	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
5	1:LOAD CASE	0.001	0.000	0.000	0.001	0.000	0.000	-0.000
6	1:LOAD CASE	0.001	0.000	0.000	0.001	0.000	0.000	-0.000
7	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	-0.000
8	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
9	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
10	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
11	1:LOAD CASE	0.000	-0.000	0.000	0.001	0.000	0.000	-0.000
12	1:LOAD CASE	0.001	-0.000	0.000	0.001	0.000	0.000	-0.000
13	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
14	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
15	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
16	1:LOAD CASE	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
17	1:LOAD CASE	0.001	-0.000	0.000	0.001	0.000	0.000	-0.000

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	6	1:LOAD CASE	**0.001**	0.000	0.000	0.001	0.000	0.000	-0.000
Min X	1	1:LOAD CASE	**0.000**	0.000	0.000	0.000	0.000	0.000	-0.000
Max Y	6	1:LOAD CASE	0.001	**0.000**	0.000	0.001	0.000	0.000	-0.000
Min Y	12	1:LOAD CASE	0.001	**-0.000**	0.000	0.001	0.000	0.000	-0.000
Max Z	1	1:LOAD CASE	0.000	0.000	**0.000**	0.000	0.000	0.000	-0.000
Min Z	1	1:LOAD CASE	0.000	0.000	**0.000**	0.000	0.000	0.000	-0.000
Max rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	**0.000**	0.000	-0.000
Min rX	1	1:LOAD CASE	0.000	0.000	0.000	0.000	**0.000**	0.000	-0.000
Max rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	**0.000**	-0.000
Min rY	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	**0.000**	-0.000
Max rZ	7	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	**-0.000**
Min rZ	1	1:LOAD CASE	0.000	0.000	0.000	0.000	0.000	0.000	**-0.000**
Max Rst	6	1:LOAD CASE	0.001	0.000	0.000	**0.001**	0.000	0.000	-0.000

Print Time/Date: 19/02/2013 18:02 STAAD.Pro V8i (SELECTseries 3)/Academic 20.07.08.22 Print Run 2 of 2

Stiffness of proposed frame

$K = \frac{P}{\Delta} = \frac{1\ k}{0.1\ in} = 10\ ksi$ using STAAD values of displacement

B.3 story displacement load cases/combos

allowable inter-story drift

$$\frac{H}{400} = \frac{(13\ ft)\left(12\frac{in}{ft}\right)}{400} = 0.39\ in \geq 0.23398\ in\ maximum\ in\ RAM\ model, OK$$

load case definitions

1	D	DeadLoad	RAMUSER
2	Lp	PosLiveLoad	RAMUSER
3	Sp	PosRoofLiveLoad	RAMUSER
4	E1	Wind	EQ_IBC09_X_+E_F
5	E2	Wind	EQ_IBC09_X_-E_F
6	E3	Wind	EQ_IBC09_Y_+E_F
7	E4	Wind	EQ_IBC09_Y_-E_F
8	E5	Seismic	EQ_IBC09_X_+E_F
9	E6	Seismic	EQ_IBC09_X_-E_F
10	E7	Seismic	EQ_IBC09_Y_+E_F
11	E8	Seismic	EQ_IBC09_Y_-E_F
12	W1	Wind Calc X	W_User
13	W2	Wind Calc Y	W_User

load combinations

1 *	1.000 D
2 *	1.000 D + 1.000 Lp
3 *	1.000 D + 1.000 Sp
4 *	1.000 D + 0.750 Lp + 0.750 Sp
5 *	1.000 D + 1.000 W1
6 *	1.000 D + 1.000 W2
7 *	1.000 D - 1.000 W1
8 *	1.000 D - 1.000 W2
9 *	1.000 D + 0.750 Lp + 0.750 Sp + 0.750 W1
10 *	1.000 D + 0.750 Lp + 0.750 Sp + 0.750 W2
11 *	1.000 D + 0.750 Lp + 0.750 Sp - 0.750 W1
12 *	1.000 D + 0.750 Lp + 0.750 Sp - 0.750 W2
13 *	1.000 D + 0.750 Lp + 0.750 W1
14 *	1.000 D + 0.750 Lp + 0.750 W2
15 *	1.000 D + 0.750 Lp - 0.750 W1
16 *	1.000 D + 0.750 Lp - 0.750 W2
17 *	1.000 D + 0.750 Sp + 0.750 W1
18 *	1.000 D + 0.750 Sp + 0.750 W2
19 *	1.000 D + 0.750 Lp-0.525 E1

20 *	1.000 D + 0.750 Sp - 0.750 W2
21 *	0.600 D + 1.000 W1
22 *	0.600 D + 1.000 W2
23 *	0.600 D - 1.000 W1
24 *	0.600 D - 1.000 W2
25 *	1.012 D + 0.700 E1
26 *	1.012 D + 0.700 E2
27 *	1.012 D + 0.700 E3
28 *	1.012 D + 0.700 E4
29 *	1.012 D + 0.700 E5
30 *	1.012 D + 0.700 E6
31 *	1.012 D + 0.700 E7
32 *	1.012 D + 0.700 E8
33 *	1.012 D - 0.700 E1
34 *	1.012 D - 0.700 E2
35 *	1.012 D - 0.700 E3
36 *	1.012 D - 0.700 E4
37 *	1.012 D - 0.700 E5
38 *	1.012 D - 0.700 E6
39 *	1.012 D - 0.700 E7
40 *	1.012 D - 0.700 E8
41 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E1
42 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E2
43 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E3
44 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E4
45 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E5
46 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E6
47 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E7
48 *	1.009 D + 0.750 Lp + 0.750 Sp + 0.525 E8
49 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E1
50 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E2
51 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E3
52 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E4
53 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E5
54 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E6
55 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E7
56 *	1.009 D + 0.750 Lp + 0.750 Sp - 0.525 E8
57 *	1.009 D + 0.750 Lp + 0.525 E1
58 *	1.009 D + 0.750 Lp + 0.525 E2
59 *	1.009 D + 0.750 Lp + 0.525 E3
60 *	1.009 D + 0.750 Lp + 0.525 E4
61 *	1.009 D + 0.750 Lp + 0.525 E5
62 *	1.009 D + 0.750 Lp + 0.525 E6
63 *	1.009 D + 0.750 Lp + 0.525 E7

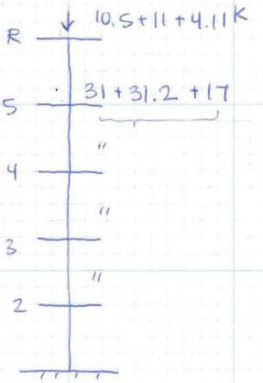
64 *	1.009 D + 0.750 Lp + 0.525 E8
65 *	1.009 D + 0.750 Lp - 0.525 E1
66 *	1.009 D + 0.750 Lp - 0.525 E2
67 *	1.009 D + 0.750 Lp - 0.525 E3
68 *	1.009 D + 0.750 Lp - 0.525 E4
69 *	1.009 D + 0.750 Lp - 0.525 E5
70 *	1.009 D + 0.750 Lp - 0.525 E6
71 *	1.009 D + 0.750 Lp - 0.525 E7
72 *	1.009 D + 0.750 Lp - 0.525 E8
73 *	1.009 D + 0.750 Sp + 0.525 E1
74 *	1.009 D + 0.750 Sp + 0.525 E2
75 *	1.009 D + 0.750 Sp + 0.525 E3
76 *	1.009 D + 0.750 Sp + 0.525 E4
77 *	1.009 D + 0.750 Sp + 0.525 E5
78 *	1.009 D + 0.750 Sp + 0.525 E6
79 *	1.009 D + 0.750 Sp + 0.525 E7
80 *	1.009 D + 0.750 Sp + 0.525 E8
81 *	1.009 D + 0.750 Sp - 0.525 E1
82 *	1.009 D + 0.750 Sp - 0.525 E2
83 *	1.009 D + 0.750 Sp - 0.525 E3
84 *	1.009 D + 0.750 Sp - 0.525 E4
85 *	1.009 D + 0.750 Sp - 0.525 E5
86 *	1.009 D + 0.750 Sp - 0.525 E6
87 *	1.009 D + 0.750 Sp - 0.525 E7
88 *	1.009 D + 0.750 Sp - 0.525 E8
89 *	0.588 D + 0.700 E1
90 *	0.588 D + 0.700 E2
91 *	0.588 D + 0.700 E3
92 *	0.588 D + 0.700 E4
93 *	0.588 D + 0.700 E5
94 *	0.588 D + 0.700 E6
95 *	0.588 D + 0.700 E7
96 *	0.588 D + 0.700 E8
97 *	0.588 D - 0.700 E1
98 *	0.588 D - 0.700 E2
99 *	0.588 D - 0.700 E3
100 *	0.588 D - 0.700 E4
101 *	0.588 D - 0.700 E5
102 *	0.588 D - 0.700 E6
103 *	0.588 D - 0.700 E7
104 *	0.588 D - 0.700 E8

appendix C: foundation loads

IMPACT ON FOUNDATIONS @ B2, B9, D2, D9, F2, F9

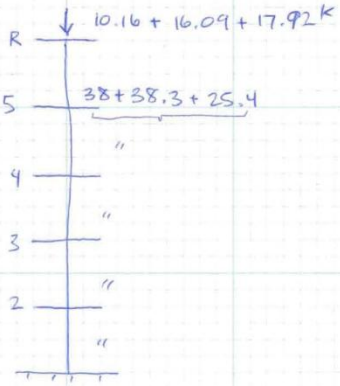
EDGE COL (B2, F2, B9, F9)

existing loads



TOTAL LOAD = 342.4 K

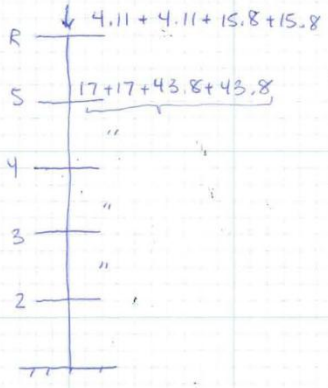
redesign loads



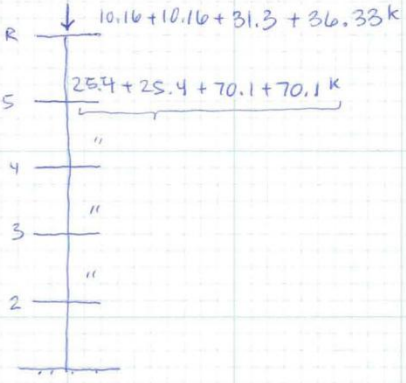
TOTAL LOAD = 443.2 K

$\Rightarrow \frac{443.2}{342.4} = 1.3 =$ 30% increase in load on col/foundation

MIDDLE COL (D2, D9)



TOTAL LOAD = 526 k



TOTAL LOAD = 857 K

$\Rightarrow \frac{857}{526} = 1.63 =$ 63% increase in load on foundation

appendix D: architectural calcs

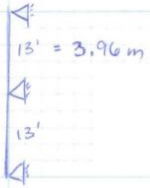
D.1 mullion design

MULLION DESIGN ½

WIND LOAD: 22 PSF × 5' = 110 PLF

$110\ PLF \times \frac{1FT}{0.3048\ m} \times \frac{4.45N}{1\#} = 1.61\ kN/m$

ASSUME: MULLION IS ALUMINUM 6063-T5
EXP JOINTS ARE RIGID



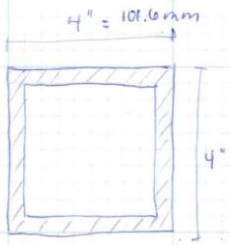
BENDING:

$+M_{max} = \alpha_m \cdot q \cdot L^2$
$= (0.0703)(1.61\ kN/m)(3.96m)^2$
$= 1.77\ kN \cdot m$

$-M_{max} = \alpha_m\ q\ L^2$
$= (-0.125)(1.61)(3.96)^2$
$= -3.16\ kN \cdot m$

$\therefore -M_{max} = -3.16\ kN \cdot m$ CONTROLS

$\sigma = \frac{Mc}{I} = \frac{M}{S} \Rightarrow S = \frac{M}{\sigma}$



$S = \frac{M}{\sigma} = \frac{-3.16\ kN \cdot m}{69000\ kN/m^2} = 4.57\ E\text{-}5\ m^3$
$= 45{,}700 mm^3$

$S \leq \frac{I}{y}$

$45700 mm^3 \leq \frac{(\frac{1}{12})(101.6mm)^4 - (\frac{1}{12})(101.6-2t)^4}{(101.6/2)}$

$2{,}321{,}560 + 8879603 = -(\frac{1}{12})(101.6-2t)^4$

$78696516 = (101.6-2t)^4$

$94.18 - 101.6 = -2t$

$\Rightarrow t = 3.7 = 4\ mm$ (too thin to make)
↳ try 6.35mm (≈ ¼")

MULLION DESIGN (cont) 2/2

SHEAR:

$Q_{max} = \alpha_q \, q \, L$

$= (0.625)(1.61)(3.96)$

$= 3.98 \text{ kN}$

$T = \left(\frac{3}{2}\right)\frac{V}{A} \Rightarrow A = \left(\frac{3}{2}\right)\frac{V}{T}$

$A = \left(\frac{3}{2}\right)\frac{3980 \text{ N}}{37 \text{ N/mm}^2}$

$= 157.7 \text{ mm}^2$

$157.7 \leq (101.6)^2 - (101.6 - 2t)^2$

$100.82 \leq 101.6 - 2t$

$0.39 \text{ mm} \leq t$ (again, too small $\rightarrow$ stick w/ 6.35mm ~ $\frac{1}{4}$")

DEFLECTION

$f_{max} = \frac{\alpha_f \, q \, L^4}{100 \, E \, I}$

$= \frac{(0.521)(1.61)(3.96)^4}{100(70000 \text{ N/mm}^2)\left[\left(\frac{1}{12}\right)(101.6)^4 - \left(\frac{1}{12}\right)(101.6 - (6.35)(2))^4\right]}$

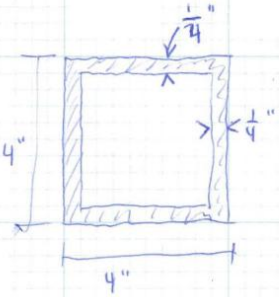
$= \frac{206.27 \times 10^{12}}{(100)(70000)(8674543)}$

$= 8.02 \text{ mm}$

$f_{allow} = \frac{\text{SPAN}}{180} = \frac{3960 \text{ mm}}{180} = 22 \not\leq 20 \Rightarrow$ use 20mm

$8.01 \text{ mm} < 20 \text{ mm}$, ∴ GOOD!

USE $\frac{1}{4}$" THICK (6.35mm) MULLION



D.2 R-value + temp gradients

existing brick veneer wall system

layer material	conductivity, k (W/mK)	thickness, l (m)	conductance, C C = k/l (W/m^2K)	resistance, R_{SI} R_{SI} = 1/C m^2K/W	temp change, ΔT $\Delta T = (R_i/\Sigma R_i)*(T_{int}-T_{ext})$ (°C)	t (°C)
exterior temp (-15 C, 85% RH)						-15
exterior film	-	-	34.00	0.029	0.393	
						-14.607
brick	1.3	0.09	14.44	0.069	0.926	
						-13.681
air gap	-	0.04	-	0.170	2.273	
						-11.408
rigid insulation (EPS 1)	0.039	0.05	0.78	1.282	17.144	
						5.736
Batt Insulation/Stud	-	0.07	-	0.896	11.981	
						17.717
gypsum board	0.16	0.02	8.00	0.125	1.672	
						19.389
interior film	-	-	8.30	0.120	1.611	
interior temp (21 C, 40% RH)						21

R_{SI} =	**2.692**
$R_{value} = 5.678*R_{SI}$ =	**15.286**
U_{SI} =	**0.371**
U_{value} =	**0.065**

redesigned insulated panel [brick skin]

layer material	conductivity, k (W/mK)	thickness, l (m)	conductance, C C = k/l (W/m^2K)	resistance, R_{SI} R_{SI} = 1/C m^2K/W	temp change, ΔT $\Delta T = (R_i/\Sigma R_i)*(T_{int}-T_{ext})$ (°C)	t (°C)
exterior temp (-15 C, 85% RH)						-15
exterior film	-	-	34.00	0.029	0.273	
						-14.727
brick	1.3	0.09	14.44	0.069	0.643	
						-14.084
air gap	-	0.04	-	0.170	1.579	
						-12.505
insulation panel	-	0.0508	-	2.466	22.902	
						10.397
3" Batt Insulation/6"Stud	-	0.07	-	0.896	8.322	
						18.720
gypsum board	0.16	0.02	8.00	0.125	1.161	
						19.881
interior film	-	-	8.30	0.120	1.119	
interior temp (21 C, 40% RH)						21

R_{SI} =	**3.876**
$R_{value} = 5.678*R_{SI}$ =	**22.007**
U_{SI} =	**0.258**
U_{value} =	**0.045**

redesigned insulated panel [metal skin]

layer material	conductivity, k (W/mK)	thickness, l (m)	conductance, C C = k/l (W/m^2K)	resistance, R_{SI} R_{SI} = 1/C m^2K/W	temp change, ΔT $\Delta T = (R_i/\Sigma R_i)*(T_{int}-T_{ext})$ (°C)	t (°C)
exterior temp (-15 C, 85% RH)						-15
exterior film	-	-	34.00	0.029	0.278	
						-14.722
metal panel	80	0.008	10000.00	0.000	0.001	
						-14.721
air gap	-	0.04	-	0.170	1.608	
						-13.113
insulation panel	0.039	0.0508	-	2.466	23.318	
						10.205
3" Batt Insulation/6"Stud	-	0.07	-	0.896	8.474	
						18.678
gypsum board	0.16	0.02	8.00	0.125	1.182	
						19.861
interior film	-	-	8.30	0.120	1.139	
interior temp (21 C, 40% RH)						21

R_{SI} =	**3.807**
$R_{value} = 5.678*R_{SI}$ =	**21.614**
U_{SI} =	**0.263**
U_{value} =	**0.046**

D.3 pressure gradient + RH

existing brick veneer wall system

layer material	permeability, μ permeability, μ (ng/Pa*s*m)	permeance, M M = μ/t (ng/Pa*s*m^2)	R_{vj} R_{vj} = 1/M (Pa*s*m^2/ng)	pressure change, ΔP $\Delta P = (R_{vj}/\Sigma R_{vj})*(P_{int}-P_{ext})$ (Pa)	P_w @ interface (Pa)	$P_{w,sat}$ $P_{w,sat}=1000e^{(52.58-6790.5/T-5.028lnT)}$ (Pa)	RH $RH=P_w/Pw_{sat}$ (%)
exterior temp (-15 C, 85% RH)					162.43	191.1	85.0
exterior film	-	75000	0.000013	0.163			
					162.6	197.4	82.4
brick	10	111.1111111	0.009000	109.864			
					272.5	212.9	128.0
air gap		7200	0.000139	1.695			
					274.2	255.6	107.2
rigid insulation (EPS 1)	2	40	0.025000	305.179			
					579.3	913.5	63.4
Batt Insulation/Stud	3	42.85714286	0.023333	284.834			
					864.2	2012.8	42.9
gypsum board	2	100	0.010000	122.072			
					986.2	2234.3	44.1
interior film	-	15000	0.000067	0.814			
interior temp (21 C, 40% RH)					987.1	2467.6	40.0
			0.067552	824.62			

redesigned insulated panel [brick skin]

layer material	permeability, μ (ng/Pa*s*m)	permeance, M M = μ/t (ng/Pa*s*m^2)	R_{vj} R_{vj} = 1/M (Pa*s*m^2/ng)	pressure change, ΔP $\Delta P = (R_{vj}/\Sigma R_{vj})*(P_{int}-P_{ext})$ (Pa)	P_w @ interface (Pa)	$P_{w,sat}$ $P_{w,sat}=1000e^{(52.58-6790.5/T-5.028lnT)}$ (Pa)	RH $RH=P_w/Pw_{sat}$ (%)
exterior temp (-15 C, 85% RH)					162.4310376	191.1	85.0
exterior film	-	75000	0.000013	0.161804			
					162.592842	195.4	83.2
brick	10	111.1	0.009000	109.217666			
					271.810507	206.0	131.9
air gap		7200	0.000139	1.685458			
					273.495965	234.1	116.8
insulation panel	2	39.37	0.025400	308.236524			
					581.732489	1253.4	46.4
Batt Insulation/Stud	3	42.86	0.023333	283.156911			
					864.889400	2143.2	40.4
gypsum board	2	100	0.010000	121.352962			
					986.242362	2303.4	42.8
interior film	-	15000	0.000067	0.809020			
interior temp (21 C, 40% RH)					987.051	2467.6	40.0
			0.067952	824.62			

redesigned insulated panel [metal skin]

layer material	permeability, μ (ng/Pa*s*m)	permeance, M M = μ/t (ng/Pa*s*m^2)	R_{vj} R_{vj} = 1/M (Pa*s*m^2/ng)	pressure change, ΔP $\Delta P = (R_{vj}/\Sigma R_{vj})*(P_{int}-P_{ext})$ (Pa)	P_w @ interface (Pa)	$P_{w,sat}$ $P_{w,sat}=1000e^{(52.58-6790.5/T-5.028lnT)}$ (Pa)	RH $RH=P_w/Pw_{sat}$ (%)
exterior temp (-15 C, 85% RH)					162.43	191.1	85.0
exterior film	-	75000	0.000013	0.184			
					162.6	195.5	83.2
metal panel	10	1250	0.000800	11.041			
					173.7	195.5	88.8
air gap		7200	0.000139	1.917			
					175.6	222.9	78.8
insulation panel	2	39.37007874	0.025400	350.537			
					526.1	1237.5	42.5
Batt Insulation/Stud	3	42.85714286	0.023333	322.015			
					848.1	2137.7	39.7
gypsum board	2	100	0.010000	138.007			
					986.1	2300.5	42.9
interior film	-	15000	0.000067	0.920			
interior temp (21 C, 40% RH)					987.1	2467.6	40.0
			0.059752	824.62			

appendix E: mechanical calcs

E.1 HVAC loads for typical floor

HVAC Loads for Typical Floor

Room Name	Area (sf)	Lighting Load (W/sf)	Misc. Load (W/sf)	Number of People	Total Load (btu)	CFM Required	Adjusted CFM
220 Office	240	1.0	0.83	1	1757	80	75
302 Conference	290	1.0	6.90	10	10366	471	475
304 Copy	130	1.0	0.00	0	444	20	25
306 Office	150	1.0	1.33	1	1450	66	75
308 Office	150	1.0	1.33	1	1450	66	75
310 Office	150	1.0	1.33	1	1450	66	75
312 Office	150	1.0	1.33	1	1450	66	75
320 Conference	430	1.0	6.51	14	14594	663	675
322 Kitchen	330	1.0	4.85	8	8627	392	400
324 Conference	430	1.0	6.51	14	14594	663	675
330 Office	150	1.0	1.33	1	1450	66	75
332 Office	150	1.0	1.33	1	1450	66	75
334 Office	150	1.0	1.33	1	1450	66	75
336 Office	150	1.0	1.33	1	1450	66	75
338 Copy	110	1.0	0.00	0	375	17	25
420 Office	250	1.0	0.80	1	1791	81	75
418 Office	150	1.0	1.33	1	1450	66	75
416 Office	150	1.0	1.33	1	1450	66	75
414 Office	150	1.0	1.33	1	1450	66	75
410 Office	150	1.0	1.33	1	1450	66	75
408 Office	150	1.0	1.33	1	1450	66	75
406 Office	150	1.0	1.33	1	1450	66	75
404 Office	150	1.0	1.33	1	1450	66	75
402 Office	250	1.0	0.80	1	1791	81	75
142 Copy	110	1.0	0.00	0	375	17	25
140 Office	150	1.0	1.33	1	1450	66	75
138 Office	150	1.0	1.33	1	1450	66	75
136 Office	150	1.0	1.33	1	1450	66	75
134 Office	150	1.0	1.33	1	1450	66	75
132 Office	150	1.0	1.33	1	1450	66	75
130 Office	160	1.0	1.25	1	1484	67	75
124 Conference	400	1.0	7.00	14	14492	659	650
122 Conference	260	1.0	6.15	8	8388	381	375
120 Conference	410	1.0	6.83	14	14526	660	650
110 Office	160	1.0	1.25	1	1484	67	75
108 Office	150	1.0	1.33	1	1450	66	75
106 Office	150	1.0	1.33	1	1450	66	75
104 Office	150	1.0	1.33	1	1450	66	75
102 Copy	110	1.0	0.00	0	375	17	25
202 Office	240	1.0	0.83	1	1757	80	75
204 Office	150	1.0	1.33	1	1450	66	75
206 Office	150	1.0	1.33	1	1450	66	75
208 Office	150	1.0	1.33	1	1450	66	75
210 Office	160	1.0	1.25	1	1484	67	75
214 Office	150	1.0	1.33	1	1450	66	75
216 Office	150	1.0	1.33	1	1450	66	75
218 Office	160	1.0	1.25	1	1484	67	75

Room Name	Area (sf)	Lighting Load (W/sf)	Misc. Load (W/sf)	Number of People	Total Load (btu)	CFM Required	Adjusted CFM
Open Office NW	1738	1.0	1.15	10	15308	696	700
309 Office	150	1.0	1.33	1	1450	66	75
311 Office	150	1.0	1.33	1	1450	66	75
510 Office	150	1.0	1.33	1	1450	66	75
512 Office	150	1.0	1.33	1	1450	66	75
700 Training Room	600	1.0	6.67	20	20800	945	950
560 Conference	670	1.0	5.37	18	19164	871	875
800 File Room	600	1.0	0.00	0	2048	93	100
329 Office	150	1.0	1.33	1	1450	66	75
331 Office	150	1.0	1.33	1	1450	66	75
530 Office	150	1.0	1.33	1	1450	66	75
532 Office	150	1.0	1.33	1	1450	66	75
Open Office NE	2442	1.0	1.06	13	20523	933	925
Open Office SW	1800	1.0	1.44	13	18332	833	825
609 Office	150	1.0	1.33	1	1450	66	75
607 Office	150	1.0	1.33	1	1450	66	75
605 Office	150	1.0	1.33	1	1450	66	75
603 Office	160	1.0	1.25	1	1484	67	75
107 ITS Server	570	1.0	0.00	0	1945	88	100
107a Storage	240	1.0	0.00	0	819	37	25
111 Guest Office	80	1.0	2.50	1	1211	55	50
001 Elev Lobby	610	1.0	0.00	0	2082	95	100
100 Reception	600	1.0	2.67	8	9549	434	425
129 Office	100	1.0	2.00	1	1279	58	50
131 Guest Office	100	1.0	2.00	1	1279	58	50
135 Guest Office	100	1.0	2.00	1	1279	58	50
133 Kitchen	380	1.0	6.32	12	12548	570	575
909 Office	150	1.0	1.33	1	1450	66	75
907 Office	150	1.0	1.33	1	1450	66	75
905 Office	150	1.0	1.33	1	1450	66	75
903 Office	150	1.0	1.33	1	1450	66	75
Open Office SE	1437	1.0	1.39	10	14280	649	650
100W Corridor	400	1.0	0.00	0	1365	62	50
500W Corridor	800	1.0	0.00	0	2730	124	125
500 Corridor	500	1.0	0.00	0	1707	78	75
300 Corridor	700	1.0	0.00	0	2389	109	100
700n Corridor	191	1.0	0.00	0	652	30	25
800n Corridor	210	1.0	0.00	0	717	33	25
100e Corridor	315	1.0	0.00	0	1075	49	50

TOTALS	
Square Footage	26423
CFM Required	14800
CFM/SF	0.56
Total Population	100
Population Div.	41.3%

E.2 ASHRAE 62.1-2007 outdoor air requirements

Ventilation for Acceptable Indoor Air Quality (ASHRAE 62.1-2007)

	Program Area (SF)	Room Type	People Outdoor Air Rate, Rp	Area Outdoor Air Rate, Ra	Occupant Density, #/1000 sf	Air Class	Zone Population, P_z	Breathing Zone OA, $V_{bz,\ cfm}$	E_z	Zone OA, $V_{oz\ cfm}$
220 Office	240	Office Space	5	0.06	5	1	1	19.4	1.0	19.4
302 Conference	290	Conference/ meeting	5	0.06	50	1	10	67.4	1.0	67.4
304 Copy	130	Storage Rooms	0	0.12	0	0	0	15.6	1.0	15.6
306 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
308 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
310 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
312 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
320 Conference	430	Conference/ meeting	5	0.06	50	1	14	95.8	1.0	95.8
322 Kitchen	330	Office Space	5	0.06	5	1	8	59.8	1.0	59.8
324 Conference	430	Conference/ meeting	5	0.06	50	1	14	95.8	1.0	95.8
330 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
332 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
334 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
336 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
338 Copy	110	Storage Rooms	0	0.12	0	0	0	13.2	1.0	13.2
420 Office	250	Office Space	5	0.06	5	1	1	20	1.0	20
418 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
416 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
414 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
410 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
408 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
406 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
404 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
402 Office	250	Office Space	5	0.06	5	1	1	20	1.0	20
142 Copy	110	Storage Rooms	0	0.12	0	0	0	13.2	1.0	13.2
140 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
138 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
136 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
134 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
132 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
130 Office	160	Office Space	5	0.06	5	1	1	14.6	1.0	14.6
124 Conference	400	Conference/ meeting	5	0.06	50	1	14	94	1.0	94
122 Conference	260	Conference/ meeting	5	0.06	50	1	8	55.6	1.0	55.6
120 Conference	410	Conference/ meeting	5	0.06	50	1	14	94.6	1.0	94.6
110 Office	160	Office Space	5	0.06	5	1	1	14.6	1.0	14.6
108 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
106 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
104 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
102 Copy	110	Storage Rooms	0	0.12	0	0	0	13.2	1.0	13.2
202 Office	240	Office Space	5	0.06	5	1	1	19.4	1.0	19.4
204 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
206 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
208 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
210 Office	160	Office Space	5	0.06	5	1	1	14.6	1.0	14.6
214 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
216 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
218 Office	160	Office Space	5	0.06	5	1	1	14.6	1.0	14.6

	Program Area (SF)	Room Type	People Outdoor Air Rate, Rp	Area Outdoor Air Rate, Ra	Occupant Density, #/1000 sf	Air Class	Zone Population, P_z	Breathing Zone OA, $V_{bz,\ cfm}$	E_z	Zone OA, $V_{oz\ cfm}$
Open Office NW	1738	Office Space	5	0.06	5	1	10	154.28	1.0	154.28
309 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
311 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
510 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
512 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
700 Training Room	600	Conference/ meeting	5	0.06	50	1	20	136	1.0	136
560 Conference	670	Conference/ meeting	5	0.06	50	1	18	130.2	1.0	130.2
800 File Room	600	Storage Rooms	0	0.12	0	0	0	72	1.0	72
329 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
331 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
530 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
532 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
Open Office NE	2442	Office Space	5	0.06	5	1	13	211.52	1.0	211.52
Open Office SW	1800	Office Space	5	0.06	5	1	13	173	1.0	173
609 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
607 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
605 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
603 Office	160	Office Space	5	0.06	5	1	1	14.6	1.0	14.6
107 ITS Server	570	Electrical Equip Rooms	0	0.06	0	0	0	34.2	1.0	34.2
107a Storage	240	Storage Rooms	0	0.12	0	0	0	28.8	1.0	28.8
111 Office	80	Office Space	5	0.06	5	1	1	9.8	1.0	9.8
001 Elev Lobby	610	Reception Areas	5	0.06	5	1	0	36.6	1.0	36.6
100 Reception	600	Reception Areas	5	0.06	5	1	8	76	1.0	76
129 Office	100	Office Space	5	0.06	5	1	1	11	1.0	11
131 Office	100	Office Space	5	0.06	5	1	1	11	1.0	11
135 Office	100	Office Space	5	0.06	5	1	1	11	1.0	11
133 Kitchen	380	Office Space	5	0.06	5	1	12	82.8	1.0	82.8
909 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
907 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
905 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
903 Office	150	Office Space	5	0.06	5	1	1	14	1.0	14
Open Office SE	1437	Office Space	5	0.06	5	1	10	136.22	1.0	136.22
100W Corridor	400	Corridors	0	0.06	0	1	0	24	1.0	24
500W Corridor	800	Corridors	0	0.06	0	1	0	48	1.0	48
500 Corridor	500	Corridors	0	0.06	0	1	0	30	1.0	30
300 Corridor	700	Corridors	0	0.06	0	1	0	42	1.0	42
700n Corridor	191	Corridors	0	0.06	0	1	0	11.46	1.0	11.46
800n Corridor	210	Corridors	0	0.06	0	1	0	12.6	1.0	12.6
100e Corridor	315	Corridors	0	0.06	0	1	0	18.9	1.0	18.9

System Checksums

By ACADEMIC

AHU-01 — **Packaged Terminal Air Conditioner**

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	20,115	0	20,115	17
Glass/Door Cond	718	0	718	1
Wall Cond	2,648	0	2,648	2
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	19,816		19,816	17
Sub Total ==>	43,297	0	43,297	37
Internal Loads				
Lights	18,258	4,564	22,822	19
People	34,878	0	34,878	29
Misc	0	0	0	0
Sub Total ==>	53,136	4,564	57,700	49
Ceiling Load	0	0	0	0
Ventilation Load	0	0	20,017	17
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-2,450	-2,450	-2
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	96,433	2,114	118,564	100.00

CLG SPACE PEAK

Mo/Hr: Sum of
OADB: Peaks

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	27,352	37
Glass/Door Cond	-219	0
Wall Cond	2,658	4
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	5,346	7
Sub Total ==>	35,137	47
Internal Loads		
Lights	18,258	25
People	20,880	28
Misc	0	0
Sub Total ==>	39,138	53
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing	0	0
Exhaust Heat		
OA Preheat Diff.		
RA Preheat Diff.		
Additional Reheat		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	74,275	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-10,229	-10,229	8.10
Wall Cond	-6,560	-6,560	5.19
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-54,828	-54,828	43.39
Sub Total ==>	-71,618	-71,618	56.68
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-54,736	43.32
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-71,618	-126,354	100.00

TEMPERATURES

	Cooling	Heating
SADB	53.5	90.8
Ra Plenum	75.0	70.0
Return	76.1	70.0
Ret/OA	78.5	54.1
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	3,233	3,233
Terminal	3,233	3,233
Main Fan	3,233	3,233
Sec Fan	0	0
Nom Vent	789	789
AHU Vent	789	789
Infil	790	790
MinStop/Rh	0	0
Return	4,023	4,023
Exhaust	1,579	1,579
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	24.4	24.4
cfm/ft²	0.53	0.53
cfm/ton	327.22	
ft²/ton	615.26	
Btu/hr·ft²	19.50	-20.79
No. People	85	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter gr/lb	Leave DB °F	Leave WB °F	Leave gr/lb
Main Clg	9.9	118.6	80.0	3,233	77.9	64.9	75.6	53.5	52.5	60.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	9.9	118.6								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	6,079		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	2,232	670	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-126.4	3,233	54.1	90.8
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-126.4			

Project Name:
Dataset Name: MTOB 1-1.TRC

TRACE® 700 v6.2.9 calculated at 03:31 PM on 02/25/2013
Alternative - 1 System Checksums Report Page 1 of 4

System Checksums

By ACADEMIC

AHU-02 — **Packaged Terminal Air Conditioner**

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	24,662	0	24,662	18
Glass/Door Cond	-108	0	-108	0
Wall Cond	2,491	0	2,491	2
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	25,243		25,243	19
Sub Total ==>	52,288	0	52,288	39
Internal Loads				
Lights	23,703	5,926	29,629	22
People	34,110	0	34,110	25
Misc	0	0	0	0
Sub Total ==>	57,813	5,926	63,738	47
Ceiling Load	0	0	0	0
Ventilation Load	0	0	21,643	16
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-3,305	-3,305	-2
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	110,100	2,621	134,364	100.00

CLG SPACE PEAK

Mo/Hr: Sum of
OADB: Peaks

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	30,852	37
Glass/Door Cond	-808	-1
Wall Cond	2,496	3
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	6,806	8
Sub Total ==>	39,346	47
Internal Loads		
Lights	23,703	28
People	20,203	24
Misc	0	0
Sub Total ==>	43,906	53
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing		
Exhaust Heat	0	0
Grand Total ==>	83,251	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-11,161	-11,161	7.40
Wall Cond	-7,158	-7,158	4.75
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-71,180	-71,180	47.21
Sub Total ==>	-89,500	-89,500	59.36
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-61,267	40.64
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-89,500	-150,767	100.00

TEMPERATURES

	Cooling	Heating
SADB	52.3	94.4
Ra Plenum	75.0	70.0
Return	76.3	70.0
Ret/OA	78.8	53.3
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	3,433	3,433
Terminal	3,433	3,433
Main Fan	3,433	3,433
Sec Fan	0	0
Nom Vent	883	883
AHU Vent	883	883
Infil	1,026	1,026
MinStop/Rh	0	0
Return	4,459	4,459
Exhaust	1,909	1,909
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	25.7	25.7
cfm/ft²	0.43	0.43
cfm/ton	306.58	
ft²/ton	704.83	
Btu/hr·ft²	17.03	-19.10
No. People	82	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	11.2	134.4	89.9	3,433	77.9	64.7	74.5	52.3	51.3	57.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	11.2	134.4								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	7,892		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	2,436	731	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-150.8	3,433	53.3	94.4
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-150.8			

Project Name:
Dataset Name: MTOB 1-1.TRC

TRACE® 700 v6.2.9 calculated at 03:31 PM on 02/25/2013

System Checksums

By ACADEMIC

AHU-03 — **Packaged Terminal Air Conditioner**

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	31,859	0	31,859	30
Glass/Door Cond	933	0	933	1
Wall Cond	4,271	0	4,271	4
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	18,540		18,540	17
Sub Total ==>	55,603	0	55,603	52
Internal Loads				
Lights	15,924	3,981	19,905	19
People	18,321	0	18,321	17
Misc	0	0	0	0
Sub Total ==>	34,245	3,981	38,226	36
Ceiling Load	0	0	0	0
Ventilation Load	0	0	14,613	14
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-1,962	-1,962	-2
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	89,848	2,019	106,481	100.00

CLG SPACE PEAK

Mo/Hr: Sum of
OADB: Peaks

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	41,680	54
Glass/Door Cond	-44	0
Wall Cond	4,619	6
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	4,690	6
Sub Total ==>	50,944	66
Internal Loads		
Lights	15,924	21
People	10,634	14
Misc	0	0
Sub Total ==>	26,558	34
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing	0	0
Exhaust Heat		
OA Preheat Diff.		
RA Preheat Diff.		
Additional Reheat		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	77,502	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-10,634	-10,634	10.40
Wall Cond	-6,820	-6,820	6.67
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-47,820	-47,820	46.77
Sub Total ==>	-65,275	-65,275	63.84
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-36,965	36.16
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-65,275	-102,240	100.00

TEMPERATURES

	Cooling	Heating
SADB	57.3	84.9
Ra Plenum	75.0	70.0
Return	75.8	70.0
Ret/OA	77.1	61.6
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	4,102	4,102
Terminal	4,102	4,102
Main Fan	4,102	4,102
Sec Fan	0	0
Nom Vent	533	533
AHU Vent	533	533
Infil	689	689
MinStop/Rh	0	0
Return	4,791	4,791
Exhaust	1,222	1,222
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	13.0	13.0
cfm/ft²	0.77	0.77
cfm/ton	462.27	
ft²/ton	597.52	
Btu/hr·ft²	20.08	-19.28
No. People	43	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter DB/WB/HR °F	Enter DB/WB/HR gr/lb	Leave DB/WB/HR °F	Leave DB/WB/HR °F	Leave DB/WB/HR gr/lb
Main Clg	8.9	106.5	77.4	4,102	76.7	63.3	69.7	57.3	54.5	61.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	8.9	106.5								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	5,302		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	2,320	696	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-102.2	4,102	61.6	84.9
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-102.2			

Project Name:
Dataset Name: MTOB 1-1.TRC

TRACE® 700 v6.2.9 calculated at 03:31 PM on 02/25/2013

System Checksums

By ACADEMIC

AHU-04 — **Packaged Terminal Air Conditioner**

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	36,368	0	36,368	26
Glass/Door Cond	1,639	0	1,639	1
Wall Cond	5,187	0	5,187	4
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	26,094		26,094	19
Sub Total ==>	69,288	0	69,288	50
Internal Loads				
Lights	21,475	5,369	26,843	19
People	25,158	0	25,158	18
Misc	0	0	0	0
Sub Total ==>	46,632	5,369	52,001	37
Ceiling Load	0	0	0	0
Ventilation Load	0	0	20,750	15
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-2,601	-2,601	-2
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	115,920	2,768	139,438	100.00

CLG SPACE PEAK

Mo/Hr: Sum of
OADB: Peaks

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	42,604	45
Glass/Door Cond	1,086	1
Wall Cond	5,536	6
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	9,037	10
Sub Total ==>	58,262	62
Internal Loads		23
Lights	21,475	16
People	14,785	0
Misc	0	38
Sub Total ==>	36,260	0
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing		0
Exhaust Heat	0	0
OA Preheat Diff.		0
RA Preheat Diff.		0
Additional Reheat		0
Underflr Sup Ht Pkup		0
Supply Air Leakage		0
Grand Total ==>	94,522	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-11,835	-11,835	8.80
Wall Cond	-7,590	-7,590	5.65
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-64,488	-64,488	47.97
Sub Total ==>	-83,913	-83,913	62.42
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-50,526	37.58
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-83,913	-134,438	100.00

TEMPERATURES

	Cooling	Heating
SADB	56.2	86.7
Ra Plenum	75.0	70.0
Return	75.9	70.0
Ret/OA	77.5	60.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	4,718	4,718
Terminal	4,718	4,718
Main Fan	4,718	4,718
Sec Fan	0	0
Nom Vent	728	728
AHU Vent	728	728
Infil	930	930
MinStop/Rh	0	0
Return	5,648	5,648
Exhaust	1,658	1,658
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	15.4	15.4
cfm/ft²	0.66	0.66
cfm/ton	406.06	
ft²/ton	615.33	
Btu/hr·ft²	19.50	-18.80
No. People	60	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter DB/WB/HR °F	Enter DB/WB/HR gr/lb	Leave DB/WB/HR °F	Leave DB/WB/HR °F	Leave DB/WB/HR gr/lb
Main Clg	11.6	139.4	100.6	4,718	77.2	64.0	72.0	56.2	54.0	61.4
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	11.6	139.4								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	7,150		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	2,582	775	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-134.4	4,718	60.0	86.7
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-134.4			

Project Name:
Dataset Name: MTOB 1-1.TRC

TRACE® 700 v6.2.9 calculated at 03:31 PM on 02/25/2013
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Room Checksums

By ACADEMIC

220 Office

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 17
Outside Air: OADB/WB/HR: 84 / 69 / 90

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	2,835	0	2,835	45
Glass/Door Cond	262	0	262	4
Wall Cond	522	0	522	8
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	756		756	12
Sub Total ==>	4,374	0	4,374	70
Internal Loads				
Lights	721	180	901	14
People	540	0	540	9
Misc	0	0	0	0
Sub Total ==>	1,261	180	1,441	23
Ceiling Load	0	0	0	0
Ventilation Load	0	0	494	8
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-30	-30	0
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	5,635	150	6,280	100.00

CLG SPACE PEAK

Mo/Hr: 6 / 17
OADB: 82

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	3,029	61
Glass/Door Cond	197	4
Wall Cond	502	10
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	216	4
Sub Total ==>	3,945	79
Internal Loads		
Lights	721	15
People	300	6
Misc	0	0
Sub Total ==>	1,021	21
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Exhaust Heat	0	0
Grand Total ==>	4,965	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-1,787	-1,787	27.44
Wall Cond	-1,146	-1,146	17.60
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-2,165	-2,165	33.23
Sub Total ==>	-5,098	-5,098	78.27
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-1,415	21.73
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-5,098	-6,513	100.00

TEMPERATURES

	Cooling	Heating
SADB	58.4	87.1
Ra Plenum	75.0	70.0
Return	75.5	70.0
Ret/OA	76.2	65.3
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	280	280
Terminal	280	280
Main Fan	280	280
Sec Fan	0	0
Nom Vent	20	20
AHU Vent	20	20
Infil	31	31
MinStop/Rh	0	0
Return	311	311
Exhaust	52	52
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	7.3	7.3
cfm/ft²	1.17	1.17
cfm/ton	534.78	
ft²/ton	458.62	
Btu/hr·ft²	26.17	-27.14
No. People	1	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	0.5	6.3	5.3	280	76.2	63.1	69.4	58.4	55.5	64.3
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.5	6.3								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	240		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	390	117	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-6.5	280	65.3	87.1
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-6.5			

Project Name:
Dataset Name: MTOB 1-1.TRC

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Room Checksums

By ACADEMIC

306 Office

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 8
Outside Air: OADB/WB/HR: 69 / 65 / 88

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	1,906	0	1,906	62
Glass/Door Cond	-68	0	-68	-2
Wall Cond	131	0	131	4
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	140		140	5
Sub Total ==>	2,109	0	2,109	69
Internal Loads				
Lights	451	113	563	18
People	338	0	338	11
Misc	0	0	0	0
Sub Total ==>	788	113	901	29
Ceiling Load	0	0	0	0
Ventilation Load	0	0	91	3
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-25	-25	-1
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	2,897	88	3,077	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 8
OADB: 69

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	1,906	77
Glass/Door Cond	-68	-3
Wall Cond	131	5
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	-127	-5
Sub Total ==>	1,842	74
Internal Loads		
Lights	451	18
People	188	8
Misc	0	0
Sub Total ==>	638	26
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing		
Exhaust Heat	0	0
OA Preheat Diff.		
RA Preheat Diff.		
Additional Reheat		
System Plenum Heat		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	2,480	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-673	-673	20.14
Wall Cond	-432	-432	12.92
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-1,353	-1,353	40.48
Sub Total ==>	-2,458	-2,458	73.53
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-885	26.47
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-2,458	-3,342	100.00

TEMPERATURES

	Cooling	Heating
SADB	56.9	87.9
Ra Plenum	75.0	70.0
Return	75.7	70.0
Ret/OA	75.0	63.6
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	129	129
Terminal	129	129
Main Fan	129	129
Sec Fan	0	0
Nom Vent	13	13
AHU Vent	13	13
Infil	20	20
MinStop/Rh	0	0
Return	148	148
Exhaust	32	32
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	9.9	9.9
cfm/ft²	0.86	0.86
cfm/ton	501.84	
ft²/ton	585.04	
Btu/hr·ft²	20.51	-22.28
No. People	1	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter DB/WB/HR °F	Enter DB/WB/HR gr/lb	Leave DB/WB/HR °F	Leave DB/WB/HR °F	Leave DB/WB/HR gr/lb
Main Clg	0.3	3.1	2.5	129	75.0	62.8	69.8	56.9	54.7	63.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.3	3.1								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	150		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	147	44	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-3.3	129	63.6	87.9
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-3.3			

Project Name:
Dataset Name: MTOB 1-1.TRC

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Room Checksums

By ACADEMIC

309 Office

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	0	0	0	0
Glass/Door Cond	0	0	0	0
Wall Cond	0	0	0	0
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	575		575	33
Sub Total ==>	575	0	575	33
Internal Loads				
Lights	451	113	563	32
People	338	0	338	19
Misc	0	0	0	0
Sub Total ==>	788	113	901	51
Ceiling Load	0	0	0	0
Ventilation Load	0	0	376	21
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-85	-85	-5
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	1,363	27	1,766	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 15
OADB: 86

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	0	0
Glass/Door Cond	0	0
Wall Cond	0	0
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	229	26
Sub Total ==>	229	26
Internal Loads		
Lights	451	52
People	188	22
Misc	0	0
Sub Total ==>	638	74
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Dehumid. Ov Sizing		
Ov/Undr Sizing	0	0
Exhaust Heat		
Sup. Fan Heat		
Ret. Fan Heat		
Duct Heat Pkup		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	867	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	0	0	0.00
Wall Cond	0	0	0.00
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-1,353	-1,353	60.47
Sub Total ==>	-1,353	-1,353	60.47
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-885	39.53
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-1,353	-2,237	100.00

TEMPERATURES

	Cooling	Heating
SADB	39.8	125.0
Ra Plenum	75.0	70.0
Return	77.5	70.0
Ret/OA	82.2	34.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	23	23
Terminal	23	23
Main Fan	23	23
Sec Fan	0	0
Nom Vent	13	13
AHU Vent	13	13
Infil	20	20
MinStop/Rh	0	0
Return	43	43
Exhaust	32	32
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	55.3	55.3
cfm/ft²	0.15	0.15
cfm/ton	156.64	
ft²/ton	1,019.50	
Btu/hr·ft²	11.77	-14.92
No. People	1	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	0.2	1.8	1.0	23	82.2	67.8	83.4	39.8	39.5	37.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.2	1.8								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	150		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	0	0	0
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-2.2	23	34.0	125.0
Aux Htg	0.0	0	0.0	0.0
Preheat	-0.1	23	34.0	39.8
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-2.2			

Project Name:
Dataset Name: MTOB 1-1.TRC

Room Checksums

By ACADEMIC

320 Conference

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 71 / 95

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	1,007	0	1,007	6
Glass/Door Cond	269	0	269	2
Wall Cond	302	0	302	2
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	1,684		1,684	10
Sub Total ==>	3,261	0	3,261	19
Internal Loads				
Lights	1,291	323	1,614	9
People	8,600	0	8,600	50
Misc	0	0	0	0
Sub Total ==>	9,891	323	10,214	59
Ceiling Load	0	0	0	0
Ventilation Load	0	0	4,015	23
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	0		0	0
Exhaust Heat		-126	-126	-1
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	13,152	197	17,364	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 8
OADB: 69

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	4,639	42
Glass/Door Cond	-165	-2
Wall Cond	319	3
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	-364	-3
Sub Total ==>	4,429	40
Internal Loads		
Lights	1,291	12
People	5,268	48
Misc	0	0
Sub Total ==>	6,559	60
Ceiling Load	0	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing		
Exhaust Heat	0	0
OA Preheat Diff.		
RA Preheat Diff.		
Additional Reheat		
System Plenum Heat		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	10,988	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-1,638	-1,638	10.36
Wall Cond	-1,051	-1,051	6.64
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-3,878	-3,878	24.52
Sub Total ==>	-6,567	-6,567	41.52
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-9,248	58.48
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-6,567	-15,816	100.00

TEMPERATURES

	Cooling	Heating
SADB	51.0	84.4
Ra Plenum	75.0	70.0
Return	75.6	70.0
Ret/OA	78.9	49.8
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	428	428
Terminal	428	428
Main Fan	428	428
Sec Fan	0	0
Nom Vent	133	133
AHU Vent	133	133
Infil	56	56
MinStop/Rh	0	0
Return	484	484
Exhaust	189	189
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	31.1	31.1
cfm/ft²	1.00	1.00
cfm/ton	295.89	
ft²/ton	297.17	
Btu/hr·ft²	40.38	-36.78
No. People	22	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter DB/WB/HR °F	Enter DB/WB/HR gr/lb	Leave DB/WB/HR °F	Leave DB/WB/HR °F	Leave DB/WB/HR gr/lb
Main Clg	1.5	17.4	10.6	428	78.9	65.4	76.3	51.0	50.9	57.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	1.5	17.4								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	430		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	358	107	30
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-15.8	428	49.8	84.4
Aux Htg	0.0	0	0.0	0.0
Preheat	-0.6	428	49.8	51.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-15.8			

Project Name:
Dataset Name: MTOB 1-1.TRC

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E.5 IBC tables used

SECTION 503
GENERAL BUILDING HEIGHT AND AREA LIMITATIONS

TABLE 503
ALLOWABLE BUILDING HEIGHTS AND AREAS[a]

Building height limitations shown in feet above grade plane. Story limitations shown as stories above grade plane.

Building area limitations shown in square feet, as determined by the definition of "Area, building," per story

GROUP		TYPE OF CONSTRUCTION							
		TYPE I		TYPE II		TYPE III		TYPE IV	T
		A	B	A	B	A	B	HT	A
	HEIGHT (feet)	UL	160	65	55	65	55	65	50
		STORIES(S) AREA (A)							
A-1	S A	UL UL	5 UL	3 15,500	2 8,500	3 14,000	2 8,500	3 15,000	2 11,50
A-2	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,50
A-3	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,50
A-4	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,50
A-5	S A	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL
B	S A	UL UL	11 UL	5 37,500	3 23,000	5 28,500	3 19,000	5 36,000	3 18,00
E	S A	UL UL	5 UL	3 26,500	2 14,500	3 23,500	2 14,500	3 25,500	1 18,50
F-1	S A	UL UL	11 UL	4 25,000	2 15,500	3 19,000	2 12,000	4 33,500	2 14,00
F-2	S A	UL UL	11 UL	5 37,500	3 23,000	4 28,500	3 18,000	5 50,500	3 21,00
H-1	S A	1 21,000	1 16,500	1 11,000	1 7,000	1 9,500	1 7,000	1 10,500	1 7,500

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A[d]	B	A[d]	B	HT	A[d]	B
Primary structural frame[g] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[f, g] Interior	3 3[a]	2 2[a]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[e]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and secondary members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

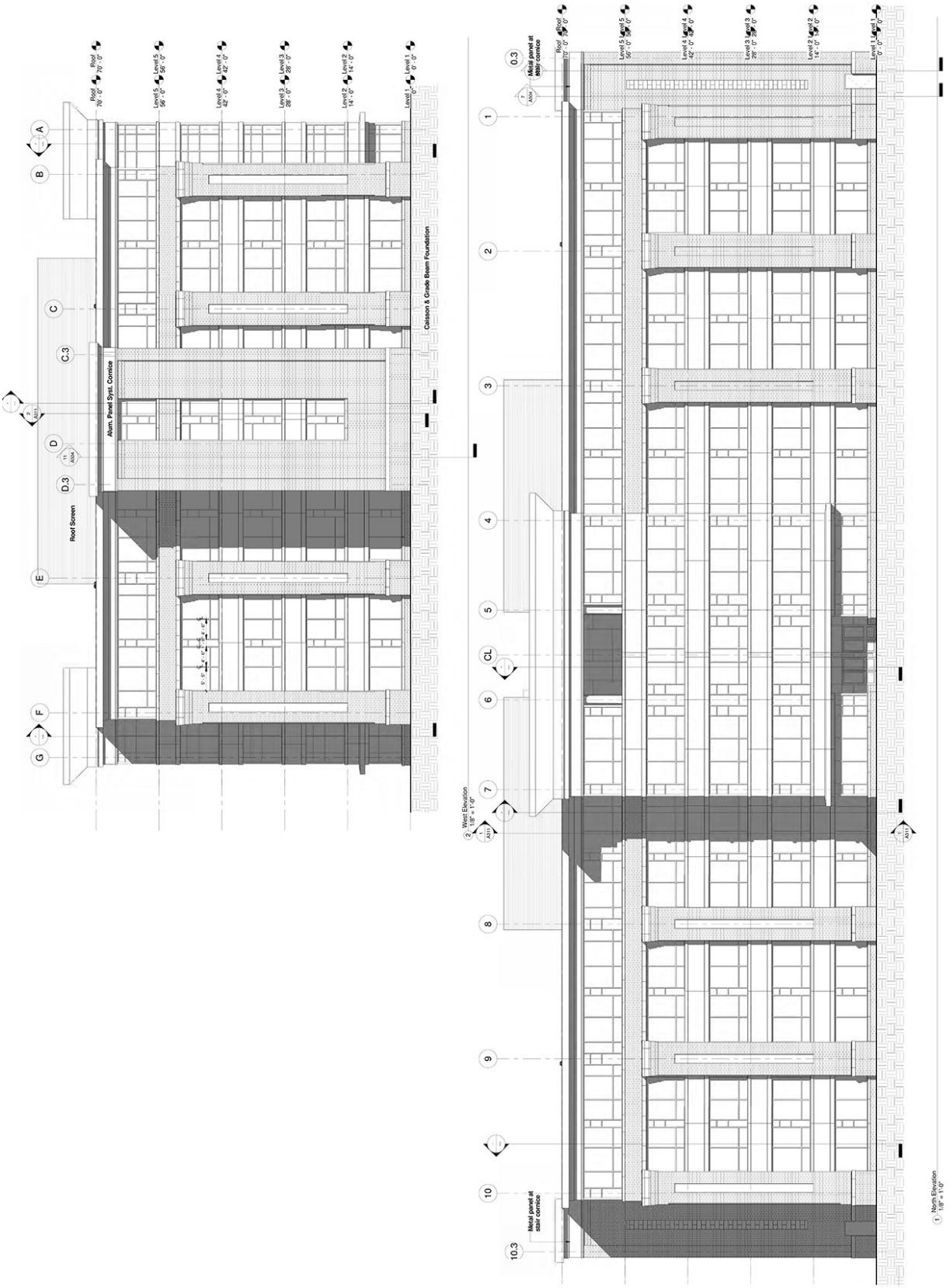
d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

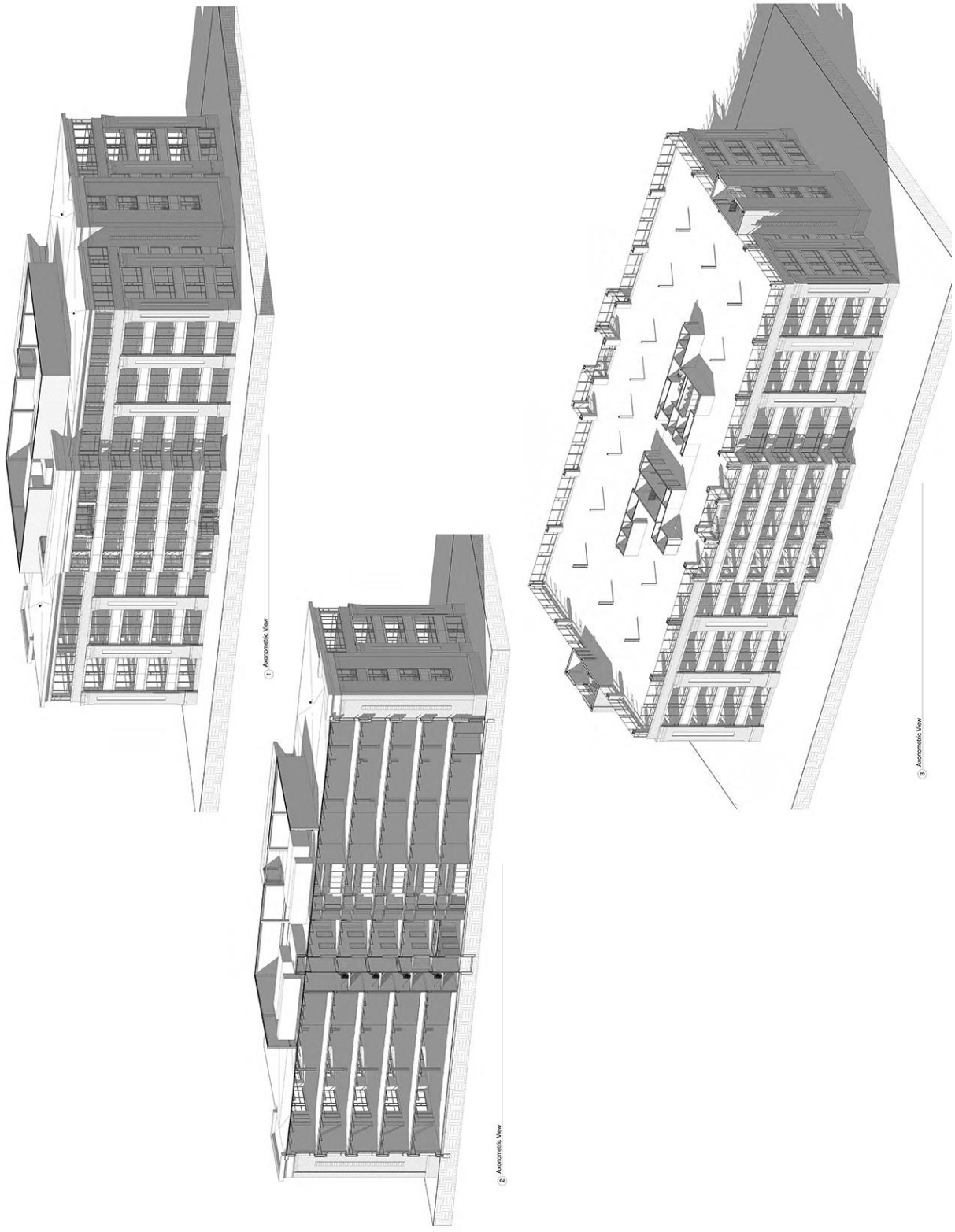
e. Not less than the fire-resistance rating required by other sections of this code.

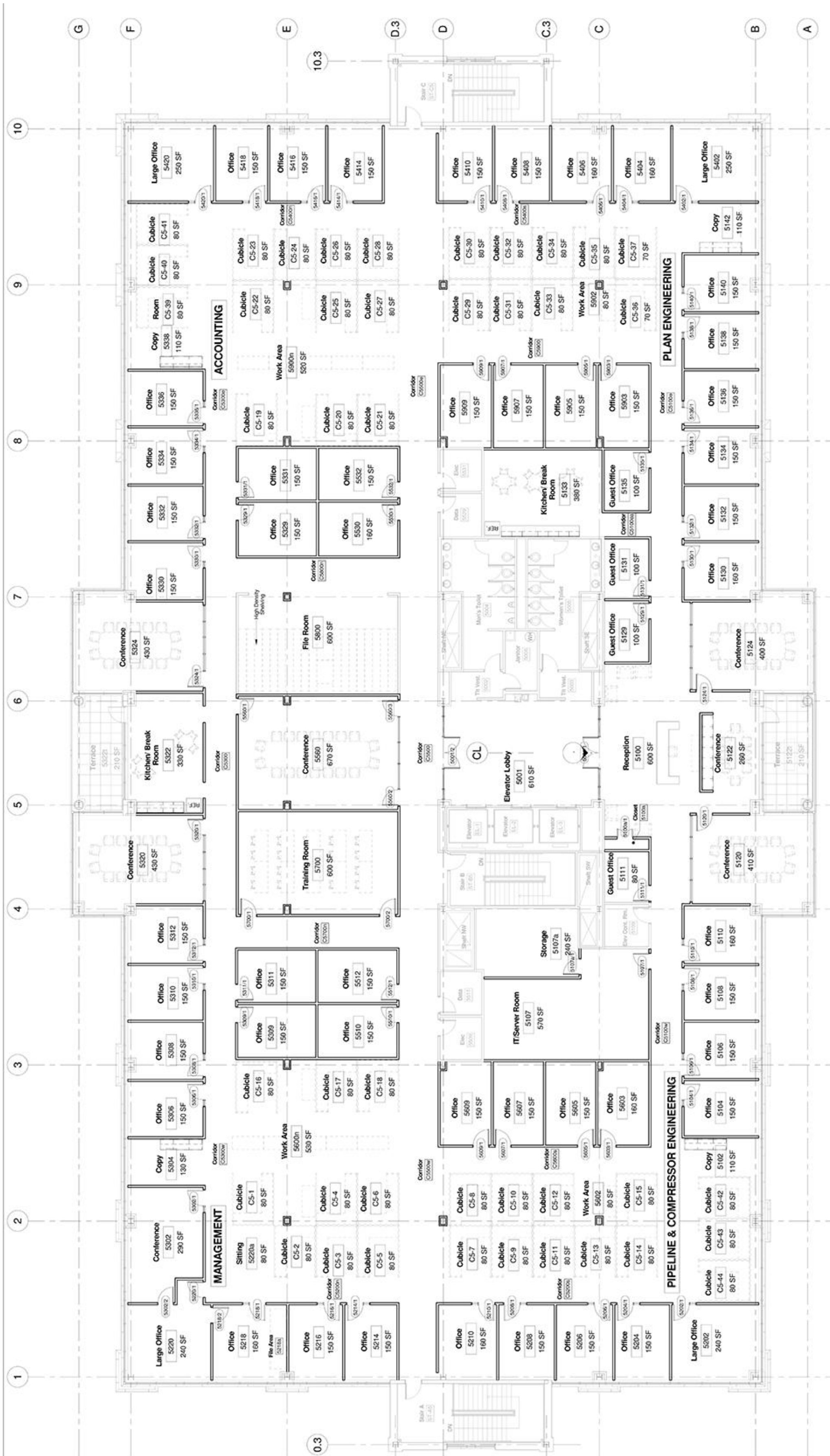
f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

g. Not less than the fire-resistance rating as referenced in Section 704.10

appendix F: additional drawings




1 Axonometric View
2 Axonometric View
3 Axonometric View



appendix F: additional drawings