APPENDIX A: COMPOSITE STEEL STRUCTURAL FLOOR PLANS

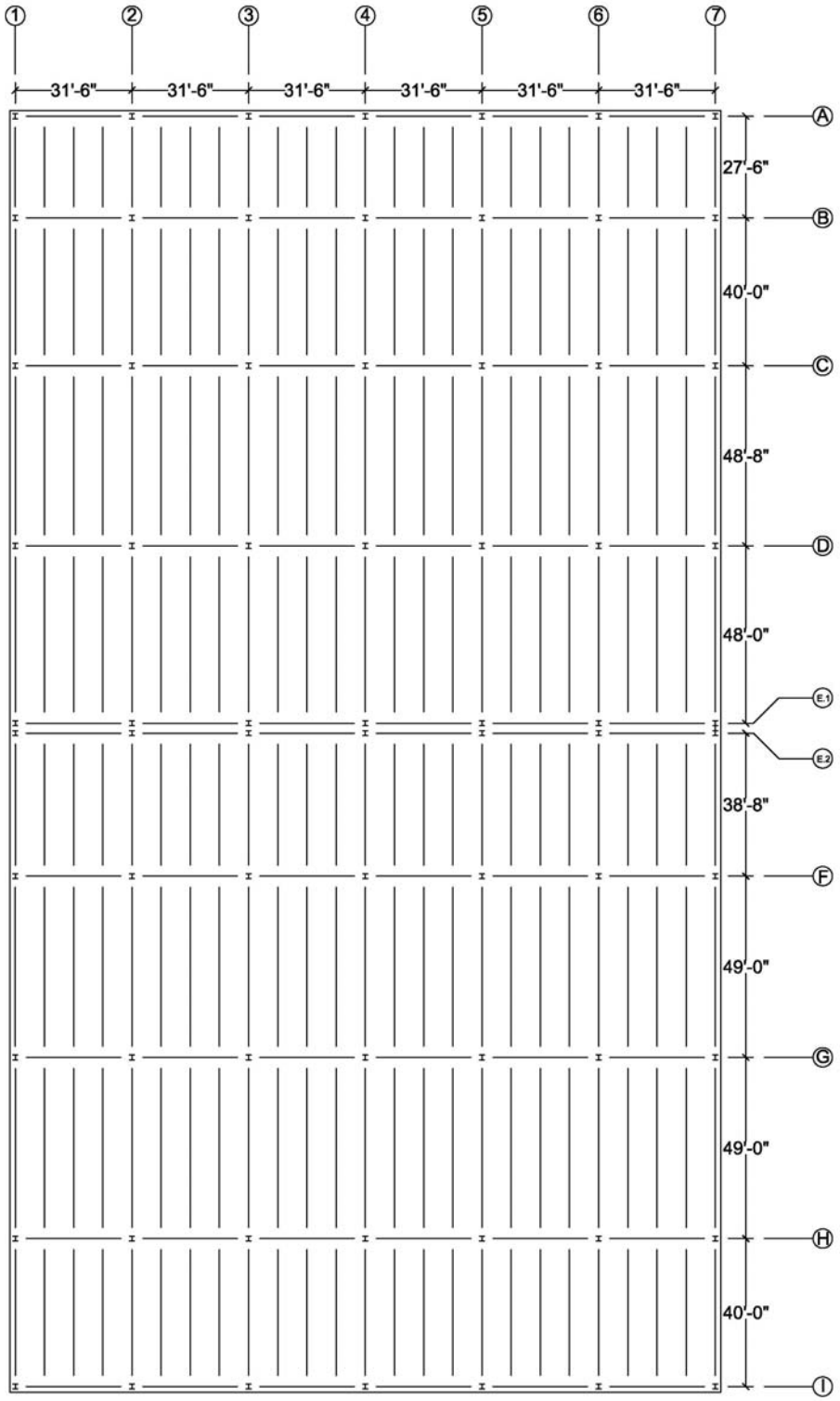


Figure 1: Preliminary Floor Plan for Levels 1st to Roof

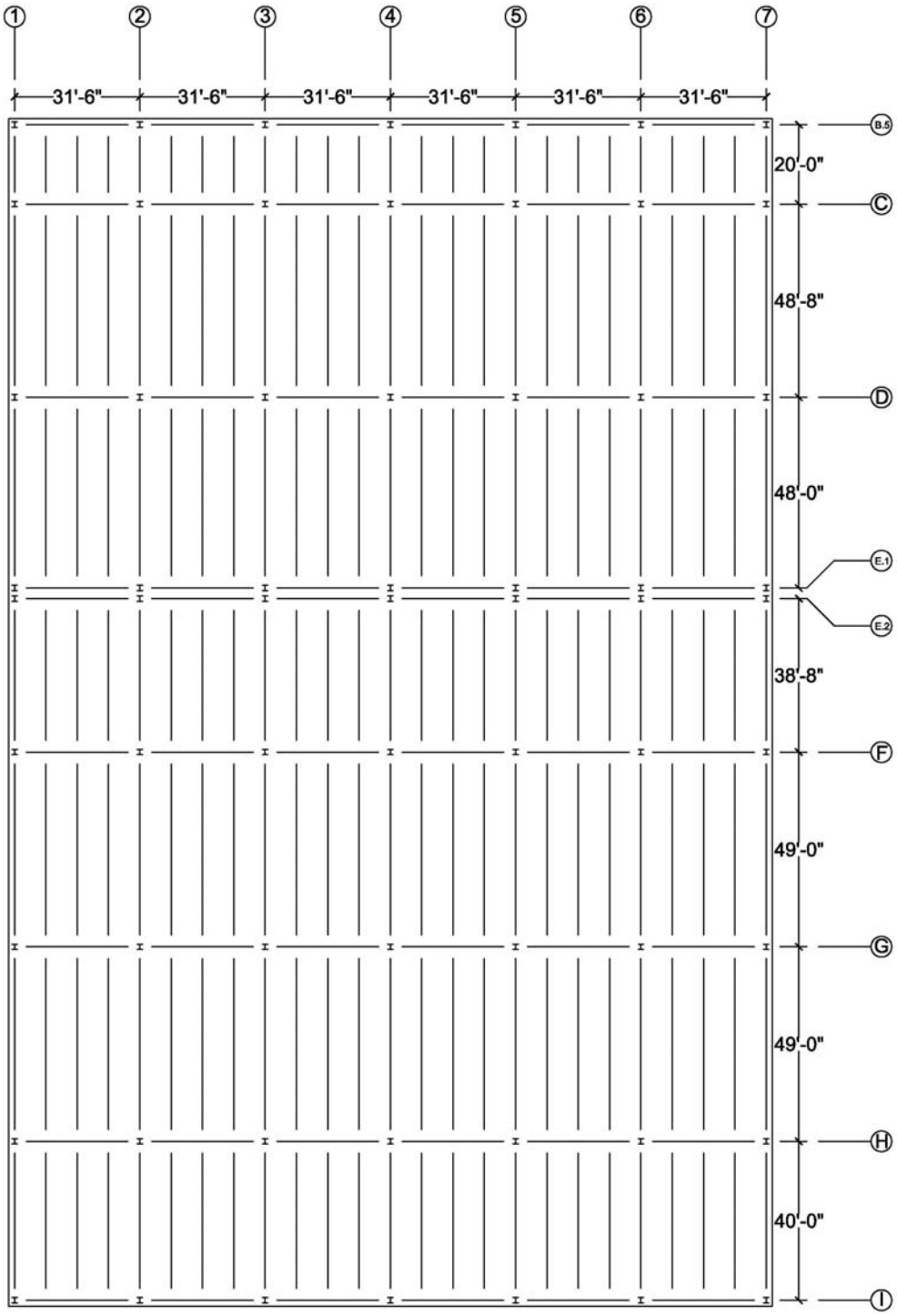


Figure 2: Preliminary Floor Plan for Mezzanine Level

APPENDIX B: PRELIMINARY COMPOSITE STEEL CALCULATIONS

COMPOSITE STEEL DECK	
Fire Rating (Hours)	2
Concrete (Type)	Lightweight
Concrete Unit Weight (pcf)	107 - 116
Concrete Thickness (in)	4.25
Loading Used (psf)	100
Superimposed Load (psf)	15
Total Load (psf)	115
Deck Thickness (in)	2
Total Floor Thickness (in)	6.25
Weight of Slab (psf)	51
Deck Type	2VLI16

Figure 1: Composite Steel Deck Calculations

Level	Roof
Member (Grid Location)	49' Int.
Slab Thickness (in)	5.25
f'_c (psi)	3000
Length (ft)	49
Tributary Area (ft)	7.875
Dead Load (psf)	0
Super Imposed Load (psf)	15
Live Load (psf)	50
w_u (psf)	108
M_u (ft-Kip)	254

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W21x55
φM_n (ft-Kip)	642
$\varphi M_n \geq M_u$	Okay
Plastic Netural Axis Location	7

ΣQ_n (Kip) [Table 3-19]	203	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	47.25	Controls
	147	
a (in)	1.685	
$a < a_{assumption}$	Conservative	
# Shear Studs	11.87	12.0
Total # Shear Studs	24.0	

Load Information	
Member Size	W21x55
φM_n (ft-Kip) [Table 3-2]	473
$w_{conc+deck}$ (psf)	42
w_{beam} (Kip/ft)	0.055
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	0.386
w_{LL} (Kip/ft)	0.158
w_u (Kip/ft)	0.71
M_u (ft-Kip)	215
$\varphi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.633
w_{DL} (Kip/ft)	0.386
$I_{required}$ (in^4)	1056
I_{member} (in^4)	1140
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.158
I_{LB} (in^4) [Table 3-20]	1770
Δ (in)	0.398
Δ < L/360	Okay

Total Deflection	
L/240	2.45
w_u (Kip/ft)	0.71
Δ (in)	1.99
Δ < L/240	Okay

Member	W21x55
Shear Studs	24.0

Calculation 1: Preliminary Roof Composite Steel Beams

Level	3rd Floor
Member (Grid Location)	49' Int.
Slab Thickness (in)	5.25
f'_c (psi)	3000
Length (ft)	49
Tributary Area (ft)	7.875
Dead Load (psf)	0
Super Imposed Load (psf)	15
Live Load (psf)	50
w_u (psf)	108
M_u (ft-Kip)	254

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W21x55
φM_n (ft-Kip)	642
$\varphi M_n \geq M_u$	Okay
Plastic Netural Axis Location	7

ΣQ_n (Kip) [Table 3-19]	203	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	47.25	Controls
	147	
a (in)	1.685	
$a < a_{assumption}$	Conservative	
# Shear Studs	11.87	12.0
Total # Shear Studs	24.0	

Load Information	
Member Size	W21x55
φM_n (ft-Kip) [Table 3-2]	473
$w_{conc+deck}$ (psf)	42
w_{beam} (Kip/ft)	0.055
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	0.386
w_{LL} (Kip/ft)	0.158
w_u (Kip/ft)	0.71
M_u (ft-Kip)	215
$\varphi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.633
w_{DL} (Kip/ft)	0.386
$I_{required}$ (in^4)	1056
I_{member} (in^4)	1140
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.158
I_{LB} (in^4) [Table 3-20]	1770
Δ (in)	0.398
Δ < L/360	Okay

Total Deflection	
L/240	2.45
w_u (Kip/ft)	0.71
Δ (in)	1.99
Δ < L/240	Okay

Member	W21x55
Shear Studs	24.0

Calculation 2: Preliminary 3rd Floor Composite Beams

Level	2nd Level
Member (Grid Location)	49' Int.
Slab Thickness (in)	5.25
f'_c (psi)	3000
Length (ft)	49
Tributary Area (ft)	7.875
Dead Load (psf)	0
Super Imposed Load (psf)	15
Live Load (psf)	60
w_u (psf)	124
M_u (ft-Kip)	292

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W21x55
φM_n (ft-Kip)	642
$\varphi M_n \geq M_u$	Okay
Plastic Netural Axis Location	7

ΣQ_n (Kip) [Table 3-19]	203	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	47.25	Controls
	147	
a (in)	1.685	
$a < a_{assumption}$	Conservative	
# Shear Studs	11.87	12.0
Total # Shear Studs	24.0	

Load Information	
Member Size	W21x55
φM_n (ft-Kip) [Table 3-2]	473
$w_{conc+deck}$ (psf)	42
w_{beam} (Kip/ft)	0.055
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	0.386
w_{LL} (Kip/ft)	0.158
w_u (Kip/ft)	0.71
M_u (ft-Kip)	215
$\varphi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.633
w_{DL} (Kip/ft)	0.386
$I_{required}$ (in^4)	1056
I_{member} (in^4)	1140
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.158
I_{LB} (in^4) [Table 3-20]	1770
Δ (in)	0.398
Δ < L/360	Okay

Total Deflection	
L/240	2.45
w_u (Kip/ft)	0.71
Δ (in)	1.99
Δ < L/240	Okay

Member	W21x55
Shear Studs	24.0

Calculation 3: Preliminary 2nd Floor Composite Beams

Level	1st Level
Member (Grid Location)	27.5' Ext.
Slab Thickness (in)	5.25
f'_c (psi)	3000
Length (ft)	27.5
Tributary Area (ft)	3.9375
Dead Load (psf)	0
Super Imposed Load (psf)	15
Live Load (psf)	50
w_u (psf)	108
M_u (ft-Kip)	40

$a_{assumption}$ (in)	1.25	
Y_2 (in)	4	
Wide Flange Shape (Table 3-19)	W12x16	
φM_n (ft-Kip)	113	
$\varphi M_n \geq M_u$	Okay	
Plastic Netural Axis Location	7	
ΣQ_n (Kip) [Table 3-19]	58.9	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	23.625	Controls
	82.5	
a (in)	0.978	
$a < a_{assumption}$	Conservative	
# Shear Studs	3.44	4.0
Total # Shear Studs	8.0	

Load Information	
Member Size	W12x16
φM_n (ft-Kip) [Table 3-2]	75.4
$w_{conc+deck}$ (psf)	42
w_{beam} (Kip/ft)	0.016
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	0.181
w_{LL} (Kip/ft)	0.079
w_u (Kip/ft)	0.34
M_u (ft-Kip)	32
$\varphi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	0.917
w_{DL} (Kip/ft)	0.181
$I_{required}$ (in^4)	88
I_{member} (in^4)	103
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.079
I_{LB} (in^4) [Table 3-20]	197
Δ (in)	0.177
Δ < L/360	Okay

Total Deflection	
L/240	1.375
w_u (Kip/ft)	0.34
Δ (in)	0.85
Δ < L/240	Okay

Member	W12x16
Shear Studs	8.0

Calculation 4: Preliminary 1st Floor Composite Beams

Level	Mezzanine
Member (Grid Location)	20' Ext.
Slab Thickness (in)	5.25
f'_c (psi)	3000
Length (ft)	20
Tributary Area (ft)	3.9375
Dead Load (psf)	0
Super Imposed Load (psf)	15
Live Load (psf)	60
w_u (psf)	124
M_u (ft-Kip)	24

$a_{assumption}$ (in)	1.25	
Y_2 (in)	4	
Wide Flange Shape (Table 3-19)	W12x16	
φM_n (ft-Kip)	113	
$\varphi M_n \geq M_u$	Okay	
Plastic Netural Axis Location	7	
ΣQ_n (Kip) [Table 3-19]	58.9	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	23.625	Controls
	60	
a (in)	0.978	
$a < a_{assumption}$	Conservative	
# Shear Studs	3.44	4.0
Total # Shear Studs	8.0	

Load Information	
Member Size	W12x16
φM_n (ft-Kip) [Table 3-2]	75.4
$w_{conc+deck}$ (psf)	42
w_{beam} (Kip/ft)	0.016
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	0.181
w_{LL} (Kip/ft)	0.079
w_u (Kip/ft)	0.34
M_u (ft-Kip)	17
$\varphi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	0.667
w_{DL} (Kip/ft)	0.181
$I_{required}$ (in^4)	34
I_{member} (in^4)	103
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.079
I_{LB} (in^4) [Table 3-20]	197
Δ (in)	0.050
Δ < L/360	Okay

Total Deflection	
L/240	1
w_u (Kip/ft)	0.34
Δ (in)	0.24
Δ < L/240	Okay

Member	W12x16
Shear Studs	8.0

Calculation 5: Preliminary Mezzanine Composite Beams

Level	Roof
Grid Location	3
Slab Thickness (in)	5.25
f'_c (psi)	3000
w_{c-top} (pcf)	108
w_{c-bot} (pcf)	108
Trib. Area of $Beam_{Top}$ (ft)	7.875
Trib. Area of $Beam_{Bot}$ (ft)	7.875
Beam $Length_{Top}$ (ft)	49
Beam $Length_{Bot}$ (ft)	49
Girder Length (ft)	31.5
Girder Tributary Area (ft)	49
P_{s-top} (Kips)	20.63725
P_{c-bot} (Kips)	20.64
$P_{c-total}$ (Kips)	41.67
P_{s-top} (Kips)	20.64
P_{s-bot} (Kips)	20.64
$P_{s-total}$ (Kips)	41.67
P_{s-top} (Kips)	20.64
P_{s-bot} (Kips)	20.64
$P_{s-total}$ (Kips)	41.67
P_{beat} (Kips)	123.02
R_a (Kips)	62.51
R_B (Kips)	62.51
a (ft)	10.5
l/2 (ft)	15.75
M_{u1} (ft-Kip)	437.58
M_{u2} (ft-Kip)	658.37
$M_{u-total}$ (ft-Kip)	1095.95
$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1280
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	7
ΣQ_n (Kip) [Table 3-19]	346
Q_n (Kip/Stud) [Table 3-21]	17.1
beff (in) ≤	294
	84.5
a (in)	1.436
$a < a_{assumption}$	Conservative
# Shear Studs	20.23
Total # Shear Studs	42.0

Controls

21.00

Load Information	
Member Size	W24x84
ϕM_n (ft-Kip) [Table 3-2]	953
$w_{steel-beam}$ (psf)	84
$w_{steel-girder}$ (psf)	20
w_{DL} (Kip/ft)	2.152
w_{LL} (Kip/ft)	0.990
w_u (Kip/ft)	4.15
M_u (ft-Kip)	515
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	2.152
$I_{required}$ (in^4)	1596
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.990
I_{LL} (in^4) [Table 3-20]	4090
Δ (in)	0.194
Δ < L/240	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	4.15
Δ (in)	0.86
Δ < L/240	Okay

Member	W24x84
Shear Studs	42.0

6 From Table 3-23

7 From Table 3-23

Level	Roof
Grid Location	H
Slab Thickness (in)	5.25
f'_c (psi)	3000
w_{c-top} (pcf)	108
w_{c-bot} (pcf)	108
Trib. Area of $Beam_{Top}$ (ft)	7.875
Trib. Area of $Beam_{Bot}$ (ft)	7.875
Beam $Length_{Top}$ (ft)	49
Beam $Length_{Bot}$ (ft)	49
Girder Length (ft)	31.5
Girder Tributary Area (ft)	44.5
P_{s-top} (Kips)	20.63725
P_{beat} (Kips)	17.01
P_{s-top} (Kips)	37.85
P_{s-top} (Kips)	20.64
P_{s-bot} (Kips)	17.01
$P_{s-total}$ (Kips)	37.85
P_{s-top} (Kips)	20.64
P_{s-bot} (Kips)	17.01
$P_{s-total}$ (Kips)	37.85
P_{beat} (Kips)	113.54
R_a (Kips)	56.77
R_B (Kips)	56.77
a (ft)	10.5
l/2 (ft)	15.75
M_{u1} (ft-Kip)	397.40
M_{u2} (ft-Kip)	596.09
$M_{u-total}$ (ft-Kip)	993.49
$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W24x76
ϕM_n (ft-Kip)	1050
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	6
ΣQ_n (Kip) [Table 3-19]	353
Q_n (Kip/Stud) [Table 3-21]	17.1
beff (in) ≤	267
	94.5
a (in)	1.631
$a < a_{assumption}$	Conservative
# Shear Studs	22.08
Total # Shear Studs	46.0

Controls

23.00

Load Information	
Member Size	W24x76
ϕM_n (ft-Kip) [Table 3-2]	750
$w_{steel-beam}$ (psf)	42
$w_{steel-girder}$ (psf)	0.076
$w_{construction-live}$ (psf)	20
w_{DL} (Kip/ft)	1.945
w_{LL} (Kip/ft)	0.890
w_u (Kip/ft)	3.76
M_u (ft-Kip)	466
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	1.945
$I_{required}$ (in^4)	1415
I_{member} (in^4)	2100
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.890
I_{LL} (in^4) [Table 3-20]	3490
Δ (in)	0.195
Δ < L/360	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	3.76
Δ (in)	0.81
Δ < L/240	Okay

Member	W24x76
Shear Studs	46.0

Calculation 6: Preliminary Roof Composite Girders

Level	3rd Floor	
Grid Location	G	
Slab Thickness (in)	5.25	
f_c (psi)	3000	
$w_{u\text{-}Top}$ (psf)	108	
$w_{u\text{-}Bot}$ (psf)	108	
Trib. Area of $Beam_{Top}$ (ft)	7.875	
Trib. Area of $Beam_{Bot}$ (ft)	7.875	
Beam $Length_{Top}$ (ft)	49	
Beam $Length_{Bot}$ (ft)	49	
Girder Length (ft)	31.5	
Gider Tributary Area (ft)	49	
$P_{1\text{-}Top}$ (Kips)	20.83725	
$P_{1\text{-}Bot}$ (Kips)	20.84	
$P_{1\text{-}Total}$ (Kips)	41.67	# 9 From Table 3-23
$P_{2\text{-}Top}$ (Kips)	20.84	
$P_{2\text{-}Bot}$ (Kips)	20.84	
$P_{2\text{-}Total}$ (Kips)	41.67	# 9 From Table 3-23
$P_{3\text{-}Top}$ (Kips)	20.84	
$P_{3\text{-}Bot}$ (Kips)	20.84	
$P_{3\text{-}Total}$ (Kips)	41.67	# 7 From Table 3-23
P_{Total} (Kips)	125.02	
R_A (Kips)	62.51	
R_B (Kips)	62.51	
a (ft)	10.5	
l/2 (ft)	15.75	
$M_{u\text{-}1}$ (ft-Kip)	437.56	
$M_{u\text{-}2}$ (ft-Kip)	656.37	
$M_{u\ Total}$ (ft-Kip)	1093.93	

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1280
$\phi M_n \geq M_u$	Okay
Plastic Netural Axis Location	7

ΣQ_n (Kip) [Table 3-19]	346	
Q_n [Kip/Studs] [Table 3-21]	17.1	
beff (in) ≤	294	
	94.5	Controls
a (in)	1.436	
$a < a_{assumption}$	Conservative	
# Shear Studs	20.23	21.00
Total # Shear Studs	42.0	

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	963
$w_{conc\text{-}deck}$ (psf)	42
w_{beam} (Kip/ft)	0.094
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	2.152
w_{LL} (Kip/ft)	0.980
w_u (Kip/ft)	4.15
M_u (ft-Kip)	515
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	2.152
$I_{required}$ (in^4)	1596
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.980
I_{LB} (in^4) [Table 3-20]	4080
Δ (in)	0.184
Δ < L/360	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	4.15
Δ (in)	0.86
Δ < L/240	Okay

Member	W24x94
Shear Studs	42.0

Level	3rd Floor	
Grid Location	H	
Slab Thickness (in)	5.25	
f_c (psi)	3000	
$w_{u\text{-}Top}$ (psf)	108	
$w_{u\text{-}Bot}$ (psf)	108	
Trib. Area of $Beam_{Top}$ (ft)	7.875	
Trib. Area of $Beam_{Bot}$ (ft)	7.875	
Beam $Length_{Top}$ (ft)	49	
Beam $Length_{Bot}$ (ft)	40	
Girder Length (ft)	31.5	
Gider Tributary Area (ft)	44.5	
$P_{1\text{-}Top}$ (Kips)	20.83725	
$P_{1\text{-}Bot}$ (Kips)	17.01	
$P_{1\text{-}Total}$ (Kips)	37.85	# 9 From Table 3-23
$P_{2\text{-}Top}$ (Kips)	20.84	
$P_{2\text{-}Bot}$ (Kips)	17.01	
$P_{2\text{-}Total}$ (Kips)	37.85	# 9 From Table 3-23
$P_{3\text{-}Top}$ (Kips)	20.84	
$P_{3\text{-}Bot}$ (Kips)	17.01	
$P_{3\text{-}Total}$ (Kips)	37.85	# 7 From Table 3-23
P_{Total} (Kips)	113.54	
R_A (Kips)	56.77	
R_B (Kips)	56.77	
a (ft)	10.5	
l/2 (ft)	15.75	
$M_{u\ 1}$ (ft-Kip)	397.40	
$M_{u\ 2}$ (ft-Kip)	596.09	
$M_{u\ Total}$ (ft-Kip)	993.49	

$a_{assumption}$ (in)	1.75	
Y_2 (in)	3.5	
Wide Flange Shape (Table 3-19)	W24x76	
ϕM_n (ft-Kip)	1060	
$\phi M_n \geq M_u$	Okay	
Plastic Netural Axis Location	6	

ΣQ_n (Kip) [Table 3-19]	393	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	267	
	94.5	Controls
a (in)	1.631	
$a < a_{assumption}$	Conservative	
# Shear Studs	22.98	23.00
Total # Shear Studs	46.0	

Load Information	
Member Size	W24x76
ϕM_n (ft-Kip) [Table 3-2]	750
$w_{conc\text{-}deck}$ (psf)	42
w_{beam} (Kip/ft)	0.076
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	1.945
w_{LL} (Kip/ft)	0.890
w_u (Kip/ft)	3.75
M_u (ft-Kip)	455
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	1.945
$I_{required}$ (in^4)	1415
I_{member} (in^4)	2100
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.890
I_{LB} (in^4) [Table 3-20]	3490
Δ (in)	0.195
Δ < L/360	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	3.75
Δ (in)	0.91
Δ < L/240	Okay

Member	W24x76
Shear Studs	46.0

Calculation 7: Preliminary 3rd Floor Composite Girders

Level	2nd Floor	
Grid Location	G	
Slab Thickness (in)	5.25	
f'_c (psi)	3000	
$w_{u\ Top}$ (psf)	124	
$w_{u\ Bot}$ (psf)	124	
Trib. Area of $Beam_{Top}$ (ft)	7.875	
Trib. Area of $Beam_{Bot}$ (ft)	7.875	
Beam $Length_{Top}$ (ft)	49	
Beam $Length_{Bot}$ (ft)	49	
Girder Length (ft)	31.5	
Girder Tributary Area (ft)	49	
$P_{1\ Top}$ (Kips)	23.92	
$P_{1\ Bot}$ (Kips)	23.92	
$P_{1\ Total}$ (Kips)	47.85	# 3 From Table 3-23
$P_{2\ Top}$ (Kips)	23.92	
$P_{2\ Bot}$ (Kips)	23.92	
$P_{2\ Total}$ (Kips)	47.85	# 3 From Table 3-23
$P_{3\ Top}$ (Kips)	23.92	
$P_{3\ Bot}$ (Kips)	23.92	
$P_{3\ Total}$ (Kips)	47.85	# 7 From Table 3-23
P_{Total} (Kips)	143.55	
R_A (Kips)	71.77	
R_B (Kips)	71.77	
a (ft)	10.5	
l/2 (ft)	15.75	
$M_{u\ 1}$ (ft-Kip)	502.41	
$M_{u\ 2}$ (ft-Kip)	753.61	
$M_{u\ Total}$ (ft-Kip)	1256.02	
$a_{assumption}$ (in)	1.75	
Y_2 (in)	3.5	
Wide Flange Shape (Table 3-19)	W24x94	
ϕM_n (ft-Kip)	1290	
$\phi M_n \geq M_u$	Okay	
Plastic Neutral Axis Location	7	
ΣQ_n (Kip) [Table 3-19]	346	
Q_n (Kip/Stud) [Table 3-21]	17.1	
beff (in) ≤	294	Controls
	94.5	
a (in)	1.436	
$a \leq a_{assumption}$	Conservative	
# Shear Studs	20.23	21.00
Total # Shear Studs	42.0	

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	953
$w_{construction}$ (psf)	42
w_{beam} (Kip/ft)	0.094
$w_{construction\ line}$ (psf)	20
w_{DL} (Kip/ft)	2.152
w_{LL} (Kip/ft)	0.980
w_u (Kip/ft)	4.15
M_u (ft-Kip)	515
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	2.152
$I_{required}$ (in^4)	1566
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.980
I_{LB} (in^4) [Table 3-20]	4000
Δ (in)	0.184
Δ < L/360	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	4.15
Δ (in)	0.86
Δ < L/240	Okay

Member	W24x94
Shear Studs	42.0

Level	2nd Floor	
Grid Location	H	
Slab Thickness (in)	5.25	
f'_c (psi)	3000	
$w_{u\ Top}$ (psf)	124	
$w_{u\ Bot}$ (psf)	124	
Trib. Area of $Beam_{Top}$ (ft)	7.875	
Trib. Area of $Beam_{Bot}$ (ft)	7.875	
Beam $Length_{Top}$ (ft)	49	
Beam $Length_{Bot}$ (ft)	49	
Girder Length (ft)	31.5	
Girder Tributary Area (ft)	44.5	
$P_{1\ Top}$ (Kips)	23.92425	
$P_{1\ Bot}$ (Kips)	19.53	
$P_{1\ Total}$ (Kips)	43.45	# 9 From Table 3-23
$P_{2\ Top}$ (Kips)	23.92	
$P_{2\ Bot}$ (Kips)	19.53	
$P_{2\ Total}$ (Kips)	43.45	# 9 From Table 3-23
$P_{3\ Top}$ (Kips)	23.92	
$P_{3\ Bot}$ (Kips)	19.53	
$P_{3\ Total}$ (Kips)	43.45	# 7 From Table 3-23
P_{Total} (Kips)	130.36	
R_A (Kips)	65.18	
R_B (Kips)	65.18	
a (ft)	10.5	
l/2 (ft)	15.75	
$M_{u\ 1}$ (ft-Kip)	456.27	
$M_{u\ 2}$ (ft-Kip)	684.40	
$M_{u\ Total}$ (ft-Kip)	1140.67	
$a_{assumption}$ (in)	1.75	
Y_2 (in)	3.5	
Wide Flange Shape (Table 3-19)	W24x94	
ϕM_n (ft-Kip)	1270	
$\phi M_n \geq M_u$	Okay	
Plastic Neutral Axis Location	7	
ΣQ_n (Kip) [Table 3-19]	346	
Q_n (Kip/Stud) [Table 3-21]	17.1	
beff (in) ≤	267	Controls
	94.5	
a (in)	1.436	
$a \leq a_{assumption}$	Conservative	
# Shear Studs	20.23	21.00
Total # Shear Studs	42.0	

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	953
$w_{construction}$ (psf)	42
w_{beam} (Kip/ft)	0.094
$w_{construction\ line}$ (psf)	20
w_{DL} (Kip/ft)	1.963
w_{LL} (Kip/ft)	0.890
w_u (Kip/ft)	3.78
M_u (ft-Kip)	469
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	1.963
$I_{required}$ (in^4)	1428
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.890
I_{LB} (in^4) [Table 3-20]	4000
Δ (in)	0.167
Δ < L/360	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	3.78
Δ (in)	0.78
Δ < L/240	Okay

Member	W24x94
Shear Studs	42.0

Calculation 8: Preliminary 2nd Floor Composite Girders

Level	1st Floor
Grid Location	O
Slab Thickness (in)	5.25
f'_c (psi)	3000
$w_{c\,top}$ (pcf)	124
$w_{c\,bot}$ (pcf)	124
Trib. Area of $Beam_{top}$ (ft)	7.875
Trib. Area of $Beam_{bot}$ (ft)	7.875
Beam $Length_{top}$ (ft)	49
Beam $Length_{bot}$ (ft)	49
Girder Length (ft)	31.5
Girder Tributary Area (ft)	49
$P_{1\,top}$ (Kips)	23.92425
$P_{1\,bot}$ (Kips)	23.92
$P_{1\,total}$ (Kips)	47.85
$P_{2\,top}$ (Kips)	23.92
$P_{2\,bot}$ (Kips)	23.92
$P_{2\,total}$ (Kips)	47.85
$P_{3\,top}$ (Kips)	23.92
$P_{3\,bot}$ (Kips)	23.92
$P_{3\,total}$ (Kips)	47.85
P_{total} (Kips)	143.55
R_A (Kips)	71.77
R_B (Kips)	71.77
a (ft)	10.5
$\ell/2$ (ft)	15.75
M_{u-1} (ft-Kip)	562.41
M_{u-2} (ft-Kip)	753.61
$M_{u\,total}$ (ft-Kip)	1256.62
$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1280
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	7
ΣQ_n (Kip) [Table 3-19]	346
Q_n (Kip/Studs) [Table 3-21]	17.1
beff (in) ≤	264
	645
a (in)	1.436
$a < a_{assumption}$	Conservative
# Shear Studs	20.23
Total # Shear Studs	42.0

Controls

21.00

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	963
$W_{noncomposite}$ (psf)	42
W_{beam} (Kip/ft)	0.094
$W_{construction\ live}$ (psf)	20
W_{DL} (Kip/ft)	2.152
W_{LL} (Kip/ft)	0.980
W_u (Kip/ft)	4.15
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
W_{DL} (Kip/ft)	2.152
$I_{required}$ (in^4)	1566
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
W_{LL} (Kip/ft)	0.980
I_{LB} (in^4) [Table 3-20]	4060
Δ (in)	0.194
Δ < L/360	Okay

Total Deflection	
L/240	1.575
W_u (Kip/ft)	4.15
Δ (in)	3.88
Δ < L/240	Okay

Member	W24x94
Shear Studs	42.0

9 From Table 3-23

9 From Table 3-23

7 From Table 3-23

Level	1st Floor
Grid Location	H
Slab Thickness (in)	5.25
f'_c (psi)	3000
$w_{c\,top}$ (pcf)	124
$w_{c\,bot}$ (pcf)	124
Trib. Area of $Beam_{top}$ (ft)	7.875
Trib. Area of $Beam_{bot}$ (ft)	7.875
Beam $Length_{top}$ (ft)	49
Beam $Length_{bot}$ (ft)	40
Girder Length (ft)	31.5
Girder Tributary Area (ft)	44.5
$P_{1\,top}$ (Kips)	23.92425
$P_{1\,bot}$ (Kips)	19.53
$P_{1\,total}$ (Kips)	43.45
$P_{2\,top}$ (Kips)	23.92
$P_{2\,bot}$ (Kips)	19.53
$P_{2\,total}$ (Kips)	43.45
$P_{3\,top}$ (Kips)	23.92
$P_{3\,bot}$ (Kips)	19.53
$P_{3\,total}$ (Kips)	43.45
P_{total} (Kips)	130.36
R_A (Kips)	65.18
R_B (Kips)	65.18
a (ft)	10.5
$\ell/2$ (ft)	15.75
M_{u-1} (ft-Kip)	456.27
M_{u-2} (ft-Kip)	684.40
$M_{u\,total}$ (ft-Kip)	1140.67
$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Wide Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1270
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	7
ΣQ_n (Kip) [Table 3-19]	346
Q_n (Kip/Studs) [Table 3-21]	17.1
beff (in) ≤	257
	645
a (in)	1.436
$a < a_{assumption}$	Conservative
# Shear Studs	20.23
Total # Shear Studs	42.0

Controls

21.03

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	963
$W_{noncomposite}$ (psf)	42
W_{beam} (Kip/ft)	0.094
$W_{construction\ live}$ (psf)	20
W_{DL} (Kip/ft)	1.503
W_{LL} (Kip/ft)	0.896
W_u (Kip/ft)	3.78
$\phi M_n \geq M_u$	963
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
W_{DL} (Kip/ft)	1.503
$I_{required}$ (in^4)	1426
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
W_{LL} (Kip/ft)	0.896
I_{LB} (in^4) [Table 3-20]	4060
Δ (in)	0.167
Δ < L/360	Okay

Total Deflection	
L/240	1.575
W_u (Kip/ft)	3.78
Δ (in)	0.78
Δ < L/240	Okay

Member	W24x94
Shear Studs	42.0

9 From Table 3-23

9 From Table 3-23

7 From Table 3-23

Calculation 9: Preliminary 1st Floor Composite Girders

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	953
$w_{precast}$ (psf)	42
w_{beam} (Kip/ft)	0.094
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	1.963
w_{LL} (Kip/ft)	0.890
w_u (Kip/ft)	3.78
M_u (ft-Kip)	459
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	1.963
$I_{required}$ (in^4)	1408
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.890
I_{LB} (in^4) [Table 3-20]	4090
Δ (in)	0.167
$\Delta < L/360$	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	3.78
Δ (in)	0.78
$\Delta < L/240$	Okay

Member	W24x94
Shear Studs	42.0

Level	Mezzanine
Grid Location	F
Slab Thickness (in)	5.25
f'_c (psi)	3000
$w_{c\ top}$ (pcf)	124
$w_{c\ bot}$ (pcf)	124
Trib. Area of $Beam_{top}$ (ft)	7.875
Trib. Area of $Beam_{bot}$ (ft)	7.875
Beam $Length_{top}$ (ft)	49
Beam $Length_{bot}$ (ft)	40
Girder Length (ft)	31.5
Girder Tributary Area (ft)	44.5
$P_{1\ top}$ (Kips)	23.92425
$P_{1\ bot}$ (Kips)	19.53
$P_{1\ total}$ (Kips)	43.45
$P_{2\ top}$ (Kips)	23.92
$P_{2\ bot}$ (Kips)	19.53
$P_{2\ total}$ (Kips)	43.45
$P_{3\ top}$ (Kips)	23.92
$P_{3\ bot}$ (Kips)	19.53
$P_{3\ total}$ (Kips)	43.45
P_{total} (Kips)	130.35
R_A (Kips)	65.18
R_B (Kips)	65.18
a (ft)	10.5
$\ell/2$ (ft)	15.75
M_{u1} (ft-Kip)	466.27
M_{u2} (ft-Kip)	684.40
$M_{u\ max}$ (ft-Kip)	1140.67

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Web Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1270
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	7

ΣQ_n (Kip) [Table 3-19]	346	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	267	Controls
	945	
a (in)	1.436	
$a < a_{assumption}$	Conservative	
# Shear studs	20.23	21.00
Total # Shear Studs	42.0	

Level	Mezzanine
Grid Location	G
Slab Thickness (in)	5.25
f'_c (psi)	3000
$w_{c\ top}$ (pcf)	124
$w_{c\ bot}$ (pcf)	124
Trib. Area of $Beam_{top}$ (ft)	7.875
Trib. Area of $Beam_{bot}$ (ft)	7.875
Beam $Length_{top}$ (ft)	49
Beam $Length_{bot}$ (ft)	49
Girder Length (ft)	31.5
Girder Tributary Area (ft)	49
$P_{1\ top}$ (Kips)	23.92425
$P_{1\ bot}$ (Kips)	23.92
$P_{1\ total}$ (Kips)	47.85
$P_{2\ top}$ (Kips)	23.92
$P_{2\ bot}$ (Kips)	23.92
$P_{2\ total}$ (Kips)	47.85
$P_{3\ top}$ (Kips)	23.92
$P_{3\ bot}$ (Kips)	23.92
$P_{3\ total}$ (Kips)	47.85
P_{total} (Kips)	143.55
R_A (Kips)	71.77
R_B (Kips)	71.77
a (ft)	10.5
$\ell/2$ (ft)	15.75
M_{u1} (ft-Kip)	592.41
M_{u2} (ft-Kip)	753.61
$M_{u\ max}$ (ft-Kip)	1256.32

$a_{assumption}$ (in)	1.75
Y_2 (in)	3.5
Web Flange Shape (Table 3-19)	W24x94
ϕM_n (ft-Kip)	1270
$\phi M_n \geq M_u$	Okay
Plastic Neutral Axis Location	7

ΣQ_n (Kip) [Table 3-19]	346	
Q_n (Kip/Studs) [Table 3-21]	17.1	
beff (in) ≤	294	Controls
	945	
a (in)	1.439	
$a < a_{assumption}$	Conservative	
# Shear studs	20.29	21.00
Total # Shear Studs	42.0	

Load Information	
Member Size	W24x94
ϕM_n (ft-Kip) [Table 3-2]	953
$w_{precast}$ (psf)	42
w_{beam} (Kip/ft)	0.094
$w_{construction\ live}$ (psf)	20
w_{DL} (Kip/ft)	1.963
w_{LL} (Kip/ft)	0.890
w_u (Kip/ft)	3.78
M_u (ft-Kip)	459
$\phi M_n \geq M_u$	Okay

Deflection During Construction	
L/360	1.050
w_{DL} (Kip/ft)	1.963
$I_{required}$ (in^4)	1408
I_{member} (in^4)	2700
$I_{member} > I_{required}$	Okay

Live Load Deflection	
w_{LL} (Kip/ft)	0.890
I_{LB} (in^4) [Table 3-20]	4090
Δ (in)	0.184
$\Delta < L/360$	Okay

Total Deflection	
L/240	1.575
w_u (Kip/ft)	3.78
Δ (in)	0.86
$\Delta < L/240$	Okay

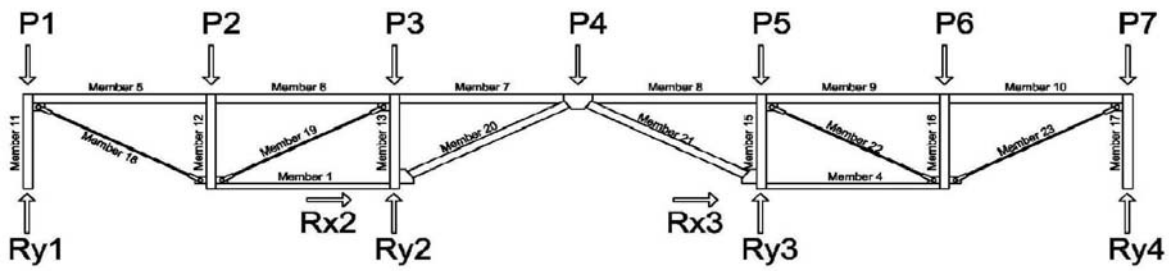
Member	W24x94
Shear Studs	42.0

Calculation 10: Preliminary Mezzanine Composite Girders

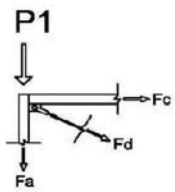
APPENDIX C: LOADS WITHIN TRUSS 2 MEMBERS

Structure1 Truss 2

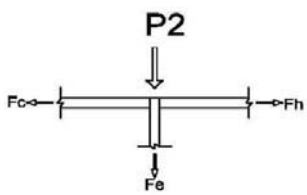
P_1	669.69 Kips	R_{y1}	1160.00 Kips	R_{x1}	0 Kips
P_2	1125.06 Kips	R_{y2}	2340.00 Kips	R_{x2}	757.94 Kips
P_3	1125.06 Kips	R_{y3}	2140.00 Kips	R_{x3}	-757.94 Kips
P_4	1125.06 Kips	R_{y4}	750.64 Kips	R_{x4}	0 Kips
P_5	1125.06 Kips				
P_6	835.23 Kips				
P_7	388.98 Kips				



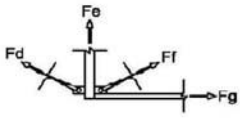
R_{y1} =	1160.00 Kips	
F_a =	-1160.00 Kips	(Compression)
ΣF_y =	0.00	



P_1 =	669.69 Kips	
F_a =	1160.00 Kips	(Compression)
F_{dy} =	490.31 Kips	
F_{dx} =	860.13 Kips	
F_d =	990.06 Kips	(Tension)
F_c =	-860.13 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	

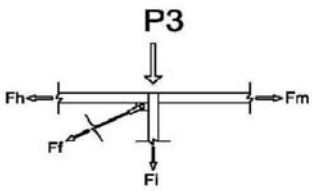


P_2 =	1125.06 Kips	
F_c =	860.13 Kips	(Compression)
F_h =	-860.13 Kips	(Compression)
F_e =	-1125.06 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	

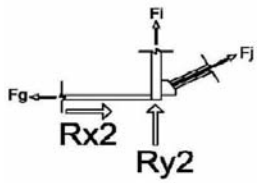


F_e =	1125.06 Kips	(Compression)
F_{dy} =	490.31 Kips	
F_{dx} =	860.13 Kips	
F_{fy} =	634.75 Kips	
F_{fx} =	1113.52 Kips	
F_f =	1281.73 Kips	(Tension)
F_g =	253.38 Kips	(Tension)
ΣF_x =	0.00	
ΣF_y =	0.00	

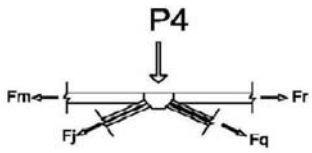
Calculations 1 through 4: Forces in Truss 2 Members



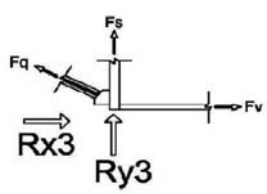
P_3 =	1125.06 Kips	
F_h =	860.13 Kips	(Compression)
F_{fy} =	634.75 Kips	
F_{fx} =	1113.52 Kips	
F_i =	-1759.81 Kips	(Compression)
F_m =	-253.38 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	



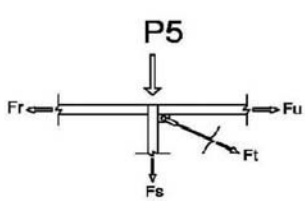
R_{y2} =	2340.00 Kips	
R_{x2} =	757.94 Kips	
F_g =	253.38 Kips	(Tension)
F_i =	-1759.81 Kips	(Compression)
F_{jy} =	-580.19 Kips	
F_{jx} =	-1017.80 Kips	
F_j =	-1171.56 Kips	(Compression)
F_k =	0.00 Kips	
ΣF_x =	0.00	
ΣF_y =	0.00	



P_4 =	1125.06 Kips	
F_m =	-253.385 Kips	
F_r =	-196.3155 Kips	
F_{qy} =	-541.37 Kips	
F_{qx} =	-949.7042 Kips	
F_{jy} =	-580.19 Kips	
F_{jx} =	-1017.803 Kips	
ΣF_x =	0.0	
ΣF_y =	0.50	

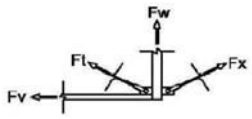


R_{y3} =	2140.00 Kips	
R_{x3} =	-757.94 Kips	
F_v =	196.32 Kips	(Compression)
F_s =	-1598.63 Kips	(Compression)
F_{qy} =	-541.37 Kips	
F_{qx} =	-949.70 Kips	
F_q =	-1093.17 Kips	(Compression)
ΣFx =	0.00	
ΣFy =	0.00	

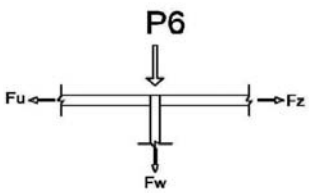


P_5 =	1125.06 Kips	
F_u =	634.45 Kips	(Compression)
F_{ty} =	473.57 Kips	
F_{tx} =	830.762 Kips	
F_s =	-1598.63 Kips	(Compression)
F_r =	-196.32 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	

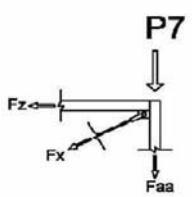
Calculations 5 through 9: Forces in Truss 2 Members



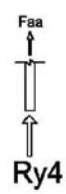
F_w =	835.23 Kips	(Compression)
F_{xy} =	361.66 Kips	
F_{xx} =	634.45 Kips	
F_{ty} =	473.57 Kips	
F_{tx} =	830.76 Kips	
F_t =	956.26 Kips	(Tension)
F_v =	196.32 Kips	(Tension)
ΣF_x =	0.00	
ΣF_y =	0.00	



P_6 =	835.23 Kips	
F_u =	-634.45 Kips	(Compression)
F_w =	-835.23 Kips	(Compression)
F_z =	634.45 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	



P_7 =	388.98 Kips	
F_{aa} =	750.64 Kips	(Compression)
F_{xy} =	361.66 Kips	
F_{xx} =	634.45 Kips	
F_y =	730.29 Kips	(Tension)
F_z =	-634.45 Kips	(Compression)
ΣF_x =	0.00	
ΣF_y =	0.00	



R_{y4} =	750.64 Kips	
F_{aa} =	-750.64 Kips	(Compression)
ΣF_y =	0.00	

Calculations 10 through 13: Forces in Truss 2 Members

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Job No	Sheet No 1	Rev	
Part			
Ref			
By	Date 09-Feb-09	Chd	
File Loads.std	Date/Time 10-Feb-2009 18:36		

Job Title

Client

Job Information

	Engineer	Checked	Approved
Name:			
Date:	09-Feb-09		

Structure Type	TRUSS

Number of Nodes	13	Highest Node	14
Number of Elements	21	Highest Beam	24

Number of Basic Load Cases	1
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	LOAD

Reactions

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kip)	FY (kip)	FZ (kip)	MX (kip*in)	MY (kip*in)	MZ (kip*in)
1	1:LOAD	0.000	1.16E 3	0.000	0.000	0.000	0.000
3	1:LOAD	757.940	2.34E 3	0.000	0.000	0.000	0.000
5	1:LOAD	-757.940	2.14E 3	0.000	0.000	0.000	0.000
7	1:LOAD	0.000	750.641	0.000	0.000	0.000	0.000

Beam End Forces

Sign convention is as the action of the joint on the beam.

			Axial	Shear		Torsion	Bending	
Beam	Node	L/C	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip*in)	My (kip*in)	Mz (kip*in)
1	2	1:LOAD	257.135	0.000	0.000	0.000	0.000	0.000
	3	1:LOAD	-257.135	0.000	0.000	0.000	0.000	0.000
4	5	1:LOAD	195.840	0.000	0.000	0.000	0.000	0.000
	6	1:LOAD	-195.840	0.000	0.000	0.000	0.000	0.000
5	8	1:LOAD	855.860	0.000	0.000	0.000	0.000	0.000
	9	1:LOAD	-855.860	0.000	0.000	0.000	0.000	0.000
6	9	1:LOAD	855.860	0.000	0.000	0.000	0.000	0.000
	10	1:LOAD	-855.860	0.000	0.000	0.000	0.000	0.000
7	10	1:LOAD	-257.135	0.000	0.000	0.000	0.000	0.000
	11	1:LOAD	257.135	0.000	0.000	0.000	0.000	0.000

Print Time/Date: 10/02/2009 18:37 STAAD.Pro for Windows Release 2006 Print Run 1 of 23

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Job No	Sheet No 2		Rev
Part			
Job Title	Ref		
	By	Date 09-Feb-09	Chd
Client	File Loads.std	Date/Time 10-Feb-2009 18:36	

Beam End Forces Cont...

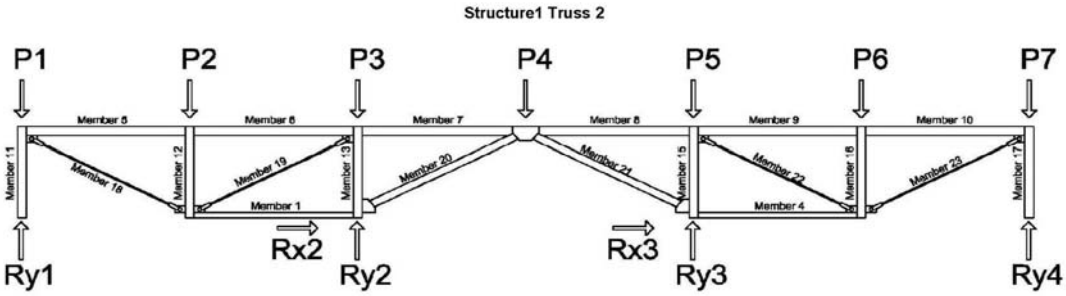
Beam	Node	L/C	Axial Fx (kip)	Shear Fy (kip)	Shear Fz (kip)	Torsion Mx (kip˙in)	Bending My (kip˙n)	Bending Mz (kip˙in)
8	11	1:LOAD	-195.840	0.000	0.000	0.000	0.000	0.000
	12	1:LOAD	195.840	0.000	0.000	0.000	0.000	0.000
9	12	1:LOAD	632.906	0.000	0.000	0.000	0.000	0.000
	13	1:LOAD	-632.906	0.000	0.000	0.000	0.000	0.000
10	13	1:LOAD	632.906	0.000	0.000	0.000	0.000	0.000
	14	1:LOAD	-632.906	0.000	0.000	0.000	0.000	0.000
11	1	1:LOAD	1.16E 3	0.000	0.000	0.000	0.000	0.000
	8	1:LOAD	-1.16E 3	0.000	0.000	0.000	0.000	0.000
12	2	1:LOAD	1.13E 3	0.000	0.000	0.000	0.000	0.000
	9	1:LOAD	-1.13E 3	0.000	0.000	0.000	0.000	0.000
13	3	1:LOAD	1.76E 3	0.000	0.000	0.000	0.000	0.000
	10	1:LOAD	-1.76E 3	0.000	0.000	0.000	0.000	0.000
15	5	1:LOAD	1.6E 3	0.000	0.000	0.000	0.000	0.000
	12	1:LOAD	-1.6E 3	0.000	0.000	0.000	0.000	0.000
16	6	1:LOAD	835.230	0.000	0.000	0.000	0.000	0.000
	13	1:LOAD	-835.230	0.000	0.000	0.000	0.000	0.000
17	7	1:LOAD	750.641	0.000	0.000	0.000	0.000	0.000
	14	1:LOAD	-750.641	0.000	0.000	0.000	0.000	0.000
18	8	1:LOAD	-985.738	0.000	0.000	0.000	0.000	0.000
	2	1:LOAD	985.738	0.000	0.000	0.000	0.000	0.000
19	2	1:LOAD	-1.28E 3	0.000	0.000	0.000	0.000	0.000
	10	1:LOAD	1.28E 3	0.000	0.000	0.000	0.000	0.000
20	3	1:LOAD	1.17E 3	0.000	0.000	0.000	0.000	0.000
	11	1:LOAD	-1.17E 3	0.000	0.000	0.000	0.000	0.000
21	11	1:LOAD	1.1E 3	0.000	0.000	0.000	0.000	0.000
	5	1:LOAD	-1.1E 3	0.000	0.000	0.000	0.000	0.000
22	12	1:LOAD	-954.509	0.000	0.000	0.000	0.000	0.000
	6	1:LOAD	954.509	0.000	0.000	0.000	0.000	0.000
23	6	1:LOAD	-728.951	0.000	0.000	0.000	0.000	0.000
	14	1:LOAD	728.951	0.000	0.000	0.000	0.000	0.000
24	3	1:LOAD	0.000	0.000	0.000	0.000	0.000	0.000
	5	1:LOAD	0.000	0.000	0.000	0.000	0.000	0.000

Print Time/Date: 10/00/2009 18:37 STAAD.Pro for Windows Release 2006 Print Run 2 of 21

STAAD Output

APPENDIX D: PRELIMINARY TRUSS 2 MEMBER SIZES

Structure1 Truss 2



COLUMNS

Member	11		12		13	
P_u (Kips)	1160	Compression	1125.06	Compression	1759.81	Compression
Length (ft)	18		18		18	
Trial Member	W14x176		W14x176		W14x176	
Table 1-1 From Steel Manual						
A_g (in^2)	51.8		51.8		51.8	
r_x (in)	6.43		6.43		6.43	
r_y (in)	4.55		4.55		4.55	
Theoretical K [Table C-C2.2]	0.5		0.5		0.5	
KL/r_x	16.8		16.8		16.8	
KL/r_y	23.7	Controls	23.7	Controls	23.7	Controls
E (ksi)	29000		29000		29000	
F_y (ksi)	50		50		50	
$4.71^*(E/F_y)^{1/2}$	113		113		113	
Use Fcr = 0.658^(Fy/Fe)*Fy						
F_e (ksi)	507		507		507	
F_{cr} (ksi)	48		48		48	
P_n (Kips)	2485		2485		2485	
ϕP_n (Kips)	2237		2237		2237	
Table 4-1 From Steel Manual						
$(KL)_y$ (ft)	18		18		18	
r_x/r_y	1.6		1.6		1.6	
ϕP_n (Kips)	1890		1890.0		1890.0	
$(KL)_{eff}$ (ft)	11.3	Okay	11.3	Okay	11.3	Okay
$\phi P_n \geq P_u$	Okay		Okay		Okay	
Member	W14x176		W14x176		W14x176	

Calculation 1: Preliminary Column Sizes for Truss 2

COLUMNS

Member	15	
P_u (Kips)	1598.63	Compression
Length (ft)	18	
Trial Member	W14x176	
Table 1-1 From Steel Manual		
A_g (in^2)	51.8	
r_x (in)	6.43	
r_y (in)	4.55	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	16.8	
KL/r_y	23.7	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	507	
F_{cr} (ksi)	48	
P_n (Kips)	2485	
φP_n (Kips)	2237	
Table 4-1 From Steel Manual		
$(KL)_y$ (ft)	18	
r_x/r_y	1.6	
φP_n (Kips)	1890	
$(KL)_{eff}$ (ft)	11.3	Okay
$\varphi P_n \geq P_u$	Okay	
Member	W14x176	

Member	16	
P_u (Kips)	835.23	Compression
Length (ft)	18	
Trial Member	W14x176	
Table 1-1 From Steel Manual		
A_g (in^2)	51.8	
r_x (in)	6.43	
r_y (in)	4.55	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	16.8	
KL/r_y	23.7	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	507	
F_{cr} (ksi)	48	
P_n (Kips)	2485	
φP_n (Kips)	2237	
Table 4-1 From Steel Manual		
$(KL)_y$ (ft)	18	
r_x/r_y	1.6	
φP_n (Kips)	1890	
$(KL)_{eff}$ (ft)	11.3	Okay
$\varphi P_n \geq P_u$	Okay	
Member	W14x176	

Member	17	
P_u (Kips)	750.64	Compression
Length (ft)	18	
Trial Member	W14x176	
Table 1-1 From Steel Manual		
A_g (in^2)	51.8	
r_x (in)	6.43	
r_y (in)	4.55	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	16.8	
KL/r_y	23.7	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	507	
F_{cr} (ksi)	48	
P_n (Kips)	2485	
φP_n (Kips)	2237	
Table 4-1 From Steel Manual		
$(KL)_y$ (ft)	18	
r_x/r_y	1.6	
φP_n (Kips)	1890	
$(KL)_{eff}$ (ft)	11.3	Okay
$\varphi P_n \geq P_u$	Okay	
Member	W14x176	

Calculation 2: Preliminary Column Sizes for Truss 2 Cont'd

BOTTOM CHORDS

Member	1	
P_u (Kips)	253.38	Tension
Length (ft)	31.5	
φ	0.9	
F_y (ksi)	50	
A_g (in^2)	5.63	

Table 5-1 From Steel Manual		
Member	W16x31	
A_g (in^2)	9.13	
ϕP_n (Kips)	411	Yielding
ϕP_n (Kips)	334	Rupture
$\phi P_n \geq P_u$ (Yield)	Okay	
Member	W16x31	

Member	4	
P_u (Kips)	196.32	Tension
Length (ft)	31.5	
φ	0.9	
F_y (ksi)	50	
A_g (in^2)	4.36	

Table 5-1 From Steel Manual		
Member	W16x31	
A_g (in^2)	9.13	
ϕP_n (Kips)	441	Yielding
ϕP_n (Kips)	334	Rupture
$\phi P_n \geq P_u$ (Yield)	Okay	
Member	W16x31	

Calculation 3: Preliminary Bottom Chord Sizes for Truss 2

TOP CHORDS

Member	5	
P_u (Kips)	860.13	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
φP_n (Kips)	1401	
φP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
φP_n (Kips)	1025	
$\varphi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Member	6	
P_u (Kips)	860.13	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
φP_n (Kips)	1401	
φP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
φP_n (Kips)	1025	
$\varphi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Member	7	
P_u (Kips)	253.38	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use Fcr = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
φP_n (Kips)	1401	
φP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
φP_n (Kips)	1025	
$\varphi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Calculation 4: Preliminary Top Chord Sizes for Truss 2

TOP CHORDS

Member	8	
P_u (Kips)	196.315	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use For = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
ϕP_n (Kips)	1401	
ϕP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
ϕP_n (Kips)	1025	
$\phi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Member	9	
P_u (Kips)	634.45	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use For = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
ϕP_n (Kips)	1401	
ϕP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
ϕP_n (Kips)	1025	
$\phi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Member	10	
P_u (Kips)	634.45	Compression
Length (ft)	31.5	
Trial Member	WT15x130.5	
Table 1-1 From Steel Manual		
A_g (in^2)	38.4	
r_x (in)	4.46	
r_y (in)	3.53	
Theoretical K [Table C-C2.2]	0.5	
KL/r_x	42.4	
KL/r_y	53.5	Controls
E (ksi)	29000	
F_y (ksi)	50	
$4.71*(E/F_y)^{1/2}$	113	
Use For = 0.658^(Fy/Fe)*Fy		
F_e (ksi)	100	
F_{cr} (ksi)	41	
P_n (Kips)	1557	
ϕP_n (Kips)	1401	
ϕP_n (Kips)	1261	
Table 4-7 From Steel Manual		
Member	WT15x130.5	
KL (ft)	31.5	
Axis	X-X	
r_x (in)	4.46	
r_y (in)	3.53	
ϕP_n (Kips)	1025	
$\phi P_n \geq P_u$	Okay	
Member	WT15x130.5	

Calculation 5: Preliminary Top Chord Sizes for Truss 2 Cont'd

BRACING (Tension)

Member	18	
P_u (Kips)	990.06	Tension
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	26.19	
r (in)	2.89	
r_{design} (in)	3.00	
r_{final} (in)*	1.50	
*2 Members Will Be Used		
$I_{required}$ (in^4)	59	
Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Member	19	
P_u (Kips)	1284.73	Tension
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	33.99	
r (in)	3.29	
r_{design} (in)	4.00	
r_{final} (in)*	2.00	
*2 Members Will Be Used		
$I_{required}$ (in^4)	136	
Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Member	22	
P_u (Kips)	956.26	Tension
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	25.30	
r (in)	2.84	
r_{design} (in)	3.00	
r_{final} (in)*	1.50	
*2 Members Will Be Used		
$I_{required}$ (in^4)	57	
Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Member	23	
P_u (Kips)	730.29	Tension
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	19.32	
r (in)	2.48	
r_{design} (in)	3.00	
r_{final} (in)*	1.50	
*2 Members Will Be Used		
$I_{required}$ (in^4)	43	
Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Calculation 6: Preliminary Tension Bracing Sizes for Truss 2

BRACING (Compression)

Member	20	
P_u (Kips)	1171.56	Compression
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	30.99	
r (in)	3.14	
r_{design} (in)	4.00	
r_{final} (in)*	2.00	

*2 Members Will Be Used

$I_{required}$ (in^4) 124

Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Member	21	
P_u (Kips)	1093.17	Compression
Length (ft)	36.3	
φ	0.9	
F_y (ksi)	42	
A_g (in^2)	28.92	
r (in)	3.03	
r_{design} (in)	4.00	
r_{final} (in)*	2.00	

*2 Members Will Be Used

$I_{required}$ (in^4) 116

Table 1-13 From Steel Manual		
Trial Member	HSS10x0.50	
A_g (in^2)	13.9	
r (in)	3.38	Okay
I_{member} (in^4)	159	Okay
Member	HSS10x0.50	

Calculation 7: Preliminary Compression Bracing Sizes for Truss 2

APPENDIX E: CURVED TENSION MEMBERS WITHIN TRUSS 2

Joseph W. Wilcher III	Job No	Sheet No 1	Rev
Software licensed to PSUAE	Part		
Job Title	Ref		
	By	Date 27-Feb-09	Chd
Client	File Truss 1, Structure 1, Mem	Date/Time 03-Mar-2009 20:36	

Job Information

	Engineer	Checked	Approved
Name:			
Date:	27-Feb-09		

Structure Type	SPACE FRAME

Number of Nodes	26	Highest Node	26
Number of Elements	25	Highest Beam	25

Number of Basic Load Cases	1
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	LOAD

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (ft)	L/C		d (ft)	Max My (kip*ft)	d (ft)	Max Mz (kip*ft)
1	1	1.845	1:LOAD	Max -ve	0.000	0.000	0.000	0.000
				Max +ve	0.000	0.000	1.845	-650.586
2	2	1.796	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.796	-1.22E 3
3	3	1.748	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.748	-1.71E 3
4	4	1.695	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.695	-2.11E 3
5	5	1.644	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.644	-2.45E 3
6	6	1.599	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.599	-2.71E 3
7	7	1.538	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.538	-2.9E 3
8	8	1.496	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.496	-3.04E 3
9	9	1.436	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.436	-3.12E 3
10	10	1.401	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.401	3.14E 3
11	11	1.342	1:LOAD	Max -ve	0.000	0.000		

Print Time/Date: 03/03/2009 20:36 STAAD.Pro for Windows Release 2005 Print Run 1 of 3

STADD Output for Curved Tension Members

Joseph W. Wilcher III

Software licensed to PSU/AE

Job No	Sheet No 2	Rev	
Job Title	Part		
	Ref		
	By	Date 27-Feb-09	Chd
Client	File Truss 1, Strucutre 1, Mem	Date/Time 03-Mar-2009 20:36	

Beam Maximum Moments Cont...

Beam	Node A	Length (ft)	L/C		d (ft)	Max My (kip*ft)	d (ft)	Max Mz (kip*ft)
				Max +ve	0.000	0.000	0.000	-3.14E 3
12	12	1.301	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-3.13E 3
13	13	1.257	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-3.07E 3
14	14	1.222	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.98E 3
15	15	1.173	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.85E 3
16	16	1.147	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.69E 3
17	17	1.105	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.51E 3
18	18	1.086	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.3E 3
19	19	1.049	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-2.07E 3
20	20	1.023	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-1.82E 3
21	21	1.001	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-1.55E 3
22	22	0.980	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-1.27E 3
23	23	0.959	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-972.661
24	24	0.951	1:LOAD	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-665.458
25	25	0.933	1:LOAD	Max -ve	0.000	0.000	0.933	0.000
				Max +ve	0.000	0.000	0.000	-338.251

Print Time/Date: 03/03/2009 20:36 STAAD.Pro for Windows Release 2006 Print Run 2 of 3

STADD Output for Curved Tension Members Cont'd

Curved Tension Member Analysis				
Structure 1 Truss 2			Moment From STAAD (ft-Kips)	3144.6
Member	19	Looking at 1 of the 2 Members	Lever Arm (ft)	11.604
F (Kips)	640.87		Angle (Degrees)	30
F_x (Kips)	556.76		R_x (Kips)	270.99
F_y (Kips)	317.38		R (Kips)	313

Preliminary Size	HSS10x0.5	
Table 4-5 In Steel Manual		
KL (ft)	23.42	
φP_n (Kips)	343	Okay
New Member	-	
φP_n (Kips)	-	

Final Member	HSS10.0x0.500

Calculation 1: Curved Tension Member Analysis for Truss 2

APPENDIX F: LATERAL RESISTING SYSTEM CALCULATIONS

Wind Parameters For Structure 1					
Basic Wind Speed (V)	Wind Exposure Category	Building Category	Importance Factor	Wind Directionality Factor (K_d)	Topographic Factor (K_{zt})
90 mph	B	III	1.15	0.85	1
Number of Stories	Building Height (ft)	N-S Building Length (ft)	E-W Building Length (ft)	L/B Along N-S Direction	L/B Along E-W Direction
5	88.167	179.50	189.00	0.950	1.05

Table 1: Wind Parameters for Structure 1

Wind Parameters For Strucutre 2					
Basic Wind Speed (V)	Wind Exposure Category	Building Category	Importance Factor	Wind Directionality Factor (K_d)	Topographic Factor (K_{zt})
90 mph	B	III	1.15	0.85	1
Number of Stories	Building Height (ft)	N-S Building Length (ft)	E-W Building Length (ft)	L/B Along N-S Direction	L/B Along E-W Direction
5	88.167	167.00	189.00	0.884	1.13

Table 2: Wind Parameters for Structure 2

Gust Factor: N-S Direction For Structure 1						
Stiffness	B (ft)	L (ft)	h (ft)	c	z (ft)	I_z
Rigid	189.00	179.50	88.167	0.3	64.667	0.268
l (ft)	ϵ	L_z (ft)	Q	g_o	g_v	G
320	1/3.0	400	0.82	3.4	3.4	0.82

Gust Factor: E-W Direction For Structure 1						
Stiffness	B (ft)	L (ft)	h (ft)	c	z (ft)	I_z
Rigid	179.50	189.00	88.167	0.3	64.667	0.268
l (ft)	ϵ	L_z (ft)	Q	g_o	g_v	G
320	1/3.0	400	0.82	3.4	3.4	0.82

Table 3: Gust Factors for Structure 1

Gust Factor: N-S Direction For Structure 2						
Stiffness	B (ft)	L (ft)	h (ft)	c	z (ft)	I_z
Rigid	189.00	167.00	88.167	0.3	64.667	0.268
l (ft)	∈	L_z (ft)	Q	g_Q	g_V	G
320	1/3.0	400	0.82	3.4	3.4	0.82

Gust Factor: E-W Direction Structure 2						
Stiffness	B (ft)	L (ft)	h (ft)	c	z (ft)	I_z
Rigid	167.00	189.00	88.167	0.3	64.667	0.268
l (ft)	∈	L_z (ft)	Q	g_Q	g_V	G
320	1/3.0	400	0.82	3.4	3.4	0.83

Table 4: Gust Factors for Structure 2

Wind Factors: N-S Direction For Strucutre 1				
C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}	GC_{pi}
0.8	-0.5	0.82	±0.18	±0.55

Wind Factors: E-W Direction For Structure 1				
C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}	GC_{pi}
0.8	-0.5	0.82	±0.18	±0.55

Table 5: Wind Factors for Structure 1

Wind Factors: N-S Direction For Structure 2				
C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}	GC_{pi}
0.8	-0.5	0.82	±0.18	±0.55

Wind Factors: E-W Direction Structure 2				
C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}	GC_{pi}
0.8	-0.5	0.83	±0.18	±0.55

Table 6: Wind Factors for Structure 2

Seismic Parameters For Structure 1													
S_s	S_1	Site Class	Occupancy Category	Importance Factor	Fa	Fv	S_{MS}	S_{M1}	S_{DS}	S_{D1}	Seismic Design Category	R	C_u
0.153	0.05	D	III	1.25	1.6	2.4	0.245	0.120	0.163	0.080	B	3.25	1.7
T_a	T	T_L	C_S	Roof Dead Load (psf)	Floor Dead Load (psf)	Snow Load (psf)	Wall Load (psf)	W_{roof} (Kips)	W_{floor} (Kips)	W_{Total} (Kips)	A (ft^2)	P (ft)	V (Kips)
0.787	1.34	8	0.0230	175	See Below	19	35	5937	48276	54213	33926	737	1248

Table 7: Seismic Parameters for Structure 1

Weight of Structure 1							
Level	Slab (psf)	Beams (psf)	Girders (psf)	Columns (psf)	Trusses (psf)	Floor Dead Load (psf)	W_{floor} (Kips)
Roof	51	40	84	-	-	175	5937
3rd Floor	51	40	84	61	-	236	8006
2nd Floor	51	40	84	82	-	257	8719
1st Floor	51	40	84	109	-	284	9635
Mezzazine	51	135	-	132	-	318	10788
Ground	81	-	-	-	247	328	11128
Track Level	-	-	-	-	-	-	-

Table 8: Weight of Structure 1

Seismic Parameters For Structure 2													
S_s	S_1	Site Class	Occupancy Category	Importance Factor	Fa	Fv	S_{MS}	S_{M1}	S_{DS}	S_{D1}	Seismic Design Category	R	C_u
0.153	0.05	D	III	1.25	1.6	2.4	0.245	0.120	0.163	0.080	B	3.25	1.7
T_a	T	T_L	C_S	Roof Dead Load (psf)	Floor Dead Load (psf)	Snow Load (psf)	Wall Load (psf)	W_{roof} (Kips)	W_{floor} (Kips)	W_{Total} (Kips)	A (ft^2)	P (ft)	V (Kips)
0.787	1.34	8	0.0230	167	See Below	19	35	5666	46648	52313	33926	737	1204

Table 9: Seismic Parameters for Structure 2

Weight of Structure 2							
Level	Slab (psf)	Beams (psf)	Girders (psf)	Columns (psf)	Trusses (psf)	Floor Dead Load (psf)	W_{floor} (Kips)
Roof	51	40	76	-	-	167	5666
3rd Floor	51	40	76	61	-	228	7735
2nd Floor	51	40	76	82	-	249	8447
1st Floor	51	40	76	99	-	266	9024
Mezzazine	51	135	-	132	-	318	10788
Ground	81	-	-	-	233	314	10653
Track Level	-	-	-	-	-	-	-

Table 9: Weight of Structure 2

Wind (North-South) For Structure 1										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	88.17	5.75	0.95	19.3	23.3	-18.5	41.8	43.1	43.1	247.8
3	76.67	11.5	0.92	18.6	22.5	-18.5	41.0	171.6	214.7	1730.3
2	65.17	11.5	0.87	17.6	14.8	-10.4	25.2	368.5	583.2	6318.5
1	53.67	11.875	0.82	16.6	13.9	-10.4	24.3	624.6	1207.8	16952.7
Mezzaine	41.42	15.1	0.77	15.6	13.1	-10.4	23.5	1015.0	2222.8	42854.0
Ground	23.5	10.96	0.65	13.2	11.0	-10.4	21.5	1015.0	2222.8	42854.0
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1015.0	2222.8	42854.0

Wind (North-South) For Strucutre 1										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	88.17	5.75	0.95	19.3	23.3	-18.5	41.8	45.4	45.4	261.2
3	76.67	11.5	0.92	18.6	22.5	-18.5	41.1	180.9	226.3	1823.7
2	65.17	11.5	0.87	17.6	14.8	-10.4	25.2	388.4	614.7	6659.7
1	53.67	11.875	0.82	16.6	13.9	-10.4	24.4	658.3	1273.1	17868.4
Mezzaine	41.42	15.1	0.77	15.6	13.1	-10.4	23.5	1070.0	2343.0	45170.1
Ground	23.5	10.96	0.65	13.2	11.1	-10.4	21.5	1070.0	2343.0	45170.1
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1070.0	2343.0	45170.1

Calculation 1: Shear & Moment Due to Wind Forces for Structure 1

Wind (North-South) For Structure 2										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	88.17	5.75	0.95	19.3	23.3	-18.5	41.8	40.1	40.1	230.5
3	76.67	11.5	0.92	18.6	22.5	-18.5	41.0	159.7	199.8	1609.8
2	65.17	11.5	0.87	17.6	14.8	-10.4	25.2	342.8	542.6	5878.5
1	53.67	11.875	0.82	16.6	13.9	-10.4	24.3	581.1	1123.7	15772.2
Mezzaine	41.42	15.1	0.77	15.6	13.1	-10.4	23.5	944.3	2068.0	39869.8
Ground	23.5	10.96	0.65	13.2	11.0	-10.4	21.5	944.3	2068.0	39869.8
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	944.3	2068.0	39869.8

Wind (North-South) For Strucutre 2										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	88.17	5.75	0.95	19.3	23.3	-18.5	41.9	45.5	45.5	261.5
3	76.67	11.5	0.92	18.6	22.6	-18.5	41.1	181.1	226.6	1826.2
2	65.17	11.5	0.87	17.6	14.8	-10.5	25.3	388.9	615.6	6668.8
1	53.67	11.875	0.82	16.6	14.0	-10.5	24.4	659.3	1274.9	17893.4
Mezzaine	41.42	15.1	0.77	15.6	13.1	-10.5	23.6	1071.6	2346.5	45235.0
Ground	23.5	10.96	0.65	13.2	11.1	-10.5	21.5	1071.6	2346.5	45235.0
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1071.6	2346.5	45235.0

Calculation 2: Shear & Moment Due to Wind Forces for Structure 2

Seismic For Structure 1					
Level	Height (ft)	Tributary Area (ft)	C_{vx}	F_x (Kips)	Overturning Moment (ft-Kips)
Roof	88.17	5.75	0.25	316	1815.4
3rd Floor	76.67	11.5	0.31	388	7677.9
2nd Floor	65.17	11.5	0.23	283	22928.6
1st Floor	53.67	11.875	0.15	181	30187.6
Mezzanine	41.42	15.1	0.06	80	48421.6
Ground	23.5	10.96	1.00	1248	48421.6
Track Level	0	0	1.00	1248	48421.6

Calculation 3: Shear & Moment Due to Seismic Forces for Structure 1

Seismic For Structure 2					
Level	Height (ft)	Tributary Area (ft)	C_{vx}	F_x (Kips)	Overturning Moment (ft-Kips)
Roof	88.17	5.75	0.25	300	1724.7
3rd Floor	76.67	11.5	0.31	378	7347.1
2nd Floor	65.17	11.5	0.23	277	22120.0
1st Floor	53.67	11.875	0.14	166	29055.3
Mezzazine	41.42	15.1	0.07	84	46603.0
Ground	23.5	10.96	1.00	1204	46603.0
Track Level	0	0	1.00	1204	46603.0

Calculation 4: Shear & Moment Due to Seismic Forces for Structure 2

Brace Frame 1: Structure 1		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0017	588.24
3	0.0013	769.23
2	0.0008	1250.00
1	0.0005	2000.00
Mezzanine	0.0001	10000.00
Total		2921.49

Brace Frame A: Structure 1		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0022	454.55
3	0.0016	625.00
2	0.0011	909.09
1	0.0006	1666.67
Mezzanine	0.0002	5000.00
Total		1731.06

Brace Frame 2: Structure 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0017	588.24
3	0.0013	769.23
2	0.0009	1111.11
1	0.0005	2000.00
Mezzanine	0.0001	10000.00
Total		2893.72

Brace Frame B: Structure 1		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0021	476.19
3	0.0015	666.67
2	0.001	1000.00
1	0.0006	1666.67
Mezzanine	0.0002	5000.00
Total		1761.90

Brace Frame 3: Structure 2		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0016	625.00
3	0.0012	833.33
2	0.0008	1250.00
1	0.0004	2500.00
Mezzanine	0.0001	10000.00
Total		3041.67

Brace Frame C: Structure 2		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0021	476.19
3	0.0016	625.00
2	0.001	1000.00
1	0.0006	1666.67
Mezzanine	0.0002	5000.00
Total		1753.57

Brace Frame 4: Structure 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0017	588.24
3	0.0013	769.23
2	0.0009	1111.11
1	0.0005	2000.00
Mezzanine	0.0002	5000.00
Total		1893.72

Brace Frame D: Structure 2		
Level	Displacement (in)	Stiffness (Kip/in)
Roof	0.0018	555.56
3	0.0014	714.29
2	0.0009	1111.11
1	0.0005	2000.00
Mezzanine	0.0002	5000.00
Total		1876.19

Calculation 5: Stiffness of Brace Frames

Story	Frame Stiffness: Structure 1				Center of Rigidity	
	1	2	A	B	X_R (ft)	Y_R (ft)
Roof	588.24	588.24	454.55	476.19	92.30	88.34
3	769.23	769.23	625.00	666.67	91.45	88.34
2	1250.00	1111.11	909.09	1000.00	90.00	83.14
1	2000.00	2000.00	1666.67	1666.67	94.50	88.34
Mezzanine	10000.00	10000.00	5000.00	5000.00	94.50	88.34

Story	Frame Stiffness Structure 2				Center of Rigidity	
	3	4	C	D	X_R (ft)	Y_R (ft)
Roof	625.00	588.24	476.19	555.56	87.23	79.60
3	833.33	769.23	625.00	714.29	88.20	78.80
2	1250.00	1111.11	1000.00	1111.11	89.53	77.26
1	2500.00	2000.00	1666.67	2000.00	85.91	72.96
Mezzanine	10000.00	5000.00	5000.00	5000.00	94.50	54.72

Calculation 5: Stiffness of Brace Frames

Torsional Moment Due To Wind: Structure 1						
Level	Story Force (Kips) North-South	Story Force (Kips) East-West	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	43.10	45.40	0.00	-2.20	0.00	-99.77
3	171.60	180.90	0.00	-3.05	0.00	-551.45
2	368.50	388.40	5.20	-4.50	1914.79	-1747.80
1	624.60	658.30	0.00	0.00	0.00	0.00
Mezzanine	1015.00	1070.00	0.00	0.00	0.00	0.00

Torsional Moment Due To Wind: Structure 2						
Level	Story Force (Kips) North-South	Story Force (Kips) East-West	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	40.10	45.50	2.49	-7.27	99.74	-330.75
3	159.70	181.10	3.28	-6.30	524.35	-1140.93
2	342.80	388.90	4.83	-4.97	1655.19	-1934.27
1	581.10	659.30	9.12	-8.59	5299.86	-5663.99
Mezzanine	944.30	1071.60	3.61	0.00	3411.44	0.00

Torsional Moment Due To Seismic: Structure 1					
Level	Story Force (Kips)	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	340.00	0.00	-2.20	0.00	-747.21
3	418.00	0.00	-3.05	0.00	-1274.23
2	304.00	5.20	-4.50	1579.64	-1368.00
1	195.00	0.00	0.00	0.00	0.00
Mezzanine	86.00	0.00	0.00	0.00	0.00

Torsional Moment Due To Seismic: Structure 2					
Level	Story Force (Kips)	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	300.00	2.49	-7.27	746.21	-2180.77
3	378.00	3.28	-6.30	1241.10	-2381.40
2	277.00	4.83	-4.97	1337.48	-1377.71
1	166.00	9.12	-8.59	1513.98	-1426.09
Mezzanine	84.00	3.61	0.00	303.46	0.00

Calculation 6: Torsional Moment Due to Wind & Seismic on Both Structures

Wind Direct Forces: Structure 1 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
1	588.24	43.10	1176.47	21.55
2	588.24	43.10	1176.47	21.55
			Total	43.10
Wind Direct Forces: Structure 1 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
A	454.55	45.40	930.74	22.17
B	476.19	45.40	930.74	23.23
			Total	45.40

Wind Direct Forces: Structure 2 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
3	625.00	40.10	1213.24	20.66
4	588.24	40.10	1213.24	19.44
			Total	40.10
Wind Direct Forces: Structure 2 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
C	476.19	45.50	1031.75	21.00
D	555.56	45.50	1031.75	24.50
			Total	45.50

Wind Direct Forces: Structure 1 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
1	769.23	171.60	1538.46	85.80
2	769.23	171.60	1538.46	85.80
			Total	171.60
Wind Direct Forces: Structure 1 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
A	625.00	180.90	1291.67	87.53
B	666.67	180.90	1291.67	93.37
			Total	180.90

Wind Direct Forces: Structure 2 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
3	833.33	159.70	1602.56	83.04
4	769.23	159.70	1602.56	76.66
			Total	159.70
Wind Direct Forces: Structure 2 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
C	625.00	181.10	1339.29	84.51
D	714.29	181.10	1339.29	96.59
			Total	181.10

Wind Direct Forces: Structure 1 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
1	1250.00	368.50	2361.11	195.09
2	1111.11	368.50	2361.11	173.41
			Total	368.50
Wind Direct Forces: Structure 1 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
A	909.09	388.40	1909.09	184.95
B	1000.00	388.40	1909.09	203.45
			Total	388.40

Wind Direct Forces: Structure 2 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
3	1250.00	342.80	2361.11	181.48
4	1111.11	342.80	2361.11	161.32
			Total	342.80
Wind Direct Forces: Structure 2 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
C	1000.00	388.90	2111.11	184.22
D	1111.11	388.90	2111.11	204.68
			Total	388.90

Wind Direct Forces: Structure 1 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
1	2000.00	624.60	4000.00	312.30
2	2000.00	624.60	4000.00	312.30
			Total	624.60
Wind Direct Forces: Structure 1 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
A	1666.67	658.30	3333.33	329.15
B	1666.67	658.30	3333.33	329.15
			Total	658.30

Wind Direct Forces: Structure 2 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
3	2500.00	581.10	4500.00	322.83
4	2000.00	581.10	4500.00	258.27
			Total	581.10
Wind Direct Forces: Structure 2 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
C	1666.67	659.30	3666.67	299.68
D	2000.00	659.30	3666.67	359.62
			Total	659.30

Wind Direct Forces: Structure 1 (N-S Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
1	10000.00	1015.00	20000.00	507.50
2	10000.00	1015.00	20000.00	507.50
			Total	1015.00
Wind Direct Forces: Structure 1 (E-W Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
A	5000.00	1070.00	10000.00	535.00
B	5000.00	1070.00	10000.00	535.00
			Total	1070.00

Wind Direct Forces: Structure 2 (N-S Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
3	10000.00	944.30	15000.00	629.53
4	5000.00	944.30	15000.00	314.77
			Total	944.30
Wind Direct Forces: Structure 2 (E-W Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
C	5000.00	1071.60	10000.00	535.80
D	5000.00	1071.60	10000.00	535.80
			Total	1071.60

Calculation 7: Direct Forces Due to Wind on Both Structures

Seismic Direct Forces: Structure 1 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
1	588.24	340.00	1176.47	170.00
2	588.24	340.00	1176.47	170.00
			Total	340.00
Seismic Direct Forces: Structure 1 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
A	454.55	340.00	930.74	166.05
B	476.19	340.00	930.74	173.95
			Total	340.00

Seismic Direct Forces: Structure 2 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
3	625.00	300.00	1213.24	154.55
4	588.24	300.00	1213.24	145.45
			Total	300.00
Seismic Direct Forces: Structure 2 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
C	476.19	300.00	1031.75	138.46
D	555.56	300.00	1031.75	161.54
			Total	300.00

Seismic Direct Forces: Structure 1 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
1	769.23	418.00	1538.46	209.00
2	769.23	418.00	1538.46	209.00
			Total	418.00
Seismic Direct Forces: Structure 1 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
A	625.00	418.00	1291.67	202.26
B	666.67	418.00	1291.67	215.74
			Total	418.00

Seismic Direct Forces: Structure 2 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
3	833.33	378.00	1602.56	196.56
4	769.23	378.00	1602.56	181.44
			Total	378.00
Seismic Direct Forces: Structure 2 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
C	625.00	378.00	1339.29	176.40
D	714.29	378.00	1339.29	201.60
			Total	378.00

Seismic Direct Forces: Structure 1 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
1	1250.00	304.00	2361.11	160.94
2	1111.11	304.00	2361.11	143.06
			Total	304.00
Seismic Direct Forces: Structure 1 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
A	909.09	304.00	1909.09	144.76
B	1000.00	304.00	1909.09	159.24
			Total	304.00

Seismic Direct Forces: Structure 2 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
3	1250.00	277.00	2361.11	146.65
4	1111.11	277.00	2361.11	130.35
			Total	277.00
Seismic Direct Forces: Structure 2 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
C	1000.00	277.00	2111.11	131.21
D	1111.11	277.00	2111.11	145.79
			Total	277.00

Seismic Direct Forces: Structure 1 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
1	2000.00	195.00	4000.00	97.50
2	2000.00	195.00	4000.00	97.50
			Total	195.00
Seismic Direct Forces: Structure 1 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
A	1666.67	195.00	3333.33	97.50
B	1666.67	195.00	3333.33	97.50
			Total	195.00

Seismic Direct Forces: Structure 2 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
3	2500.00	166.00	4500.00	92.22
4	2000.00	166.00	4500.00	73.78
			Total	166.00
Seismic Direct Forces: Structure 2 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
C	1666.67	166.00	3666.67	75.45
D	2000.00	166.00	3666.67	90.55
			Total	166.00

Seismic Direct Forces: Structure 1 (N-S Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
1	10000.00	86.00	20000.00	43.00
2	10000.00	86.00	20000.00	43.00
			Total	86.00
Seismic Direct Forces: Structure 1 (E-W Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
A	5000.00	86.00	10000.00	43.00
B	5000.00	86.00	10000.00	43.00
			Total	86.00

Seismic Direct Forces: Structure 2 (N-S Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
3	10000.00	84.00	15000.00	56.00
4	5000.00	84.00	15000.00	28.00
			Total	84.00
Seismic Direct Forces: Structure 2 (E-W Direction)				
Mezzanine	K_i	P	ΣK_i	Force (Kips)
C	5000.00	84.00	10000.00	42.00
D	5000.00	84.00	10000.00	42.00
			Total	84.00

Calculation 8: Direct Forces Due to Seismic on Both Structures

Forces By Torsional Moment: N-S Direction (Structure 1)				
Roof	K_i	d_i	$K_id_i^2$	Force (Kips)
1	588.24	-88.34	4590562	0.00
2	588.24	88.34	4590562	0.00
A	454.55	96.70	4250405	0.00
B	476.19	-92.30	4056805	0.00
		Total	17488334	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
3rd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	769.23	-88.34	6003043	0.000
2	769.23	88.33	6001684	0.000
A	625.00	97.55	5947502	0.000
B	666.67	-91.45	5575402	0.000
		Total	23527630	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
2nd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	1250.00	-83.14	8640325	-5.626
2	1111.11	93.53	9719845	5.626
A	909.09	99.00	8910000	4.872
B	1000.00	-90.00	8100000	-4.872
		Total	35370170	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
1st Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	2000.00	-88.34	15607911	0.000
2	2000.00	88.33	15604378	0.000
A	1666.67	94.50	14883750	0.000
B	1666.67	-94.50	14883750	0.000
		Total	60979789	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
Mezzanine	K_i	d_i	$K_id_i^2$	Force (Kips)
1	10000.00	-88.34	78039556	0.000
2	10000.00	88.33	78021889	0.000
A	5000.00	94.50	44651250	0.000
B	5000.00	-94.50	44651250	0.000
		Total	245363945	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
Roof	K_i	d_i	$K_id_i^2$	Force (Kips)
1	588.24	-88.34	4590562	0.296
2	588.24	88.34	4590562	-0.296
A	454.55	96.70	4250405	-0.251
B	476.19	-92.30	4056805	0.251
		Total	17488334	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
3rd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	769.23	-88.34	6003043	1.593
2	769.23	88.33	6001684	-1.593
A	625.00	97.55	5947502	-1.429
B	666.67	-91.45	5575402	1.429
		Total	23527630	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
2nd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	1250.00	-83.14	8640325	5.135
2	1111.11	93.53	9719845	-5.135
A	909.09	99.00	8910000	-4.447
B	1000.00	-90.00	8100000	4.447
		Total	35370170	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
1st Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
1	2000.00	-88.34	15607911	0.000
2	2000.00	88.33	15604378	0.000
A	1666.67	94.50	14883750	0.000
B	1666.67	-94.50	14883750	0.000
		Total	60979789	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
Mezzanine	K_i	d_i	$K_id_i^2$	Force (Kips)
1	10000.00	-88.34	78039556	0.000
2	10000.00	88.33	78021889	0.000
A	5000.00	94.50	44651250	0.000
B	5000.00	-94.50	44651250	0.000
		Total	245363945	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
Roof	K_i	d_i	$K_id_i^2$	Force (Kips)
3	625.00	-79.60	3960100	-0.286
4	588.24	84.57	4206810	0.286
C	476.19	101.77	4931968	0.279
D	555.56	-87.23	4227263	-0.279
		Total	17326141	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
3rd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	833.33	-78.80	5174533	-1.518
4	769.23	85.37	5605788	1.518
C	625.00	100.80	6350400	1.456
D	714.29	-88.20	5556600	-1.456
		Total	22687322	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
2nd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	1250.00	-77.26	7461385	-4.613
4	1111.11	86.91	8392030	4.612
C	1000.00	99.47	9894281	4.751
D	1111.11	-89.53	8906245	-4.751
		Total	34653940	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
1st Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	2500.00	-72.96	13307904	-15.487
4	2000.00	91.21	16637434	15.488
C	1666.67	103.09	17712580	14.589
D	2000.00	-85.91	14761056	-14.589
		Total	62418974	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
Mezzanine	K_i	d_i	$K_id_i^2$	Force (Kips)
3	10000.00	-54.72	29942784	-10.421
4	5000.00	109.45	59893229	10.421
C	5000.00	94.50	44651250	8.998
D	5000.00	-94.50	44651250	-8.998
		Total	179138513	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
Roof	K_i	d_i	$K_id_i^2$	Force (Kips)
3	625.00	-79.60	3960100	-1.656
4	588.24	84.57	4206810	1.655
C	476.19	101.77	4931968	1.613
D	555.56	-87.23	4227263	-1.613
		Total	17326141	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
3rd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	833.33	-78.80	5174533	-6.891
4	769.23	85.37	5605788	6.891
C	625.00	100.80	6350400	6.611
D	714.29	-88.20	5556600	-6.611
		Total	22687322	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
2nd Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	1250.00	-77.26	7461385	-16.995
4	1111.11	86.91	8392030	16.993
C	1000.00	99.47	9894281	17.504
D	1111.11	-89.53	8906245	-17.506
		Total	34653940	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
1st Floor	K_i	d_i	$K_id_i^2$	Force (Kips)
3	2500.00	-72.96	13307904	-33.683
4	2000.00	91.21	16637434	33.685
C	1666.67	103.09	17712580	31.728
D	2000.00	-85.91	14761056	-31.729
		Total	62418974	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
Mezzanine	K_i	d_i	$K_id_i^2$	Force (Kips)
3	10000.00	-54.72	29942784	-71.527
4	5000.00	109.45	59893229	71.532
C	5000.00	94.50	44651250	61.763
D	5000.00	-94.50	44651250	-61.763
		Total	179138513	0.00

Calculation 9: Torsional Forces on both Structures Due to Wind

Forces By Torsional Moment: N-S Direction (Structure 1)				
Roof	K_i	d_i	Kd_i^2	Force (Kips)
1	588.24	-88.34	4590562	0.000
2	588.24	88.34	4590562	0.000
A	454.55	96.70	4250405	0.000
B	476.19	-92.30	4056805	0.000
		Total	17488334	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
3rd Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	769.23	-88.34	6003043	0.000
2	769.23	88.33	6001684	0.000
A	625.00	97.55	5947502	0.000
B	666.67	-91.45	5575402	0.000
		Total	23527630	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
2nd Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	1250.00	-83.14	8640325	-4.641
2	1111.11	93.53	9719845	4.641
A	909.09	99.00	8910000	4.019
B	1000.00	-90.00	8100000	-4.019
		Total	35370170	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
1st Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	2000.00	-88.34	15607911	0.000
2	2000.00	88.33	15604378	0.000
A	1666.67	94.50	14883750	0.000
B	1666.67	-94.50	14883750	0.000
		Total	60979789	0.00

Forces By Torsional Moment: N-S Direction (Structure 1)				
Mezzanine	K_i	d_i	Kd_i^2	Force (Kips)
1	10000.00	-88.34	78039556	0.000
2	10000.00	88.33	78021889	0.000
A	5000.00	94.50	44651250	0.000
B	5000.00	-94.50	44651250	0.000
		Total	245363945	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
Roof	K_i	d_i	Kd_i^2	Force (Kips)
1	588.24	-88.34	4590562	2.220
2	588.24	88.34	4590562	-2.220
A	454.55	96.70	4250405	-1.878
B	476.19	-92.30	4056805	1.878
		Total	17488334	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
3rd Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	769.23	-88.34	6003043	3.680
2	769.23	88.33	6001684	-3.680
A	625.00	97.55	5947502	-3.302
B	666.67	-91.45	5575402	3.302
		Total	23527630	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
2nd Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	1250.00	-83.14	8640325	4.019
2	1111.11	93.53	9719845	-4.019
A	909.09	99.00	8910000	-3.481
B	1000.00	-90.00	8100000	3.481
		Total	35370170	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
1st Floor	K_i	d_i	Kd_i^2	Force (Kips)
1	2000.00	-88.34	15607911	0.000
2	2000.00	88.33	15604378	0.000
A	1666.67	94.50	14883750	0.000
B	1666.67	-94.50	14883750	0.000
		Total	60979789	0.00

Forces By Torsional Moment: E-W Direction (Structure 1)				
Mezzanine	K_i	d_i	Kd_i^2	Force (Kips)
1	10000.00	-88.34	78039556	0.000
2	10000.00	88.33	78021889	0.000
A	5000.00	94.50	44651250	0.000
B	5000.00	-94.50	44651250	0.000
		Total	245363945	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
Roof	K_i	d_i	Kd_i^2	Force (Kips)
3	625.00	-79.60	3960100	-2.143
4	588.24	84.57	4206810	2.142
C	476.19	101.77	4931968	2.087
D	555.56	-87.23	4227263	-2.087
		Total	17326141	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
3rd Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	833.33	-78.80	5174533	-3.592
4	769.23	85.37	5605788	3.592
C	625.00	100.80	6350400	3.446
D	714.29	-88.20	5556600	-3.446
		Total	22687322	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
2nd Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	1250.00	-77.26	7461385	-3.727
4	1111.11	86.91	8392030	3.727
C	1000.00	99.47	9894281	3.839
D	1111.11	-89.53	8906245	-3.839
		Total	34653940	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
1st Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	2500.00	-72.96	13307904	-4.424
4	2000.00	91.21	16637434	4.424
C	1666.67	103.09	17712580	4.167
D	2000.00	-85.91	14761056	-4.168
		Total	62418974	0.00

Forces By Torsional Moment: N-S Direction (Structure 2)				
Mezzanine	K_i	d_i	Kd_i^2	Force (Kips)
3	10000.00	-54.72	29942784	-0.927
4	5000.00	109.45	59893229	0.927
C	5000.00	94.50	44651250	0.800
D	5000.00	-94.50	44651250	-0.800
		Total	179138513	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
Roof	K_i	d_i	Kd_i^2	Force (Kips)
3	625.00	-79.60	3960100	6.262
4	588.24	84.57	4206810	-6.261
C	476.19	101.77	4931968	-6.100
D	555.56	-87.23	4227263	6.100
		Total	17326141	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
3rd Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	833.33	-78.80	5174533	6.893
4	769.23	85.37	5605788	-6.893
C	625.00	100.80	6350400	-6.613
D	714.29	-88.20	5556600	6.613
		Total	22687322	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
2nd Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	1250.00	-77.26	7461385	3.839
4	1111.11	86.91	8392030	-3.839
C	1000.00	99.47	9894281	-3.955
D	1111.11	-89.53	8906245	3.955
		Total	34653940	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
1st Floor	K_i	d_i	Kd_i^2	Force (Kips)
3	2500.00	-72.96	13307904	4.167
4	2000.00	91.21	16637434	-4.168
C	1666.67	103.09	17712580	-3.926
D	2000.00	-85.91	14761056	3.926
		Total	62418974	0.00

Forces By Torsional Moment: E-W Direction (Structure 2)				
Mezzanine	K_i	d_i	Kd_i^2	Force (Kips)
3	10000.00	-54.72	29942784	0.000
4	5000.00	109.45	59893229	0.000
C	5000.00	94.50	44651250	0.000
D	5000.00	-94.50	44651250	0.000
		Total	179138513	0.00

Calculation 10: Torsional Forces on both Structures Due to Seismic

Net Force On Frames (N-S Direction): Structure 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	21.55	0.00	21.55
2	21.55	0.00	21.55
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	85.80	0.00	85.80
2	85.80	0.00	85.80
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	195.09	-5.63	200.71
2	173.41	5.63	179.04
A	-	4.87	4.87
B	-	-4.87	4.87

Net Force On Frames (N-S Direction): Structure 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	312.30	0.00	312.30
2	312.30	0.00	312.30
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	507.50	0.00	507.50
2	507.50	0.00	507.50
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (E-W Direction): Structure 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	0.30	0.30
2	-	-0.30	0.30
A	22.17	-0.25	22.42
B	23.23	0.25	23.48

Net Force On Frames (E-W Direction): Structure 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	1.59	1.59
2	-	-1.59	1.59
A	87.53	-1.43	88.96
B	93.37	1.43	94.80

Net Force On Frames (E-W Direction): Structure 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	5.14	5.14
2	-	-5.14	5.14
A	184.95	-4.45	189.40
B	203.45	4.45	207.89

Net Force On Frames (E-W Direction): Structure 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	0.00	0.00
2	-	0.00	0.00
A	329.15	0.00	329.15
B	329.15	0.00	329.15

Net Force On Frames (E-W Direction): Structure 1			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	0.00	0.00
2	-	0.00	0.00
A	535.00	0.00	535.00
B	535.00	0.00	535.00

Net Force On Frames (N-S Direction): Structure 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	20.66	-0.29	20.94
4	19.44	0.29	19.73
C	-	0.28	0.28
D	-	-0.28	0.28

Net Force On Frames (N-S Direction): Structure 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	83.04	-1.52	84.56
4	76.66	1.52	78.17
C	-	1.46	1.46
D	-	-1.46	1.46

Net Force On Frames (N-S Direction): Structure 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	181.48	-4.61	186.10
4	161.32	4.61	165.93
C	-	4.75	4.75
D	-	-4.75	4.75

Net Force On Frames (N-S Direction): Structure 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	322.83	-15.49	338.32
4	258.27	15.49	273.76
C	-	14.59	14.59
D	-	-14.59	14.59

Net Force On Frames (N-S Direction): Structure 2			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	629.53	-71.53	701.06
4	314.77	71.53	386.30
C	-	61.76	61.76
D	-	-61.76	61.76

Net Force On Frames (E-W Direction): Structure 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	-1.66	1.66
4	-	1.66	1.66
C	21.00	1.61	22.61
D	24.50	-1.61	26.11

Net Force On Frames (E-W Direction): Structure 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	-6.89	6.89
4	-	6.89	6.89
C	84.51	6.61	91.12
D	96.59	-6.61	103.20

Net Force On Frames (E-W Direction): Structure 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	-16.99	16.99
4	-	16.99	16.99
C	184.22	17.50	201.72
D	204.68	-17.51	222.19

Net Force On Frames (E-W Direction): Structure 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	-33.68	33.68
4	-	33.69	33.69
C	299.68	31.73	331.41
D	359.62	-31.73	391.35

Net Force On Frames (E-W Direction): Structure 2			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	-71.53	71.53
4	-	71.53	71.53
C	535.80	61.76	597.56
D	535.80	-61.76	597.56

Calculation 11: Net Force on Both Structures Due to Wind

Net Force On Frames (N-S Direction): Structure 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	170.00	0.00	170.00
2	170.00	0.00	170.00
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	209.00	0.00	209.00
2	209.00	0.00	209.00
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	160.94	-4.64	165.58
2	143.06	4.64	147.70
A	-	4.02	4.02
B	-	-4.02	4.02

Net Force On Frames (N-S Direction): Structure 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	97.50	0.00	97.50
2	97.50	0.00	97.50
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (N-S Direction): Structure 1			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	43.00	0.00	43.00
2	43.00	0.00	43.00
A	-	0.00	0.00
B	-	0.00	0.00

Net Force On Frames (E-W Direction): Structure 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	2.22	2.22
2	-	-2.22	2.22
A	166.05	-1.88	167.92
B	173.95	1.88	175.83

Net Force On Frames (E-W Direction): Structure 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	3.68	3.68
2	-	-3.68	3.68
A	202.26	-3.30	205.56
B	215.74	3.30	219.04

Net Force On Frames (E-W Direction): Structure 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	4.02	4.02
2	-	-4.02	4.02
A	144.76	-3.48	148.24
B	159.24	3.48	162.72

Net Force On Frames (E-W Direction): Structure 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	0.00	0.00
2	-	0.00	0.00
A	97.50	0.00	97.50
B	97.50	0.00	97.50

Net Force On Frames (E-W Direction): Structure 1			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	0.00	0.00
2	-	0.00	0.00
A	43.00	0.00	43.00
B	43.00	0.00	43.00

Net Force On Frames (N-S Direction): Structure 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	154.55	-2.14	156.69
4	145.45	2.14	147.60
C	-	2.09	2.09
D	-	-2.09	2.09

Net Force On Frames (N-S Direction): Structure 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	196.56	-3.59	200.15
4	181.44	3.59	185.03
C	-	3.45	3.45
D	-	-3.45	3.45

Net Force On Frames (N-S Direction): Structure 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	146.65	-3.73	150.37
4	130.35	3.73	134.08
C	-	3.84	3.84
D	-	-3.84	3.84

Net Force On Frames (N-S Direction): Structure 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	92.22	-4.42	96.65
4	73.78	4.42	78.20
C	-	4.17	4.17
D	-	-4.17	4.17

Net Force On Frames (N-S Direction): Structure 2			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	56.00	-0.93	56.93
4	28.00	0.93	28.93
C	-	0.80	0.80
D	-	-0.80	0.80

Net Force On Frames (E-W Direction): Structure 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	6.26	6.26
4	-	-6.26	6.26
C	138.46	-6.10	144.56
D	161.54	6.10	167.64

Net Force On Frames (E-W Direction): Structure 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	6.89	6.89
4	-	-6.89	6.89
C	176.40	-6.61	183.01
D	201.60	6.61	208.21

Net Force On Frames (E-W Direction): Structure 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	3.84	3.84
4	-	-3.84	3.84
C	131.21	-3.95	135.17
D	145.79	3.95	149.74

Net Force On Frames (E-W Direction): Structure 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	4.17	4.17
4	-	-4.17	4.17
C	75.45	-3.93	79.38
D	90.55	3.93	94.47

Net Force On Frames (E-W Direction): Structure 2			
Mezzanine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
3	-	0.00	0.00
4	-	0.00	0.00
C	42.00	0.00	42.00
D	42.00	0.00	42.00

Calculation 12: Net Force on Both Structures Due to Seismic

APPENDIX G: DRIFT RESULTS

Controlling Wind Drift: Frame 1									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.041	<	0.345	Acceptable	0.509	<	1.94	Acceptable
3rd	11.500	0.049	<	0.345	Acceptable	0.468	<	1.595	Acceptable
2nd	11.500	0.140	<	0.345	Acceptable	0.419	<	1.25	Acceptable
1st	12.250	0.150	<	0.368	Acceptable	0.278	<	0.905	Acceptable
Mezzanine	17.917	0.129	<	0.538	Acceptable	0.129	<	0.5375	Acceptable

Controlling Wind Drift: Frame A									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.079	<	0.345	Acceptable	0.681	<	1.94	Acceptable
3rd	11.500	0.094	<	0.345	Acceptable	0.602	<	1.595	Acceptable
2nd	11.500	0.161	<	0.345	Acceptable	0.508	<	1.25	Acceptable
1st	12.250	0.161	<	0.368	Acceptable	0.347	<	0.905	Acceptable
Mezzanine	17.917	0.186	<	0.538	Acceptable	0.186	<	0.5375	Acceptable

Controlling Wind Drift: Frame 2									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.042	<	0.345	Acceptable	0.514	<	1.94	Acceptable
3rd	11.500	0.050	<	0.345	Acceptable	0.472	<	1.595	Acceptable
2nd	11.500	0.136	<	0.345	Acceptable	0.421	<	1.25	Acceptable
1st	12.250	0.147	<	0.368	Acceptable	0.285	<	0.905	Acceptable
Mezzanine	17.917	0.139	<	0.538	Acceptable	0.139	<	0.5375	Acceptable

Controlling Wind Drift: Frame B									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.075	<	0.345	Acceptable	0.674	<	1.94	Acceptable
3rd	11.500	0.089	<	0.345	Acceptable	0.599	<	1.595	Acceptable
2nd	11.500	0.161	<	0.345	Acceptable	0.510	<	1.25	Acceptable
1st	12.250	0.160	<	0.368	Acceptable	0.349	<	0.905	Acceptable
Mezzanine	17.917	0.188	<	0.538	Acceptable	0.188	<	0.5375	Acceptable

Table 1: Drift Results for Structure 1 Due to Wind

Controlling Wind Drift: Frame 3									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.036	<	0.345	Acceptable	0.489	<	1.94	Acceptable
3rd	11.500	0.045	<	0.345	Acceptable	0.453	<	1.595	Acceptable
2nd	11.500	0.135	<	0.345	Acceptable	0.408	<	1.25	Acceptable
1st	12.250	0.146	<	0.368	Acceptable	0.273	<	0.905	Acceptable
Mezzanine	17.917	0.127	<	0.538	Acceptable	0.127	<	0.5375	Acceptable

Controlling Wind Drift: Frame C									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.075	<	0.345	Acceptable	0.681	<	1.94	Acceptable
3rd	11.500	0.090	<	0.345	Acceptable	0.606	<	1.595	Acceptable
2nd	11.500	0.161	<	0.345	Acceptable	0.517	<	1.25	Acceptable
1st	12.250	0.160	<	0.368	Acceptable	0.356	<	0.905	Acceptable
Mezzanine	17.917	0.196	<	0.538	Acceptable	0.196	<	0.5375	Acceptable

Controlling Wind Drift: Frame 4									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.034	<	0.345	Acceptable	0.477	<	1.94	Acceptable
3rd	11.500	0.041	<	0.345	Acceptable	0.443	<	1.595	Acceptable
2nd	11.500	0.119	<	0.345	Acceptable	0.402	<	1.25	Acceptable
1st	12.250	0.122	<	0.368	Acceptable	0.282	<	0.905	Acceptable
Mezzanine	17.917	0.160	<	0.538	Acceptable	0.160	<	0.5375	Acceptable

Controlling Wind Drift: Frame D									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) D_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) D_{wind} = H/400		
Roof	11.500	0.060	<	0.345	Acceptable	0.677	<	1.94	Acceptable
3rd	11.500	0.079	<	0.345	Acceptable	0.617	<	1.595	Acceptable
2nd	11.500	0.166	<	0.345	Acceptable	0.538	<	1.25	Acceptable
1st	12.250	0.168	<	0.368	Acceptable	0.372	<	0.905	Acceptable
Mezzanine	17.917	0.204	<	0.538	Acceptable	0.204	<	0.5375	Acceptable

Table 2: Drift Results for Structure 2 Due to Wind

Controlling Seismic Drift: Frame 1									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.129	<	0.230	Acceptable	0.738	<	1.293	Acceptable
3rd	11.500	0.140	<	0.230	Acceptable	0.609	<	1.063	Acceptable
2nd	11.500	0.201	<	0.230	Acceptable	0.469	<	0.833	Acceptable
1st	12.250	0.189	<	0.245	Acceptable	0.269	<	0.603	Acceptable
Mezzanine	17.917	0.080	<	0.358	Acceptable	0.080	<	0.358	Acceptable

Controlling Seismic Drift: Frame A									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.197	<	0.230	Acceptable	0.932	<	1.293	Acceptable
3rd	11.500	0.192	<	0.230	Acceptable	0.736	<	1.063	Acceptable
2nd	11.500	0.218	<	0.230	Acceptable	0.544	<	0.833	Acceptable
1st	12.250	0.217	<	0.245	Acceptable	0.326	<	0.603	Acceptable
Mezzanine	17.917	0.110	<	0.358	Acceptable	0.110	<	0.358	Acceptable

Controlling Seismic Drift: Frame 2									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.127	<	0.230	Acceptable	0.742	<	1.293	Acceptable
3rd	11.500	0.143	<	0.230	Acceptable	0.616	<	1.063	Acceptable
2nd	11.500	0.199	<	0.230	Acceptable	0.472	<	0.833	Acceptable
1st	12.250	0.189	<	0.245	Acceptable	0.273	<	0.603	Acceptable
Mezzanine	17.917	0.085	<	0.358	Acceptable	0.085	<	0.358	Acceptable

Controlling Seismic Drift: Frame B									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.193	<	0.230	Acceptable	0.927	<	1.293	Acceptable
3rd	11.500	0.186	<	0.230	Acceptable	0.734	<	1.063	Acceptable
2nd	11.500	0.218	<	0.230	Acceptable	0.548	<	0.833	Acceptable
1st	12.250	0.216	<	0.245	Acceptable	0.330	<	0.603	Acceptable
Mezzanine	17.917	0.114	<	0.358	Acceptable	0.114	<	0.358	Acceptable

Table 3: Drift Results for Structure 1 Due to Seismic

Controlling Seismic Drift: Frame 3									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.110	<	0.230	Acceptable	0.653	<	1.293	Acceptable
3rd	11.500	0.126	<	0.230	Acceptable	0.543	<	1.063	Acceptable
2nd	11.500	0.183	<	0.230	Acceptable	0.418	<	0.833	Acceptable
1st	12.250	0.171	<	0.245	Acceptable	0.235	<	0.603	Acceptable
Mezzanine	17.917	0.064	<	0.358	Acceptable	0.064	<	0.358	Acceptable

Controlling Seismic Drift: Frame 4									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.103	<	0.230	Acceptable	0.641	<	1.293	Acceptable
3rd	11.500	0.117	<	0.230	Acceptable	0.538	<	1.063	Acceptable
2nd	11.500	0.167	<	0.230	Acceptable	0.421	<	0.833	Acceptable
1st	12.250	0.153	<	0.245	Acceptable	0.253	<	0.603	Acceptable
Mezzanine	17.917	0.100	<	0.358	Acceptable	0.100	<	0.358	Acceptable

Controlling Seismic Drift: Frame C									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.163	<	0.230	Acceptable	0.781	<	1.293	Acceptable
3rd	11.500	0.157	<	0.230	Acceptable	0.618	<	1.063	Acceptable
2nd	11.500	0.184	<	0.230	Acceptable	0.461	<	0.833	Acceptable
1st	12.250	0.182	<	0.245	Acceptable	0.277	<	0.603	Acceptable
Mezzanine	17.917	0.095	<	0.358	Acceptable	0.095	<	0.358	Acceptable

Controlling Seismic Drift: Frame D									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $D_{SEISMIC} = 0.020h_{sx}$		
Roof	11.500	0.149	<	0.230	Acceptable	0.774	<	1.293	Acceptable
3rd	11.500	0.147	<	0.230	Acceptable	0.625	<	1.063	Acceptable
2nd	11.500	0.189	<	0.230	Acceptable	0.478	<	0.833	Acceptable
1st	12.250	0.185	<	0.245	Acceptable	0.289	<	0.603	Acceptable
Mezzanine	17.917	0.104	<	0.358	Acceptable	0.104	<	0.358	Acceptable

Table 4: Drift Results for Structure 2 Due to Seismic

APPENDIX H: STEEL CONNECTIONS

Pin Connection Plate At Bottom of Truss 1 Structure 1

Member	15	
P_u (Kips)	255.82	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	2.33	
	2.88	Controls
w (in)	10	
Tension Rupture		
φP_n (Kips)	315.9	Okay
Shear Rupture		
a (in)	3	
b (in)	3	
d (in)	4	
A_{sf} (in^2)	11.25	
φP_n (Kips)	438.75	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	506.25	Okay

10 in x 1.125 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 1 Structure 1

Member	16	
P_u (Kips)	328.56	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.25	
b_{eff} (in)	2.70	
	3.13	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	381.47	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	13.125	
φP_n (Kips)	511.875	Okay
Bearing On Pin		
A_{pb} (in^2)	5	
φP_n (Kips)	337.5	Okay
Tension Tielding		
φP_n (Kips)	590.625	Okay

10.5 in x 1.25 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 1 Structure 1

Member	19	
P_u (Kips)	175.21	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.25	
b_{eff} (in)	1.44	
	3.13	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	381.47	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	13.125	
φP_n (Kips)	511.875	Okay
Bearing On Pin		
A_{pb} (in^2)	5	
φP_n (Kips)	337.5	Okay
Tension Tielding		
φP_n (Kips)	590.625	Okay

10.5 in x 1.25 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 1 Structure 1

Member	20	
P_u (Kips)	135.59	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	1.24	
	2.88	Controls
w (in)	10	
Tension Rupture		
φP_n (Kips)	315.90	Okay
Shear Rupture		
a (in)	3	
b (in)	3	
d (in)	4	
A_{sf} (in^2)	11.25	
φP_n (Kips)	438.75	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	506.25	Okay

10 in x 1.125 in pin-connected member with a 4 in pin

Calculation 1: Pin & Plate Size for Trusses

Pin Connection Plate At Bottom of Truss 2 Structure 1

Member	15	
P_u (Kips)	495.03	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.5	
b_{eff} (in)	3.38	
	3.63	Controls
w (in)	14	
Tension Rupture		
φP_n (Kips)	530.89	Okay
Shear Rupture		
a (in)	4	
b (in)	4	
d (in)	6	
A_{sf} (in^2)	21	
φP_n (Kips)	819	Okay
Bearing On Pin		
A_{pb} (in^2)	9	
φP_n (Kips)	607.5	Okay
Tension Tielding		
φP_n (Kips)	945	Okay

14 in x 1.5 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 2 Structure 1

Member	16	
P_u (Kips)	642.37	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	3.76	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 2 Structure 1

Member	19	
P_u (Kips)	478.13	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.5	
b_{eff} (in)	3.27	
	3.63	Controls
w (in)	14	
Tension Rupture		
φP_n (Kips)	530.89	Okay
Shear Rupture		
a (in)	4	
b (in)	4	
d (in)	6	
A_{sf} (in^2)	21	
φP_n (Kips)	819	Okay
Bearing On Pin		
A_{pb} (in^2)	9	
φP_n (Kips)	607.5	Okay
Tension Tielding		
φP_n (Kips)	945	Okay

14 in x 1.5 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 2 Structure 1

Member	20	
P_u (Kips)	365.15	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.5	
b_{eff} (in)	2.50	
	3.63	Controls
w (in)	14	
Tension Rupture		
φP_n (Kips)	530.89	Okay
Shear Rupture		
a (in)	4	
b (in)	4	
d (in)	6	
A_{sf} (in^2)	21	
φP_n (Kips)	819	Okay
Bearing On Pin		
A_{pb} (in^2)	9	
φP_n (Kips)	607.5	Okay
Tension Tielding		
φP_n (Kips)	945	Okay

14 in x 1.5 in pin-connected member with (2) 3 in pins

Calculation 2: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 3 Structure
1

Member	15	
P_u (Kips)	515.245	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	3.02	
w (in)	4.13	Controls
	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 3 Structure
1

Member	16	
P_u (Kips)	682.66	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	4.00	
w (in)	4.13	Controls
	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 3 Structure
1

Member	19	
P_u (Kips)	682.66	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	4.00	
w (in)	4.13	Controls
	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 3 Structure
1

Member	20	
P_u (Kips)	515.245	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	3.02	
w (in)	4.13	Controls
	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Calculation 3: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 4 Structure 1

Member	15	
P_u (Kips)	928.145	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	2.125	
b_{eff} (in)	4.48	
	4.88	Controls
w (in)	18	
Tension Rupture		
φP_n (Kips)	1011.08	Okay
Shear Rupture		
a (in)	5	
b (in)	5	
d (in)	8	
A_{sf} (in^2)	38.25	
φP_n (Kips)	1491.75	Okay
Bearing On Pin		
A_{pb} (in^2)	17	
φP_n (Kips)	1147.5	Okay
Tension Tielding		
φP_n (Kips)	1721.25	Okay

18 in x 2.125 in pin-connected member with (2) 4 in pins

Pin Connection Plate At Bottom of Truss 4 Structure 1

Member	16	
P_u (Kips)	1208.12	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	2.375	
b_{eff} (in)	5.22	
	5.38	Controls
w (in)	19	
Tension Rupture		
φP_n (Kips)	1245.81	Okay
Shear Rupture		
a (in)	5.5	
b (in)	5.5	
d (in)	8	
A_{sf} (in^2)	45.125	
φP_n (Kips)	1759.875	Okay
Bearing On Pin		
A_{pb} (in^2)	19	
φP_n (Kips)	1282.5	Okay
Tension Tielding		
φP_n (Kips)	2030.625	Okay

19 in x 2.375 in pin-connected member with (2) 4 in pins

Pin Connection Plate At Bottom of Truss 4 Structure 1

Member	19	
P_u (Kips)	1238.41	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	2.375	
b_{eff} (in)	5.35	
	5.38	Controls
w (in)	19	
Tension Rupture		
φP_n (Kips)	1245.81	Okay
Shear Rupture		
a (in)	5.5	
b (in)	5.5	
d (in)	8	
A_{sf} (in^2)	45.125	
φP_n (Kips)	1759.875	Okay
Bearing On Pin		
A_{pb} (in^2)	19	
φP_n (Kips)	1282.5	Okay
Tension Tielding		
φP_n (Kips)	2030.625	Okay

19 in x 2.375 in pin-connected member with (2) 4 in pins

Pin Connection Plate At Bottom of Truss 4 Structure 1

Member	20	
P_u (Kips)	897.855	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	2.125	
b_{eff} (in)	4.33	
	4.88	Controls
w (in)	18	
Tension Rupture		
φP_n (Kips)	1011.08	Okay
Shear Rupture		
a (in)	5	
b (in)	5	
d (in)	8	
A_{sf} (in^2)	38.25	
φP_n (Kips)	1491.75	Okay
Bearing On Pin		
A_{pb} (in^2)	17	
φP_n (Kips)	1147.5	Okay
Tension Tielding		
φP_n (Kips)	1721.25	Okay

18 in x 2.125 in pin-connected member with (2) 4 in pins

Calculation 4: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 5 Structure 1

Member	15	
P_u (Kips)	219.4	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	2.00	
	2.88	Controls
w (in)	10	
Tension Rupture		
φP_n (Kips)	315.9	Okay
Shear Rupture		
a (in)	3	
b (in)	3	
d (in)	4	
A_{sf} (in^2)	11.25	
φP_n (Kips)	438.75	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	506.25	Okay

10 in x 1.125 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 5 Structure 1

Member	16	
P_u (Kips)	287.00	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.25	
b_{eff} (in)	2.35	
	3.13	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	381.47	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	13.125	
φP_n (Kips)	511.875	Okay
Bearing On Pin		
A_{pb} (in^2)	5	
φP_n (Kips)	337.5	Okay
Tension Tielding		
φP_n (Kips)	590.625	Okay

10.5 in x 1.25 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 5 Structure 1

Member	19	
P_u (Kips)	222.48	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.25	
b_{eff} (in)	1.83	
	3.13	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	381.47	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	13.125	
φP_n (Kips)	511.875	Okay
Bearing On Pin		
A_{pb} (in^2)	5	
φP_n (Kips)	337.5	Okay
Tension Tielding		
φP_n (Kips)	590.625	Okay

10.5 in x 1.25 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 5 Structure 1

Member	20	
P_u (Kips)	163.17	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	1.49	
	2.88	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	315.90	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	11.8125	
φP_n (Kips)	460.6875	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	531.5625	Okay

10.5 in x 1.125 in pin-connected member with a 4 in pin

Calculation 5: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 6 Structure 2

Member	15	
P_u (Kips)	271.15	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	2.47	
	2.88	Controls
w (in)	10	
Tension Rupture		
φP_n (Kips)	315.9	Okay
Shear Rupture		
a (in)	3	
b (in)	3	
d (in)	4	
A_{sf} (in^2)	11.25	
φP_n (Kips)	438.75	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	506.25	Okay

10 in x 1.125 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 6 Structure 2

Member	16	
P_u (Kips)	357.79	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.375	
b_{eff} (in)	2.67	
	3.38	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	453.13	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	14.4375	
φP_n (Kips)	563.0625	Okay
Bearing On Pin		
A_{pb} (in^2)	5.5	
φP_n (Kips)	371.25	Okay
Tension Tielding		
φP_n (Kips)	649.6875	Okay

10.5 in x 1.375 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 6 Structure 2

Member	19	
P_u (Kips)	357.79	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.375	
b_{eff} (in)	2.67	
	3.38	Controls
w (in)	10.5	
Tension Rupture		
φP_n (Kips)	453.13	Okay
Shear Rupture		
a (in)	3.25	
b (in)	3.25	
d (in)	4	
A_{sf} (in^2)	14.4375	
φP_n (Kips)	563.0625	Okay
Bearing On Pin		
A_{pb} (in^2)	5.5	
φP_n (Kips)	371.25	Okay
Tension Tielding		
φP_n (Kips)	649.6875	Okay

10.5 in x 1.375 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 6 Structure 2

Member	20	
P_u (Kips)	271.15	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.125	
b_{eff} (in)	2.47	
	2.88	Controls
w (in)	10	
Tension Rupture		
φP_n (Kips)	315.90	Okay
Shear Rupture		
a (in)	3	
b (in)	3	
d (in)	4	
A_{sf} (in^2)	11.25	
φP_n (Kips)	438.75	Okay
Bearing On Pin		
A_{pb} (in^2)	4.5	
φP_n (Kips)	303.75	Okay
Tension Tielding		
φP_n (Kips)	506.25	Okay

10 in x 1.125 in pin-connected member with a 4 in pin

Calculation 6: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 7 Structure
2

Member	15	
P_u (Kips)	505.975	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	2.97	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 7 Structure
2

Member	16	
P_u (Kips)	692.37	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	4.06	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 7 Structure
2

Member	19	
P_u (Kips)	606.20	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	3.55	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 7 Structure
2

Member	20	
P_u (Kips)	460.795	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	2.70	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Calculation 7: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 8 Structure
2

Member	15	
P_u (Kips)	497.525	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	2.92	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 8 Structure
2

Member	16	
P_u (Kips)	634.21	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.75	
b_{eff} (in)	3.72	
	4.13	Controls
w (in)	14.5	
Tension Rupture		
φP_n (Kips)	704.68	Okay
Shear Rupture		
a (in)	4.25	
b (in)	4.25	
d (in)	6	
A_{sf} (in^2)	25.375	
φP_n (Kips)	989.625	Okay
Bearing On Pin		
A_{pb} (in^2)	10.5	
φP_n (Kips)	708.75	Okay
Tension Tielding		
φP_n (Kips)	1141.875	Okay

14.5 in x 1.75 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 8 Structure
2

Member	19	
P_u (Kips)	435.30	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.5	
b_{eff} (in)	2.98	
	3.63	Controls
w (in)	14	
Tension Rupture		
φP_n (Kips)	530.89	Okay
Shear Rupture		
a (in)	4	
b (in)	4	
d (in)	6	
A_{sf} (in^2)	21	
φP_n (Kips)	819	Okay
Bearing On Pin		
A_{pb} (in^2)	9	
φP_n (Kips)	607.5	Okay
Tension Tielding		
φP_n (Kips)	945	Okay

14 in x 1.5 in pin-connected member with (2) 3 in pins

Pin Connection Plate At Bottom of Truss 8 Structure
2

Member	20	
P_u (Kips)	333.32	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	1.5	
b_{eff} (in)	2.28	
	3.63	Controls
w (in)	14	
Tension Rupture		
φP_n (Kips)	530.89	Okay
Shear Rupture		
a (in)	4	
b (in)	4	
d (in)	6	
A_{sf} (in^2)	21	
φP_n (Kips)	819	Okay
Bearing On Pin		
A_{pb} (in^2)	9	
φP_n (Kips)	607.5	Okay
Tension Tielding		
φP_n (Kips)	945	Okay

14 in x 1.5 in pin-connected member with (2) 3 in pins

Calculation 8: Pin & Plate Size for Trusses Cont'd

Pin Connection Plate At Bottom of Truss 9 Structure 2

Member	15	
P_u (Kips)	31.335	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	0.75	
b_{eff} (in)	0.43	
	2.13	Controls
w (in)	9	
Tension Rupture		
φP_n (Kips)	155.75625	Okay
Shear Rupture		
a (in)	2.5	
b (in)	2.5	
d (in)	4	
A_{sf} (in^2)	6.75	
φP_n (Kips)	263.25	Okay
Bearing On Pin		
A_{pb} (in^2)	3	
φP_n (Kips)	202.5	Okay
Tension Tielding		
φP_n (Kips)	303.75	Okay

9 in x 0.75 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 9 Structure 2

Member	16	
P_u (Kips)	41.53	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	0.75	
b_{eff} (in)	0.57	
	2.13	Controls
w (in)	9	
Tension Rupture		
φP_n (Kips)	155.76	Okay
Shear Rupture		
a (in)	2.5	
b (in)	2.5	
d (in)	4	
A_{sf} (in^2)	6.75	
φP_n (Kips)	263.25	Okay
Bearing On Pin		
A_{pb} (in^2)	3	
φP_n (Kips)	202.5	Okay
Tension Tielding		
φP_n (Kips)	303.75	Okay

9 in x 0.75 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 9 Structure 2

Member	19	
P_u (Kips)	41.53	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	0.75	
b_{eff} (in)	0.57	
	2.13	Controls
w (in)	9	
Tension Rupture		
φP_n (Kips)	155.76	Okay
Shear Rupture		
a (in)	2.5	
b (in)	2.5	
d (in)	4	
A_{sf} (in^2)	6.75	
φP_n (Kips)	263.25	Okay
Bearing On Pin		
A_{pb} (in^2)	3	
φP_n (Kips)	202.5	Okay
Tension Tielding		
φP_n (Kips)	303.75	Okay

9 in x 0.75 in pin-connected member with a 4 in pin

Pin Connection Plate At Bottom of Truss 9 Structure 2

Member	20	
P_u (Kips)	31.34	[For 1 Member]
F_y (ksi)	50	
F_u (ksi)	65	
t (in)	0.75	
b_{eff} (in)	0.43	
	2.13	Controls
w (in)	9	
Tension Rupture		
φP_n (Kips)	155.76	Okay
Shear Rupture		
a (in)	2.5	
b (in)	2.5	
d (in)	4	
A_{sf} (in^2)	6.75	
φP_n (Kips)	263.25	Okay
Bearing On Pin		
A_{pb} (in^2)	3	
φP_n (Kips)	202.5	Okay
Tension Tielding		
φP_n (Kips)	303.75	Okay

9 in x 0.75 in pin-connected member with a 4 in pin

Calculation 9: Pin & Plate Size for Trusses Cont'd

Pin Plate Connections To Columns [Truss 1 Structure 1]

Member	15			k	
Column	10	a	0.1	0.113	0.2
R_u (Kips)	255.82	0	5.58	5.635	6.02
t_p (in)	1.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10
kl (in)	1.125
k (in)	0.113
xl (in)	0
al (in)	0
a	0
C	5.635

C_1	1	
φ	0.75	
$D_{required}$	6.05	1/16"
D_{used}	7	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 7/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 1 Structure 1]

Member	16			k	
Column	10	a	0.1	0.119	0.2
R_u (Kips)	328.56	0	5.58	5.664	6.02
t_p (in)	1.25				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.25
k (in)	0.119
xl (in)	0
al (in)	0
a	0
C	5.664

C_1	1	
φ	0.75	
$D_{required}$	7.37	1/16"
D_{used}	8	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	19
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	4.75
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 1 Structure 1]

Member	19			k	
Column	13	a	0.1	0.119	0.2
R_u (Kips)	175.21	0	5.58	5.664	6.02
t_p (in)	1.25				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.25
k (in)	0.119
xl (in)	0
al (in)	0
a	0
C	5.664

C_1	1	
φ	0.75	
$D_{required}$	3.93	1/16"
D_{used}	4	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	19
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	4.75
$L_{weld} \geq 4t_w$	Okay

Use a 4/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 1 Structure 1]

Member	20			k	
Column	13	a	0.1	0.113	0.2
R_u (Kips)	135.59	0	5.58	5.635	6.02
t_p (in)	1.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10
kl (in)	1.125
k (in)	0.113
xl (in)	0
al (in)	0
a	0
C	5.635

C_1	1	
φ	0.75	
$D_{required}$	3.21	1/16"
D_{used}	4	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 4/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 10: Plate Connection to Column

Pin Plate Connections To Columns [Truss 2 Structure 1]

Member	15			k	
Column	10	a	0.1	0.107	0.2
R_u (Kips)	495.03	0	5.58	5.611	6.02
t_p (in)	1.5				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14
kl (in)	1.5
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	8.40
D_{used}	9

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	23
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14
$4t_w$ (in)	5.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 2 Structure 1]

Member	16			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	642.37	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	10.42
D_{used}	11

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 11/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 2 Structure 1]

Member	19			k	
Column	13	a	0.1	0.107	0.2
R_u (Kips)	478.13	0	5.58	5.611	6.02
t_p (in)	1.5				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14
kl (in)	1.5
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	8.11
D_{used}	9

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	23
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14
$4t_w$ (in)	5.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 2 Structure 1]

Member	20			k	
Column	13	a	0.1	0.107	0.2
R_u (Kips)	365.15	0	5.58	5.611	6.02
t_p (in)	1.5				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14
kl (in)	1.5
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	6.20
D_{used}	7

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	23
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14
$4t_w$ (in)	5.75
$L_{weld} \geq 4t_w$	Okay

Use a 7/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 11: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 3 Structure 1]

Member	15			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	515.25	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671

C_1	1	
φ	0.75	
$D_{required}$	8.35	1/16"
D_{used}	9	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 3 Structure 1]

Member	16			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	682.66	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671

C_1	1	
φ	0.75	
$D_{required}$	11.07	1/16"
D_{used}	12	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 12/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 3 Structure 1]

Member	19			k	
Column	13	a	0.1	0.121	0.2
R_u (Kips)	682.66	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671

C_1	1	
φ	0.75	
$D_{required}$	11.07	1/16"
D_{used}	12	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 12/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 3 Structure 1]

Member	20			k	
Column	13	a	0.1	0.121	0.2
R_u (Kips)	515.25	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671

C_1	1	
φ	0.75	
$D_{required}$	8.35	1/16"
D_{used}	9	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 12: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 4 Structure 1]

Member	15			k	
Column	10	a	0.1	0.118	0.2
R_u (Kips)	928.15	0	5.58	5.659	6.02
t_p (in)	2.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	18
kl (in)	2.125
k (in)	0.118
xl (in)	0
al (in)	0
a	0
C	5.659
C_1	1
φ	0.75
$D_{required}$	12.15
D_{used}	13

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	33
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	18
$4t_w$ (in)	8.25
$L_{weld} \geq 4t_w$	Okay

Use a 13/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 4 Structure 1]

Member	16			k	
Column	10	a	0.1	0.125	0.2
R_u (Kips)	1208.12	0	5.58	5.690	6.02
t_p (in)	2.375				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	19
kl (in)	2.375
k (in)	0.125
xl (in)	0
al (in)	0
a	0
C	5.690
C_1	1
φ	0.75
$D_{required}$	14.90
D_{used}	15

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	37
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	19
$4t_w$ (in)	9.25
$L_{weld} \geq 4t_w$	Okay

Use a Full Penitration Weld

Pin Plate Connections To Columns [Truss 4 Structure 1]

Member	19			k	
Column	13	a	0.1	0.125	0.2
R_u (Kips)	1238.42	0	5.58	5.690	6.02
t_p (in)	2.375				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	19
kl (in)	2.375
k (in)	0.125
xl (in)	0
al (in)	0
a	0
C	5.690
C_1	1
φ	0.75
$D_{required}$	15.27
D_{used}	16

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	37
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	19
$4t_w$ (in)	9.25
$L_{weld} \geq 4t_w$	Okay

Use a Full Penitration Weld

Pin Plate Connections To Columns [Truss 4 Structure 1]

Member	20			k	
Column	13	a	0.1	0.118	0.2
R_u (Kips)	897.86	0	5.58	5.659	6.02
t_p (in)	2.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	18
kl (in)	2.125
k (in)	0.118
xl (in)	0
al (in)	0
a	0
C	5.659
C_1	1
φ	0.75
$D_{required}$	11.75
D_{used}	12

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	33
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	18
$4t_w$ (in)	8.25
$L_{weld} \geq 4t_w$	Okay

Use a 12/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 13: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 5 Structure 1]

Member	15			k	
Column	10	a	0.1	0.113	0.2
R_u (Kips)	219.4	0	5.58	5.635	6.02
t_p (in)	1.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10
kl (in)	1.125
k (in)	0.113
xl (in)	0
al (in)	0
a	0
C	5.635
C_1	1
φ	0.75
$D_{required}$	5.19
D_{used}	6

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 6/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 5 Structure 1]

Member	16			k	
Column	10	a	0.1	0.119	0.2
R_u (Kips)	287	0	5.58	5.664	6.02
t_p (in)	1.25				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.25
k (in)	0.119
xl (in)	0
al (in)	0
a	0
C	5.664
C_1	1
φ	0.75
$D_{required}$	6.43
D_{used}	7

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	19
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	4.75
$L_{weld} \geq 4t_w$	Okay

Use a 7/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 5 Structure 1]

Member	19			k	
Column	13	a	0.1	0.119	0.2
R_u (Kips)	222.48	0	5.58	5.664	6.02
t_p (in)	1.25				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.25
k (in)	0.119
xl (in)	0
al (in)	0
a	0
C	5.664
C_1	1
φ	0.75
$D_{required}$	4.99
D_{used}	5

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	19
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	4.75
$L_{weld} \geq 4t_w$	Okay

Use a 6/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 5 Structure 1]

Member	20			k	
Column	13	a	0.1	0.107	0.2
R_u (Kips)	163.17	0	5.58	5.611	6.02
t_p (in)	1.125				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.125
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	3.69
D_{used}	4

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 4/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 14: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 6 Structure 2]

Member	15
Column	10
R_u (Kips)	271.15
t_p (in)	1.125

	k		
a	0.1	0.113	0.2
0	5.58	5.635	6.02

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10
kl (in)	1.125
k (in)	0.113
xl (in)	0
al (in)	0
a	0
C	5.635

C_1	1	
φ	0.75	
$D_{required}$	6.42	1/16"
D_{used}	7	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 7/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 6 Structure 2]

Member	16
Column	10
R_u (Kips)	357.79
t_p (in)	1.375

	k		
a	0.1	0.131	0.2
0	5.58	5.716	6.02

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.375
k (in)	0.131
xl (in)	0
al (in)	0
a	0
C	5.716

C_1	1	
φ	0.75	
$D_{required}$	7.95	1/16"
D_{used}	8	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	21
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	5.25
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 6 Structure 2]

Member	19
Column	13
R_u (Kips)	357.79
t_p (in)	1.375

	k		
a	0.1	0.131	0.2
0	5.58	5.716	6.02

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10.5
kl (in)	1.375
k (in)	0.131
xl (in)	0
al (in)	0
a	0
C	5.716

C_1	1	
φ	0.75	
$D_{required}$	7.95	1/16"
D_{used}	8	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	21
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10.5
$4t_w$ (in)	5.25
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 6 Structure 2]

Member	20
Column	13
R_u (Kips)	271.15
t_p (in)	1.125

	k		
a	0.1	0.113	0.2
0	5.58	5.635	6.02

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	10
kl (in)	1.125
k (in)	0.113
xl (in)	0
al (in)	0
a	0
C	5.635

C_1	1	
φ	0.75	
$D_{required}$	6.42	1/16"
D_{used}	7	

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	17
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	10
$4t_w$ (in)	4.25
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 15: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 7 Structure 2]

Member	15			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	505.975	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	8.20
D_{used}	9

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 7 Structure 2]

Member	16			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	692.37	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	11.23
D_{used}	12

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 12/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 7 Structure 2]

Member	19			k	
Column	13	a	0.1	0.121	0.2
R_u (Kips)	606.2	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	9.83
D_{used}	10

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 10/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 7 Structure 2]

Member	20			k	
Column	13	a	0.1	0.121	0.2
R_u (Kips)	460.795	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	7.47
D_{used}	8

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 16: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 8 Structure 2]

Member	15			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	497.525	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	8.07
D_{used}	9

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 9/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 8 Structure 2]

Member	16			k	
Column	10	a	0.1	0.121	0.2
R_u (Kips)	634.21	0	5.58	5.671	6.02
t_p (in)	1.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14.5
kl (in)	1.75
k (in)	0.121
xl (in)	0
al (in)	0
a	0
C	5.671
C_1	1
φ	0.75
$D_{required}$	10.28
D_{used}	11

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	27
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14.5
$4t_w$ (in)	6.75
$L_{weld} \geq 4t_w$	Okay

Use a 11/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 8 Structure 2]

Member	19			k	
Column	13	a	0.1	0.107	0.2
R_u (Kips)	435.3	0	5.58	5.611	6.02
t_p (in)	1.5				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14
kl (in)	1.5
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	7.39
D_{used}	8

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	23
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14
$4t_w$ (in)	5.75
$L_{weld} \geq 4t_w$	Okay

Use a 8/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 8 Structure 2]

Member	20			k	
Column	13	a	0.1	0.107	0.2
R_u (Kips)	333.32	0	5.58	5.611	6.02
t_p (in)	1.5				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	14
kl (in)	1.5
k (in)	0.107
xl (in)	0
al (in)	0
a	0
C	5.611
C_1	1
φ	0.75
$D_{required}$	5.66
D_{used}	6

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	23
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	14
$4t_w$ (in)	5.75
$L_{weld} \geq 4t_w$	Okay

Use a 6/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 17: Plate Connection to Column Cont'd

Pin Plate Connections To Columns [Truss 9 Structure 2]

Member	15			k	
Column	10	a	0	0.083	0.1
R_u (Kips)	31.335	0	5.15	5.508	5.58
t_p (in)	0.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	9
kl (in)	0.75
k (in)	0.083
xl (in)	0
al (in)	0
a	0
C	5.508
C_1	1
φ	0.75
$D_{required}$	0.84
D_{used}	1

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	11
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	9
$4t_w$ (in)	2.75
$L_{weld} \geq 4t_w$	Okay

Use a 1/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 9 Structure 2]

Member	16			k	
Column	10	a	0	0.083	0.1
R_u (Kips)	41.53	0	5.15	5.508	5.58
t_p (in)	0.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	9
kl (in)	0.75
k (in)	0.083
xl (in)	0
al (in)	0
a	0
C	5.508
C_1	1
φ	0.75
$D_{required}$	1.12
D_{used}	2

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	11
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	9
$4t_w$ (in)	2.75
$L_{weld} \geq 4t_w$	Okay

Use a 2/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 9 Structure 2]

Member	19			k	
Column	13	a	0	0.083	0.1
R_u (Kips)	41.53	0	5.15	5.508	5.58
t_p (in)	0.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	9
kl (in)	0.75
k (in)	0.083
xl (in)	0
al (in)	0
a	0
C	5.508
C_1	1
φ	0.75
$D_{required}$	1.12
D_{used}	2

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	11
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	9
$4t_w$ (in)	2.75
$L_{weld} \geq 4t_w$	Okay

Use a 2/16" E70XX Fillet Weld Around Plate Perimeter

Pin Plate Connections To Columns [Truss 9 Structure 2]

Member	20			k	
Column	13	a	0	0.083	0.1
R_u (Kips)	31.335	0	5.15	5.508	5.58
t_p (in)	0.75				

Table 8-6 From Steel Manual	
Angle (deg)	60
l (in)	9
kl (in)	0.75
k (in)	0.083
xl (in)	0
al (in)	0
a	0
C	5.508
C_1	1
φ	0.75
$D_{required}$	0.84
D_{used}	1

1/16"

Fillet Weld Limitations	
Max Size: $t_p \geq 1/4"$	
t_w (in 1/16")	11
$D_{used} \leq t_w$	Okay
Min Length: $L_{weld} \geq 4t_w$	
Lweld (in)	9
$4t_w$ (in)	2.75
$L_{weld} \geq 4t_w$	Okay

Use a 1/16" E70XX Fillet Weld Around Plate Perimeter

Calculation 18: Plate Connection to Column Cont'd

Gusset Plate Info	
h (in)	30
w (in)	55
t (in)	2.25
F_y (ksi)	36
F_u (ksi)	58
l (in)	35.625

Bottom Chord Info	
Member	W16x31
t_w (in)	0.275
t_f (in)	0.44
F_y (ksi)	50
F_u (ksi)	65
d (in)	18.5

Brace Member Info	
Member	W14x257
t_w (in)	1.18
t_f (in)	1.89
F_y (ksi)	50
F_u (ksi)	65
A_g (in^2)	75.6
Bolt Type	A490N
φ (in)	1
φ R_n (Kips)	35.3
x (in)	1.75
T	10

Tables 1 through 3: Heavy Brace Member Information

Angles: Gusset Plate to Brace	
Members	2L8x6x3/4 LLBB
L (in)	Refer to Drawing
t (in)	0.75
F_y (ksi)	36
F_u (ksi)	58
Bolt Type	A490N
φ (in)	1
φ R_n (Kips)	35.3
Weld Size	-
A_g (in^2)	19.88

Angles: Gusset Plate to Column	
Members	2L6x6x3/8
L (in)	23.5
t (in)	0.75
F_y (ksi)	36
F_u (ksi)	58
Bolt Type	A325N
φ (in)	7/8
φ R_n (Kips)	21.6
A_b (in^2)	0.601
Weld Size (in)	5/16

Tables 4 & 5: Heavy Brace Member Information Cont'd

Determine Load Distrabution											
a (in)	w_{GP}/2 (in)	α (in)	d_b (in)	e_b (in)	e_c (in)	β = h_{GP}/2 (in)	Φ (Deg)	tan Φ	α-βtanΦ	$e_b$tanΦ-e_c	r (in)
1	27.5	28.5	0	0	0	15	62	1.87824	0.00	0.00	32.21
									No Moments Exist		
P_u (Kips)	V_c (Kips)	H_c (Kips)	V_b (Kips)	H_b (Kips)							
617.45	287.58	0.00	0.00	546.39							

Calculation 19: Uniform Force Method

Brace Member to Double Angle Connection								
Wide Flange Limit States								
Tension Yielding			Tension Rupture			Block Shear		
A_g (in^2)	75.6		A_n (in^2)	74.2725		a (in)	2	
P_u (Kips)	617.45		x (in)	1.75		L (in)	38	
φR_n (Kips)	3402	Okay	L (in)	36	10 Bolts	T/2 (in)	5	
			U	0.951388889		t_w (in)	1.18	
			A_e (in^2)	70.66203125		A_{gv} (in^2)	44.84	
				64.26	Controls	A_{nv} (in^2)	38.20	
			φR_n (Kips)	3132.675	Okay	A_{nt} (in^2)	4.34	
						$0.6F_uA_{nv}$	1489.90	
						$0.6F_yA_{gv}$	1345.20	Controls
						$U_{bs}F_uA_{nt}$	281.86	
						φR_n (Kips)	1220.29	Okay
Bolts (Shear, Bearing, & Tearout)								
Bolt Shear			Bearing of Wide Flange			Bearing On Angles		
φR_n (Kips)	35.3	1 Bolt	$\varphi 2.4F_ut_wd_b$	138.06	1 Bolt	$\varphi 2.4F_utd_b$	156.6	1 Bolt
Tearout Flange Web (1)			Tearout Flange Other (2-10)			Tearout Angles Edge (10)		
L_c (in)	1.46875		L_c (in)	2.9375		L_c (in)	1.46875	
$\varphi 1.2F_uL_ct_w$	101.3878	1 Bolt	$\varphi 1.2F_uL_ct_w$	202.775625	1 Bolt	$\varphi 1.2F_uL_ct$	115.003125	1 Bolt
Tearout Angles Other (1-9)								
L_c (in)	2.9375							
$\varphi 1.2F_uL_ct$	230.0063	1 Bolt						
Bolt 1	35.3	138.06	156.6	101.39	230.01			
Bolt 2	35.3	138.06	156.6	202.78	230.01			
Bolt 3	35.3	138.06	156.6	202.78	230.01			
Bolt 4	35.3	138.06	156.6	202.78	230.01			
Bolt 5	35.3	138.06	156.6	202.78	230.01			
Bolt 6	35.3	138.06	156.6	202.78	230.01			
Bolt 7	35.3	138.06	156.6	202.78	230.01			
Bolt 8	35.3	138.06	156.6	202.78	230.01			
Bolt 9	35.3	138.06	156.6	202.78	230.01			
Bolt 10	35.3	138.06	156.6	202.78	115.00			
φR_n (Kips)	706	Okay						
Double Angle Limit States								
Tension Yielding			Tension Rupture			Block Shear		
A_g (in^2)	19.88	Both	A_n (in^2)	19.03625		a (in)	2	
P_u (Kips)	617.45		x (in)	2.55		L (in)	38	
φR_n (Kips)	715.68	Okay	L (in)	36	10 Bolts	LL/2 (in)	5.5	
			U	0.929166667		t (in)	0.75	
			A_e (in^2)	17.68784896		A_{gv} (in^2)	28.50	
				16.898	Controls	A_{nv} (in^2)	23.86	
			φR_n (Kips)	735.063	Okay	A_{nt} (in^2)	5.08	
						$0.6F_uA_{nv}$	830.31	
						$0.6F_yA_{gv}$	615.60	Controls
						$U_{bs}F_uA_{nt}$	294.53	
						φR_n (Kips)	682.60	Okay

Calculation 20: Brace Member to Double Angle Connection Limit States

Double Angle Connection From Brace Member to Gusset Plate								
Double Angle Limit States								
Tension Yielding			Tension Rupture			Block Shear		
A_g (in^2)	19.88	Both	A_n (in^2)	18.1925		a (in)	3	
P_u (Kips)	617.45		x (in)	2.55		L (in)	27	
φR_n (Kips)	715.68	Okay	L (in)	24	9	SL/2 (in)	2.75	
			U	0.89375	Use 0.9	t (in)	0.75	
			A_e (in^2)	16.37325	Controls	A_{gv} (in^2)	40.50	
				16.898		A_{nv} (in^2)	22.36	
			φR_n (Kips)	735.063	Okay	A_{nt} (in^2)	1.78	
						$0.6F_uA_{nv}$	778.11	Controls
						$0.6F_yA_{gv}$	874.80	
						$U_{bs}F_uA_{nt}$	103.31	
						φR_n (Kips)	661.06	Okay
Bolts (Shear, Bearing, & Tearout)								
Bolt Shear			Bearing On Angles			Bearing On Gusset Plate		
φR_n (Kips)	35.3	1 Bolt	$\varphi 2.4F_utd_b$	156.6	1 Bolt	ta < tp : Only Check Angles		
Tearout Angle (1)			Tearout Angle Other (2-9)			Tearout Gusset Edge (9)		
L_c (in)	1.46875		L_c (in)	1.9375		L_c (in)	1.46875	
$\varphi 1.2F_uL_ct$	57.50156		$\varphi 1.2F_uL_ct_w$	75.85313		$\varphi 1.2F_uL_ct_w$	172.5047	
Tearout Gusset Other (1-8)								
L_c (in)	1.9375							
$\varphi 1.2F_uL_ct$	227.5594							
Bolt 1	35.3	156.6	-	57.50	227.56			
Bolt 2	35.3	156.6	-	75.85	227.56			
Bolt 3	35.3	156.6	-	75.85	227.56			
Bolt 4	35.3	156.6	-	75.85	227.56			
Bolt 5	35.3	156.6	-	75.85	227.56			
Bolt 6	35.3	156.6	-	75.85	227.56			
Bolt 7	35.3	156.6	-	75.85	227.56			
Bolt 8	35.3	156.6	-	75.85	227.56			
Bolt 9	35.3	156.6	-	75.85	172.50			
φR_n (Kips)	635.4	Okay						
Gusset Plate Limit States								
Tension Yielding			Tension Rupture			Block Shear		
A_g (in^2)	80.15625		A_n (in^2)	30.5625		A_{gv} (in^2)	29.53125	
P_u (Kips)	617.45		P_u (Kips)	617.45		A_{nv} (in^2)	16.24219	
φR_n (Kips)	4184.156	Okay	φR_n (Kips)	1329.469	Okay	A_{nt} (in^2)	4.640625	
						$0.6F_uA_{nv}$	565.2281	Controls
						$0.6F_yA_{gv}$	637.875	
						$U_{bs}F_uA_{nt}$	269.1563	
						φR_n (Kips)	625.7883	Okay

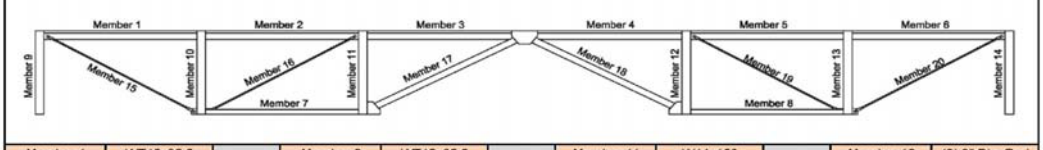
Calculation 21: Brace Double Angles to Gusset Plate Limit States

Gusset Plate to Column Connection								
Shear Stresses In Bolts			Avaible Tensile Strength Per Bolt			Calculate r_{ut}		
f_v (ksi)	29.9059		F_t (ksi)	50.10	< 90 ksi	r_{ut} (Kips)	0	No Prying
			φr_n (Kips)	22.58357426				
Weld Limit States								
Using Table 10-2 In Manual								
n	8		L (in)	23.5		Weld Size (in)	5/16	
P_u (Kips)	287.58							
φR_n (Kips)	338	Okay						
Double Angle Limit States								
Shear Yield			Shear Rupture			Block Shear		
A_{gv} (in^2)	17.625		Anv (in2)	11.625		A_{gv} (in^2)	35.25	
φR_n (Kips)	685.26	Okay	φR_n (Kips)	303.4125	Okay	A_{nv} (in^2)	24.00	
						A_{nt} (in^2)	3.86	
						$0.6F_uA_{nv}$	835.20	
						$0.6F_yA_{gv}$	761.40	Controls
						$U_{bs}F_uA_{nt}$	223.62	
						φR_n (Kips)	738.76	Okay
Bolts (Shear, Bearing, & Tearout)								
Bolt Shear			Bearing on Angles			Bearing On Column		
φR_n (Kips)	21.6	1 Bolt	$\varphi 2.4F_utd_b$	68.5125	1 Bolt	ta < tc : Only Check Angles		
Tearout Angle (1)			Tearout Angle Other (2-8)			Tearout Column Edge (8)		
L_c (in)	1.03125	1 Bolt	L_c (in)	2.0625	1 Bolt	L_c (in)	1.03125	1 Bolt
$\varphi 1.2F_uL_ct$	40.37344		$\varphi 1.2F_uL_ct$	80.746875		$\varphi 1.2F_uL_ct$	45.2460938	
Tearout Column Other (1-7)								
L_c (in)	2.0625	1 Bolt						
$\varphi 1.2F_uL_ct$	90.49219							
Bolt 1	21.6	68.51	-	40.37	90.49			
Bolt 2	21.6	68.51	-	80.75	90.49			
Bolt 3	21.6	68.51	-	80.75	90.49			
Bolt 4	21.6	68.51	-	80.75	90.49			
Bolt 5	21.6	68.51	-	80.75	90.49			
Bolt 6	21.6	68.51	-	80.75	90.49			
Bolt 7	21.6	68.51	-	80.75	45.25			
φR_n (Kips)	302.4	Okay						

Calculation 22: Gusset Plate to Column Limit States

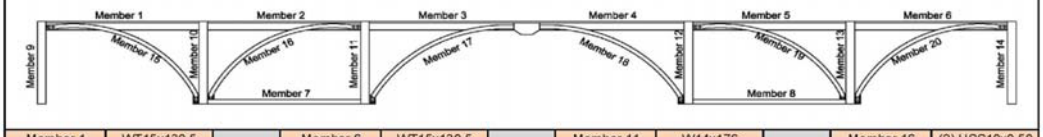
APPENDIX I: FINAL MEMBER SIZES FOR TRUSSES

STRUCTURE 1 TRUSS 1



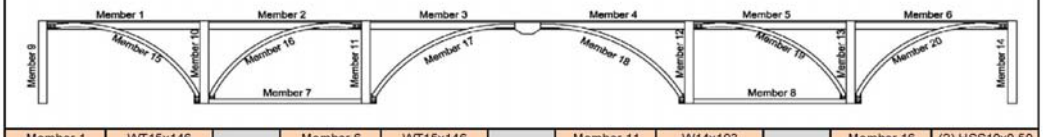
Member 1	WT15x95.5		Member 6	WT15x95.5		Member 11	W14x159		Member 16	(2) 3" Dia. Rod
Member 2	WT15x95.5		Member 7	W16x31		Member 12	W14x159		Member 17	W14x257
Member 3	WT20x251.5		Member 8	W16x31		Member 13	W14x99		Member 18	W14x257
Member 4	WT20x251.5		Member 9	W14x99		Member 14	W14x99		Member 19	(2) 3" Dia. Rod
Member 5	WT15x95.5		Member 10	W14x99		Member 15	(2) 2" Dia. Rod		Member 20	(2) 2" Dia. Rod

STRUCTURE 1 TRUSS 2



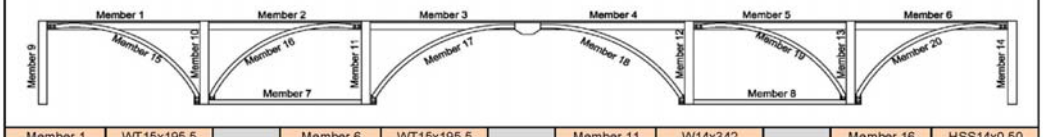
Member 1	WT15x130.5		Member 6	WT15x130.5		Member 11	W14x176		Member 16	(2) HSS10x0.50
Member 2	WT15x130.5		Member 7	W16x31		Member 12	W14x176		Member 17	(2) HSS10x0.50
Member 3	WT15x130.5		Member 8	W16x31		Member 13	W14x176		Member 18	(2) HSS10x0.50
Member 4	WT15x130.5		Member 9	W14x176		Member 14	W14x176		Member 19	(2) HSS10x0.50
Member 5	WT15x130.5		Member 10	W14x176		Member 15	(2) HSS10x0.50		Member 20	(2) HSS10x0.50

STRUCTURE 1 TRUSS 3



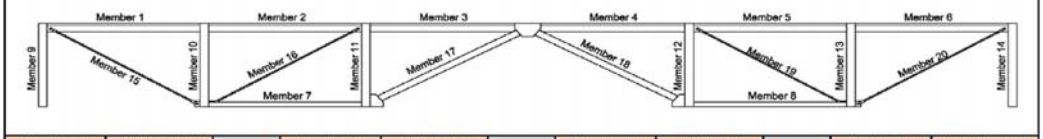
Member 1	WT15x146		Member 6	WT15x146		Member 11	W14x193		Member 16	(2) HSS10x0.50
Member 2	WT15x146		Member 7	W16x31		Member 12	W14x193		Member 17	(2) HSS10x0.50
Member 3	WT15x146		Member 8	W16x31		Member 13	W14x193		Member 18	(2) HSS10x0.50
Member 4	WT15x146		Member 9	W14x193		Member 14	W14x193		Member 19	(2) HSS10x0.50
Member 5	WT15x146		Member 10	W14x193		Member 15	(2) HSS10x0.50		Member 20	(2) HSS10x0.50

STRUCTURE 1 TRUSS 4



Member 1	WT15x195.5		Member 6	WT15x195.5		Member 11	W14x342		Member 16	HSS14x0.50
Member 2	WT15x195.5		Member 7	W16x50		Member 12	W14x342		Member 17	HSS14x0.50
Member 3	WT15x195.5		Member 8	W16x50		Member 13	W14x342		Member 18	HSS14x0.50
Member 4	WT15x195.5		Member 9	W14x342		Member 14	W14x342		Member 19	HSS14x0.50
Member 5	WT15x195.5		Member 10	W14x342		Member 15	HSS14x0.50		Member 20	HSS14x0.50

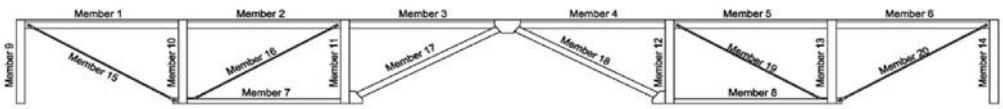
STRUCTURE 1 TRUSS 5



Member 1	WT15x95.5		Member 6	WT15x95.5		Member 11	W14x132		Member 16	(2) 3" Dia. Rod
Member 2	WT15x95.5		Member 7	W16x31		Member 12	W14x132		Member 17	W14x233
Member 3	WT20x251.5		Member 8	W16x31		Member 13	W14x99		Member 18	W14x233
Member 4	WT20x251.5		Member 9	W14x99		Member 14	W14x99		Member 19	(2) 3" Dia. Rod
Member 5	WT15x95.5		Member 10	W14x99		Member 15	(2) 2" Dia. Rod		Member 20	(2) 2" Dia. Rod

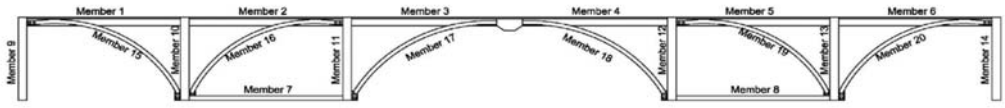
Tables 1 through 5: Final Member Sizes for Trusses

STRUCTURE 2 TRUSS 6



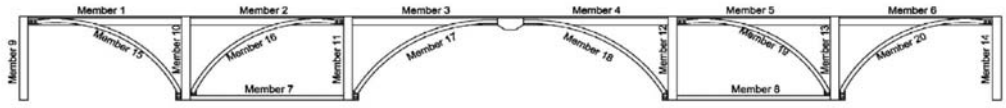
Member 1	WT15x95.5		Member 6	WT15x95.5		Member 11	W14x193		Member 16	(2) 3" Dia. Rod
Member 2	WT15x95.5		Member 7	W16x31		Member 12	W14x193		Member 17	W14x311
Member 3	WT18x400		Member 8	W16x31		Member 13	W14x99		Member 18	W14x311
Member 4	WT18x400		Member 9	W14x99		Member 14	W14x99		Member 19	(2) 3" Dia. Rod
Member 5	WT15x95.5		Member 10	W14x99		Member 15	(2) 2" Dia. Rod		Member 20	(2) 2" Dia. Rod

STRUCTURE 2 TRUSS 7



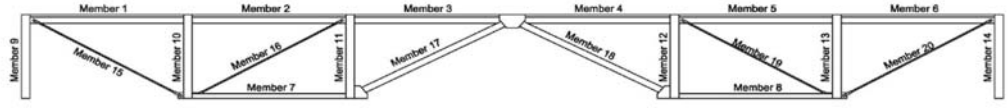
Member 1	WT15x146		Member 6	WT15x146		Member 11	W14x193		Member 16	HSS10x0.50
Member 2	WT15x146		Member 7	W16x31		Member 12	W14x193		Member 17	HSS10x0.50
Member 3	WT15x146		Member 8	W16x31		Member 13	W14x193		Member 18	HSS10x0.50
Member 4	WT15x146		Member 9	W14x193		Member 14	W14x193		Member 19	HSS10x0.50
Member 5	WT15x146		Member 10	W14x193		Member 15	HSS10x0.50		Member 20	HSS10x0.50

STRUCTURE 2 TRUSS 8



Member 1	WT15x146		Member 6	WT15x146		Member 11	W14x193		Member 16	HSS10x0.50
Member 2	WT15x146		Member 7	W16x31		Member 12	W14x193		Member 17	HSS10x0.50
Member 3	WT15x146		Member 8	W16x31		Member 13	W14x193		Member 18	HSS10x0.50
Member 4	WT15x146		Member 9	W14x193		Member 14	W14x193		Member 19	HSS10x0.50
Member 5	WT15x146		Member 10	W14x193		Member 15	HSS10x0.50		Member 20	HSS10x0.50

STRUCTURE 2 TRUSS 9



Member 1	WT15x95.5		Member 6	WT15x95.5		Member 11	W14x99		Member 16	(2) 1" Dia. Rod
Member 2	WT15x95.5		Member 7	W16x31		Member 12	W14x99		Member 17	W14x145
Member 3	WT15x95.5		Member 8	W16x31		Member 13	W14x99		Member 18	W14x145
Member 4	WT15x95.5		Member 9	W14x99		Member 14	W14x99		Member 19	(2) 1" Dia. Rod
Member 5	WT15x95.5		Member 10	W14x99		Member 15	(2) 1" Dia. Rod		Member 20	(2) 1" Dia. Rod

Tables 6 through 9: Final Member Sizes for Trusses Cont'd

APPENDIX J: LED SPECIFICATIONS

Date: _____ Type: _____

Firm Name: _____

Project: _____

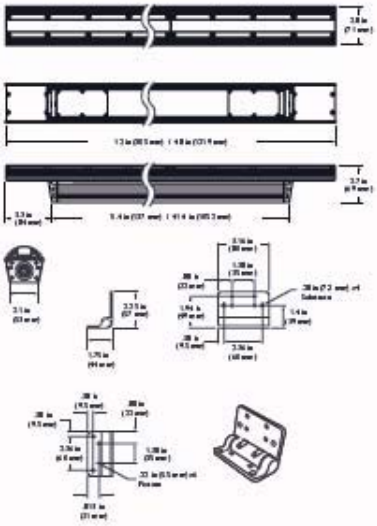
eW Graze Powercore

2700 K, 10° x 60° Lens

Linear, white LED surface light for wall washing and grazing

eW® Graze Powercore is a linear lighting fixture optimized for surface grazing and wall-washing applications requiring high-quality white light. Featuring Powercore® technology, eW Graze Powercore processes power directly from line voltage, eliminating the need for low-voltage, external power supplies. Available in 2700 K or 4000 K color temperatures, eW Graze Powercore offers superior illumination quality and dramatic energy savings for new installations and retrofit upgrades. Combining a space-efficient, low-profile aluminum housing and flexible mounting options allows for discrete placement within a wide range of compact architectural details

- Tailor light output to specific applications — eW Graze Powercore is available in 1 ft and 4 ft exterior-rated housings, with 10° x 60° and 30° x 60° beam angle options.
- High-performance illumination and beam quality — eW Graze Powercore offers superior beam quality for striation-free saturation as close as 6 in (152 mm) from fixture placement. With a 60° horizontal beam angle, eW Graze Powercore accommodates end-to-end or incremental placement without visible light scalloping between fixtures.
- Supports new applications for white light— Long-life LEDs (50,000 hours at 50% lumen maintenance) significantly reduce or eliminate maintenance problems, allowing the use of white lighting in spaces where bulb maintenance may be limited or unfeasible.
- Universal power input range — eW Graze Powercore accepts line voltage input of 100, 120, 220 – 240, and 277 VAC.
- Versatile installation options — Constant torque, locking hinges offer simple position control from various angles, without special tools. The low-profile extruded aluminum housing accommodates installation within wide-ranging architectural niches.
- "Cool lighting" functionality — eW Graze Powercore fixtures do not heat illuminated surfaces, discharge infrared radiation or emit ultraviolet light.
- Dimming capable — Patented DIMand™ technology offers smooth dimming capability with standard ELV-type dimmers.
- Trouble-free, code-compliant installation — IP66, UL wet location ratings. UL / cUL, FCC, CE, RoHS, WEEE certified.



For detailed product information, please refer to the eW Blast Powercore Product Guide at www.colorkinetics.com/ls/essentialwhite/ewgraze/

PHILIPS

Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	1 ft	4 ft
Output	Beam Angle	10° x 60°	
	Color Temperature	2700 K (+375 / -300)	
	Lumens†	404	1616
	Efficacy (Lm/W)	27.9	
	Mixing Distance	6 in (152 mm) to uniform beam saturation	
	Lumen Maintenance‡	100,000+ hours L70 @ 25° C 50,000 hours L70 @ 50° C	
Electrical	Input Voltage	100 / 120 / 220 – 240 / 277 VAC	
	Power Consumption	14.5 W maximum at full output, steady state	58.0 W maximum at full output, steady state
Control		Commercially available ELV control dimmers	
Physical	Dimensions (Height x Width x Depth)	2.7 x 12 x 2.8 in (69 x 305 x 71 mm)	2.7 x 48 x 2.8 in (69 x 1219 x 71 mm)
	Weight	2.7 lb (1.2 kg)	10.8 lb (4.9 kg)
	Housing	Extruded anodized aluminum	
	Lens	Clear polycarbonate	
	Fixture Connectors	Integral male / female waterproof connectors	
	Mounting	Multi-positional constant torque locking hinges	
	Temperature	40° 122° F (40° 50° C) Operating -4° – 122° F (-20° – 50° C) Startup	
	Humidity	0 – 95%, non-condensing	
	Fixture Run Lengths*	88 – 110 VAC 97 – 120 VAC 180 – 220 VAC 197 – 240 VAC	*Configuration:* *1 ft (305 mm) fixtures installed end-to-end, 20A circuit, standard 50 ft (15.2 m) Leader Cable*
Certification and Safety	Certification	UL / cUL, FCC Class A, CE, RoHS, WEEE	
	LED Class	Class 2 LED product	
	Environment	Dry / Damp / Wet Location, IP66	

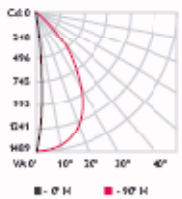
† Lumen measurement complies with IES LM 79 08.
‡ L_{70} = 70% maintenance of lumen output. (When light output drops below 70% of initial output.)
* These figures, provided as a guideline, are accurate for this configuration only. Changing the configuration can affect the fixture run lengths.

OPTIBIN OKTECHNOLOGY | POWERCORE OKTECHNOLOGY | DIAMAND OKTECHNOLOGY

Photometrics

2700 K, 1 ft, 10° x 60° lens

Polar Candela Distribution



	0	22.5	44	67.5	90
0	1470	1470	1470	1470	1470
3	917	979	880	228	1470
15	90	90	131	460	1384
25	37	43	61	139	1140
35	22	26	36	67	715
45	11	12	25	43	271
55	4	8	12	27	70
65	1	2	6	13	26
75	1	1	1	5	9
85	1	0	0	1	1
90	0	0	0	0	0

Illuminance at Distance

	Power Consumption	14.5 W
	Lumens	404
For lux multiply fc by 10.7	Efficacy	27.9 Lm/W

Fixtures

Item	Beam Angle	Voltage	Size	Item Number	Philips 12NC
aW Graze Powercore, 2700 K	10° x 60°	120 VAC	1 ft	523-000330-00	910503700276
			4 ft	523-000330-02	910503700278
		277 VAC	1 ft	523-000330-08	910503700284
			4 ft	523-000330-10	910503700286
		220 – 240 VAC	1 ft	523-000330-16	910503700292
			4 ft	523-000330-18	910503700294
		100 VAC	1 ft	523-000330-24	910503700300
			4 ft	523-000330-26	910503700302

Use Item Number when ordering in North America.

Accessories

Item	Type	Size	Item Number	Philips 12NC
Leader Cable	UL / cUL	50 ft (15.2 m)	108-000041-00	910503700320
	CE		108-000041-01	910503700320
Jumper Cable	UL / cUL	End-to-End	108-000039-00	910503700314
		1 ft (305 mm)	108-000039-01	910503700315
		5 ft (1.5 m)	108-000039-02	910503700316
	CE	End-to-End	108-000040-00	910503700317
		1 ft (305 mm)	108-000040-01	910503700318
		5 ft (1.5 m)	108-000040-02	910503700319

PHILIPS

Philips Color Kinetics
3 Burlington Woods Drive
Burlington, Massachusetts 01803 USA
Tel 888.FullRGB
Tel 617.423.9999
Fax 617.423.9998
www.colorkinetics.com

DAS-000009-01 F01 02-09

APPENDIX K: IESNA REQUIREMENTS

in enclosures that isolate ballast vibrations, or electronic ballasts.

ILLUMINANCE SELECTION

In 1979, the IESNA established an illuminance selection procedure, which was published in the 6th, 7th, and 8th editions of its *Lighting Handbook*. The philosophy of that procedure was to enable the lighting designer to select illuminances based on a knowledge of space and occupant characteristics as well as the task and worker characteristics.

The philosophy of that procedure has been embraced again in this edition, but the procedure has been modified and simplified to place visual performance and therefore illuminance selection more in balance with the other important lighting design criteria presented in this chapter and discussed throughout this edition of the *IESNA Lighting Handbook*. Specifically, the recommended illuminances provided in the Design Guide are based on the Society's judgment of best practice for "typical" applications. Every situation is unique so, naturally, typical conditions may not be appropriate for a specific application. As a professional, the lighting designer should have a better understanding of the particular space and the needs of the occupants and clients than what can be presented in a recommended illuminance value for a typical space.

Illuminance Recommendations

In 1979, the IESNA established nine illuminance categories, "A," the lowest set of recommended illuminances, through "I," the highest set. Each of the nine categories had general descriptions of the visual task, irrespective of the application. Generally, the same approach has been employed in this edition of the *IESNA Lighting Handbook* to help lighting designers establish the best task illuminance. However, four important modifications have been adopted.

- The recommended illuminances are no longer provided without reference to a specific application. Every application in the Design Guide has a specific recommended illuminance (horizontal, vertical, or both) representing best practice for a typical application.
- The nine illuminance selection categories established earlier by the IESNA have been reduced to seven categories and organized into three sets of visual tasks (orientation and simple, common, and special). These groupings provide additional clarity to the category descriptions (Figure 10-9).
- Additional precision has been given to the task descriptions in each category. In the previous three editions it was impossible for the lighting designer to unambiguously ascertain what constituted, for example, "low contrast" or "small size." Specific ranges of contrast and size have been established for this edition (Figures 10-10 and 10-11).
- Recommended illuminances increase roughly logarithmically with increasing task difficulty by combined changes in task contrast and task size, as defined in Figure 10-10. These recommendations are guided by both the scientific literature and practical experience.

High illuminances can partially compensate for small size and low contrast to maintain high levels of visual performance. Changes in visual performance as a function of task contrast and size, background reflectance, and observer age can be calculated precisely.[6] For well-controlled situations, this procedure can be a useful predictive tool. However, performance at a visual task depends on many uncontrolled vi-

Figure 10-9. Determination of Illuminance Categories*

Orientation and simple visual tasks. Visual performance is largely unimportant. These tasks are found in public spaces where reading and visual inspection are only occasionally performed. Higher levels are recommended for tasks where visual performance is occasionally important.

A	Public spaces	30 lx (3 fc)
B	Simple orientation for short visits	50 lx (5 fc)
C	Working spaces where simple visual tasks are performed	100 lx (10 fc)

Common visual tasks. Visual performance is important. These tasks are found in commercial, industrial and residential applications. Recommended illuminance levels differ because of the characteristics of the visual task being illuminated. Higher levels are recommended for visual tasks with critical elements of low contrast or small size.

D	Performance of visual tasks of high contrast and large size	300 lx (30 fc)
E	Performance of visual tasks of high contrast and small size, or visual tasks of low contrast and large size	500 lx (50 fc)
F	Performance of visual tasks of low contrast and small size	1000 lx (100 fc)

Special visual tasks. Visual performance is of critical importance. These tasks are very specialized, including those with very small or very low contrast critical elements. Recommended illuminance levels should be achieved with supplementary task lighting. Higher recommended levels are often achieved by moving the light source closer to the task.

G	Performance of visual tasks near threshold	3000 to 10,000 lx (300 to 1000 fc)

* Expected accuracy in illuminance calculations are given in Chapter 9, Lighting Calculations. To account for both uncertainty in photometric measurements and uncertainty in space reflections, measured illuminances should be with ± 10% of the recommended value. It should be noted, however, that the final illuminance may deviate from these recommended values due to other lighting design criteria.

Figure 1

IESNA Lighting Design Guide

Transportation-6

Very Important | Important | Somewhat important | Blank = Not important or not applicable

V. TRANSPORTATION[a] LOCATIONS AND TASKS	Design Issues	Appearance of Space and Luminaires	Color Appearance (and Color Contrast)	Daylighting Integration and Control	Direct Glare	Flicker (and Strobe)	Light Distribution on Surfaces	Light Distribution on Task Plane (Uniformity)	Luminances of Room Surfaces	Modeling of Faces or Objects	Point(s) of Interest	Reflected Glare	Shadows	Source/Task/Eye Geometry	Sparkle/Desirable Reflected Highlights	Surface Characteristics	System Control and Flexibility	Special Considerations	Notes on Special Considerations	Illuminance (Horizontal)	Category or Value (lux)[b]	Illuminance (Vertical)	Category or Value (lux)[b]	Notes on illuminance — see end of section	Reference Chapter(s)
Workshops (see Machining in Section II, Industrial)																									
General																									
On bench top																			(6)		D		B		
Machine shop																			(6)		E		C		
Cargo holds																					G		E		
Safety																									
During cargo handling																					A		A		
Passageways and trunks																					D		B		
																					A		A		
Transportation Terminals																									Ch. 23
Waiting room and lounge																									
Ticket counters																					B		A		
Baggage checking																					E		D		
Rest rooms																					D		B		
Concourse																					B		D		
Boarding area																					A		A		
																					B		B		

Notes:

(a) Design issues are listed for room or space. Refer to specific task under Reading or Graphic Design and Materials, for example, for task design issues and illuminance

(b) Low illuminances (less than 30 lux) are given in lux; values greater than 30 lux are given in letter categories.

Figure 2

APPENDIX L: AVANTE 2x4 SPECIFICATIONS

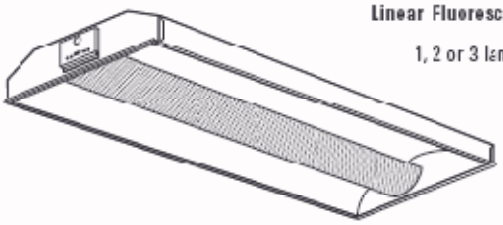
LITHONIA LIGHTING®

Catalog Number	
Notes	Type

Avante®
Recessed Direct/Indirect Lighting

2AV 2'x4'

Linear Fluorescent
T8
1, 2 or 3 lamps



FEATURES & SPECIFICATIONS

INTENDED USE

The Avante 2x4 is a general lighting luminaire for large spaces including open offices, circulation areas, classrooms, libraries, cafeterias, airport ticketing and wait areas, and numerous other commercial applications. Static or air functions available.

CONSTRUCTION

Housing is gloss white enamel on cold rolled steel. All edges hemmed or rounded.

All shieldings pivot on light traps and swing down for easy lamp access.

Molded light traps prevent light leaks between shielding and endplates.

All air and screw slot units supplied with screw-on tee bar clips. Ballast access is from below.

OPTICAL SYSTEM

Twin matte white polyester powder paint finished reflectors provide uniform light distribution. Optional low brightness diffuse aluminum stepped reflectors available.

All diffusers control direct light distribution and glare by shielding lamps from direct view.

Metal diffuser staggered round holes (MDR) 52% open perforated metal with .075" diameter holes backed with white acrylic diffuser.

Straight blade louver (SBL) sides of perforated metal with staggered round holes and solid blade louvered center. Sides and louver backed with white acrylic diffuser.

Metal diffuser aligned mini slots (MDM) 46% open perforated metal backed with white acrylic diffuser.

Acrylic diffuser prismatic lens (ADP) extruded acrylic lens backed with white acrylic diffuser.

Metal diffuser with center slots (MDC). 52% open metal, .075" diameter holes with 1" wide solid center. Slotted with 1/2"x2" open slots. Diffuser is backed with white acrylic overlay.

ELECTRICAL SYSTEM

All ballasts supplied are class P, thermally protected, resetting, HPF, non-PCB, UL Listed, CSA Certified. Ballasts are sound rated A. Standard combinations conform to UL 935.

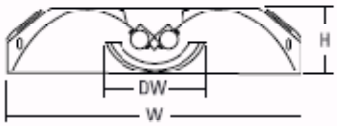
INSTALLATION

Trims available for standard 1" and 9/16" tee bar or screw slot grids.

Fixtures can be row mounted end-to-end.

Specifications

Length: 48" (1219)
Width: 24" (602)
Diffuser Width: 8" (203)
Depth: 5-1/2" (140)



All dimensions are inches (millimeters).

Drywall ceiling adapters available.

LISTING

UL Listed to US and Canadian safety standards. Chicago Plenum approved and NYC approved (see Options).

Specifications are subject to change without notice.

Avante is covered by one or more of the following patents: 5,918,829; 399,586; 411,641; 413,402; 2,212,513; 87513.

ORDERING INFORMATION

For shortest lead times, configure product using **standard options (shown in bold).**

Example: 2AV G 2 32 MDR MVOLT GEB10IS

2AV — Series
- **2AV** 2' wide

Trim type
- G Grid trim
- ST Screw slot

Number of amps
- 1
- 2
- 3
- Not Included.

Air function
- (blank) **Static (no air function)**
- A Air return/supply

32 — Lamp type
- 32 32W T8 (48")

Diffuser
- **MDR Metal diffuser, round holes**
- SBL Straight blade louver, round holes
- MDM Metal diffuser, mini slots
- ADP Acrylic diffuser, linear prismatic lens
- MDC Metal diffuser, round holes with large center slots[1]

Others available.

Voltage
- **MVOLT**[2]
- 347
- Others available.

Options
- **GEB10IS Electronic ballast, ≤ 10% THD, instant start**
- GEB10PS Electronic ballast, ≤ 10% THD, program start
- ALG Acrylic filter guard[1]
- **EL14 Emergency battery pack (nominal 1200 lumens, see Life Safety section)**
- 6LR Internal fast-blow fuse[3]
- LP_ Lamped. Specify lamp type and color
- **PWS1836 6' prewire, 3/8" dia., 18-gauge, 3 wires**
- NYC New York City approved
- CP Chicago Plenum approved
- APB Air pattern control blades[1]

Reflector option
- ASR Aluminum stepped reflector

Accessories

Order as separate catalog number.

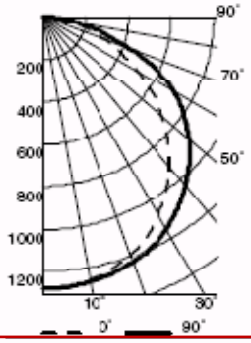
DGA34 Drywall ceiling adapter, unit installation. Use G trim plus DGA accessory for fixture trim flange and fixture support in plaster or plasterboard ceilings.

NOTES:
1. Refer to options and accessories section for more detailed information.
2. MVOLT (120-277 volt).
3. Must specify voltage, 120 or 277.

Fluorescent **Sheet #: 2AV 2X4 T8** ARCH-280

2AV 2x4 Direct/Indirect Lighting

2AV G 2 32 MDR, (2) 32W T8 lamps, 2850 lumens per lamp, s/m 1.2 (along) 1.3 (across), test no. LTL 10121



Coefficients of Utilization

CP Summary 0°	CP Summary 90°	pf pc pw	80% 70%	80% 50%	80% 30%	70% 50%	70% 30%	70% 10%	50% 50%	50% 30%	50% 10%
0°	1280	1280	0	81	81	81	79	79	79	76	76	76
5°	1279	1277	1	74	71	68	69	66	64	66	64	62
15°	1233	1253	2	67	61	57	60	56	52	58	54	51
25°	1141	1194	3	61	54	48	53	47	43	50	46	42
35°	1005	1101	4	56	47	41	46	41	36	45	40	36
45°	828	969	5	51	42	36	41	36	31	40	35	31
55°	623	806	6	47	38	32	37	31	27	36	31	27
65°	406	590	7	44	34	28	34	28	24	33	27	24
75°	211	291	8	41	31	25	31	25	21	30	25	21
85°	46	64	9	38	29	23	28	23	19	27	22	19
90	0	0	10	36	26	21	26	21	17	25	21	17

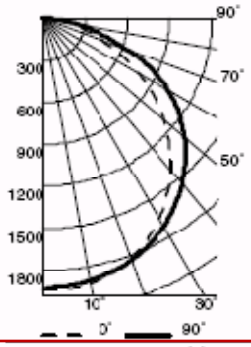
RCR

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1010	17.7	26.0
0° - 40°	1669	29.3	43.0
0° - 60°	3015	52.9	77.7
0° - 90°	3882	68.1	100.0
90° - 180°	0	0.0	0.0
0° - 180°	3882	68.1	100.0

Efficiency: 68.1%

2AV G 3 32 MDR, (3) 32W T8 lamps, 2850 lumens per lamp, s/m 1.3 (along) 1.3 (across), test no. LTL 10155



Coefficients of Utilization

CP Summary 0°	CP Summary 90°	pf pc pw	80% 70%	80% 50%	80% 30%	70% 50%	70% 30%	70% 10%	50% 50%	50% 30%	50% 10%
0°	1934	1934	0	81	81	81	79	79	79	76	76	76
5°	1941	1913	1	74	71	68	69	67	64	66	64	62
15°	1880	1871	2	67	62	57	60	56	52	58	54	51
25°	1747	1781	3	61	54	48	53	47	43	51	46	42
35°	1539	1632	4	56	48	41	47	41	37	45	40	36
45°	1275	1435	5	51	42	36	42	36	31	40	35	31
55°	956	1179	6	47	38	32	37	32	27	36	31	27
65°	611	840	7	44	34	28	34	28	24	33	28	24
75°	298	431	8	41	31	26	31	25	21	30	25	21
85°	66	90	9	38	29	23	28	23	19	28	23	19
90	0	0	10	36	27	21	26	21	17	26	21	17

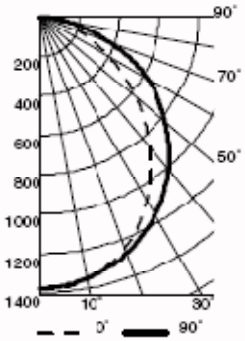
RCR

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1529	17.9	26.2
0° - 40°	2527	29.6	43.3
0° - 60°	4552	53.2	78.0
0° - 90°	5837	68.3	100.0
90° - 180°	0	0.0	0.0
0° - 180°	5837	68.3	100.0

Efficiency: 68.3%

2AVG 3 32 MDR ASR, (3) 32W T8 lamps, 2850 lumens per lamp, s/m 1.2 (along) 1.3 (across), test no. LTL 10120



Coefficients of Utilization

CP Summary 0°	CP Summary 90°	pf pc pw	80% 70%	80% 50%	80% 30%	70% 50%	70% 30%	70% 10%	50% 50%	50% 30%	50% 10%
0°	1377	1377	0	50	50	50	49	49	49	47	47	47
5°	1380	1370	1	46	44	42	43	41	40	41	40	39
15°	1309	1317	2	42	39	36	38	35	33	36	34	32
25°	1171	1223	3	38	34	31	33	30	28	32	29	27
35°	974	1090	4	35	30	26	30	26	24	29	26	23
45°	745	920	5	32	27	23	26	23	20	26	23	20
55°	511	726	6	30	24	21	24	20	18	23	20	18
65°	297	514	7	28	22	18	22	18	16	21	18	16
75°	134	254	8	26	20	17	20	17	14	19	16	14
85°	33	54	9	24	19	15	18	15	13	18	15	13
90	0	0	10	23	17	14	17	14	12	16	14	12

RCR

Zonal Lumen Summary

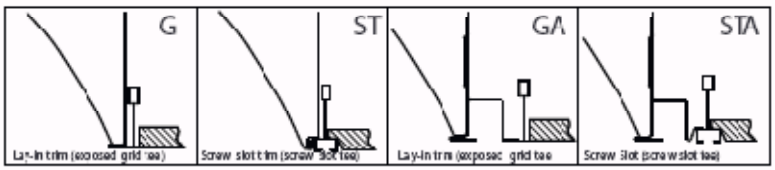
Zone	Lumens	% Lamp	% Fixture
0° - 30°	1061	12.3	29.2
0° - 40°	1697	19.9	47.1
0° - 60°	2907	34.0	80.6
0° - 90°	3606	42.2	100.0
90° - 180°	0	0.0	0.0
0° - 180°	3606	42.2	100.0

Efficiency: 42.2%

For additonal photometric information, visit our website at 'lithonia.com'.

MOUNTING DATA

Ceiling Type	Appropriate Trim Type
Exposed grid tee (1" and 9/16")	G
Concealed grid tee	G
Screw slot	ST
Plaster or plasterboard	G*



*DGA accessory available to provide ceiling trim flange and fixture support for plaster or plasterboard ceiling. Recommended rough-in dimensions for DGA installation is 34-3/4" x 48-3/4" (Tolerance is +1/8", -0").

LITHONIA LIGHTING®
An Acuity Brands Company

Sheet #: 2AV 2X4 T8

Lithonia Lighting
Fluorescent
One Lithonia Way, Conyers, GA 30012
Phone: 800-858-7703 Fax: 770-929-8789
www.lithonia.com

APPENDIX M: WAITING TERMINAL CALCULATIONS

Lumen Method For Waiting Terminal 1		
Compute Cavity Ratios		
RCR	1.86	
CCR	0	
FCR	1.00	
ρ_{cc}		
Base Reflectance	80	
Wall Reflectance	60	
ρ_{cc}	1.8	62
	1.86	61
	2	60
ρ_{fc}		
Base Reflectance	30	
Wall Reflectance	60	
ρ_{fc}	1	29
	1.00	29
	1.2	28
ρ_w		
Wall Area (ft^2)	420	
Window Area (ft^2)	980	
ρ_w	0.32	
CU		
RCR	1.17	
CU @ 61/32/20	63	
Correction Factor	67	

Light Loss Factors		
1) LLD		
Mean Lumens		2802
Intial Lumens		2950
LLD		0.949831
2) LDD		
Category		VI
Cleaning Period		3
LDD		0.97
3) RSDD		
RSDD		0.9
4) BF		
BF		1.18
LLF	0.978458	
# Luminares		10.55712

Calculation 1: Lumen Method for Waiting Terminal 1

CU @ 72/28/20	80		
	50	32	30
1	71		68
1.17	69.30	66.447	66.13
2	61		57

CU
61
63

	70		
	50	32	30
1	69		66
1.17	67.47	64.617	64.30
2	60		56

Calculation 2: Determining CU

9-30 LIGHTING CALCULATIONS

GENERAL INFORMATION

Project identification: UNION STATION EXPANSION : WAITING TERMINAL
(Give name of area and/or building and room number)

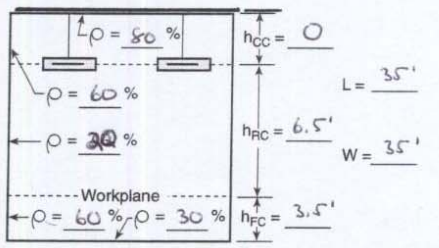
Average maintained illuminance for design: 50 lux or footcandles

Lamp data:
Type and color: T8 WHITE
Number per luminaire: 3
Total lumens per luminaire: 2950(3) = 8850

Luminaire data:
Manufacturer: AVANTE [LITHONIA]
Catalog number: 3AV-6-3-32-MDR-MVOLT-GEB10ES

SELECTION OF COEFFICIENT OF UTILIZATION

Step 1: Fill in sketch at right



Step 2: Determine Cavity Ratios

Room Cavity Ratio, RCR = 1.86
Ceiling Cavity Ratio, CCR = 0
Floor Cavity Ratio, FCR = 1.00

Step 3: Obtain Effective Ceiling Cavity Reflectance (ρ_{CC}) ρ_{CC} = 61

Step 4: Obtain Effective Floor Cavity Reflectance (ρ_{FC}) ρ_{FC} = 29

Step 5: Obtain Coefficient of Utilization (CU) from Manufacturer's Data CU = 67

SELECTION OF LIGHT LOSS FACTORS

Nonrecoverable		Recoverable	
Luminaire ambient temperature	—	Room surface dirt depreciation RSDD	0.9
Voltage to luminaire	—	Lamp lumen depreciation LLD	0.95
Ballast factor	1.18	Lamp burnouts factor LBO	1.0
Luminaire surface depreciation	—	Luminaire dirt depreciation LDD	0.97

Total light loss factor, LLF (product of individual factors above) = 0.978

CALCULATIONS

(Average Maintained Illuminance)

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

$$= \frac{50(35)(35)}{(3)(2950)(0.67)(0.978)} = 10.56$$

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

$$= \frac{12(3)(2950)(0.67)(0.978)}{(35)(35)} = 57 \text{ Fc}$$

Calculated by: Joseph W. Wilcher III Date: 3/17/09

Figure 9-25. Average illuminance calculation sheet.

Figure 9-27. Percent Effective Ceiling or Floor Cavity Reflectances for Various Reflectance Combinations*

Percent Base† Reflectance	90	80	70	60	50
Percent Wall Reflectance	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0
Cavity Ratio					
0.2	89 88 88 87 86 85 85 84 84 82	79 78 78 77 77 76 76 75 74 72	70 69 68 68 67 67 66 66 65 64	60 59 59 59 58 57 56 56 55 53	50 50 49 49 48 48 47 46 46 44
0.4	88 87 86 85 84 83 81 80 79 76	79 77 76 75 74 73 72 71 70 68	69 68 67 66 65 64 63 62 61 58	60 59 59 58 57 55 54 53 52 50	50 49 48 48 47 46 45 45 44 42
0.6	87 86 84 82 80 79 77 76 74 73	78 76 75 73 71 70 68 66 65 63	69 67 65 64 63 61 59 58 57 54	60 58 57 56 55 53 51 51 50 46	50 48 47 46 45 44 43 42 41 38
0.8	87 85 82 80 77 75 73 71 69 67	78 75 73 71 69 67 65 63 61 57	68 66 64 62 60 58 56 55 53 50	59 57 56 55 54 51 48 47 46 43	50 48 47 45 44 42 40 39 38 36
1.0	86 83 80 77 75 72 69 66 64 62	77 74 72 69 67 65 62 60 57 55	68 65 62 60 58 55 53 52 50 47	59 57 55 53 51 48 45 44 43 41	50 48 46 44 43 41 38 37 36 34
1.2	85 82 78 75 72 69 66 63 60 57	76 73 70 67 64 61 58 55 53 51	67 64 61 59 57 54 50 48 46 44	59 56 54 51 49 46 44 42 40 38	50 47 45 43 41 39 36 35 34 29
1.4	85 80 77 73 69 65 62 59 57 52	76 72 68 65 62 59 55 53 50 48	67 63 60 58 55 51 47 45 44 41	59 56 53 49 47 44 41 39 38 36	50 47 45 42 40 38 35 34 35 27
1.6	84 79 75 71 67 63 59 56 53 50	75 71 67 63 60 57 53 50 47 44	67 62 59 56 53 47 45 43 41 38	59 55 52 48 45 42 39 37 35 33	50 47 44 41 39 36 33 32 30 26
1.8	83 78 73 69 64 60 56 53 50 48	75 70 66 62 58 54 50 47 44 41	66 61 58 54 51 46 42 40 38 35	58 55 51 47 44 40 37 35 33 31	50 46 43 40 38 35 31 30 28 25
2.0	83 77 72 67 62 56 53 50 47 43	74 69 64 60 56 52 48 45 41 38	66 60 56 52 49 45 40 38 36 33	58 54 50 46 43 39 35 33 31 29	50 46 43 40 37 34 30 28 26 24
2.2	82 76 70 65 59 54 50 47 44 40	74 68 63 58 54 49 45 42 38 35	66 60 55 51 48 43 38 36 34 32	58 53 49 45 42 37 34 31 29 28	50 46 42 38 36 33 29 27 24 22
2.4	82 75 69 64 58 53 48 45 41 37	73 67 61 56 52 47 43 40 36 33	65 60 54 50 46 41 37 35 32 30	58 53 48 44 41 36 32 30 27 26	50 46 42 37 35 31 27 25 23 21
2.6	81 74 67 62 56 51 46 42 38 35	73 66 60 55 50 45 41 38 34 31	65 59 54 49 45 40 35 33 30 28	58 53 48 43 39 35 31 28 26 24	50 46 41 37 34 30 26 23 21 20
2.8	81 73 66 60 54 49 44 40 36 34	73 65 59 53 48 43 39 36 32 29	65 59 53 48 43 38 33 30 28 26	58 53 47 43 38 34 29 27 24 22	50 46 41 36 33 29 25 22 20 19
3.0	80 72 64 58 52 47 42 38 34 30	72 65 58 52 47 42 37 34 30 27	64 58 52 47 42 37 32 29 27 24	57 52 46 42 37 32 28 25 23 20	50 45 40 36 32 28 24 21 19 17
3.2	79 71 63 56 50 45 40 36 32 28	72 65 57 51 45 40 35 33 28 25	64 58 51 46 40 36 31 28 25 23	57 51 45 41 36 31 27 23 22 18	50 44 39 35 31 27 23 20 18 16
3.4	79 70 62 54 48 43 38 34 30 27	71 64 56 49 44 39 34 32 27 24	64 57 50 45 39 35 29 27 24 22	57 51 45 40 35 30 26 23 20 17	50 44 39 35 30 26 22 19 17 15
3.6	78 69 61 53 47 42 36 32 28 25	71 63 54 48 43 38 32 30 25 23	63 56 49 44 38 33 28 25 22 20	57 50 44 39 34 29 25 22 19 16	50 44 39 34 29 25 21 18 16 14
3.8	78 69 60 51 45 40 35 31 27 23	70 62 53 47 41 36 31 28 24 22	63 56 49 43 37 32 27 24 21 19	57 50 43 38 33 29 24 21 19 15	50 44 38 34 29 25 21 17 15 13
4.0	77 69 58 51 44 39 33 29 25 22	70 61 53 46 40 35 30 26 22 20	63 55 48 42 36 31 26 23 20 17	57 49 42 37 32 28 23 20 18 14	50 44 38 33 28 24 20 17 15 12
4.2	77 62 57 50 43 37 32 28 24 21	69 60 52 45 39 34 29 25 21 18	62 55 47 41 35 30 25 22 19 16	56 49 42 37 32 27 22 19 17 14	50 43 37 32 28 24 20 17 14 12
4.4	76 61 56 49 42 36 31 27 23 20	69 60 51 44 38 33 28 24 20 17	62 54 46 40 34 29 24 21 18 15	56 49 42 36 31 27 22 19 16 13	50 43 37 32 27 23 19 16 13 11
4.6	76 60 55 47 40 35 30 26 22 19	69 59 50 43 37 32 27 23 19 15	62 53 45 39 33 28 24 21 17 14	56 49 41 35 30 26 21 18 16 13	50 43 36 31 26 22 18 15 13 10
4.8	75 59 54 46 39 34 28 25 21 18	68 58 49 42 36 31 26 22 18 14	62 53 45 38 32 27 23 20 16 13	56 48 41 34 29 25 21 18 15 12	50 43 36 31 26 22 18 15 12 09
5.0	75 59 53 45 38 33 28 24 20 16	68 58 48 41 35 30 25 21 18 14	61 52 44 36 31 26 22 19 16 12	56 48 40 34 28 24 20 17 14 11	50 42 35 30 25 21 17 14 12 09
6.0	73 61 49 41 34 29 24 20 16 11	66 55 44 38 31 27 22 19 15 10	60 51 41 35 28 24 19 16 13 09	55 45 37 31 25 21 17 14 11 07	50 42 34 29 23 19 15 13 10 06
7.0	70 58 45 38 30 27 21 18 14 08	64 53 41 35 28 24 19 16 12 07	58 43 38 32 26 22 17 14 11 06	54 43 35 30 24 20 15 12 09 05	49 41 32 27 21 18 14 11 08 05
8.0	68 55 42 35 27 23 18 15 12 06	62 50 38 32 25 21 17 14 11 05	57 46 35 29 23 19 15 13 10 05	53 42 33 28 22 18 14 11 08 04	49 40 30 25 19 16 12 10 07 03
9.0	66 52 38 31 25 21 16 14 11 05	61 49 36 30 23 19 15 13 10 04	56 45 33 27 21 18 14 12 09 04	52 40 31 26 20 16 12 10 07 03	48 39 29 24 18 15 11 09 07 03
10.0	65 51 36 29 22 19 15 11 09 04	59 46 33 27 21 18 14 11 08 03	55 43 31 25 19 16 12 10 08 03	51 39 29 24 18 15 11 09 07 02	47 37 27 22 17 14 10 08 06 02

* Values in this table are based on a length to width ratio of 1.6.
†Ceiling, floor, or floor of cavity.

Figure 9-27. *Continued**

Percent Base† Reflectance	40	30	20	10	0
Percent Wall Reflectance	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0	90 80 70 60 50 40 30 20 10 0
Cavity Ratio					
0.2	40 40 39 39 39 38 38 37 36 36	31 31 30 30 29 29 29 28 28 27	21 20 20 20 20 20 19 19 19 17	11 11 11 10 10 10 10 09 09 09	02 02 02 01 01 01 01 00 00 0
0.4	41 40 39 39 38 37 36 35 34 34	31 31 30 30 29 28 28 27 26 25	22 21 20 20 20 19 19 18 18 16	12 11 11 11 11 10 10 09 09 08	04 03 03 02 02 02 01 01 00 0
0.6	41 40 39 38 37 36 34 33 32 31	32 31 30 29 28 27 26 26 25 23	23 21 21 20 19 19 18 18 17 15	13 13 12 11 11 10 10 09 08 08	05 05 04 03 03 02 02 01 01 0
0.8	41 40 38 37 36 35 33 32 31 29	32 31 30 29 28 26 25 25 23 22	24 22 21 20 19 19 18 17 16 14	15 14 13 12 11 10 10 09 08 07	07 06 05 04 04 03 02 02 01 0
1.0	42 40 38 37 35 33 32 31 29 27	33 32 30 29 27 25 24 23 22 20	25 23 22 20 19 18 17 16 15 13	16 14 13 12 12 11 10 09 08 07	08 07 06 05 04 03 02 02 01 0
1.2	42 40 38 36 34 32 30 29 27 25	33 32 30 28 27 25 23 22 21 19	25 23 22 20 19 17 17 16 14 12	17 15 14 13 12 11 10 09 07 06	10 08 07 06 05 04 03 02 01 0
1.4	42 39 37 35 33 31 29 27 25 23	34 32 30 28 26 24 22 21 19 18	26 24 22 20 18 17 16 15 13 12	18 16 14 13 12 11 10 09 07 06	11 09 08 07 06 04 03 02 01 0
1.6	42 39 37 35 32 30 27 25 23 22	34 33 29 27 25 23 22 20 18 17	26 24 22 20 18 17 16 15 13 11	19 17 15 14 12 11 09 08 07 06	12 10 09 07 06 05 03 02 01 0
1.8	42 39 36 34 31 29 26 24 22 21	35 33 29 27 25 23 21 19 17 16	27 25 23 20 18 17 15 14 12 10	19 17 15 14 13 11 09 08 06 05	13 11 09 08 07 05 04 03 01 0
2.0	42 39 36 34 31 28 25 23 21 19	35 33 29 26 24 22 20 18 16 14	28 25 23 20 18 16 15 13 11 09	20 18 16 14 13 11 09 08 06 05	14 12 10 09 07 05 04 03 01 0
2.2	42 39 36 33 30 27 24 22 19 18	36 32 29 26 24 22 19 17 15 13	28 25 23 20 18 16 14 12 10 09	21 19 16 14 13 11 09 07 06 05	15 13 11 09 07 06 04 03 01 0
2.4	43 39 35 33 29 27 24 21 18 17	36 32 29 26 24 22 19 16 14 12	29 26 23 20 18 16 14 12 10 08	22 19 17 15 13 11 09 07 06 05	16 13 11 09 08 06 04 03 01 0
2.6	43 39 35 32 29 26 23 20 17 15	36 32 29 25 23 21 18 16 14 12	29 26 23 20 18 16 14 11 09 08	23 20 17 15 13 11 09 07 06 04	17 14 12 10 08 06 05 03 02 0
2.8	43 39 35 32 28 25 22 19 16 14	37 33 29 25 23 21 17 15 13 11	30 27 23 20 18 15 13 11 09 07	23 20 18 16 13 11 09 07 05 03	17 15 13 10 08 07 05 03 02 0
3.0	43 39 35 31 27 24 21 18 16 13	37 33 29 25 22 20 17 15 12 10	30 27 23 20 17 15 13 11 09 07	24 21 18 16 13 11 09 07 05 03	18 16 13 11 09 07 05 03 02 0
3.2	43 39 35 31 27 23 20 71 15 13	37 33 29 25 22 19 16 14 12 10	31 27 23 20 17 15 12 11 09 06	25 21 18 16 13 11 09 07 05 03	19 16 14 11 09 07 05 03 02 0
3.4	43 39 34 30 26 23 20 17 14 12	37 33 29 25 22 19 16 14 11 09	31 27 23 20 17 15 12 10 08 06	26 22 18 16 13 11 09 07 05 03	20 17 14 12 09 07 05 03 02 0
3.6	44 39 34 30 26 22 19 16 14 11	38 33 29 24 21 18 15 13 10 09	32 27 23 20 17 15 12 10 08 05	26 22 19 16 13 11 09 06 04 03	20 17 15 12 10 08 05 04 02 0
3.8	44 38 33 29 25 22 18 16 13 10	38 33 28 24 21 18 15 13 10 08	32 28 23 20 17 15 12 10 07 05	27 23 19 17 14 11 09 06 04 02	21 18 15 12 10 08 05 04 02 0
4.0	44 38 33 29 25 21 18 15 12 10	38 33 28 24 21 18 14 12 09 07	33 28 23 20 17 14 11 09 07 05	27 23 20 17 14 11 09 06 04 02	22 18 15 13 10 08 05 04 02 0
4.2	44 38 33 29 24 21 17 15 12 10	38 33 28 24 20 17 14 12 09 07	33 28 23 20 17 14 11 09 07 04	28 24 20 17 14 11 09 06 04 02	22 19 16 13 10 08 06 04 02 0
4.4	44 38 33 28 24 20 17 14 11 09	39 33 28 24 20 17 14 11 09 06	34 28 24 20 17 14 11 09 07 04	28 24 20 17 14 11 08 06 04 02	23 19 16 13 10 08 06 04 02 0
4.6	44 38 32 28 23 19 16 14 11 08	39 33 28 24 20 17 13 10 08 06	34 29 24 20 17 14 11 09 07 04	29 25 20 17 14 11 08 06 04 02	23 20 17 13 11 08 06 04 02 0
4.8	44 38 32 27 22 19 16 13 10 08	39 33 28 24 20 17 13 10 08 05	35 29 24 20 17 13 10 08 06 04	29 25 20 17 14 11 08 06 04 02	24 20 17 14 11 08 06 04 02 0
5.0	45 38 31 27 22 19 15 13 10 07	39 33 28 24 19 16 13 10 08 05	35 29 24 20 16 13 10 08 06 04	30 25 20 17 14 11 08 06 04 02	25 21 17 14 11 08 06 04 02 0
6.0	44 37 30 25 20 17 13 11 08 05	39 33 27 23 18 15 11 09 06 04	36 30 24 20 16 13 10 08 05 02	31 26 21 18 14 11 08 06 03 01	27 23 18 15 12 09 06 04 02 0
7.0	44 36 29 24 19 16 12 10 07 04	40 33 26 22 17 14 10 08 05 03	36 30 24 20 15 12 03 07 04 02	32 27 21 17 13 11 08 06 03 01	28 24 19 15 12 09 06 04 02 0
8.0	44 35 28 23 18 15 11 09 06 03	40 33 26 21 16 13 09 07 04 02	37 30 23 19 15 12 08 06 03 01	33 27 21 17 13 10 07 05 03 01	30 25 20 15 12 09 06 04 02 0
9.0	44 35 26 21 16 13 10 08 05 02	40 33 25 20 15 12 09 07 04 02	37 29 23 19 14 11 08 06 03 01	34 28 21 17 13 10 07 05 02 01	31 25 20 15 12 09 06 04 02 0
10.0	43 34 25 20 15 12 08 07 05 02	40 32 24 19 14 11 08 06 03 01	37 29 22 18 13 10 07 05 03 01	34 28 21 17 12 10 07 05 02 01	31 25 20 15 12 09 06 04 02 0

* Values in this table are based on a length to width ratio of 1.6.
† Ceiling, floor, or floor of cavity.