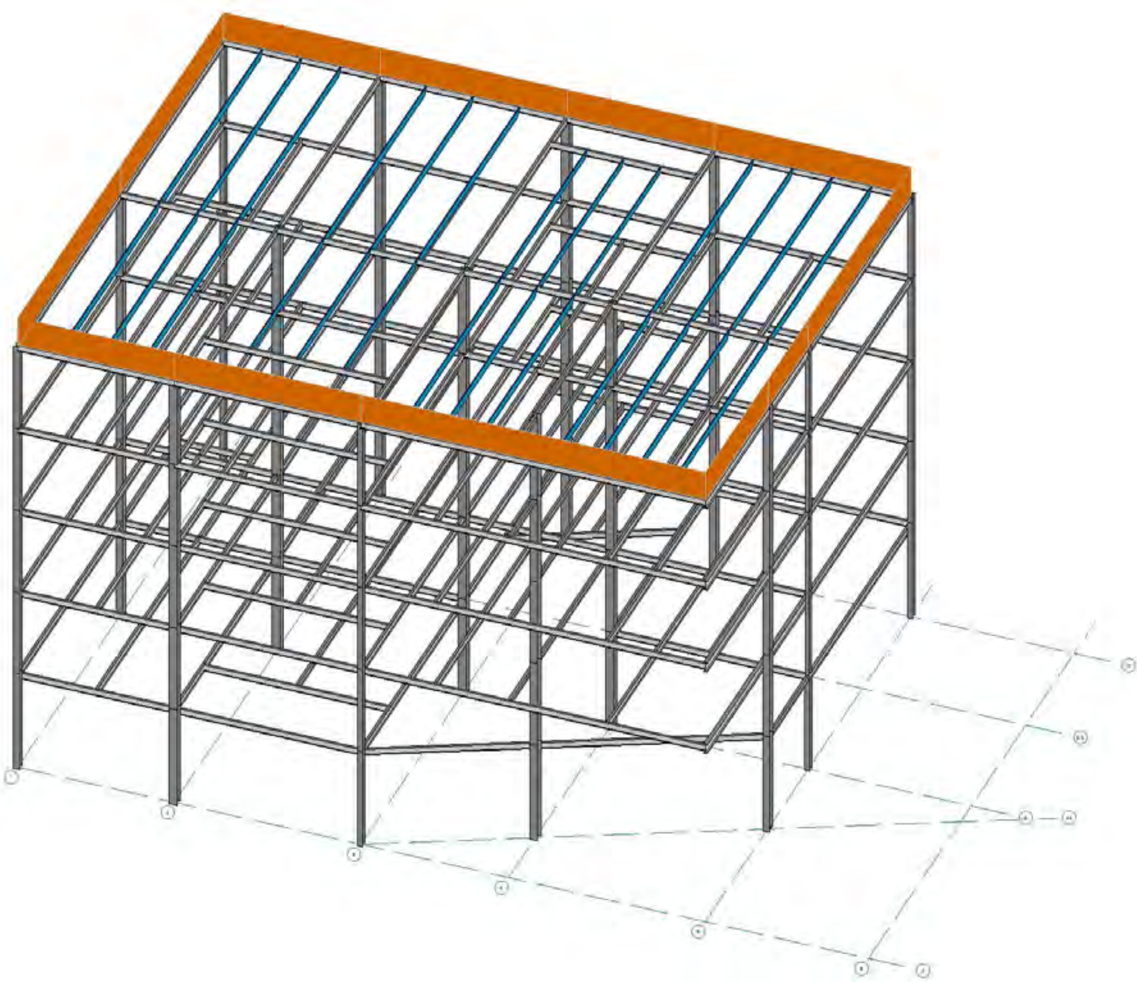
ARCH 3224 STEEL II SPRING 2021

ADDISON HELLIER

PROJECT MANUAL



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Project

Corvette Museum of America

Structural Design Criteria

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Student

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1.00 Introduction

This report has been prepared to provide a basis of structural design and record of calculations for the proposed Corvette Museum of America at 350 Corvette Drive, Bowling Green, Kentucky. The scope of structural components covered under this report is:

- Floor and roof systems
    - Composite floor
    - Metal deck roof

2.00 Design Criteria

2.01 CODES AND REFERENCES

- Governing Building Code: International Building, IBC 2018
- ASCE 7-16: Minimum Design Loads for Buildings
- Kentucky Building Code, KCBH 2018
- Structural Steel: AISC – 15th Edition
- Steel Deck: SDI
- Steel Joists: SJI – Load Tables for Steel Joists and Steel Girders

2.02 GRAVITY LOADS

2.02.01.01 Floor Systems Dead Loads

For design of the floor systems, dead loadings are assumed as per Figure 01.

Area	Item	Loading (psf)	Notes
Composite Floors LWC, 3 ½” + 3”	Composite Slab	48	3”-19 G M.D. + 3 ½” LWC Slab
	Ponding	5	3/8” avg. thick
	Floor Fill Beams	4	Or Self Weight
	Support Girders	4	Or Self Weight
	Columns	4	Or Self Weight
	Misc.	3	EOS Support, Façade Support
	Total	68	

Figure 01 – Floor System Dead Loads

2.02.01.02 Roof Systems Dead Loads

Area	Item	Loading (psf)	Notes
Typical Roof	Wide Flange Beams	5	Or Self Weight
	Wide Flange Girders	4	Or Self Weight
	Joists	3	Or Self Weight
	Total	12	

* Open Web Steel Joist load based on weight (lb/ft) * 1 ft width from Vulcraft design catalog

Figure 02 – Roof Dead Loads

2.02.02 Superimposed Dead Loads

2.02.02.01 Floor Systems Superimposed Dead Loads

Area	Item	Loading (psf)	Notes
Typical Floor Area	Hung MEP	5 / 25	Standard / Above MEP Rooms
	Flooring/Ceilings	5	
	Misc.	5	
	Total	15 / 35	

Figure 03 – Floor System Superimposed Dead Loads

2.02.02.02 Roof Systems Superimposed Dead Loads

Area	Item	Loading (psf)	Notes
Typical Roof	Roof Deck	3	Nucor 1.5B (20 ga)
	Roof	1	
	Insulation	1	
	Hung MEP	5	
	Lighting	5	
	Total	15	

Figure 04 – Roof System Superimposed Dead Loads

2.02.03 Live Loads

Area	Loading (psf)	Notes
Levels 2 and 5 (Restaurant/Event)	100	
Levels 3 and 4 (Similar Density to Retail)	75	
Party Deck	100	Assembly
MEP @ Level 5	150	
Admin Offices	65	50 psf Office + 15 psf Partitions
Gift Shop	100	
Restaurant	100	
Roof	20	First Floor

Figure 05 – Floor System Live Loads

2.02.04 Snow Loads

Ground Snow Load (P_g) for Warren County, KY:
15 psf per ASCE 7-16 Fig. 7.2-1, KHBC 2018 Table 1608.2

For Flat Roofs:

- C_e = 0.9 (Exposure C (Mean Roof Ht > 30 ft), Fully Exposed)
- C_t = 1.0 (ASCE 7-16 Table 7.3-2)
- I_s = 1.0 (Risk Category II per ASCE 7-16 Table 1.5-1)
- $P_f = 0.7 * C_e * C_t * I_s * P_g$ = **9.45 psf**

2.03 Other Gravity Loads

2.03.01 Concentrated Floor Loads

Area	Concentrated Load	Notes
Elevator Machine Room Grating	300 lbs	4 in^2 area
Stair Treads	300 lbs	
Exhibited Corvette*	3400 lbs	C1 - Generation 1 (1953-1962)
	3200 lbs	C2 – Generation 2 (1963-1967)
	3500 lbs	C3 – Generation 3 (1968-1982)

	3350 lbs	C4 – Generation 4 (1984-1997)
	3250 lbs	C5 – Generation 5 (1998-2005)
	3200 lbs	C6 – Generation 6 (2006-2014)
	3350 lbs	C7 – Generation 7 (2015-2019)
	3400 lbs	C8 – Generation 8 (2020-Present)

** Max. Curb Weights per corvsport.com*

Figure 06 – Concentrated Loads

2.03.02 Impact Loads

2.03.03 Miscellaneous Equipment

2.04 Miscellaneous Loads

Load Type	Category	Value	Notes
Rain	100 Yr, 1 Hr Rainfall	3.29 in	KCBH 2018 Table 1611.1
Ice	Nominal Thickness (t)	0.75 in	KHBC 2018 Table 1614.1
	Concurrent Wind Speed (V_c)	30 mph	

Figure 07 - Non-Snow Precipitation Loads

2.05 Wind Loads

Parameter	Value	Notes
Occupancy Category	II	
Basic Wind Speed, V	105 mph **115 mph**	ASCE 7-16, Fig. 26.5-1B **KHBC 2018, Table 1609.3**
Exposure	C	

Figure 08 – Wind Load Criteria

2.06 Seismic Loads

Parameter	Value	Notes
Occupancy Category	II	
Importance Factor, I_e	1.00	ASCE 7-16, 1.5.-2
Soil Site Class	C	
S_S	0.24	Seismic Criteria from seismicmaps.org
S_1	0.126	
S_{DS}	0.208	
S_{D1}	0.126	
T_L	12 Seconds	

Figure 09 – Seismic Load Criteria

2.07 Load Combinations

- D = Dead Load
- L = Live Load
- S = Snow Load
- W = Wind Load
- E = Seismic Load
- H = Load due to Lateral Earth Pressure
- T = Self Restraining Force

2.07.01 STRENGTH DESIGN/ LOAD AND RESISTANCE FACTOR DESIGN (LRFD)

Load Combinations determined by IBC 2018, Section 1605.2

- *1.4(D+F+T)*………………………………………………… (Equation 16-1)
- *1.2(D + F+T) + 1.6(L + H) + 0.5(Lr or S)*…………………… (Equation 16-2)
- *1.2(D + F) + 1.6(Lr or S) +1.6H + [f1 x L or (+/- 0.5W)]* … (Equation 16-3)
- *1.2(D + F) ± 1.0W + (f1 x L) 1.6H + 0.5(Lr or S)*………… (Equation 16-4)
- *1.2(D + F) ± 1.0E + (f1 x L) + 1.6H + (f2 x S)*……………… (Equation 16-5)
- *0.9(D + F) ± 1.0E + 1.6H*…………………………………… (Equation 16-6)
- *0.9D ± 1.0W + 1.6H*………………………………………… (Equation 16-7)

f1 = 1.0 (Floors in places of public assembly) / 0.5 (Other)

f2 = 0.7 (Roofs that do not shed snow) / 0.2 (Other roof configurations)

2.07.02 Allowable Strength Design (ASD)

Load Combinations determined by IBC 2018, Section 1605.3

- *D + F + T*………………………………………………… (Equation 16-8)
- *D + H + L + F + T* …………………………………………… (Equation 16-9)
- *D + H + F + (Lr or S)* ……………………………………… (Equation 16-10)
- *D + H + F+ 0.75L + 0.75(Lr or S)* ………………………… (Equation 16-11)
- *D + H + F + (0.6W or 0.7E)*………………………………… (Equation 16-12)
- *D + H + F + 0.75(0.6W) + 0.75L + 0.75(Lr or S)*………… (Equation 16-13)
- *D + H + F + 0.75(0.7E) + 0.75L + 0.75S*…………………… (Equation 16-14)
- *0.6D ± 0.6W + H*……………………………………………… (Equation 16-15)
- *0.6(D+F) ± 0.7E + H*………………………………………… (Equation 16-16)

2.08 Geotechnical Summary

- Limestone bearing stratum at 15'-0" below ground floor elevation exists with layers of clayey soils lying above the limestone.
- Allowable end bearing pressure for bearing stratum is 30 ksf and skin friction is 4.0 ksf for portion into bearing stratum, after initial 2' penetration.

2.09 Serviceability

2.09.01 Camber Criteria

2.09.02 Deflection Limits

Deflection Limits Determined by IBC 2018, Table 1604.3

Member Type	Loading	Deflection Limit	Notes
Roof Member Supporting Plaster Ceiling	L or S or W	$\Delta \leq L / 360$	
	D + L	$\Delta \leq L / 240$	
Roof Member Supporting non-Plaster Ceiling	L or S or W	$\Delta \leq L / 240$	
	D + L	$\Delta \leq L / 180$	
Floor Members	L	$\Delta \leq L / 360$	
	D + L	$\Delta \leq L / 240$	
Spandrel Members Supporting Metal Panel	SDL + L	$\Delta \leq L / 360$	

Members Supporting Brick/Unreinforced CMU or Glass	D + L	Δ ≤ L / 600 or 0.3”	(ACI 530-05: Section 1.10)
Building Drift Due to Wind Load	W	Δ ≤ H / 400	
Allowable Story Drift Due to Seismic Load	E	Δ ≤ 0.015hsx	ASCE 7-05: Table 12.12-1

Figure 10 – Deflection Limits

2.09.02.01 Material Specific Deflection Criteria Per IBC 2018, Section 1604.3

Construction Material	Governing Reference for Δ
Reinforced Concrete	ACI 318
Masonry	TMS 402
Steel	AISC 360, AISI S100, ASCE 8

Figure 11 – Material Deflection References

2.010 Materials

2.010.01 Concrete

Type	f'_c (psi)	Notes
All Precast Concrete (NW)	5000	
All C.I.P. Concrete (NW)	4000	
All Piers and Pilecaps (NW)	4000	
All Concrete on Metal Deck (NW)	4000	
Grade Beams	4000	

Figure 12 – Concrete Material Data

2.010.02 Reinforcing Steel

Type	Yield Stress (ksi)	Grade	Notes
All Deformed Bars	60	ASTM A615	Except where welded
Welded Deformed Bars	75	ASTM A706	
Welded Wire Fabric		ASTM A185 and A82	
All Welds:		E70XX per AWS	

Figure 13 – Steel Reinforcement Material Data

2.010.03 Structural Steel

Type	Yield Stress (ksi)	Grade	Notes
All Rolled Shapes	50	ASTM A992	
All Angles and Channels	36	ASTM A36	
All Structural Tubing	42 (round), 46 (rect)	ASTM A500, Grade B	
All Steel Pipe	35	ASTM A53 Grade B	
All Connection Plate Material	50	ASTM A572	
All High Strength Bolts		ASTM A325 or A490	
All Anchor Bolts		ASTM F1554	
All Welds:		E70XX per AWS	

Figure 14 – Steel Material Data

LOAD CALCULATIONS

- WIND LOADS
- SEISMIC LOADS
- SNOW LOADS

SUPPLIED HAND CALCULATIONS FOR WIND ARE INCORRECT, HOWEVER THE CORRECT VALUES ARE PROVIDED IN THE CLASS-SUPPLIED ANSWER KEY THAT FOLLOWS. I DID NOT HAVE TIME TO RE-WORK THOSE CALCULATIONS.

Wind Load Calculations

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ASCE7-16 CHAPTER 26

TOP OF ROOF = 62'-0" + 4'-0" PARAPET

→ BUILDING ≠ LOW-RISE

WHAT TO DETERMINE: p (PRESSURE)

$p = qGC_p - q_i(GC_{pi})$

WHERE $q = 0.00256 K_z K_{zt} K_d K_e V^2$

TABLE 27.2-1: DETERMINE WIND LOADS

1) RISK CATEGORY: II (TABLE 1.5-1)
2) BASIC WIND SPEED: V = 105 mph (FIG. 26.5-1B)
3) a) $K_d = 0.85$ (TABLE 26.6-1)
   b) EXPOSURE CATEGORY C (26.7.3)
   c) $K_{zt} = 1.0$ (26.8.2)
   d) $K_e = 1.0$ (TABLE 26.9-1, CONSERVATIVE)
   e) $G = 0.85$ (26.11.1)
   f) AREA OF OPENINGS UNKNOWN
   - IF FULLY ENCLOSED: $GC_{pi} = \pm 0.18$
   - IF PARTIALLY ENCLOSED: $GC_{pi} = \pm 0.55$
4) $K_z = 1.13$ FOR $z = 60$ft; $= 1.17$ FOR $z = 70$ft → $K_z = 1.138$ FOR $z = 62$ft
   FOR ROOF
5) $q_z = 0.00256 K_z K_{zt} K_d K_e V^2$ (EQN 26.10-1)
   $q_z = 0.00256(1.138)(1.0)(0.85)(1.0)(105)^2$
   $q_z = 27.301$ lb/ft² (ROOF)
6) C_p (WINDWARD) = 0.8 $\frac{L}{B} = \frac{90}{70} = 1.2857$
   C_p (LEEWARD) = −0.443 (INTERPOLATED)
   C_p (SIDEWALL) = −0.7

$\boxed{P_2 \text{ (EVAL. AT } z = 20 \text{ ft)}}$

$K_{z_{20}} = 0.90$ (26.10-1)

$q_{z_2} = 0.00256 K_{z_{20}} K_{zt} K_d K_e V^2$

$= 0.00256(0.9)(1.0)(0.85)(1.0)(105)^2$

→ $q_{z_2} = 21.5914$ lb/ft²

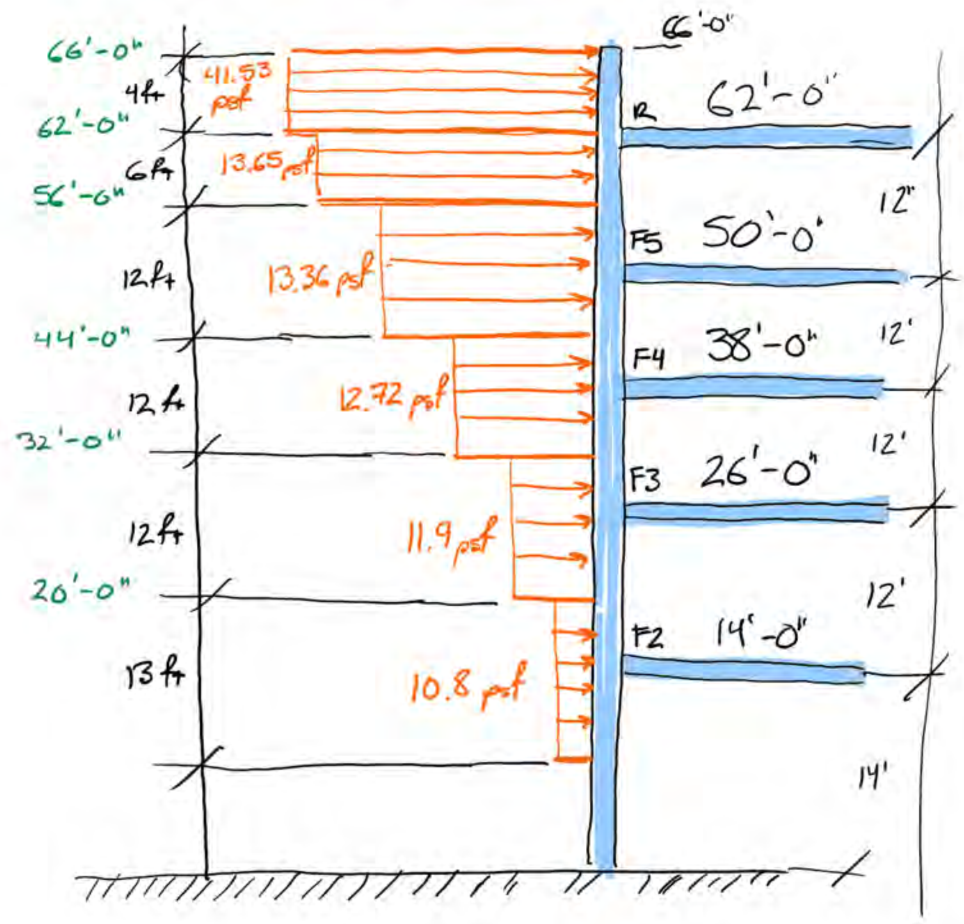
* $q_i = q_z$ FOR WINDWARD WALL OF ENCLOSED

$P_2 = q_{z_2} GC_p - q_i(GC_{pi})$

$= 21.5914(0.85)(0.8) - 21.5914(0.18)$

$P_2 = 10.796$ lb/ft² → $\boxed{P_2 = 10.8 \text{ psf}}$

7) $p = qGC_p - q_i(GC_{pi})$



$\boxed{P_4 \ (z = 44 \text{ ft})}$

$K_{z_{44}}$: $K_{z_{40}} = 1.04$, $K_{z_{50}} = 1.09$ — INTERP: $K_{z_{44}} = 1.06$

$q_4 = 0.00256(1.06)(0.85)(105)^2$

→ $q_4 = 25.4298$

$P_4 = 25.4298(0.85)(0.80) - 25.4298(0.18)$

$P_4 = 12.7149$ lb/ft² → $\boxed{P_4 = 12.72 \text{ psf}}$

$\boxed{P_5 \ (z = 56 \text{ ft})}$

$K_{z_{56}}$: $K_{z_{50}} = 1.09$, $K_{z_{60}} = 1.13$ — INTERP: $K_{z_{56}} = 1.114$

$q_5 = 0.00256(1.114)(0.85)(105)^2$

→ $q_5 = 26.7253$

$P_5 = 26.7253(0.85)(0.8) - 26.7253(0.18)$

$P_5 = 13.3626$ lb/ft² → $\boxed{P_5 = 13.36 \text{ psf}}$

$\boxed{P_R \text{ (ROOF } z = 62 \text{ ft)}}$ (WALL P AT ROOF HEIGHT)

$K_{z_{62}}$: $K_{z_{60}} = 1.13$, $K_{z_{70}} = 1.17$ — INTERP. $K_{z_{62}} = 1.138$

$q_R = 0.00256(1.138)(0.85)(105)^2$

→ $q_R = 27.3011$

$P_R = 27.3011(0.85)(0.80) - 27.3011(0.18)$

$P_R = 13.6506$ lb/ft² → $\boxed{P_R = 13.65 \text{ psf}}$

P_3 ($z = 32$ ft)

$K_{z_{32}}$: $K_{z_{30}} = 0.98$, $K_{z_{40}} = 1.04$ — INTERP: $K_{z_{32}} = 0.992$

$q_{z_3} = 0.60256(0.992)(1.0)(0.85)(1.0)(105)^2$

$\hookrightarrow q_{z_3} = 23.7985$

$P_3 = 23.7985(0.85)(0.8) - 23.7985(0.18)$

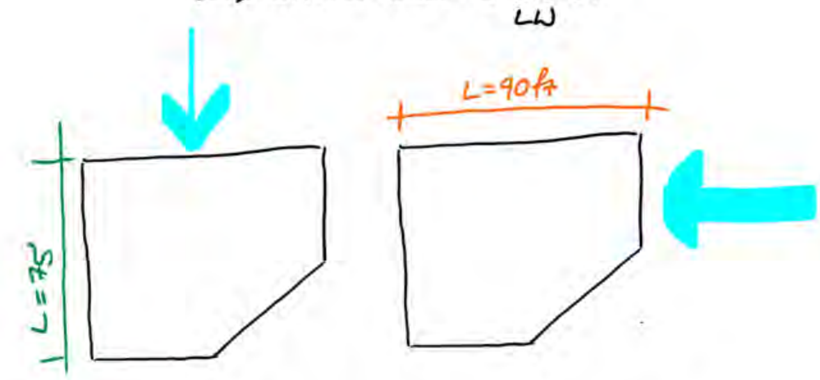
$P_3 = 11.899$ lb/ft^2 $\longrightarrow$ $\boxed{P_3 = 11.9 \text{ psf}}$

ROOF WIND PRESSURE

FIGURE 27.3-1

NOTE 4: MONOSLOPE ROOF (FLAT)

$\hookrightarrow$ WHOLE ROOF = WW or LW



C_p FOR ROOF ($h = 62'-0"$) $\theta < 10°$

NORTH-SOUTH WW/LW DIRECTION

$\frac{h}{L} = \frac{62 \text{ ft}}{75 \text{ ft}} = 0.827$

INTERPOLATE BETWEEN $\frac{h}{L} \leq 0.5$ AND $\frac{h}{L} \geq 1.0$

	$C_p(\leq 0.5)$	$C_p(\geq 1.0)$	$C_p(0.827)$
0 – h/2	0.9, 0.18	1.3, 0.18	1.16, 0.18
h/2 – h	0.9, 0.18	0.7, 0.18	0.77, 0.18
h – L	0.5, 0.18	0.7, 0.18	0.63, 0.18

DETERMINE P

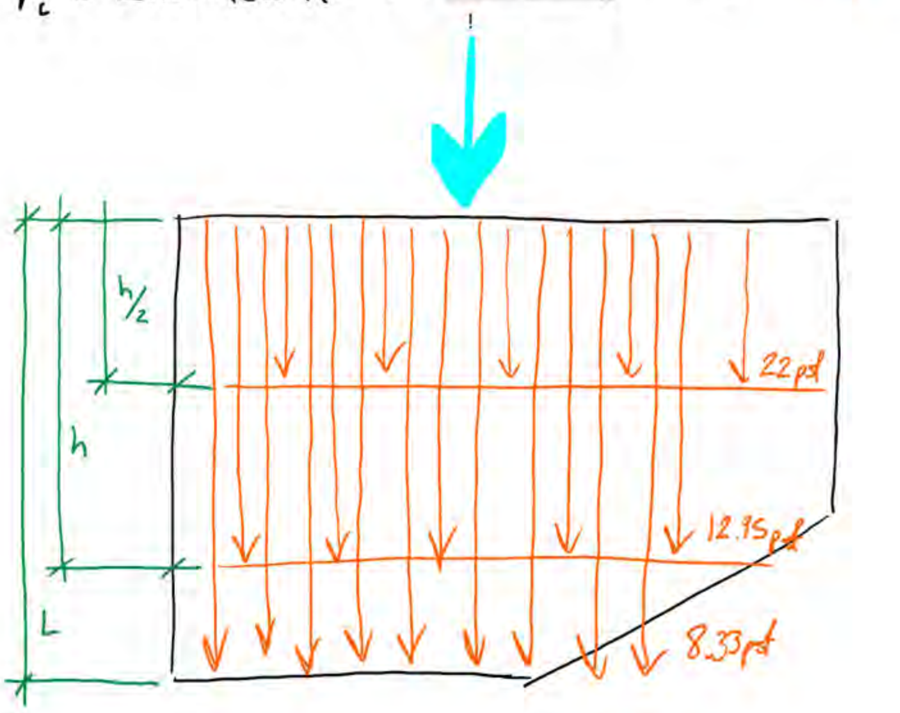
$P = q_h G C_p - q_i (GC_{pi})$

$q_h = q_{62} = 0.00256(1.138)(0.85)(105)^2 = 27.3011$

$P_{h/2} = 27.3011(0.85)(1.16) - 27.3011(0.18) \rightarrow P_{h/2} = 22$ psf

$P_h = 27.3011(0.85)(0.77) - 27.3011(0.18) \longrightarrow P_h = 12.95$ psf

$P_L = 27.3011(0.85)(0.63) - 27.3011(0.18) \longrightarrow P_L = 8.33$ psf



PARAPET ($z = 66$ ft)

$P_p = q_p(GC_{pn})$ (27.3-3)

$GC_{pn} = +1.5$ FOR WINDWARD PARAPET

$K_{z_{66}}$: $K_{z_{60}} = 1.13$, $K_{z_{70}} = 1.17$ — INTERP. $K_{z_{66}} = 1.154$

$q_p = 0.00256(1.154)(0.85)(105)^2$

$\hookrightarrow q_p = 27.6849$

$P_p = 27.6849(1.5) = 41.5274$ lb/ft^2

$\hookrightarrow$ $\boxed{P_p = 41.53 \text{ psf}}$

EAST-WEST WW/LW DIRECTION

$\frac{h}{L} = \frac{62 \text{ ft}}{90 \text{ ft}} = 0.689$

INTERPOLATE BETWEEN $\frac{h}{L} \leq 0.5$ AND $\frac{h}{L} \geq 1.0$

	$C_p(\leq 0.5)$	$C_p(\geq 1.0)$	$C_p(0.689)$
0 – h/2	0.9, 0.18	1.3, 0.18	1.05, 0.18
h/2 – h	0.9, 0.18	0.7, 0.18	0.82, 0.18
h – L	0.5, 0.18	0.7, 0.18	0.58, 0.18

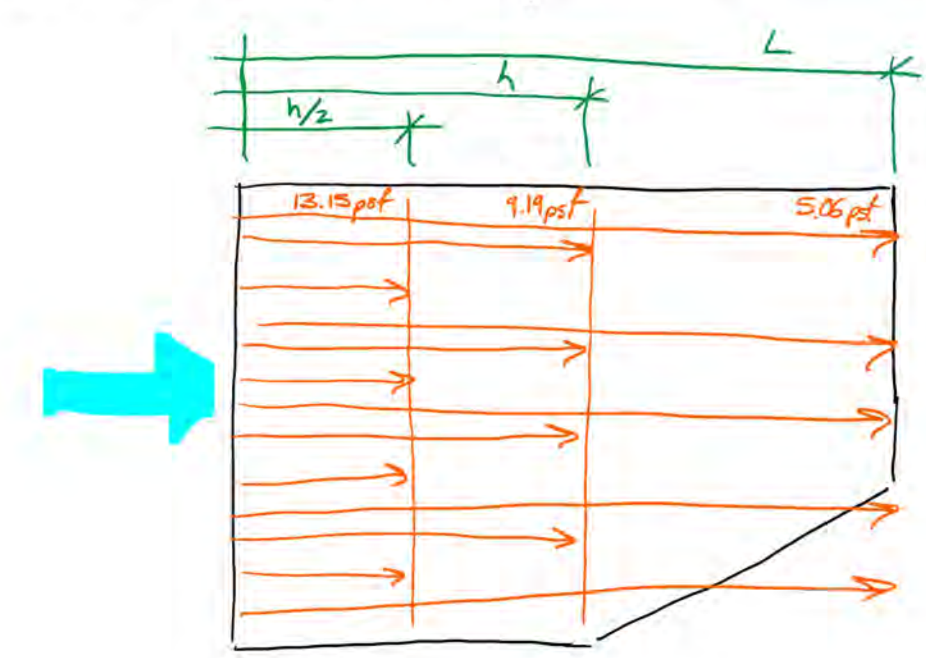
$P = q_h G C_p - q_i (GC_{pi})$

$q_h = q_{62} = 0.00256(1.138)(0.85)(105)^2 = 27.3011$

$P_{h/2} = 27.3011(0.85)(1.05) - 27.3011(0.18) \rightarrow P_{h/2} = 13.15$ psf

$P_h = 27.3011(0.85)(0.82) - 27.3011(0.18) \longrightarrow P_h = 9.19$ psf

$P_L = 27.3011(0.85)(0.58) - 27.3011(0.18) \longrightarrow P_L = 5.06$ psf



Party Deck Wind Calcs

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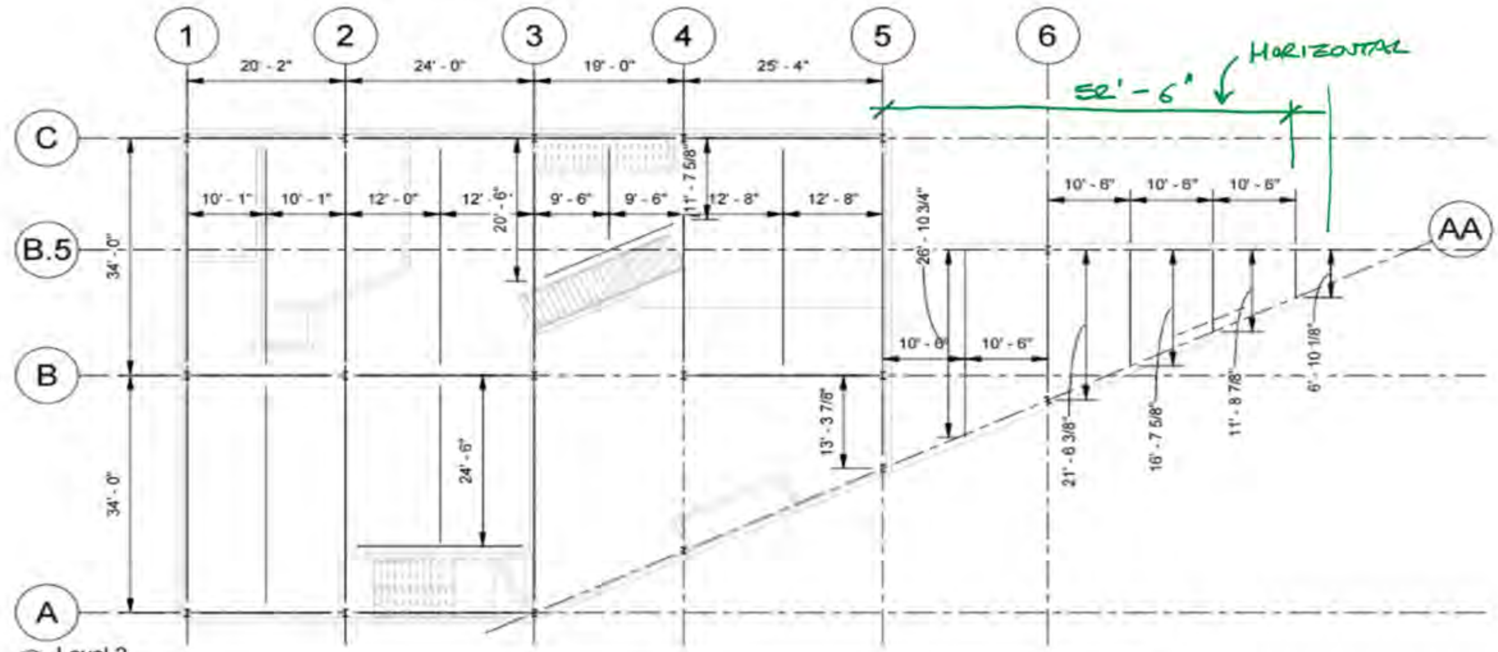
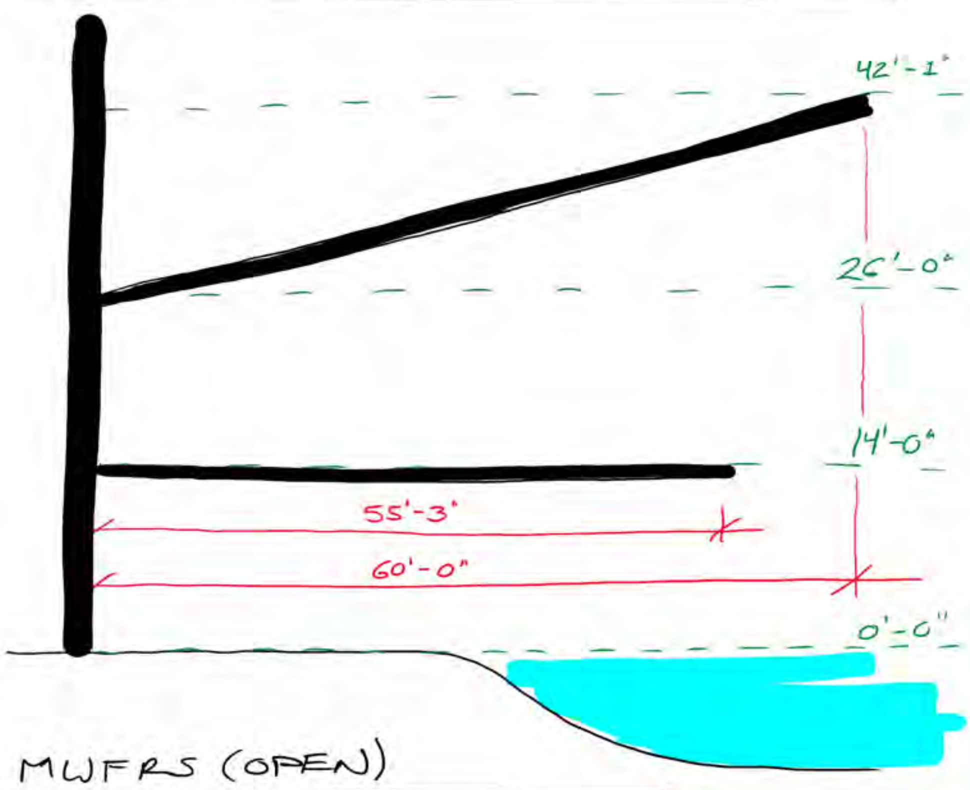


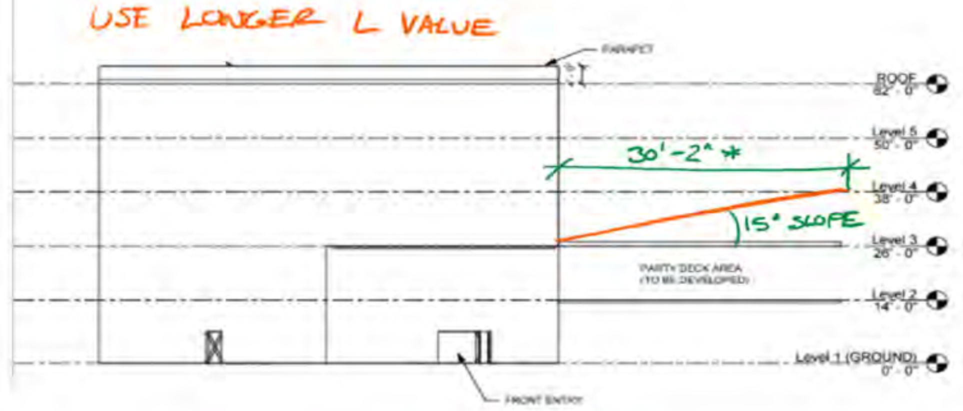
1 Level 2
1/16" = 1'-0"

ADJUSTED ELEVATION:



USE 15° SLOPE FOR

USE LONGER L VALUE



USE HORIZONTAL DISTANCE = 60 ft BASED ON STRUCT. PLAN

ASSUMED 3 ft OVERHANG FROM DECK PLATFORM, THEN ROUNDED TO WHOLE FT VALUE TO BE CONSERVATIVE.

MWFRS (OPEN)

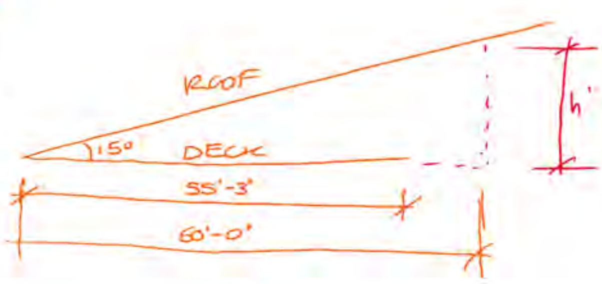
ASCE 7-16 27.3.2

$p = q_h G C_N$

q_h = VELOCITY PRESSURE AT MEAN ROOF HEIGHT (HIGHEST LOAD FOR ANY WIND DIRECTION)

G = GUST FACTOR

C_N = NET PRESSURE COEFFICIENT



$\tan(15°) = \frac{h'}{60'-0"} \longrightarrow h' = 16.08\text{ ft}$

↳ CALL IT 16'-1"

q_h (PER 26.10-1)

MEAN ROOF HEIGHT $= \frac{26\text{ ft} + 42.0833}{2} = 34.04$ (CALL IT 34 ft)

$q_{30.71} = 0.00256\, K_z K_{zt} K_d K_e V^2 \quad \equiv = 34\text{ ft}$

SEE MWFRS CALC. FOR ENCLOSED BUILDING:

$K_{zt} = 1.0$

$K_d = 0.85$

$K_e = 1.0$

$V = 105\text{ mph}$

$K_{z_{36.71}} = \begin{cases} 30\text{ ft} = 0.98 \\ 40\text{ ft} = 1.04 \end{cases}$ INTERPOLATE

↳ $K_{z_{34}} = 1.004$

$q_{h=30.71} = 0.00256(1.004)(1.0)(0.85)(1.0)(105)^2$

↳ $\boxed{q_h = 24.0864}$

G (PER 26.11)

USE $\boxed{G = 0.85}$ (26.11.1)

↳ RIGID STRUCTURE

C_N (FIGS 27.3-4 — 27.3-7)

PER FIG. 27.3-4 (WINDWARD/LEEWARD ALONG SLOPE)

$L = 60\text{ ft}$ (SEE ABOVE) $\longrightarrow \frac{h}{L} = 0.5667$

$h = 34\text{ ft}$ $\quad 0.25 < 0.567 < 1.0$ ✓ OK

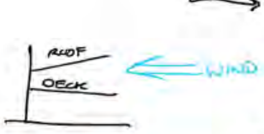
$\theta = 15°$ $\quad 15° < 45°$ ✓ OK

ASSUME: FOR $\gamma = 0°$, CLEAR WIND FLOW

FOR $\gamma = 180°$, OBSTRUCTED WIND FLOW

↳ AGAINST FACE OF BUILDING

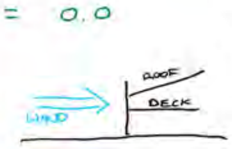
WIND DIRECTION $\gamma = 0°$:



LOAD CASE A: $C_{NW} = -0.9$, $C_{NL} = -1.3$

LOAD CASE B: $C_{NW} = -1.9$, $C_{NL} = 0.0$

WIND DIRECTION $\gamma = 180°$:



LOAD CASE A: $C_{NW} = 0.4$, $C_{NL} = -1.1$

LOAD CASE B: $C_{NW} = 1.2$, $C_{NL} = -0.3$

PER FIG. 27.3-7 (WINDWARD/LEEWARD ⊥ TO SLOPE)

ASSUME CLEAR WIND FLOW FROM BOTH DIRECTIONS

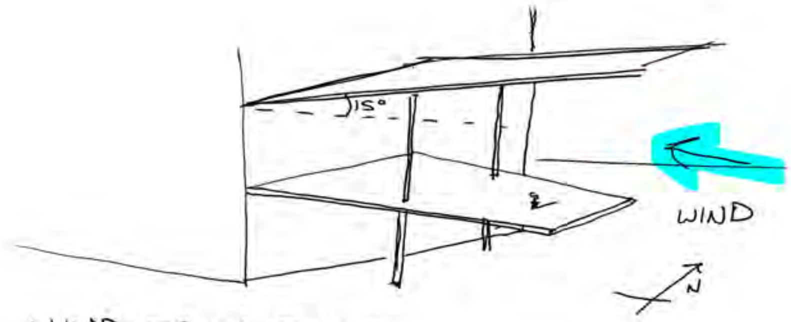
$L = 60\text{ ft}$ $\quad$ MAX WIDTH OF PARTY DECK = 33 ft

$h = 34\text{ ft}$ $\quad$ (ACCORDING TO ARCH. DWGS, LEVEL 2)

$33\text{ ft} < 34\text{ ft} \longrightarrow$ DISTANCE FROM WINDWARD EDGE IS ALWAYS $< h$

LOAD CASE A: $C_N = -0.8$

LOAD CASE B: $C_N = 0.8$



WIND FROM EAST:

$P = q_h G C_N$

LOAD CASE A

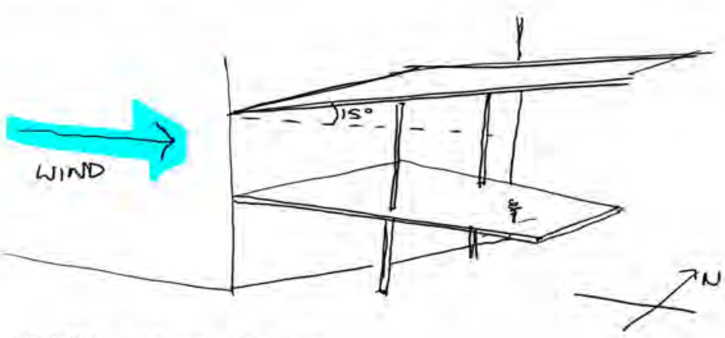
$P_W = 24.0864(0.85)(-0.9) \longrightarrow \boxed{P_W = -18.43 \text{ psf}}$

$P_L = 24.0864(0.85)(-1.3) \longrightarrow \boxed{P_L = -26.62 \text{ psf}}$

LOAD CASE B

$P_W = 24.0864(0.85)(-1.9) \longrightarrow \boxed{P_W = -38.9 \text{ psf}}$

$P_L = 24.0864(0.85)(0.0) \longrightarrow \boxed{P_L = 0.0 \text{ psf}}$



WIND FROM WEST

$P = q_h G C_N$

LOAD CASE A

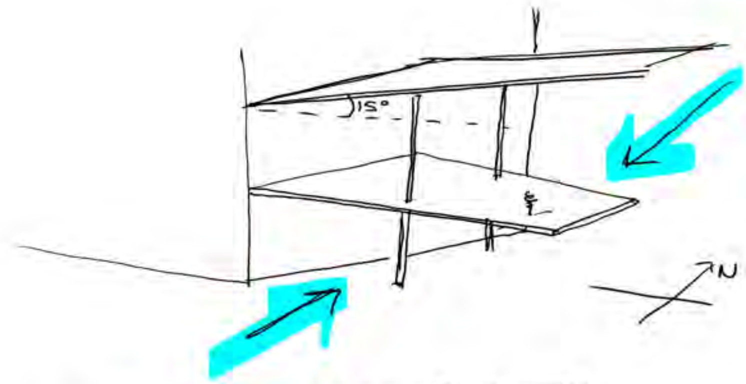
$P_W = 24.0864(0.85)(0.4) \longrightarrow \boxed{P_W = 8.19 \text{ psf}}$

$P_L = 24.0864(0.85)(-1.1) \longrightarrow \boxed{P_L = -22.52 \text{ psf}}$

LOAD CASE B

$P_W = 24.0864(0.85)(1.2) \longrightarrow \boxed{P_W = 24.57 \text{ psf}}$

$P_L = 24.0864(0.85)(-0.3) \longrightarrow \boxed{P_L = -6.14 \text{ psf}}$



WIND FROM NORTH OR SOUTH

$P = q_h G C_N$

LOAD CASE A

$P = 24.0846(0.85)(-0.8) \longrightarrow \boxed{P = 16.38 \text{ psf}}$

LOAD CASE B

$P = 24.0846(0.85)(0.8) \longrightarrow \boxed{P = -16.38 \text{ psf}}$

GREATEST p VALUES:

- 24.57 psf (WIND FROM WEST, LOAD CASE B)
- −38.9 psf (UPLIFT) (WIND FROM EAST, LOAD CASE B)

Building Dimensions

Height (ft)	L (ft)	B (ft)	Pp (ft)
62	70	90	4

Wind Load Parameters

Tb 1.5-1	Risk Category	II	Sec 26.9	Ke, Ground elevation	1
Fig 26.5-1B	V, Speed	105	Sec 26.11	G, Gust effect	0.85
Tb 26.6-1	Kd, Directionality	0.85	Sec 26.2	Enclosure Class	Enclosed
Sec 26.7.3	Exposure Category	B	Tb 26.13-1	Gcpi, Internal pressure	0.18
Sec 26.8.2	Kzt, Topograpy	1			

Velocity Pressure

Tb 26.10-1	Kz	Varies	
Eqn 26.10-1	$q = .00256 K_z K_{zt} K_d K_e V^2$	23.9904	kz

Wind Pressure

Fig 27.3-1	Cp	Wall	0.8	WW	
			-0.500	LW (long)	0.78 L/B
			-0.404	LW (trans)	1.29 L/B
	$GCpn$		1.5, -1	WW,LW	

Eqn 27.3-1 $p = qGC_p - q_i(GC_{pi})$ Eqn 27.3-3 $pp = qp(GC_{pn})$

			WALLS (psf)			PARAPET (psf)		
	Height (ft)	Kz	qz	WW	LW (long)	LW (trans)	WW	LW	
	0-15	0.57	13.67	**9.30**	-5.81	-4.69	20.51	-13.67	
	20	0.62	14.87	**10.11**	-6.32	-5.10	22.31	-14.87	
	25	0.66	15.83	**10.77**	-6.73	-5.43	23.75	-15.83	
	30	0.70	16.79	**11.42**	-7.14	-5.76	25.19	-16.79	
	40	0.76	18.23	**12.40**	-7.75	-6.25	27.35	-18.23	
	50	0.81	19.43	**13.21**	-8.26	-6.67	29.15	-19.43	
	60	0.85	20.39	**13.87**	-8.67	-7.00	30.59	-20.39	
	70	0.89	21.35	14.52	-9.07	-7.32	32.03	-21.35	
	80	0.93	22.31	15.17	-9.48	-7.65	33.47	-22.31	
	90	0.96	23.03	15.66	-9.79	-7.90	34.55	-23.03	
	100	0.99	23.75	16.15	-10.09	-8.15	35.63	-23.75	
	120	1.04	24.95	16.97	-10.60	-8.56	37.43	-24.95	
	140	1.09	26.15	17.78	-11.11	-8.97	39.22	-26.15	
	160	1.13	27.11	18.43	-11.52	-9.30	40.66	-27.11	
	180	1.17	28.07	19.09	-11.93	-9.63	42.10	-28.07	
	200	1.20	28.79	19.58	-12.24	-9.88	43.18	-28.79	
	250	1.28	30.71	20.88	-13.05	-10.53	46.06	-30.71	
	300	1.35	32.39	22.02	-13.76	-11.11	48.58	-32.39	
	350	1.41	33.83	23.00	-14.38	-11.60	50.74	-33.83	
	400	1.47	35.27	23.98	-14.99	-12.10	52.90	-35.27	
	450	1.52	36.47	24.80	-15.50	-12.51	54.70	-36.47	
	500	1.56	37.43	25.45	-15.91	-12.84	56.14	-37.43	
Inter	62	0.858	20.58	**14.00**	**-8.75**	**-7.06**	30.88	-20.58	ROOF
	66	0.874	20.97	14.26	-8.91	-7.19	**31.45**	**-20.97**	PARAPET

Note: Per 27.1.5 Min wind design load 16 psf(walls)

Roof Uplift Eqn 27.3-1 $p = qGC_p - q_i(GC_{pi})$

Direction	h/L	Cp	Pup (psf)	Parameter	Dist to CL (ft)
Long	0.89	-1.212	**-24.91**	0 to 31	4
		-0.744	**-16.72**	31 to 62	
		-0.656	-15.18	62 to 124	
		-0.612	-14.41	> 124	
Trans	0.69	-1.052	**-22.11**	0 to 31	14
		-0.824	**-18.12**	31 to 62	
		-0.576	-13.78	62 to 124	
		-0.452	-11.61	> 124	

Btwn .5 & 1

Reference

Cp

Wall

Surface	L/B		Cp	Use
WW	All		0.8	qz
LW	0-1	0	-0.5	qh
	2	2	-0.3	
	≥4	4	-0.2	
Side	All		-0.7	qh

Long	Trans
-0.442	-0.404

Roof

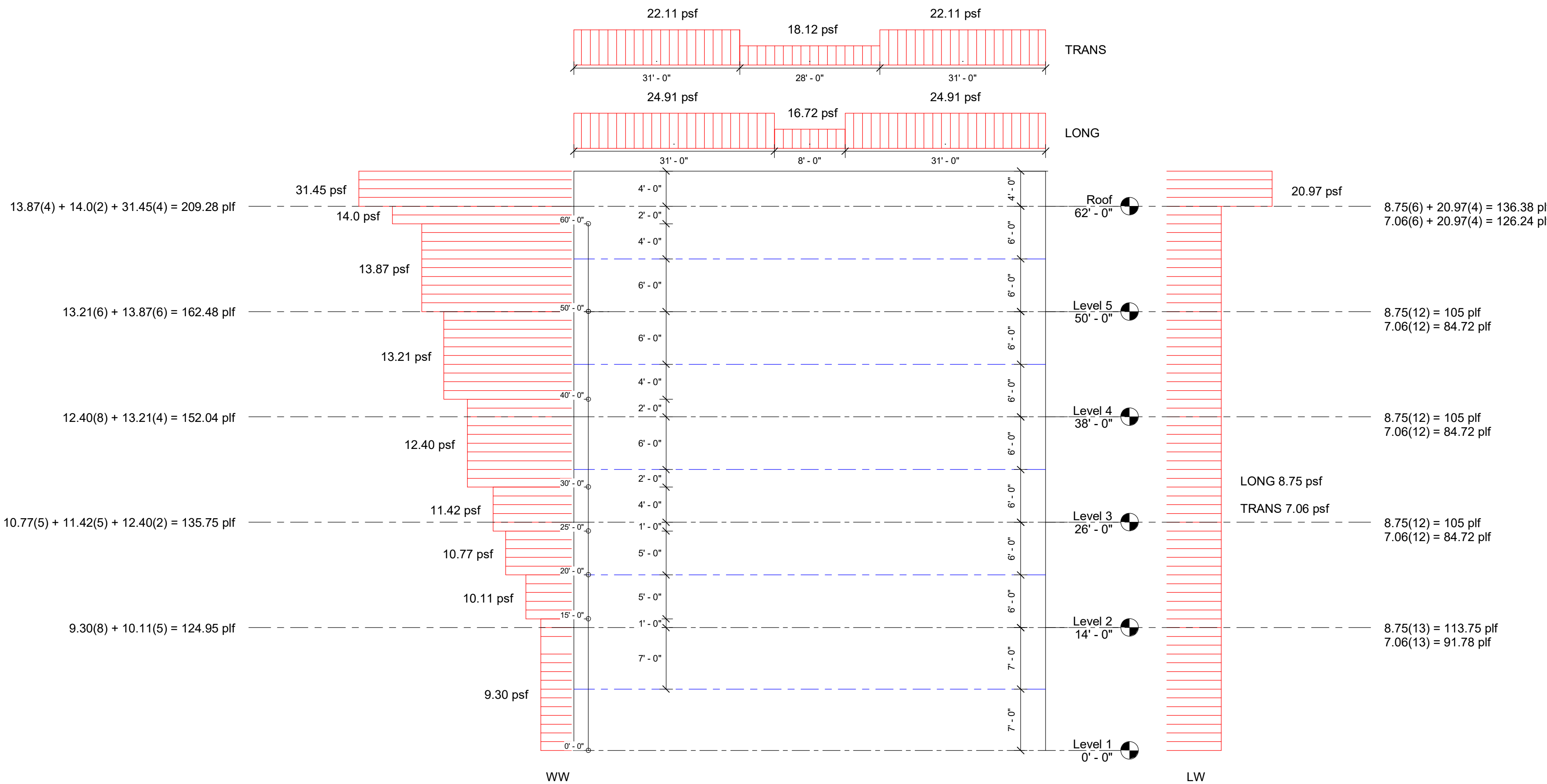
		h/L	Horiz from WW	Cp	Long	Trans
					0.89	0.69
θ<10	≤0.5	0.5	0 to h/2	-0.9	-1.212	-1.052
			h/2 to h	-0.9	-0.744	-0.824
			h to 2h	-0.5	-0.656	-0.576
			>2h	-0.3	-0.612	-0.452
	≥1.0	1	0 to h/2	-1.3		
			>h/2	-0.7		

LONG

0 to h/2		h/2 to h		h to 2h		>2h	
0.50	-0.90	0.50	-0.90	0.50	-0.50	0.50	-0.30
0.89	-1.212	0.89	-0.744	0.89	-0.656	0.89	-0.61
1.00	-1.30	1.00	-0.70	1.00	-0.70	1.00	-0.70

TRANS

0 to h/2		h/2 to h		h to 2h		h to 2h	
0.50	-0.90	0.50	-0.90	0.50	-0.50	0.50	-0.30
0.69	-1.052	0.69	-0.824	0.69	-0.576	0.69	-0.45
1.00	-1.30	1.00	-0.70	1.00	-0.70	1.00	-0.70



22.11 psf
18.12 psf
22.11 psf
TRANS
31' - 0"
28' - 0"
31' - 0"
24.91 psf
16.72 psf
24.91 psf
LONG
31' - 0"
8' - 0"
31' - 0"
31.45 psf
14.0 psf
13.87 psf
13.21 psf
12.40 psf
11.42 psf
10.77 psf
10.11 psf
9.30 psf
13.87(4) + 14.0(2) + 31.45(4) = 209.28 plf
13.21(6) + 13.87(6) = 162.48 plf
12.40(8) + 13.21(4) = 152.04 plf
10.77(5) + 11.42(5) + 12.40(2) = 135.75 plf
9.30(8) + 10.11(5) = 124.95 plf
Roof
62' - 0"
Level 5
50' - 0"
Level 4
38' - 0"
Level 3
26' - 0"
Level 2
14' - 0"
Level 1
0' - 0"
20.97 psf
LONG 8.75 psf
TRANS 7.06 psf
8.75(6) + 20.97(4) = 136.38 plf
7.06(6) + 20.97(4) = 126.24 plf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
8.75(13) = 113.75 plf
7.06(13) = 91.78 plf
WW
LW

Building Dimensions

Height (ft)	L (ft)	B (ft)	Pp (ft)
62	70	90	4

Wind Load Parameters

Tb 1.5-1	Risk Category	II	Sec 26.9	Ke, Ground elevation	1
Fig 26.5-1B	V, Speed	105	Sec 26.11	G, Gust effect	0.85
Tb 26.6-1	Kd, Directionality	0.85	Sec 26.2	Enclosure Class	Enclosed
Sec 26.7.3	Exposure Category	B	Tb 26.13-1	Gcpi, Internal pressure	0.18
Sec 26.8.2	Kzt, Topograpy	1			

Velocity Pressure

Tb 26.10-1 Kz Varies

Eqn 26.10-1 $q = .00256K_zK_{zt}K_dK_eV^2$ 23.9904 kz

Wind Pressure

Fig 27.3-1 Cp Wall

0.8	WW		
-0.500	LW (long)	0.78	L/B
-0.404	LW (trans)	1.29	L/B

$GCpn$ 1.5, -1 WW,LW

Eqn 27.3-1 $p = qGC_p - q_i(GC_{pi})$ Eqn 27.3-3 $pp = qp(GC_{pn})$

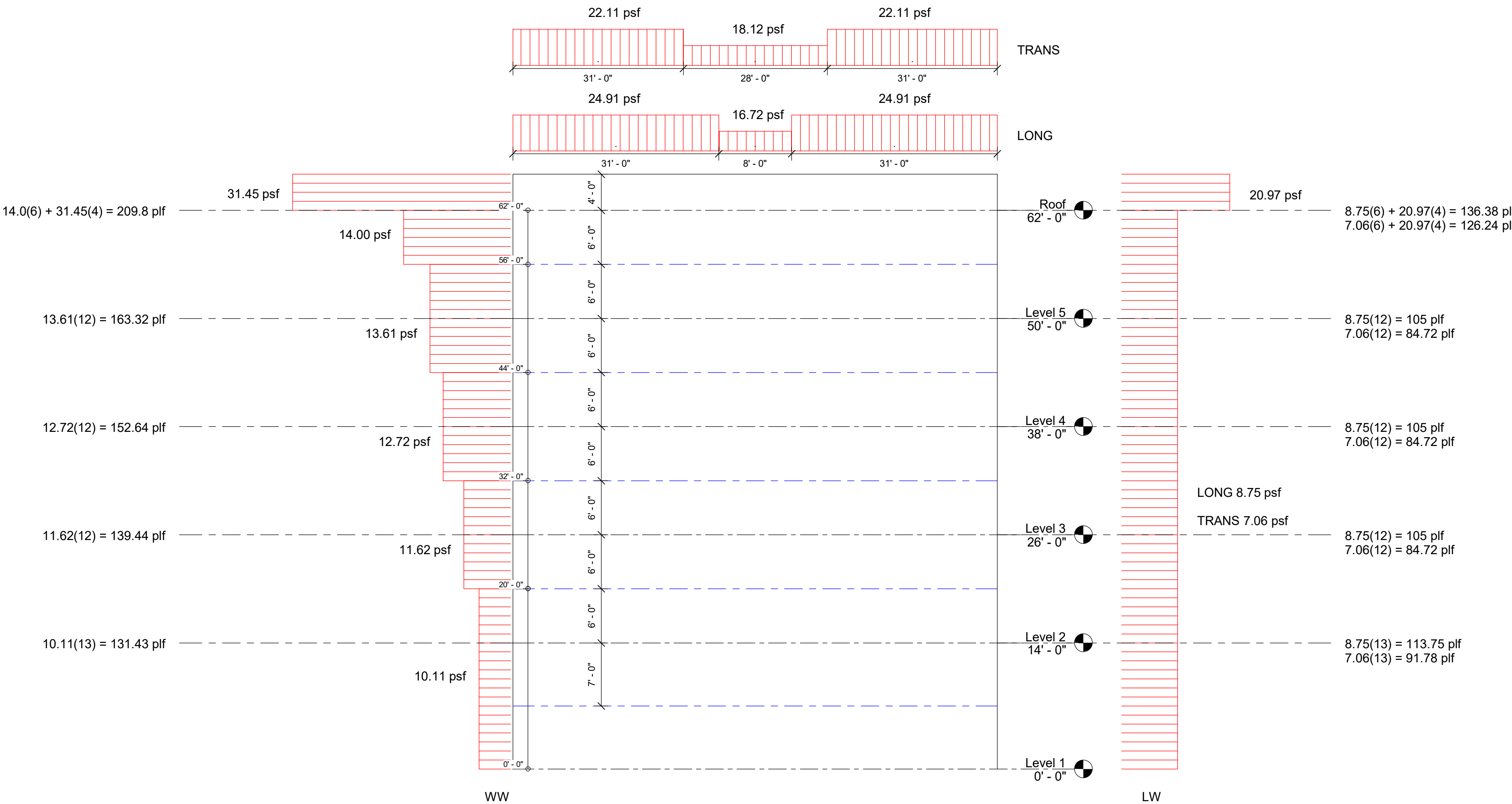
			WALLS (psf)			PARAPET (psf)		
	Height (ft)	Kz	qz	WW	LW (long)	LW (trans)	WW	LW	
	0-15	0.57	13.67	9.30	-5.81	-4.69	20.51	-13.67	
	20	0.62	14.87	10.11	-6.32	-5.10	22.31	-14.87	
	25	0.66	15.83	10.77	-6.73	-5.43	23.75	-15.83	
	30	0.70	16.79	11.42	-7.14	-5.76	25.19	-16.79	
	40	0.76	18.23	12.40	-7.75	-6.25	27.35	-18.23	
	50	0.81	19.43	13.21	-8.26	-6.67	29.15	-19.43	
	60	0.85	20.39	13.87	-8.67	-7.00	30.59	-20.39	
	70	0.89	21.35	14.52	-9.07	-7.32	32.03	-21.35	
	80	0.93	22.31	15.17	-9.48	-7.65	33.47	-22.31	
	90	0.96	23.03	15.66	-9.79	-7.90	34.55	-23.03	
	100	0.99	23.75	16.15	-10.09	-8.15	35.63	-23.75	
	120	1.04	24.95	16.97	-10.60	-8.56	37.43	-24.95	
	140	1.09	26.15	17.78	-11.11	-8.97	39.22	-26.15	
	160	1.13	27.11	18.43	-11.52	-9.30	40.66	-27.11	
	180	1.17	28.07	19.09	-11.93	-9.63	42.10	-28.07	
	200	1.20	28.79	19.58	-12.24	-9.88	43.18	-28.79	
	250	1.28	30.71	20.88	-13.05	-10.53	46.06	-30.71	
	300	1.35	32.39	22.02	-13.76	-11.11	48.58	-32.39	
	350	1.41	33.83	23.00	-14.38	-11.60	50.74	-33.83	
	400	1.47	35.27	23.98	-14.99	-12.10	52.90	-35.27	
	450	1.52	36.47	24.80	-15.50	-12.51	54.70	-36.47	
	500	1.56	37.43	25.45	-15.91	-12.84	56.14	-37.43	
Inter	20	0.620	14.87	**10.11**	-6.32	-5.10	22.31	-14.87	
	32	0.712	17.08	**11.62**	-7.26	-5.86	25.62	-17.08	
	44	0.780	18.71	**12.72**	-7.95	-6.42	28.07	-18.71	
	56	0.834	20.01	**13.61**	-8.50	-6.86	30.01	-20.01	
	62	0.858	20.58	**14.00**	**-8.75**	**-7.06**	30.88	-20.58	ROOF
	66	0.874	20.97	14.26	-8.91	-7.19	**31.45**	**-20.97**	PARAPET

Note: Per 27.1.5 Min wind design load 16 psf(walls)

Roof Uplift Eqn 27.3-1 $p = qGC_p - q_i(GC_{pi})$

Direction	h/L	Cp	Pup (psf)	Parameter	Dist to CL (ft)
Long	0.89	-1.212	**-24.91**	0 to 31	4
		-0.744	**-16.72**	31 to 62	
		-0.656	-15.18	62 to 124	
		-0.612	-14.41	> 124	
Trans	0.69	-1.052	**-22.11**	0 to 31	14
		-0.824	**-18.12**	31 to 62	
		-0.576	-13.78	62 to 124	
		-0.452	-11.61	> 124	

Btwn .5 & 1


22.11 psf
18.12 psf
22.11 psf
TRANS
31' - 0"
28' - 0"
31' - 0"
24.91 psf
16.72 psf
24.91 psf
LONG
31' - 0"
8' - 0"
31' - 0"
31.45 psf
14.0(6) + 31.45(4) = 209.8 plf
14.00 psf
13.61(12) = 163.32 plf
13.61 psf
12.72(12) = 152.64 plf
12.72 psf
11.62(12) = 139.44 plf
11.62 psf
10.11(13) = 131.43 plf
10.11 psf
Roof
62' - 0"
Level 5
50' - 0"
Level 4
38' - 0"
Level 3
26' - 0"
Level 2
14' - 0"
Level 1
0' - 0"
20.97 psf
8.75(6) + 20.97(4) = 136.38 plf
7.06(6) + 20.97(4) = 126.24 plf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
LONG 8.75 psf
TRANS 7.06 psf
8.75(12) = 105 plf
7.06(12) = 84.72 plf
8.75(13) = 113.75 plf
7.06(13) = 91.78 plf
WW
LW

Building Dimensions

Height (ft)	L (ft)	B (ft)	Pp (ft)
62	70	90	4

Wind Load Parameters

Tb 1.5-1	Risk Category	II	Sec 26.9	Ke, Ground elevation	1
Fig 26.5-1B	V, Speed	105	Sec 26.11	G, Gust effect	0.85
Tb 26.6-1	Kd, Directionality	0.85	Sec 26.2	Enclosure Class	Open
Sec 26.7.3	Exposure Category	B	Tb 26.13-1	Gcpi, Internal pressure	0
Sec 26.8.2	Kzt, Topograpy	1			

Velocity Pressure

Tb 26.10-1	Kz	0.668
Eqn 26.10-1	$q = .00256K_z K_{zt} K_d K_e V^2$	16.02559

Wind Pressure

Fig 27.3-4	Cn (15° Slope)	0 degrees	-1.1	Cnw	180 degrees	1.3	Cnw
		Obstructed	-2.100		Clear	1.800	
			-1.500	Cnl		1.600	Cnl
			-0.600			0.600	

Eqn 27.3-2 $p = q_h G C_n$

	Height (ft)	Kz	qz	LONG (psf) 0 Obstruct	LONG (psf) 180 Clear	TRANS (psf) 0/180 Clear		
Inter	26	0.668	16.03	-14.98	17.71	17.71	Case A	WW
	26	0.668	16.03	-28.61	24.52	24.52	Case B	
	26	0.668	16.03	-20.43	21.79	21.79	Case A	LW
	26	0.668	16.03	-8.17	8.17	8.17	Case B	

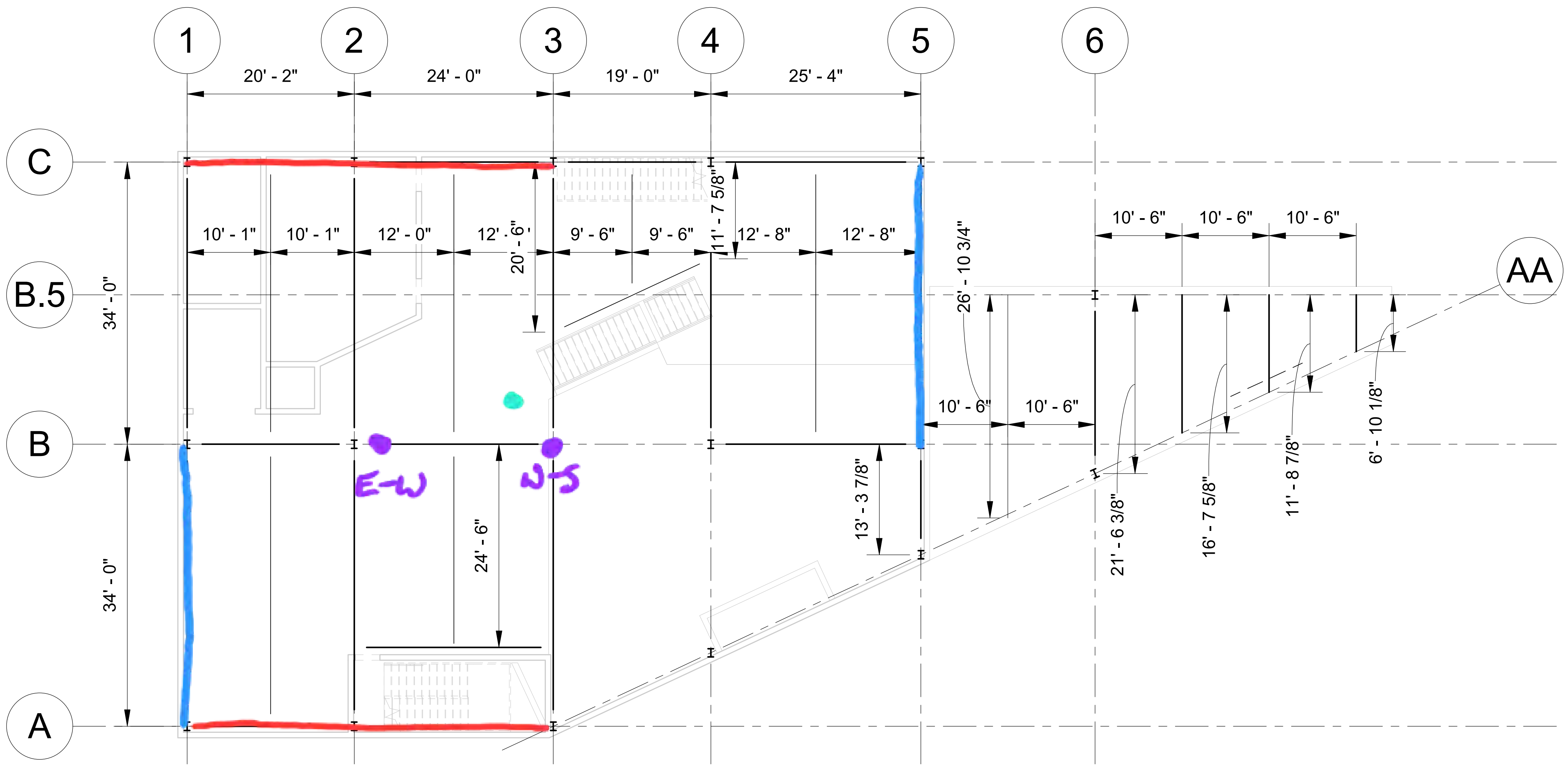
SEISMIC LOADS

MF

BF

CENTER OF MASS

CENTER OF ROTATION



1 Level 2
1/16" = 1'-0"

* AVOID SLAB OPENINGS (DON'T TRANSFER LATERAL WELL)

– CHECK IF STUDS A1-A2 CAN TAKE LAT. LOAD

OSTATE Design
Studios A+E
Atheletic Ave.
Stillwater, OK 74078

CORVETTE MUSEUM OF AMERICA

350 Corvette Dr., Bowling Green, KY 42101

S1.2
LEVEL 2

SEISMIC DESIGN CRITERIA

- OCCUPANCY CATEGORY: II
- IMPORTANCE FACTOR, I_e : 1.0
- SOIL SITE CLASS: C
- $S_S = 0.320$
- $S_1 = 0.148$

↳

SEISMICMAPS.ORG GIVES:

- $S_S = 0.24$
- $S_1 = 0.126$
- $S_{DS} = 0.208$
- $S_{D1} = 0.126$
- $T_L = 12$
- SDC = C

* USE THESE FOR CONSISTENCY

ASCE 7-16, CHAPTER 12

- STEEL ORDINARY CONCENTRICALLY BRACED FRAME : $R = 3.25$
- STEEL ORDINARY MOMENT FRAME : $R = 3.5$

↳ NO LIMITS / RESTRICTIONS FOR EITHER SYSTEM IN SDC C

DETERMINE PERIOD IN EACH DIRECTION

$T_a = C_t h_n^x$ $\qquad h_n = 62\text{ ft}$

TABLE 12.8-2

MF: $C_t = 0.028$, $x = 0.8$

BF: $C_t = 0.02$, $x = 0.75$

MF: $T_a = 0.028(62)^{0.8} = 0.76$

BF: $T_a = 0.02(62)^{0.75} = 0.44$

BOTH: $T_a < T_L$

C_S

	BRACED FRAME		MOMENT FRAME	
$C_S = \frac{S_{DS}}{R/I_e} =$	$\frac{0.208}{3.25/1.0}$	$C_{S_1} = 0.064$	$\frac{0.208}{3.5/1.0}$	$C_{S_1} = 0.059$
$C_{SMAX} = \frac{S_{D1}}{T_a(R/I_e)}$		$C_{SMAX} = 0.063$		$C_{SMAX} = 0.034$
$C_{Smin} = 0.01$		$C_{Smin} = 0.01$		$C_{Smin} = 0.01$
		$\boxed{C_{S_{BF}} = 0.063}$		$\boxed{C_{S_{MF}} = 0.034}$

DETERMINE W (TOTAL BUILDING WEIGHT)

USING INFO FROM DESIGN CRITERIA:

FLOOR DEAD LOAD = 68 psf + 15 psf = 83 psf

ROOF DEAD LOAD = 12 psf + 15 psf = 27 psf

CLADDING DEAD LOAD = 15 psf × 14 ft (LVL 2)

× 12 ft (LVL 3-R)

LEVEL	AREA	PERIMETER		
2	5350 ft^2	260 ft (h = 14 ft)		
3-5	6300 ft^2	320 ft (h = 12 ft)		70' × 90'
ROOF	6300 ft^2	320 ft		70' × 90'

WEIGHT OF FLOOR :

LEVEL	FLOOR LOAD	CLADDING	TOTAL
2	363.8^k	54.6^k	418.4^k
3 4 5	1285.2^k	172.8	1458^k
R	567^k	57.6^k	624.6^k

$$\Sigma W = 2501^k$$

BASE SHEAR: $V = C_s W$

$\boxed{V_{BF} = 156.7^k}$ k_{BF} : $T_a = 0.44 < 0.5 \therefore k = 1.0$

$\boxed{V_{MF} = 84.6^k}$ k_{MF} : INTERPOLATE:

0.5	$k = 1$
0.76	$k = 1.13$ *
2.5	$k = 2$

BF **V = 156.70 kips**

Distribute V to Each Floor k = 1

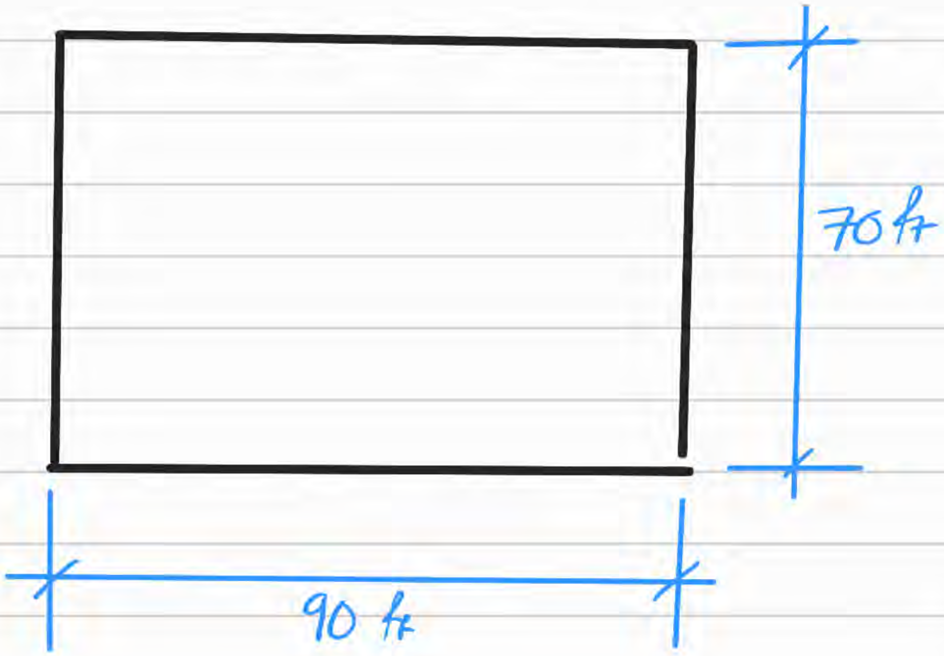
Floor	w_i	h_i	$w_i h_i^k$	cv_i	$F = c_v V$	
Roof	624.60	62.00	38725.20	0.39	60.69	kip
5	486.00	50.00	24300.00	0.24	38.08	kip
4	486.00	38.00	18468.00	0.18	28.94	kip
3	486.00	26.00	12636.00	0.13	19.80	kip
2	418.40	14.00	5857.60	0.06	9.18	kip
Ground	0.00	0.00	0.00	0.00	0.00	kip
	Total:		99986.8	1	156.70	

MF **V = 84.60 kips**

Distribute V to Each Floor k = 1.13

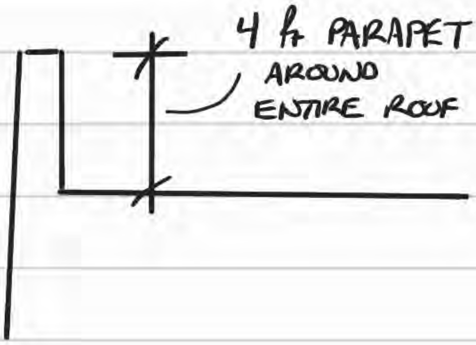
Floor	w_i	h_i	$w_i h_i^k$	cv_i	$F = c_v V$	
Roof	624.60	62.00	66222.35	0.40	34.20	kip
5	486.00	50.00	40408.47	0.25	20.87	kip
4	486.00	38.00	29634.10	0.18	15.30	kip
3	486.00	26.00	19299.95	0.12	9.97	kip
2	418.40	14.00	8254.99	0.05	4.26	kip
Ground	0.00	0.00	0.00	0.00	0.00	kip
	Total:		163819.9	1	84.60	

SNOW LOAD CALCULATIONS



LOCATION

BOWLING GREEN, KENTUCKY



PER ASCE 7-16

$P_g = 15\,psf$ (7.2-1)

$C_e = 1.0$ (PARTIALLY EXPOSED)

$C_t = 1.0$ (7.3-2)

$I_s = 1.0$ (RISK CATEGORY II)

CHAPTER 7

$P_{f_{MAX}} = 0.7 C_e C_t I_s P_g = 0.7(1.0)(15\,psf) = 10.5\,psf$ BALANCED FOR DRIFT

$= I_s P_g = 1.0(15) = 15\,psf$ FOR NO DRIFT

DRIFT AT PARAPET

$h_c = 4'\text{-}0'' - h_b$

$h_b = \dfrac{10.5\,psf}{\gamma}$

$\gamma = 0.13(15\,psf) + 14 = 16$

$= 4'\text{-}0'' - \dfrac{10.5}{16} = 4' - 0.66' \longrightarrow \underline{\underline{h_c = 3.34\,ft}}$

$$h_d = \sqrt{I_s}\,\left(0.43\sqrt[3]{\ell_u}\,\sqrt[4]{P_g+10} - 1.5\right)$$

$$= \sqrt{1.0}\,\left(0.43\left(\sqrt[3]{90\,ft}\right)\left(\sqrt[4]{15+10}\right) - 1.5\right)$$

$\hookrightarrow h_d = 2.81\ ft \longrightarrow$ PARAPET $h_d = 0.75 h_d$

$\hookrightarrow \underline{\underline{h_{d_p} = 2.11\ ft}}$

$2.11\ ft < 3.34\ ft \;\therefore\; h_d < h_c \;\therefore\; w = 4h_d$

$w = 4(2.11) = 8.44\ ft$

$$w_{MIN} = \begin{cases} 8h_c = 8(3.34') = 26.7\ ft \\ 4h_d = 8.44\ ft \end{cases}$$

$\underline{\underline{\text{USE } w = 8.44\ ft}}$

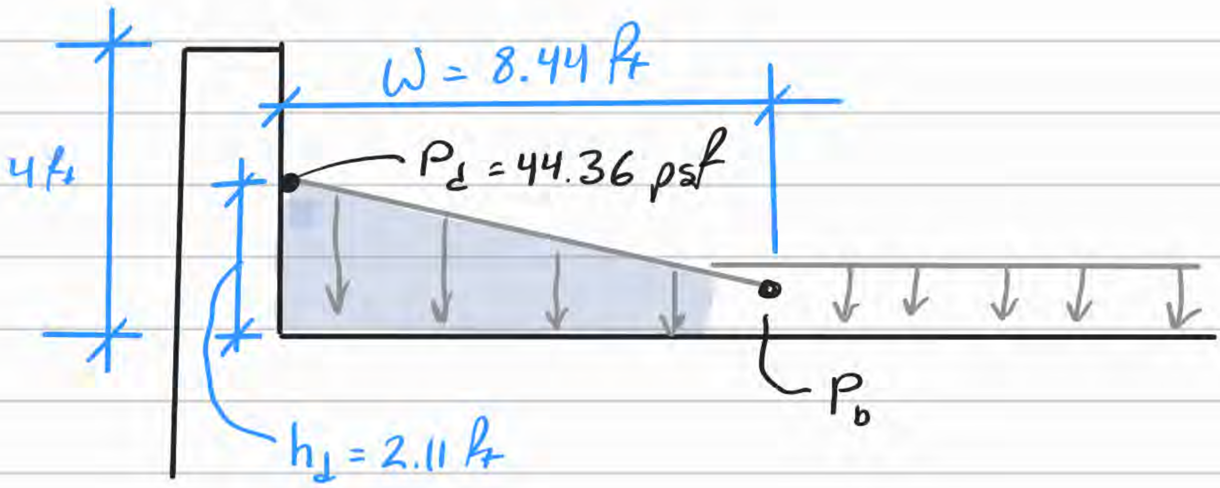
LOAD:

$P_b = \gamma h_b = 16\ pcf\,(0.66\ ft) \longrightarrow P_b = 10.5\ psf$

$P_{min} = P_g$ $\qquad P_{min} = 15\ psf$

$P_d = \gamma h_d = 16\ pcf\,(2.11\ ft) \longrightarrow P_d = 33.76\ psf$

DRIFT LOAD = 44.36 psf

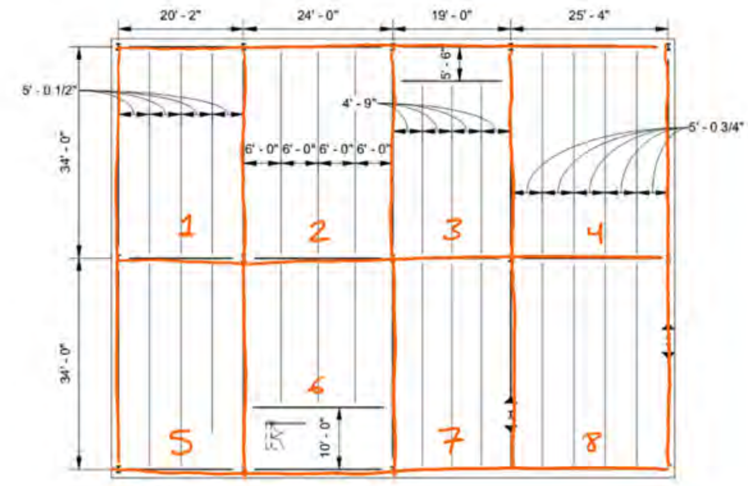


MEMBER DESIGN

- ROOF DECK
- ROOF JOISTS
- COMPOSITE BEAM
- COMPOSITE GIRDER
- CURTAIN WALL - HORIZONTAL WIND GIRT

Roof Deck Calculations

Saturday, February 13, 2021 1:17 PM



1 ROOF
1/16" = 1'-0"

DEAD LOAD: SELF WEIGHT OF DECK + MISC. MEP, ETC
* USE 15 psf

LIVE LOADS: L_r = 20 psf (ASCE 7-16 T.4.3.1)

S = 9.45 psf (SEE DESIGN CRITERIA)

USE: 1.5B GRADE 50 DECK

$\frac{L}{240}$ VALUE FOR TOTAL UNFACTORED LOAD

BAY 1 + 5 (SPAN = 5'-0 1/2")

CHECK 19 GAGE (SELF WEIGHT = 2.3 psf)

D = 2.3 + 15 = 17.3 psf

FACTORED LOADS

1.4D = 1.4(17.3) = 24.2 psf

1.2D + 0.5(L_r OR S) = 1.2(17.3) + 0.5(20) = 30.76 psf

1.2D + 1.6(L_r OR S) = 1.2(17.3) + 1.6(20) = 52.76 psf *

TOTAL UNFACTORED LOAD

2.3 psf + 15 psf + 20 psf + 9.45 psf = 46.75 psf *

D L_r S

19 GAGE, SINGLE SPAN, 5.0425 ft

$\phi W_n \approx$ 315 psf (= 319 psf FOR SPAN = 5 ft)

315 psf >> 52.76 psf ✓ OK

$\frac{L}{240} \approx$ 120 psf (= 125 psf FOR SPAN = 5 ft)

120 psf >> 46.75 psf ✓ OK

CHECK GAGE 22 DECK (SELF WEIGHT = 1.6 psf)

FACTORED: 1.2(16.6 psf) + 1.6(20 psf) = 51.92 psf

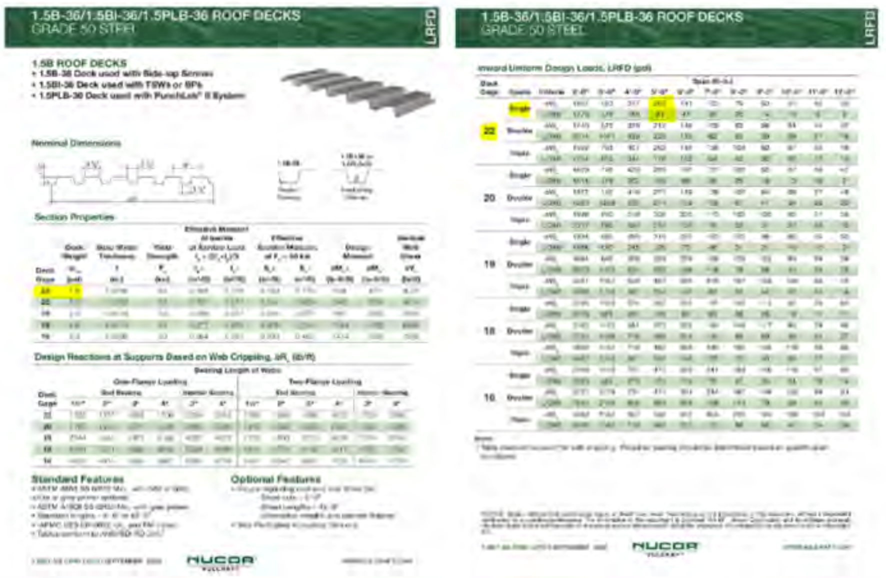
UNFACTORED: 16.6 psf + 20 psf + 9.45 psf = 46.05 psf

$\phi W_n \approx$ 200 psf FOR SINGLE SPAN

200 psf >> 51.92 psf ✓ OK

$\frac{L}{240} \approx$ 80 psf FOR SINGLE SPAN

80 psf >> 46.05 psf ✓ OK



FOR BAY 1 AND 5, USE:

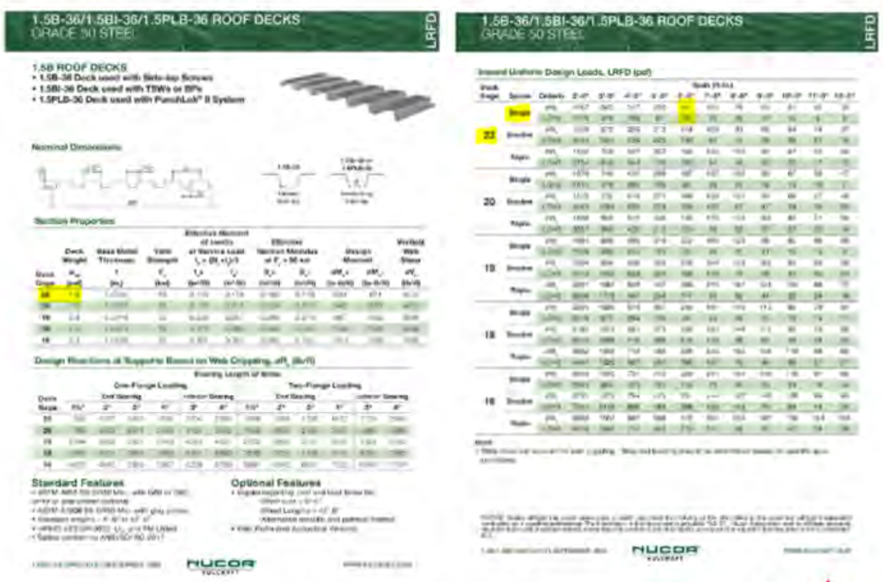
1.5B-36 GRADE 50, SINGLE SPAN, 22 GAGE

BAY 2 + 6 (SPAN = 6'-0")

CHECK 22 GAGE AGAIN:

FACTORED: 1.2(16.6 psf) + 1.6(20 psf) = 51.92 psf

UNFACTORED: 16.6 psf + 20 psf + 9.45 psf = 46.05 psf



ϕW_n = 141 psf → 141 psf >> 51.92 psf ✓ OK

$\frac{L}{240}$ = 47 psf → 47 psf > 46.05 psf ✓ OK

FOR BAY 2 AND 6, USE:

1.5B-36 GRADE 50, SINGLE SPAN, 22 GAGE

BAY 3 + 7 (SPAN = 4'-9")

IF 22 GAGE IS SUFFICIENT FOR 6'-0" SPAN, AND SINCE IT IS THE LIGHTEST GAGE LISTED, IT IS SAFE TO ASSUME THAT 22 GAGE IS SUFFICIENT FOR 4'-9" SPANS.

FOR BAY 3 AND 7, USE:

1.5B-36 GRADE 50, SINGLE SPAN, 22 GAGE

BAY 4 + 8 (SPAN = 5'-0 3/4")

IF 22 GAGE IS SUFFICIENT FOR 6'-0" SPAN, AND SINCE IT IS THE LIGHTEST GAGE LISTED, IT IS SAFE TO ASSUME THAT 22 GAGE IS SUFFICIENT FOR 5'-0 3/4" SPANS.

FOR BAY 4 AND 8, USE:

1.5B-36 GRADE 50, SINGLE SPAN, 22 GAGE

Roof Joist Calculations

Tuesday, February 9, 2021 12:19 PM

ROOF DEAD LOAD:

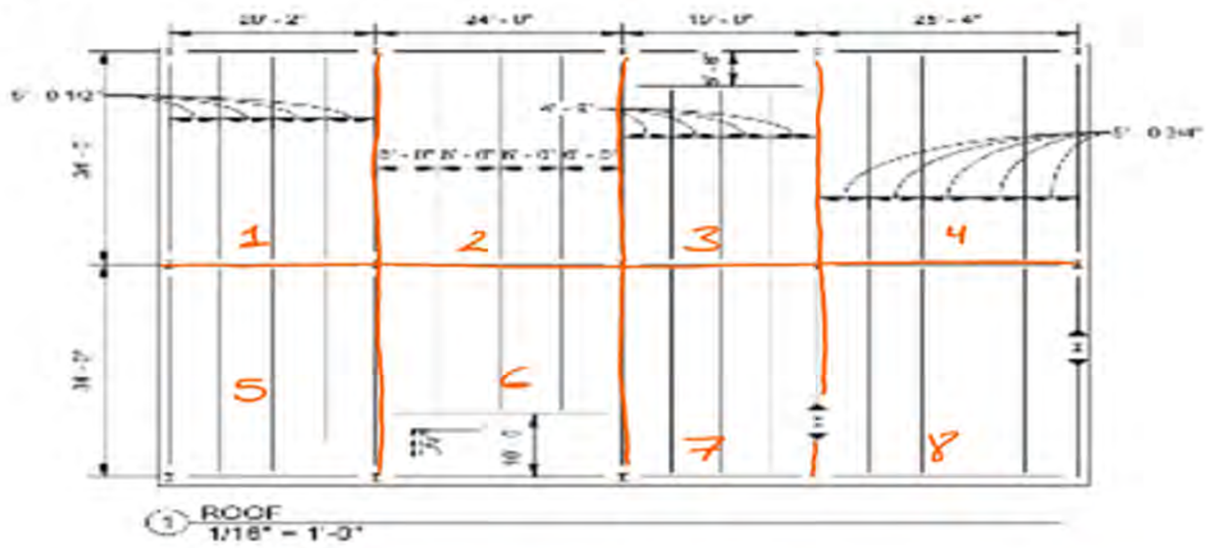
- ASSUME 3.0 psf TO START (PER DESIGN CRITERIA)
- 15 psf (MEP, LIGHTING, ETC)

ROOF LIVE LOAD:

- 20 psf (L_r)
- 9.45 psf (S)

$\frac{L}{360}$ = UNFACTORED LL

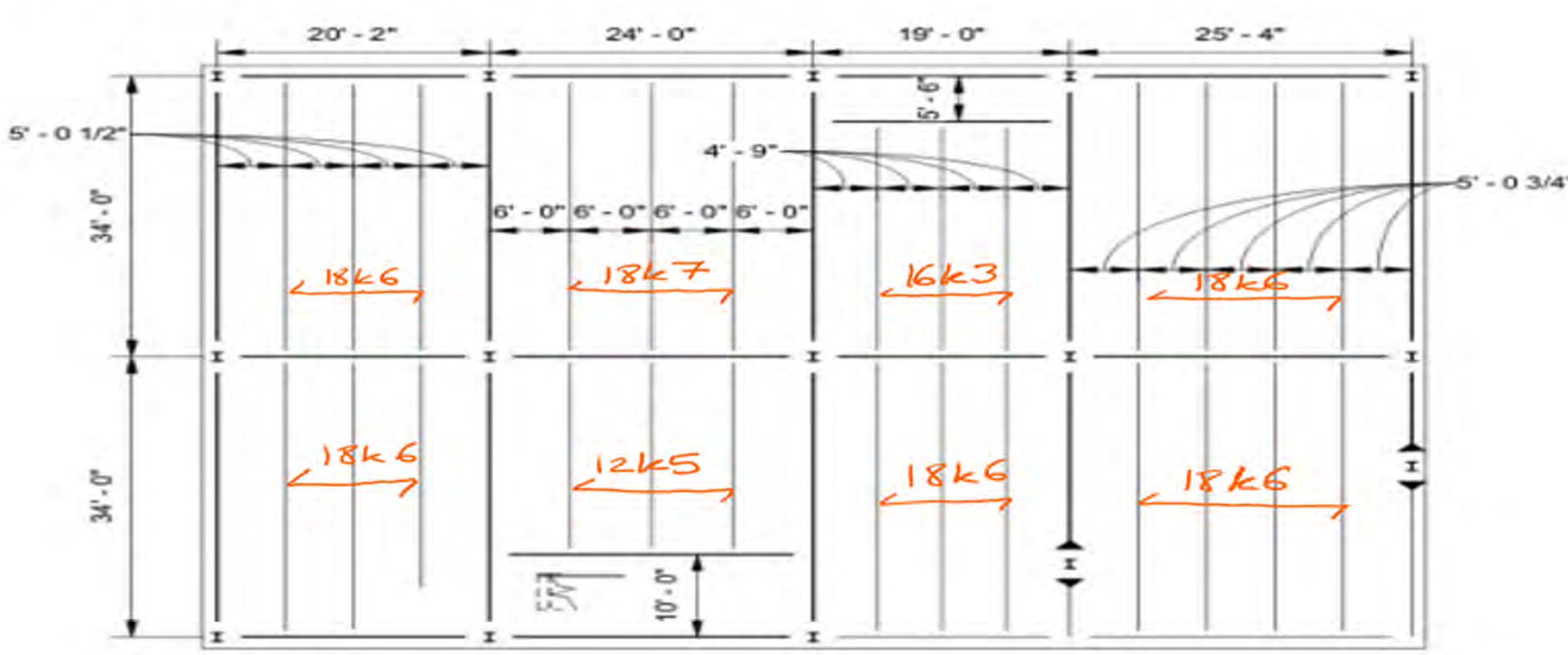
$\frac{L}{240}$ = UNFACTORED TOTAL LOAD



1.5B GRADE 50 FOR ROOF (NOT ACOUSTICAL)

3VLI GRADE 50 FOR FLOOR

CONCLUDED ROOF PLAN:



1 ROOF 1/16" = 1'-0"

BAY 01 + 05

SPAN: 34'-0"
SPACING: 5'-0½"

TRIB WIDTH = 5'-0½" = 5.042 ft

FACTORED LOADS

EQN 16-1 : $1.4[3psf(5.042ft) + 15psf] = 42.2$ plf

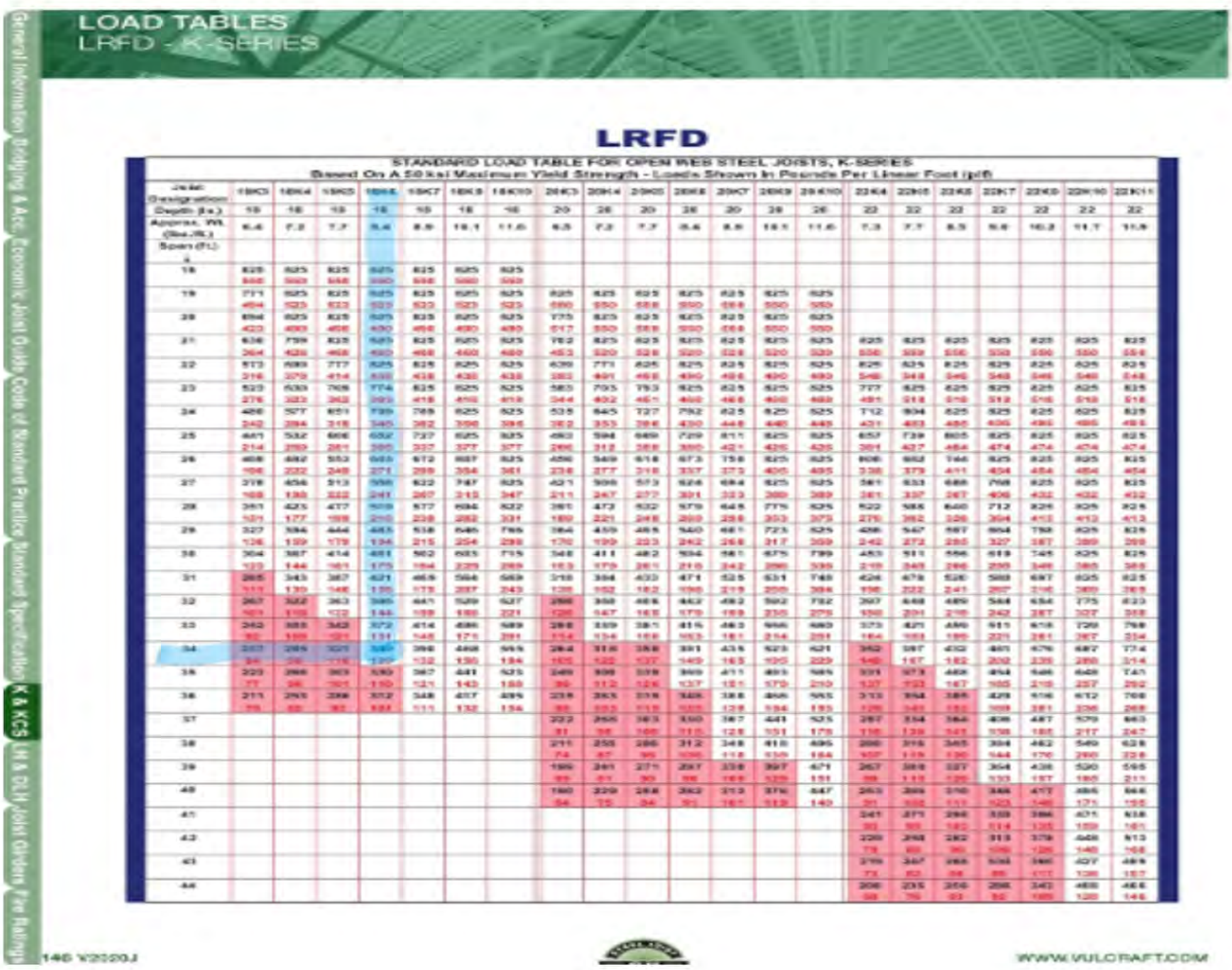
EQN 16-2 : $1.2[3(5.042)+15] + 1.6[0] + 0.5[20psf(5.042ft)] = 90.2$ plf

EQN 16-3 : $1.2[3(5.042)+15] + 1.6[20(5.042)] + 1.6[0] = \boxed{209 \text{ plf}}$

L_r OR S
(GREATER)

W_u = 209 plf

PER VULCRAFT MANUAL:



18k6 WEIGHT = 8.4 lb/ft

↳ CHECK $1.2(8.4) + 1.6[20(5.042)] = 171.4$ plf

18k6: ALLOWABLE FACTORED LOAD = 349 plf

349 plf > 209 plf ✓OK

ALLOWABLE UNFACTORED LOAD = 120 plf

UNFACTORED ROOF LOADS: (SERVICE LIVE)

20psf (5.042 ft) = 100.84 plf

120 plf > 100 plf ✓OK

$\boxed{\text{FOR BAYS 1 AND 5, USE 18k6}}$

BAY 2

SPAN = 34 ft
SPACING = 6'-0"

TRIB WIDTH = 6'-0"

FACTORED LOADS: $1.2(3\text{psf}(6\text{ft})+15) + 1.6(20\text{ psf})(6\text{ft})$

$\longrightarrow W_{u_F} = 231.6$ plf

SEE ABOVE: USE 18K6:

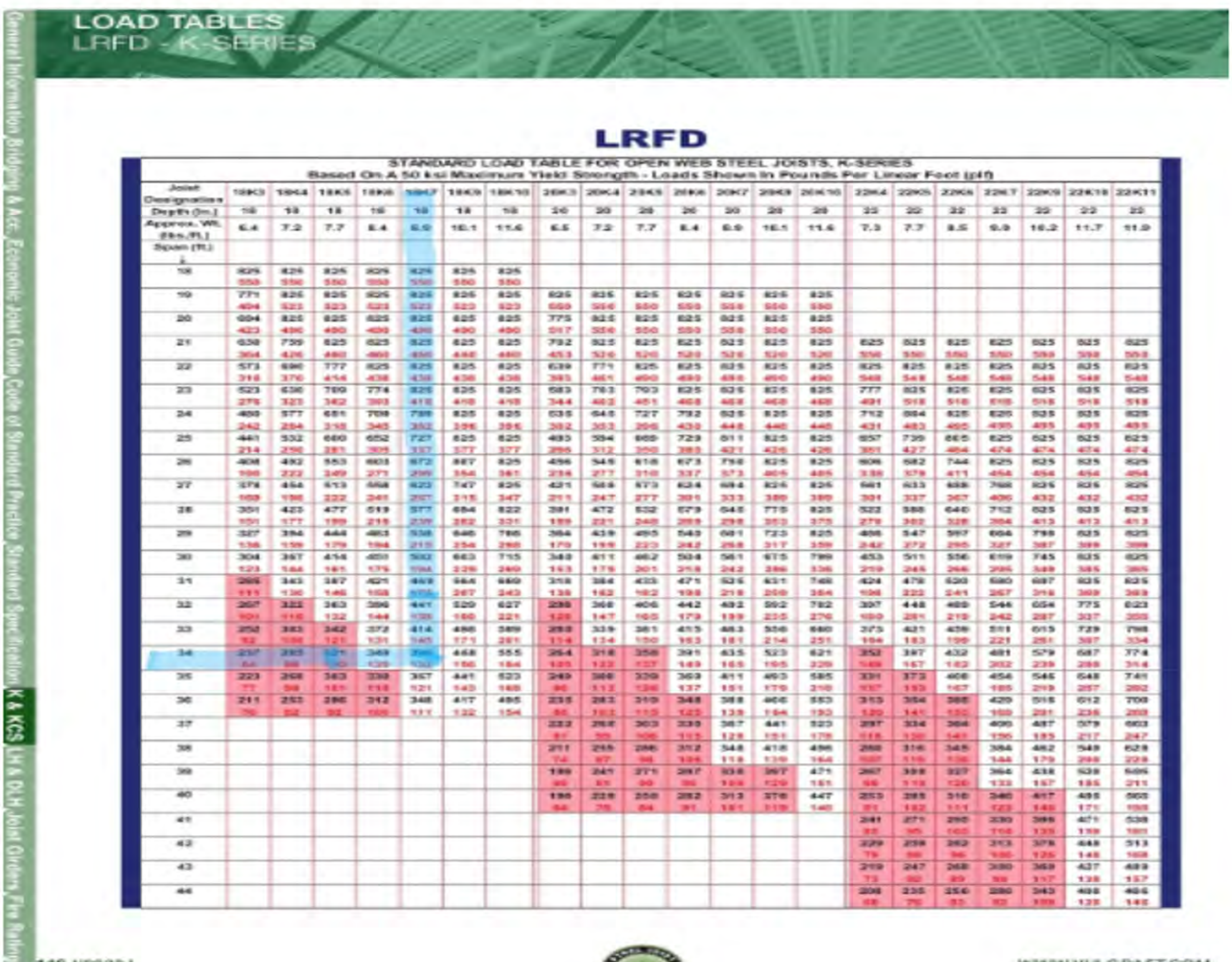
ALLOWABLE FACTORED: 349 plf > 231.6 plf ✓ OK

ALLOWABLE UNFACTORED: 120 plf

20 psf(L_r) × 6 ft = 120 plf

NOT CONSERVATIVE

PER VULCRAFT MANUAL:



18K7: ALLOWABLE FACTORED = 390 plf

390 plf > 236 plf ✓ OK

ALLOWABLE UNFACTORED = 132 plf

132 plf > 120 plf ✓ OK

USE 18K7 FOR BAY 2

BAY 3

SPAN = 34'-0" − 5'-6" = 28'-6"

⟶ DESIGN FOR 29'-0" SPAN (CONSERVATIVE)

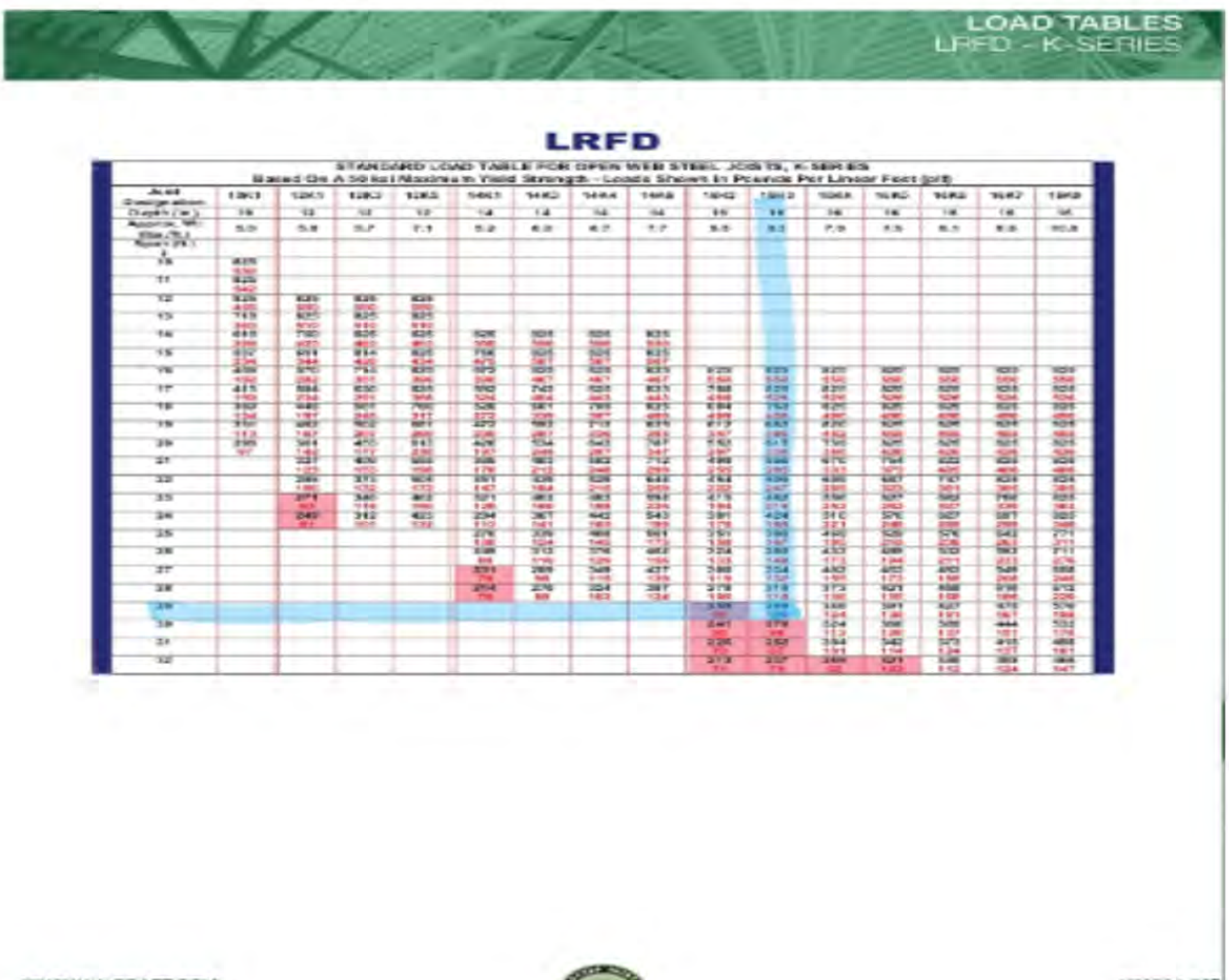
SPACING = 4'-9"   TRIB WIDTH = 4'-9" = 4.75 ft

FACTORED LOADS:

$$1.2((3\,psf)(4.75\,ft)+15)+1.6(20\,psf)(4.75\,ft)$$

$$w_{uF} = 187.1\ plf$$

PER VULCRAFT MANUAL:



16K3: WEIGHT = 6.3 plf $\left(\frac{1}{4.75\,ft}\right)$ = 1.32 psf < 3 psf

ALLOWABLE FACTORED LOAD: 289 plf

289 plf > 187.1 plf ✓ OK

ALLOWABLE UNFACTORED LOAD: 106 plf

20 psf (4.75 ft) = 95 plf

106 plf > 95 plf ✓ OK

$\boxed{\text{FOR BAY 3, USE 16K3}}$

BAY 4 + 8

SPAN = 34'-0"

SPACING = 5' - 3/4"

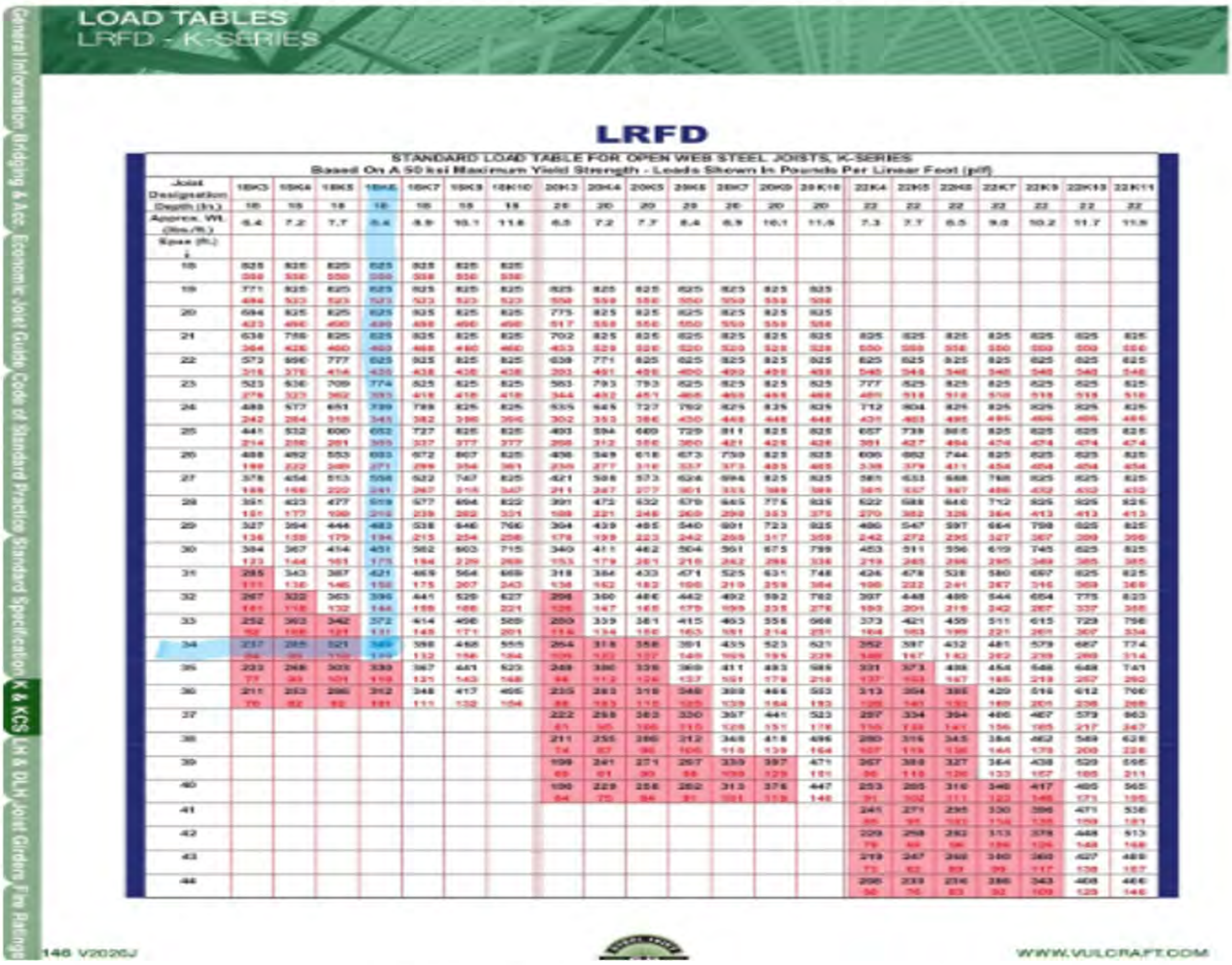
TRIB. WIDTH = 5' - 3/4"

= 5.0625 ft

FACTORED LOAD:

$$1.2((3\,psf)(5.0625\,ft)+15) + 1.6(20\,psf)(5.0625\,ft) = 198.2\,plf$$

PER VULCRAFT MANAL:



18K6: ALLOWABLE FACTORED LOAD: 349 plf

349 plf > 198.2 plf ✓OK

ALLOWABLE UNFACTORED LOAD: 120 plf

$$20\,psf(5.0625\,ft) = 101.25\,plf$$

120 plf > 101.25 plf ✓OK

✓ $\boxed{\text{FOR BAYS 4 AND 8, USE 18K6}}$

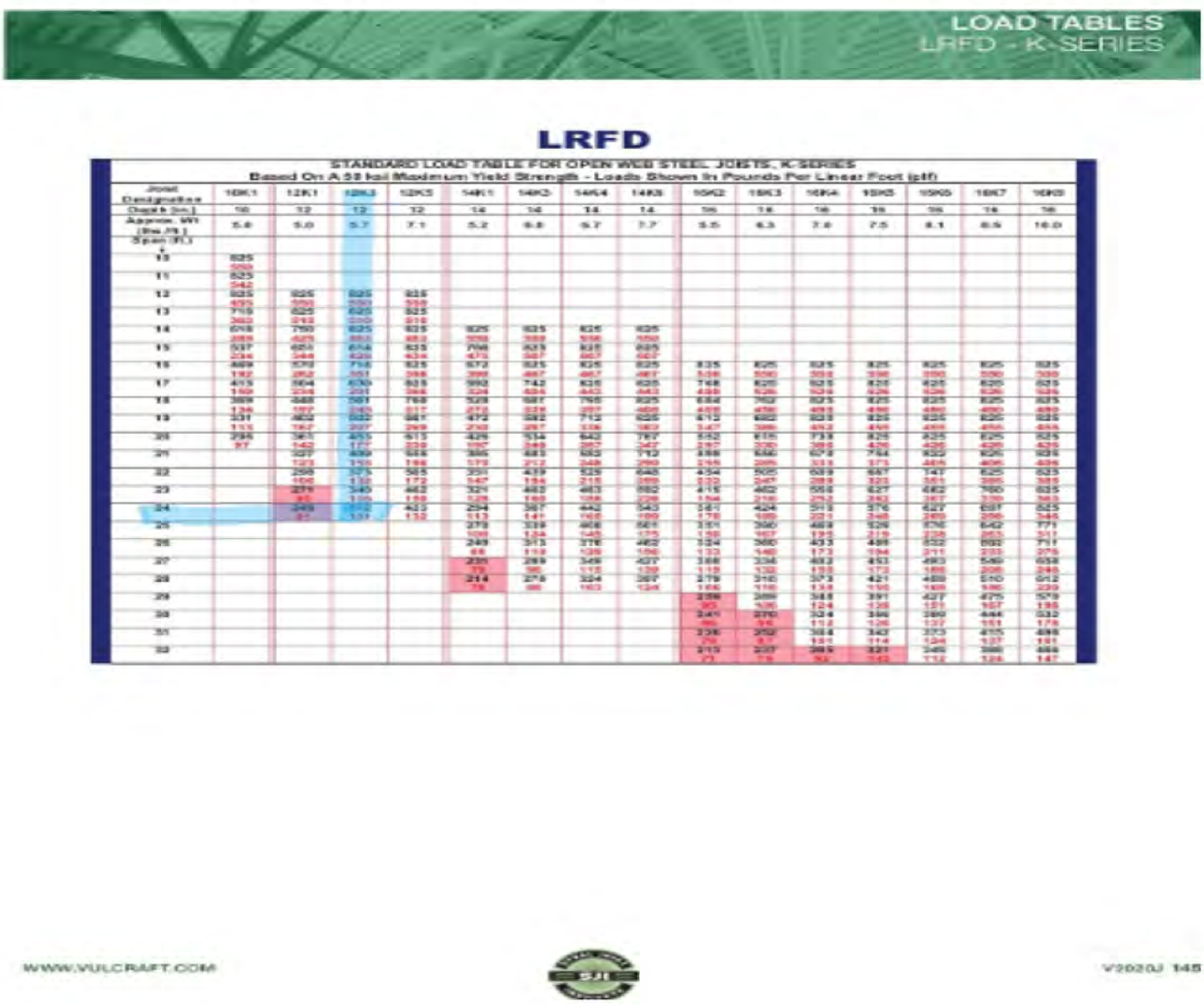
BAY 6

SPAN = 34'-0" − 10'-0" = 24'-0"

SPACING = 6'-0"   TRIB. WIDTH = 6'-0"

FACTORED LOAD: 1.2((3 psf)(6 ft) + 15) + 1.6(20 psf)(6 ft) = 236.1 plf

PER VULCRAFT MANUAL:



12k3: ALLOWABLE FACTORED LOAD:

312 plf > 236.1 plf ✓ OK

ALLOWABLE UNFACTORED LOAD:

20 psf(6 ft) = 120 plf

101 plf ≯ 120 plf ∴ TRY 12k5

12k5: ALLOWABLE FACTORED LOAD:

423 plf > 236.1 ✓ OK

ALLOWABLE UNFACTORED LOAD:

132 plf > 120 plf ✓ OK

$\boxed{\text{FOR BAY 6: USE 12k5}}$

BAY 7

SPAN = 34'-0"

SPACING = 4'-9" TRIB. WIDTH = 4'-9" = 4.75 ft

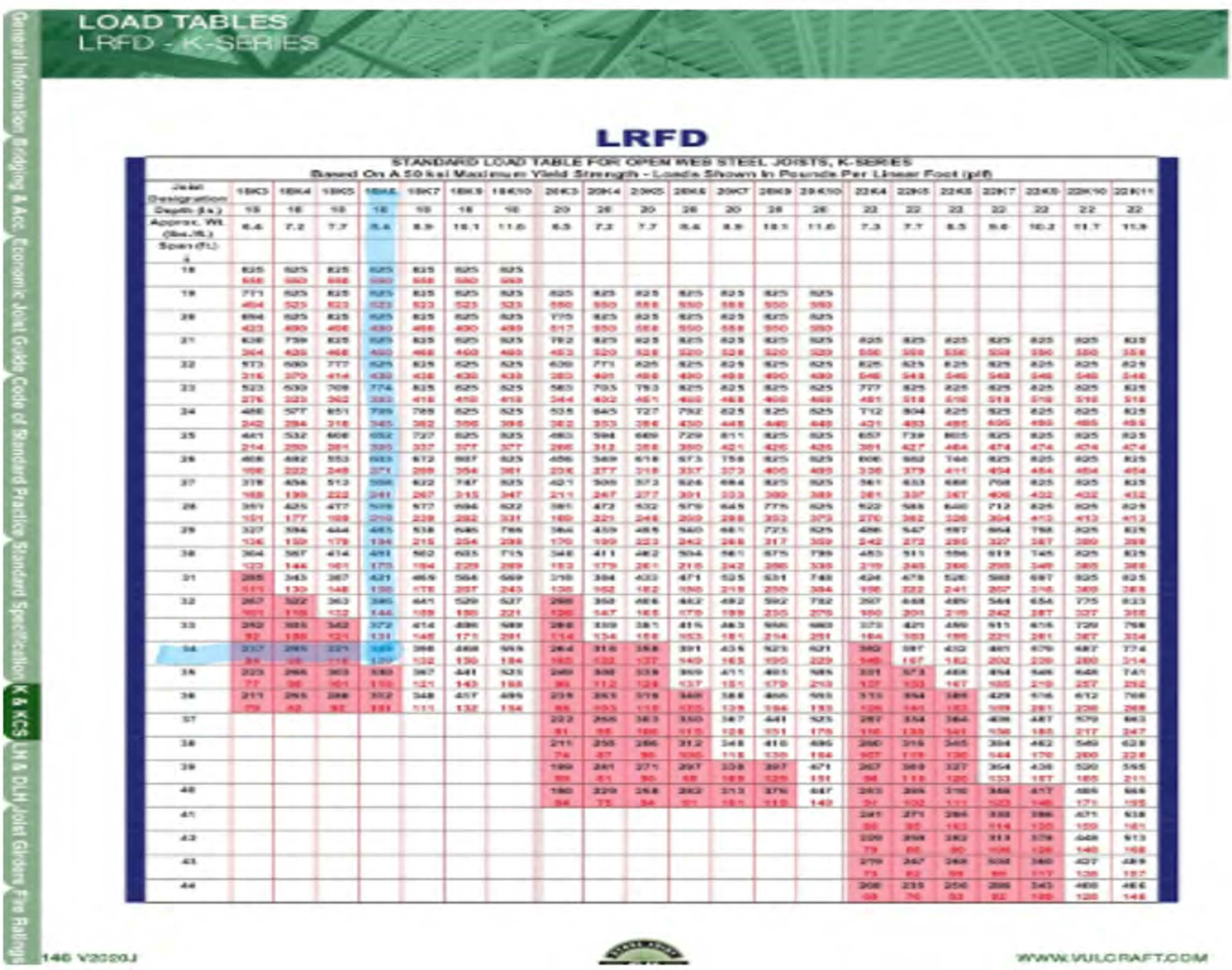
FACTORED LOAD :

$1.2((3\,psf)(4.75\,ft)+15) + 1.6(20\,psf)(4.75\,ft) = 187.1\ plf$

UNFACTORED LOAD :

$20\,psf\,(4.75\,ft) = 95\ plf$

PER VULCRAFT MANUAL :



18 k 6 :

ALLOWABLE FACTORED LOAD :

349 plf > 187.1 plf ✓ OK

ALLOWABLE UNFACTORED LOAD :

120 plf > 95 plf ✓ OK

$\boxed{\text{FOR BAY 7: USE 18 K 6}}$

Beam Location: South Bay (Between Grid 2 and Grid 3) | = Input Required

Span Length: 24 ' - 0 " = 24 ft

Trib Width:	Adjacent		1/2
Left	12 ' - 0 "		6
Right	12 ' - 0 "		6
Total	24 ' - 0 "	=	12 ft

Load Combinations:

1.4D	=	0.96 klf
1.2D+1.6L	=	1.3 klf
wu	=	1.3 klf

Loading Condition: Uniform Distributed

W Shape Selected (Based on Zx)

W14x26

Per AISC Manual:	Zx =	40.2 in^3
	Ix =	245 in^4
	As =	7.69 in^2
	Fy =	50 ksi
	f'c =	4 ksi

Pre-Composite Condition

Dead Load: 57 psf
Live Load: 25 psf

w_d = 0.68400 klf
w_l = 0.30000 klf

P_d= kips
P_l= kips

Moment:

$Mu = \frac{wl^2}{8} = \frac{749.2608}{8} = 93.66$ k-ft

ΦMn = ΦFyZx

$Zx = \frac{Mu}{\Phi fy} = \frac{1123.8912}{0.9(50\ ksi)} = 24.98\ in^3$

Deflection: Limit = $\frac{l}{360}$ = 0.8000

$\Delta_{max} = \frac{5wl^4}{384EI} = \frac{1960716534}{2728320000} = 0.719$ in OK

Camber:

Camber = 80% of Δ_{max} = FALSE = 0 in

Pre-Composite Result: Use W14x26 Cambered 0 in

Composite Condition

Dead Load: 75 psf
Live Load: 75 psf
psf

w_d = 0.9 klf
w_l = 0.9 klf

P_d= kips
P_l= kips

Load Combinations:

1.4D	=	1.26 klf
1.2D+1.6L	=	2.52 klf
wu	=	2.52 klf

Moment:

$Mu = \frac{wl^2}{8} = \frac{1451.52}{8} = 181.440$ k-ft

Effective Flange Width (b_e) (in):

Lesser of:			
	1/8 Beam Span	=	36 in
	1/2 Dist. To Adjacent Beam	=	144 in
	Dist. To Slab Edge	=	in
	x2	=	72 in

Determine Location of PNA (a): Assume 75% Composite Action

Prelim. a: $a = \frac{0.75AsFy}{0.85f'_c b_e} = \frac{288.375}{244.8} = 1.178$

$Y_2 = Ycon - \frac{a}{2} = 6.9110$ -> 6.5

Mu = 181.440 ΦMn = 234 at Position 7

ΣQ at 7 = 96.1

Actual a: $a = \frac{\Sigma Q}{0.85f'_c b_e} = \frac{96.1}{244.8} = 0.393$

Prelim a > Actual a? YES OK

I_{LB} = 523 in^4 (T. 3-20)

Deflection: Limit = $\frac{l}{360}$ = 0.8000

$\Delta_{max} = \frac{5wl^4}{384EI} = \frac{2579890176}{5824128000} = 0.443$ in OK

Composite Result: Use W14x26 Cambered 0 in

Girder Location: **Grid A Offset 9' (Between Grid 2 and Grid 3)** = Input Required

Girder Span: 24 ' - 0 " = 24 ft
Largest Beam(s) Framing Into Girder: W 14 x 26

S. Beam Span:	0 ' - 0 "	=	0	ft	Self Weight of Beam:	0.31	kips
N. Beam Span:	24 ' - 0 "	=	24	ft	Factored Beam Loads:	7.8	kips
						15.1	kips

Beam(s) Spacing:		**Trib Width:**	
12 ' - 0 "		6	
Total	12 ' - 0 "	= 6	ft

Point Load Per Beam:

8.12 kips	PreComp
15.4 kips	Composite

Load Combinations:		Pre-Comp		Composite
1.4D	=	0.479 klf	=	0.63 klf
1.2D+1.6L	=	0.65 klf	=	1.26 klf
wu	=	**0.65 klf**	=	**1.26 klf**

Select From Drop-Down
Loading Condition: 1/2 Span Point Load ft
= 1 Beams Framing into Girder = #### in

W Shape Selected (Based on Zx)

W16x26

Per AISC Manual:	Zx =	44.2	in^3
	Ix =	301	in^4
	As =	7.68	in^2
	Fy =	50	ksi
	f'c =	4	ksi

Pre-Composite Condition

Dead Load: 57 psf
Live Load: 25 psf

w_d = 0.342 klf
w_l = 0.15 klf

Moment:

$$Mu = \frac{Pl}{4} = \frac{194.803}{4} = \mathbf{48.701} \text{ k-ft}$$

$$\Phi Mn = \Phi FyZx = 584.41 \text{ k-in}$$

$$Zx = \frac{Mu}{\Phi fy} = \frac{584.410}{0.9(50\ ksi)} = 12.987 \ in^3$$

Deflection:

$$\text{Limit} = \frac{l}{360} = 0.8000$$

$$\Delta_{max} = \frac{Pl\text{^}3}{48EI} = \frac{193893079}{418992000} = \mathbf{0.4628} \text{ in}$$

OK

Camber:

Camber = 80% of Δ_{max} = FALSE = 0 in

Pre-Composite Result:	Use	W16x26	Cambered	0	in

Composite Condition

Dead Load: 75 psf
Live Load: 75 psf

w_d = 0.45 klf
w_l = 0.45 klf

Moment:

$$Mu = \frac{Pl}{4} = \frac{370.368}{4} = \mathbf{92.592} \text{ k-ft}$$

Effective Flange Width (b_e) (in):

Lesser of:				
	1/8 Girder Span	=	36	in
	1/2 Dist. To Adjacent Girder	=	288	in
	Dist. To Slab Edge	=		in
	x2	=	72	in

Determine Location of PNA (a): Assume 75% Composite Action

Prelim. a: $a = \frac{0.75AsFy}{0.85f'_c b_e} = \frac{288}{244.8} = 1.176$

$Y_2 = Ycon - \frac{a}{2} = 5.9118 \rightarrow 5.5$

Mu = 92.592 ΦMn = 248 at Position 7

ΣQ at 7 = 96

Actual a: $a = \frac{\Sigma Q}{0.85f'_c b_e} = \frac{96}{244.8} = 0.392$

Prelim a > Actual a? YES OK

I_{LB} = 575 in^4 (T. 3-20)

Deflection:

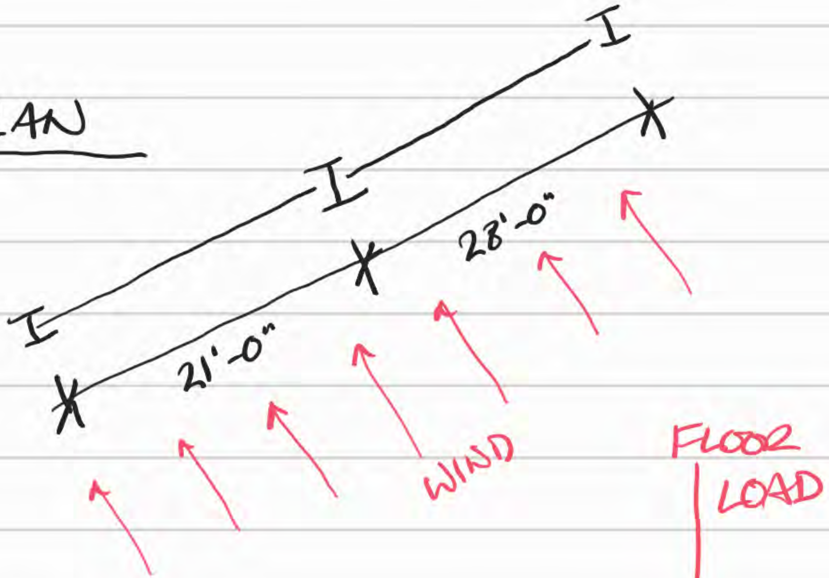
$$\text{Limit} = \frac{l}{360} = 0.8000$$

$$\Delta_{max} = \frac{Pl\text{^}3}{48EI} = \frac{193893079}{800400000} = \mathbf{0.2422452} \text{ in}$$

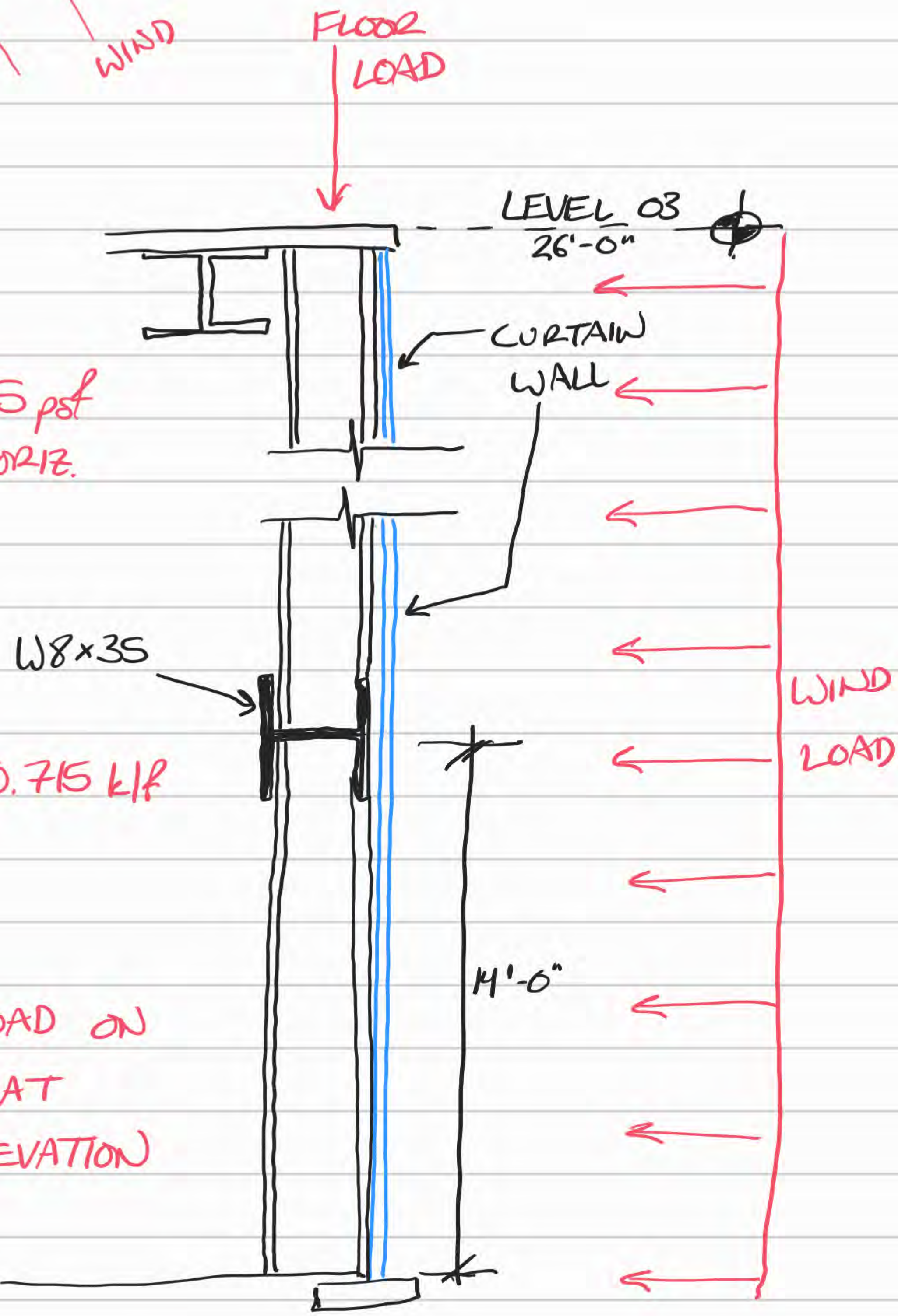
OK

Composite Result:	**Use**	**W16x26**	**Cambered**	**0**	**in**

PLAN



SECTION



WIND LOAD = 55 psf
ON W8×35 HORIZ.
BEAM

↓

$55\,psf\left(\frac{7ft}{}+\frac{6ft}{}\right)$
(VERTICAL) = 0.715 klf

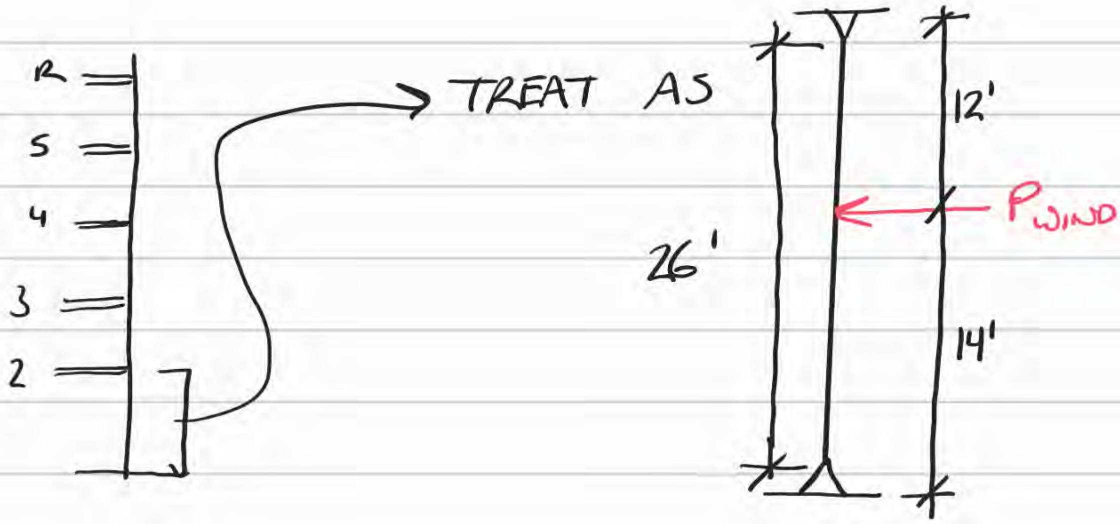
$0.715\left(\frac{28}{2}+\frac{21}{2}\right)$

→ POINT LOAD ON
COLUMN AT
14'-0" ELEVATION

↓

$P_{WIND} = 17.5^{k}$

→ REACTION FROM W8×35 BEAMS



$$M_{WIND} = \frac{Pab}{2} = \frac{17.5^{k}(14')(12')}{2} \longrightarrow \boxed{M_{WIND} = 113.1\ k\cdot ft}$$

COMBINED AXIAL LOAD

RISA FLOOR: $\rightarrow$ $P_u = 420$ kips FOR COLUMN AA-4

AISC CHAPTER H : COMBINED FORCES DESIGN

EQN H1-1A : $\underbrace{\overset{P_{WIND}}{\frac{P_r}{P_c}}}_{0.4} + \underbrace{\frac{8}{9}\left(\overset{M_{WIND}}{\frac{M_{rx}}{M_{cx}}}}_{0.6} + \overset{0 \text{ NO WEAK AXIS LOAD}}{\cancel{\frac{M_{ry}}{M_{cy}}}}\right) \leq 1.0$ IDEAL RATIO

$P_r = P_u$

$P_c = \phi P_n$

$$\frac{8}{9}\frac{M_u}{\phi M_n} = 0.6 \longrightarrow \phi M_n = \frac{8}{9}\left(\frac{113.1}{0.6}\right) = \longrightarrow \phi M_n = 167.56\ k\cdot ft$$

$\rightarrow$ SPAGHETTI TABLES! (T3-10)

$L_b = 26'\text{-}0"$ $\rightarrow$ TRY W12x53

$\phi M_n = 196$ k·ft @ $L_b = 26$ ft FOR W12×53

W12×53 ϕP_n IN AISC T. 4-1

$\underline{L_{bx} = 26 \text{ ft}}$ $\underline{L_{by} = 14 \text{ ft}}$

$L_b =$ LARGER OF L_{by} AND $L_{by\,EQ}$

$\hookrightarrow L_{by\,EQ} = \dfrac{L_{bx}}{r_x/r_y}$

$L_{by} = 14$ ft

$L_{by\,EQ} = \dfrac{26 \text{ ft}}{2.11} = 12.32$

USE $L_b = 14$ ft

PER TABLE 4-1 (W12X53)

$L_b = 14 \text{ ft} \longrightarrow \phi P_n = 502$ kips

$\dfrac{P_r}{P_c} = \dfrac{420}{502} = 0.8367 > 0.2$

$\hookrightarrow 0.8367 + \frac{8}{9}\left(\dfrac{113.1}{167.56}\right) \leq 1.0$

LONG STORY SHORT... IT'S NOT ≤ 1.0

TRY NEXT LARGEST SIZE FOR ϕM_n

$\hookrightarrow$ TRY W12×58

$\phi M_n = 226 \text{ k}\cdot\text{ft}$ $L_b = 14 \text{ ft}$ STILL

$\phi P_n = 551 \text{ kip}$

$$\frac{420^k}{551^k} = 0.762 > 0.2 \longrightarrow 0.762 + \frac{8}{9}\left(\frac{113.1}{226}\right)$$

$$= 1.2 \nleq 1.0$$

TRY A LARGER SIZE!!

RISA FLOOR

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ARCH 3224 Spring 2021

Model Narrative – RISA Floor

In the beginning of the design process for the National Corvette Museum, it was determined by both the Architect and the structural design team that the preferred building structural system would utilize hot-rolled steel members arrayed in a uniform grid fashion. Because of the overall building dimensions, this design goal could best be accomplished by employing a composite concrete slab system for all elevated floors not including the roof. While RISA 3D offers many advantages for structural design and analysis, it is not yet capable of performing such functions for a composite slab system. Because of this, RISA Floor was chosen as the primary tool for gravity load design.

First, the column grid was laid out as constrained by the Architect's schematic floor plans. Once the grids were accurately modeled, column stacks were placed at all appropriate intersections that extended from the ground level to the roof. Care was taken to avoid placing a column within the open-air atrium of the Ground Floor Lobby space that extended to Floor 03. Since Floors 03-05 were typical in layout, the beams and girders that were drawn into Floor 03 on the RISA model could be copied and pasted in the same location at the respective elevations of Floors 04 and 05 once the accuracy of their placement was verified. For the roof, the design team agreed to model K Series joists spaced within a 4 ft. – 6 ft. range between hot-rolled steel members along grid lines to meet real-world insurance stipulations.

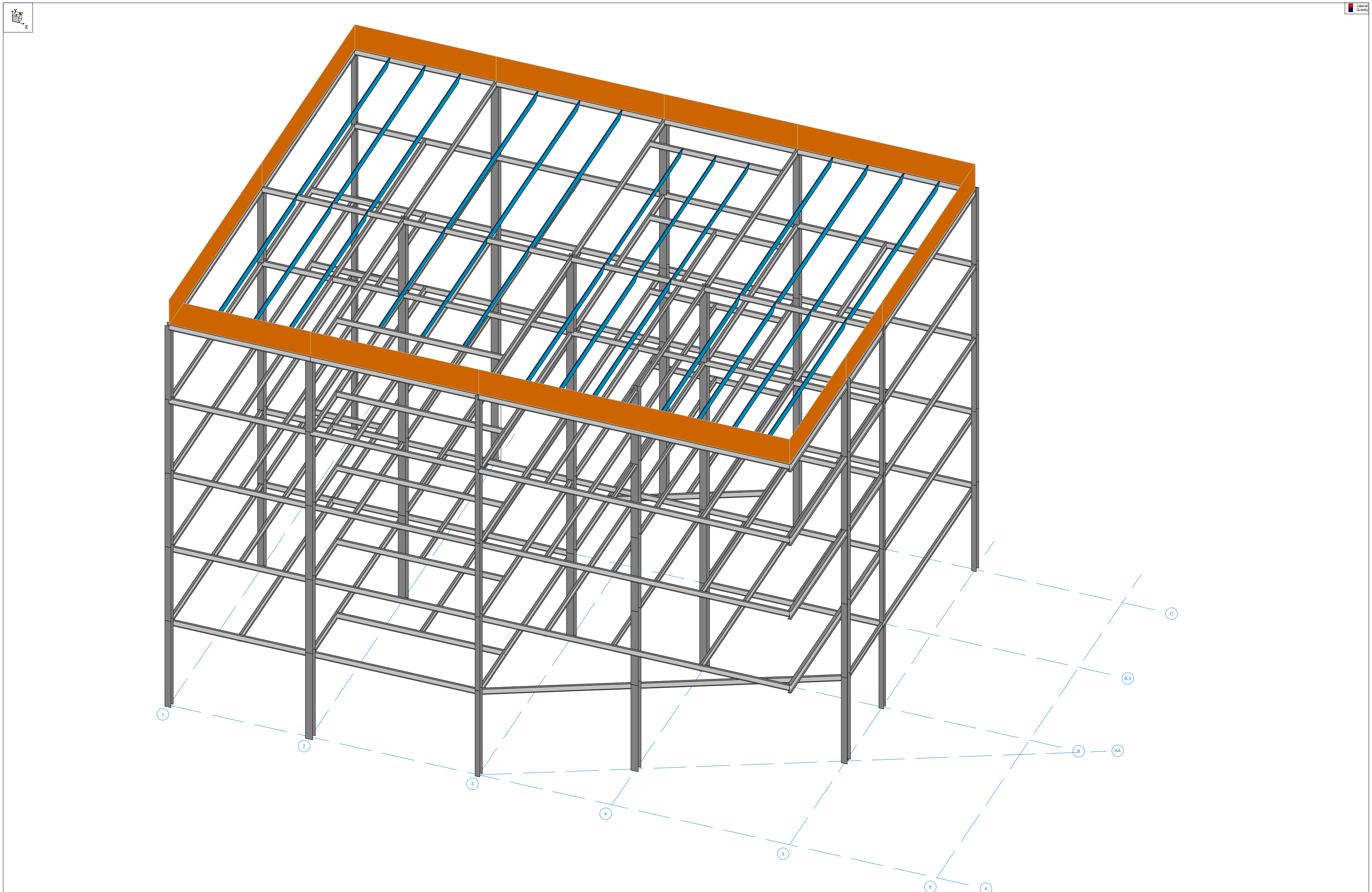
In order to accurately model the building structure for later lateral load analysis, the diaphragms were drawn according to the Architect's schematic drawings to include openings for proposed stairs and elevators. For Floors 02–05, the deck within the diaphragm boundaries was designated as Composite. For the roof, the Metal Deck option was selected. Both of these options were assigned their respective properties in the Deck Definitions spreadsheet. Once the openings are placed in RISA Floor, any diaphragms translated to RISA 3D will automatically contain centers of mass and rigidity along with industry standard eccentricities. While this does not directly impact the gravity load design, it is important for properly generating reference points for lateral load applications in future models.

After all beams, girders, and diaphragms with appropriate deck designations were accurately placed in the model with verified connections and spacing, the first and second eastern-most bays of the North and South perimeter lines were designated for Lateral Design via the Design Properties menu in anticipation of their analysis as moment frames along with the southern-most bay of the West perimeter line and the northern-most bay of the East perimeter line for analysis as braced frames. These analyses would occur later in RISA 3D.

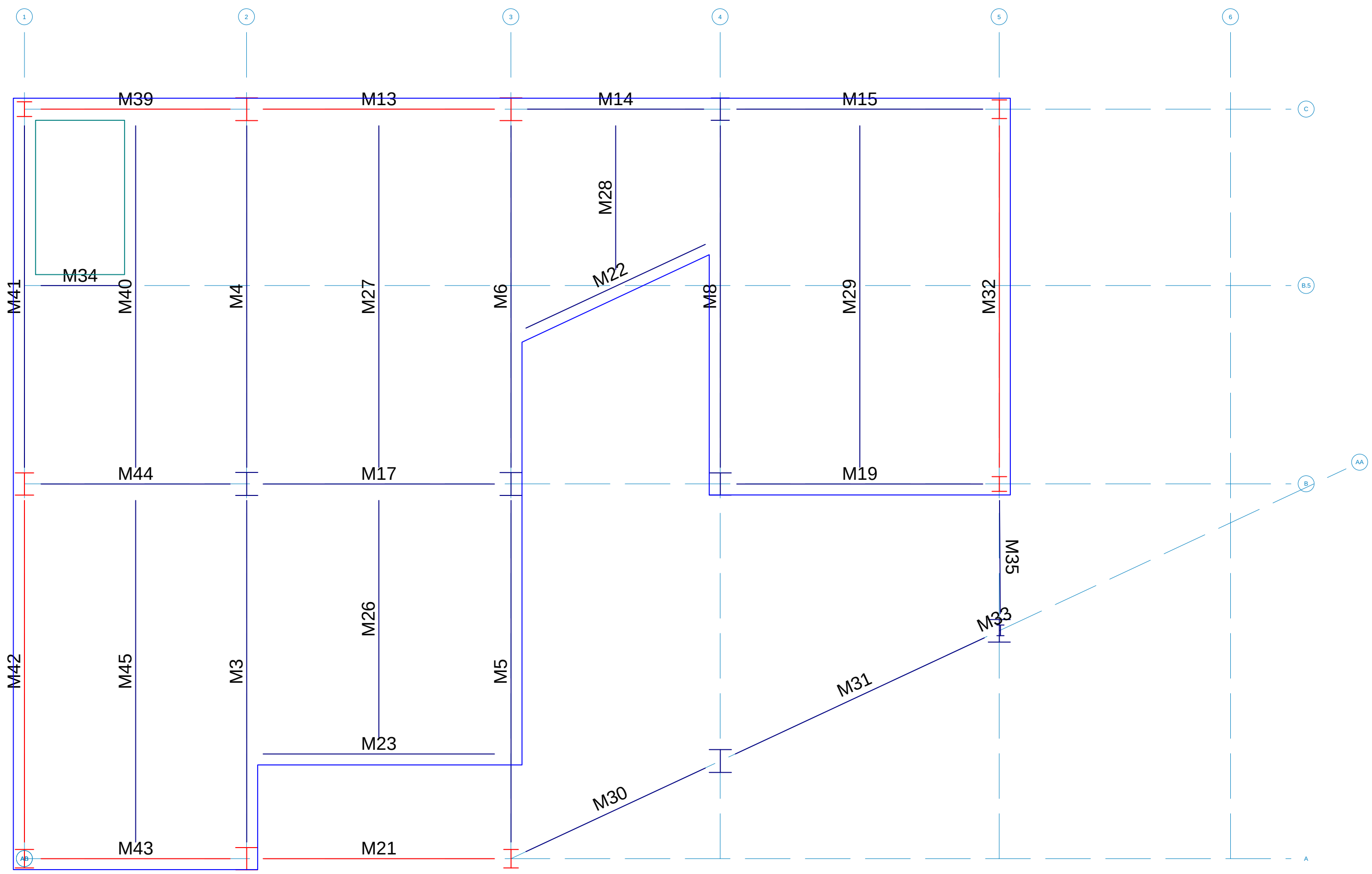
While it is vital to properly model a building's structural geometry in both RISA Floor and RISA 3D (or other synonymous design software), the model is useless without applied loads. Because structural steel is primarily designed according to LRFD (Load and Resistance Factor Design) procedures, the determined load cases would have to be applied in a series of factored combinations as well as the base "service" conditions in order to optimize the overall frame design. The load cases themselves were obtained from ASCE 7-16 in accordance with the Architect's intended occupancy usages for live loads and the dead loads other than the weight of the structure were decided using trade standards and common assumptions.

RISA Floor allows for the application of dead and live loads as areas of effect on a model, so the varying loads were applied on a floor-by-floor bases to accurately depict the loading conditions of the constructed, occupied structure. In order to simulate the dead load of the building façade (components and cladding), a line load was applied to all perimeter girders and beams on Floors 02-05 as well as the Roof.

Finally, once the structure's geometry and loads were accurately modeled with appropriate gravity load combinations in effect, the RISA Floor "Solve" function could be utilized. If all conditions and geometry are modeled correctly, the software will generate a series of load reactions and forces that are then run through a simulated library of hot-rolled steel section choices until an optimal member size is suggested for every individual beam, girder, and column in the model. Small errors in modeling and/or load application would result in errors caused by model instabilities. If/when all model errors are remedied, the final model results can be used to designate member sizes in Construction Documents for the project that are generated in a separate software.

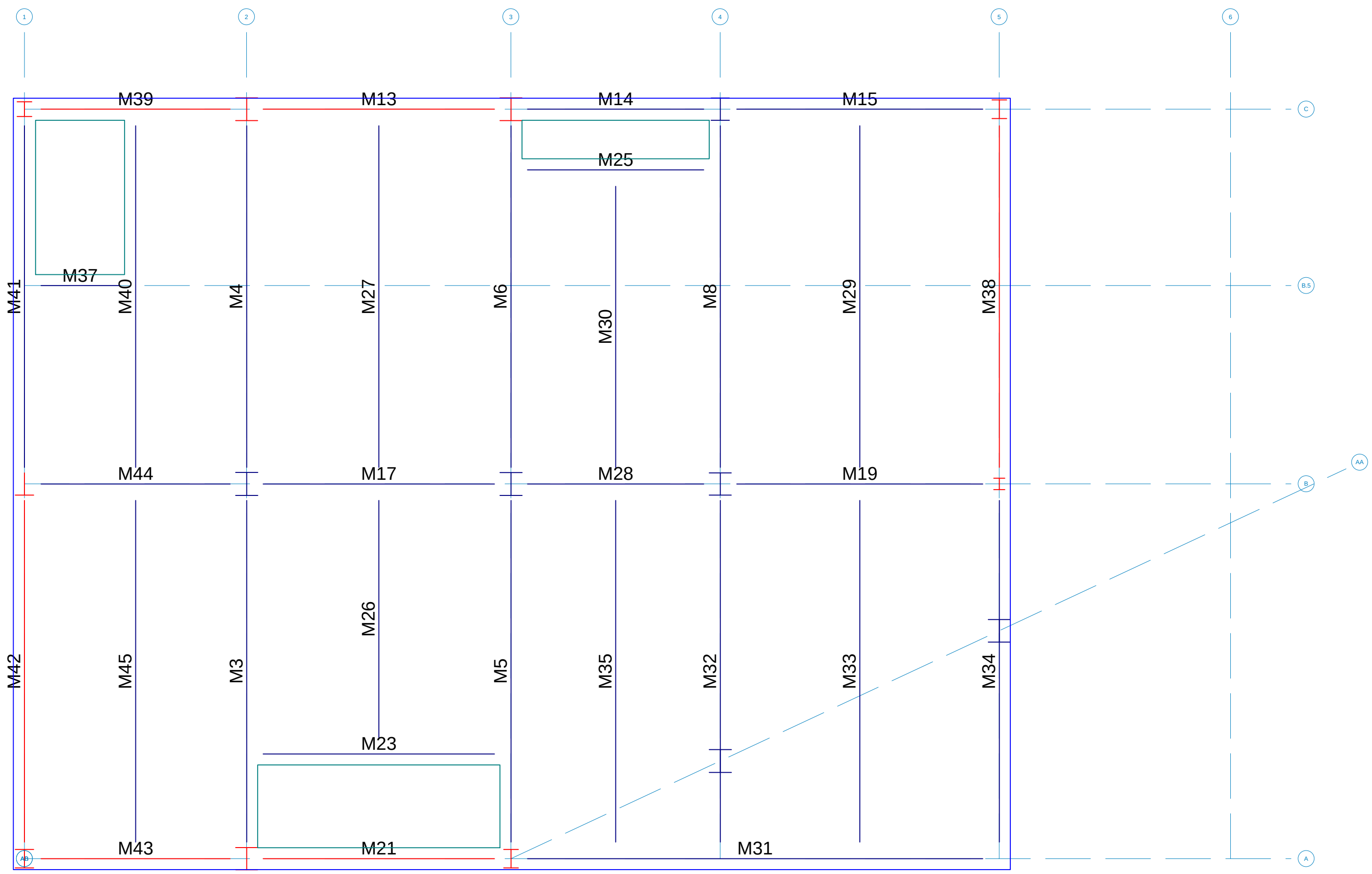


Full Model Axonometric View



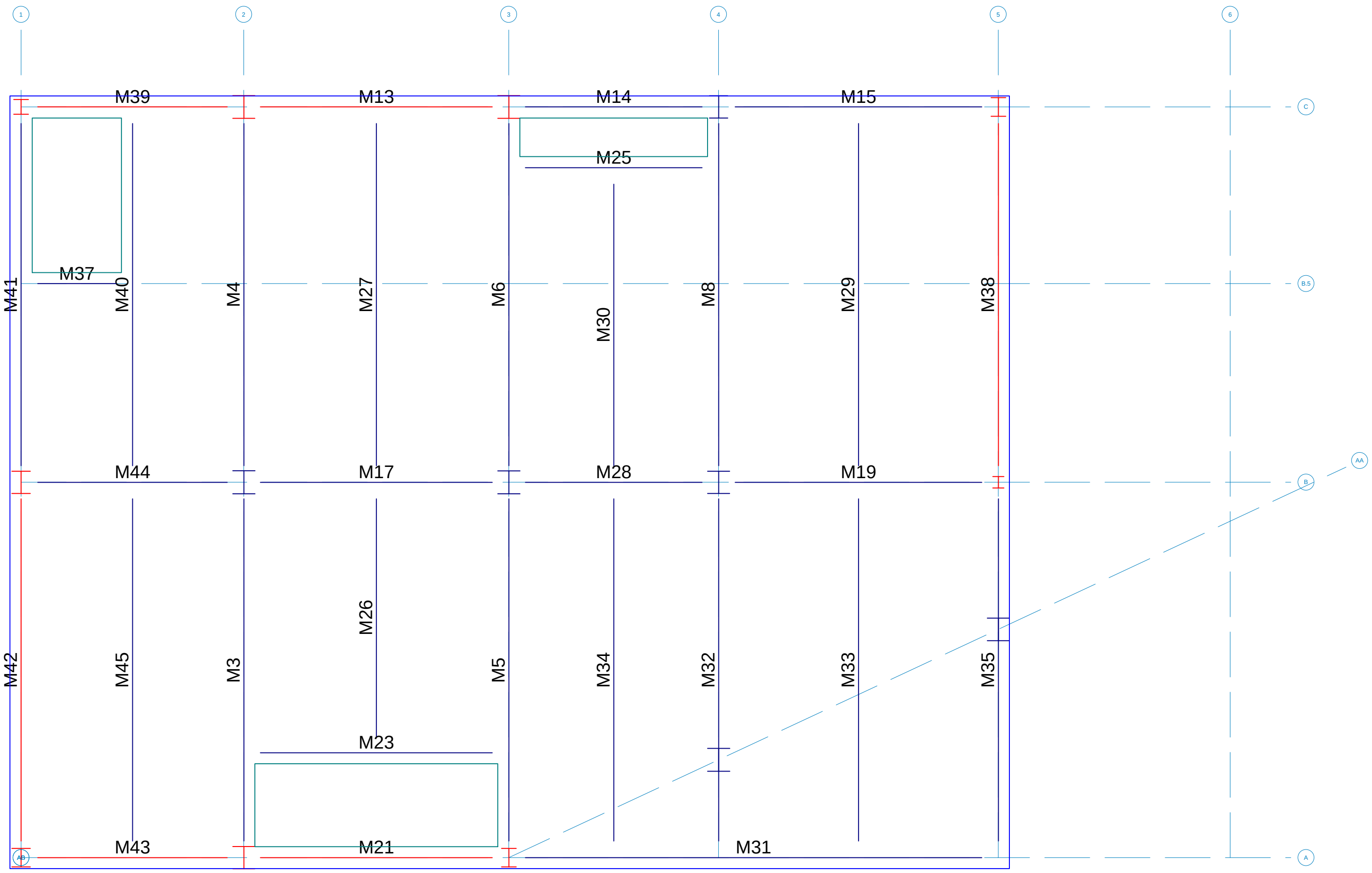
Loads: DL PreComp - PreComposite Dead Load
Results for LC 1, Service Dead

Floor 2



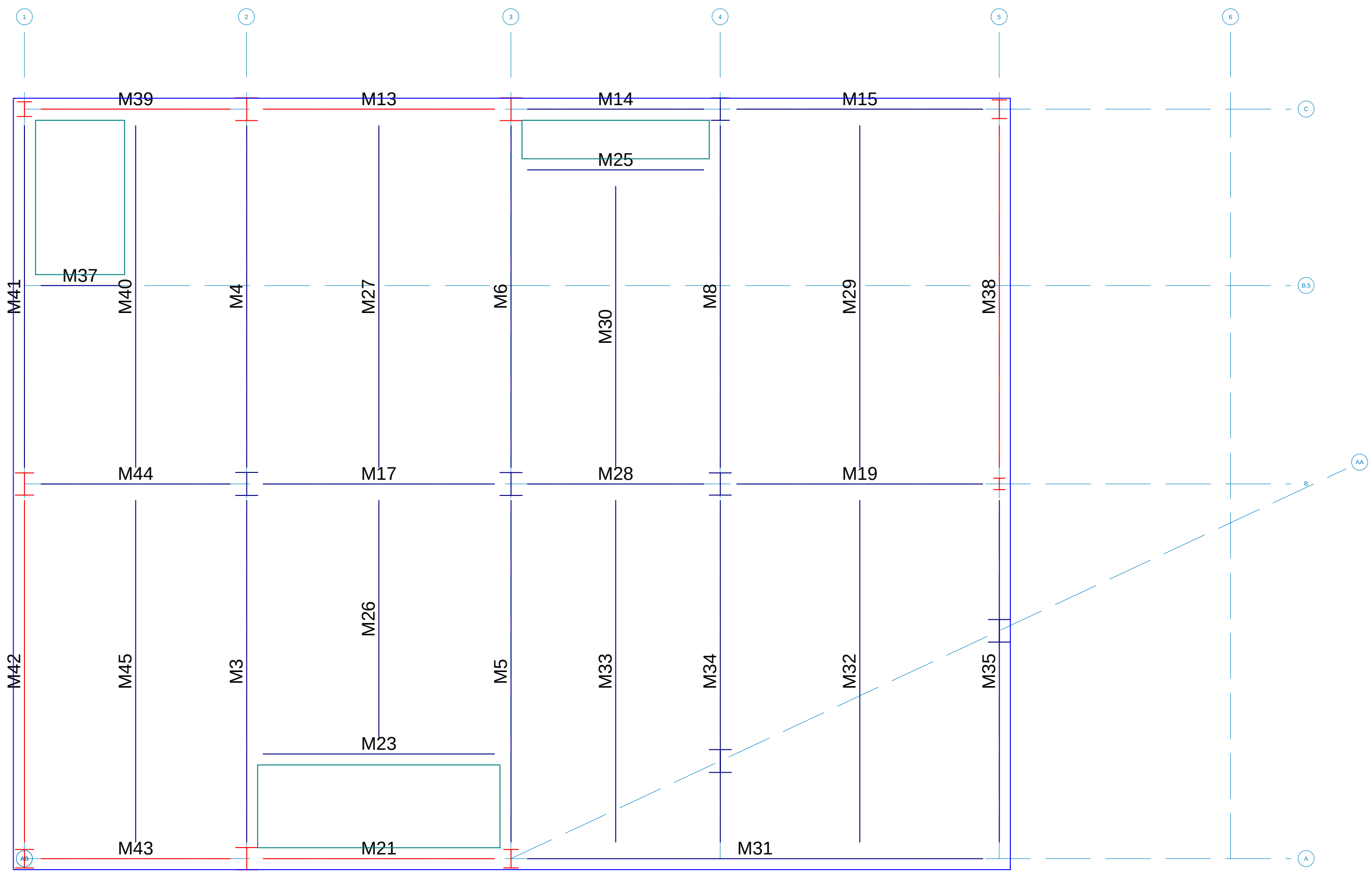
Loads: DL PreComp - PreComposite Dead Load
Results for LC 1, Service Dead

	Floor 3	



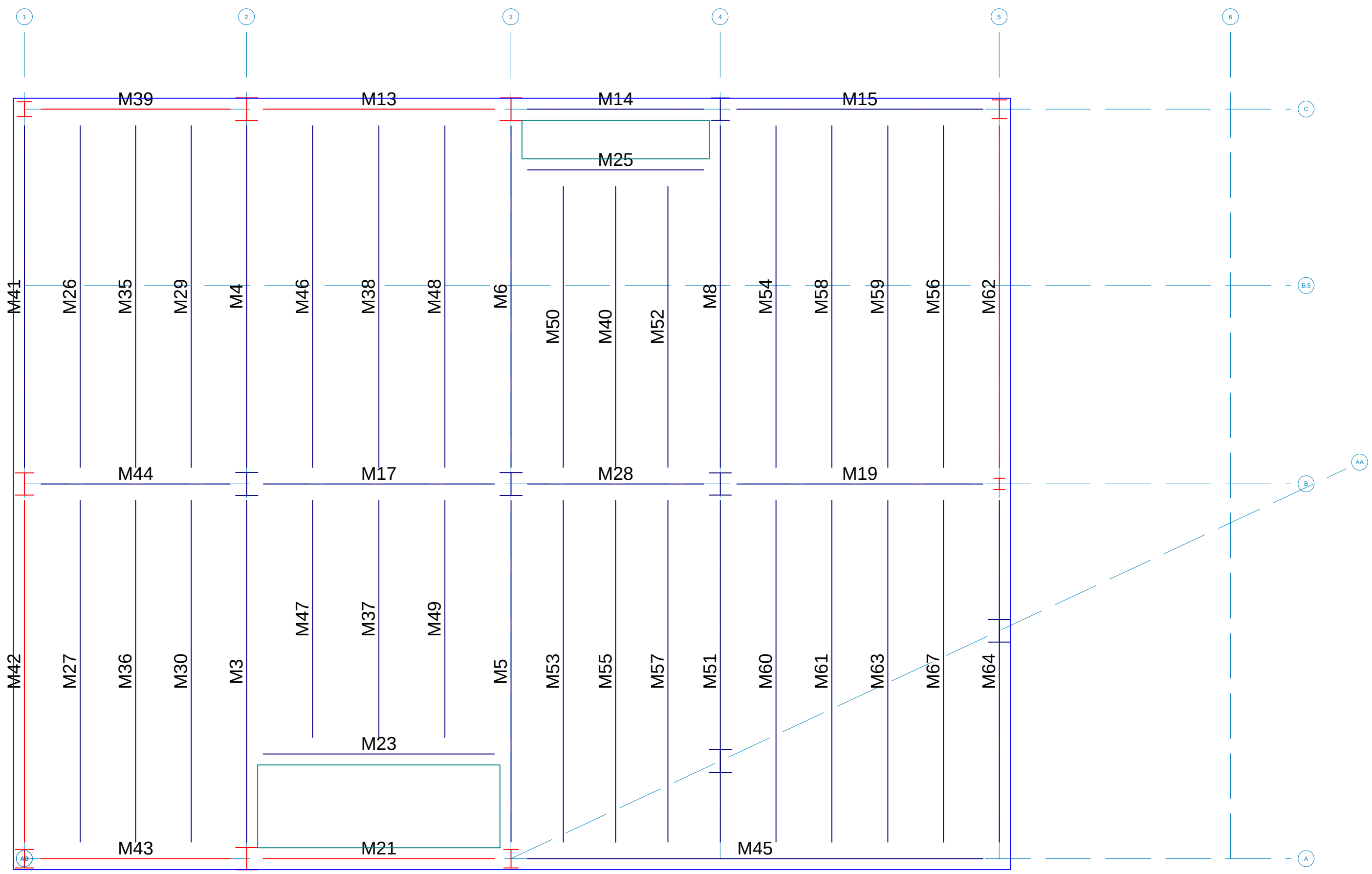
Loads: DL PreComp - PreComposite Dead Load
Results for LC 1, Service Dead

Floor 4



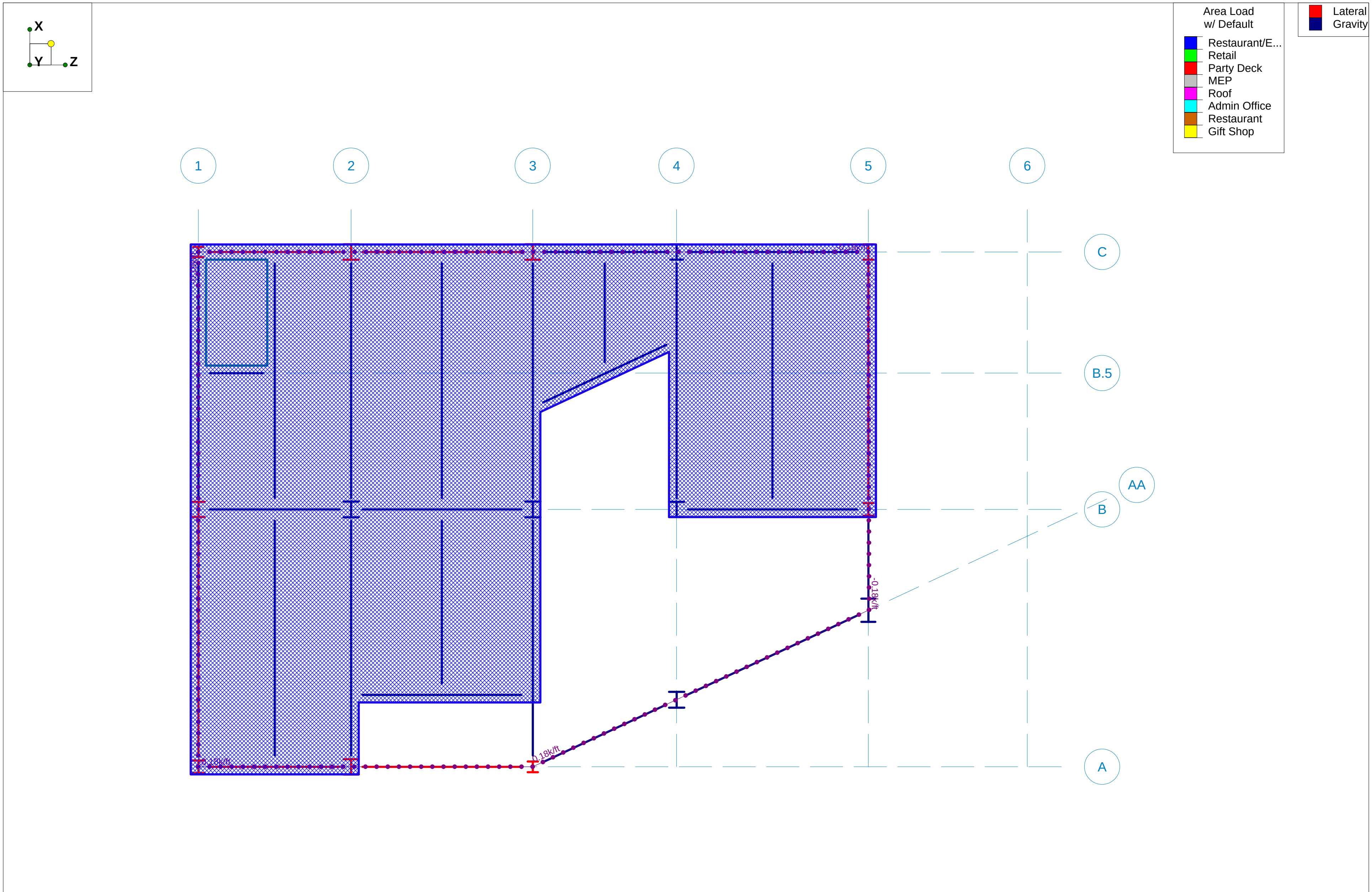
Loads: DL PreComp - PreComposite Dead Load
Results for LC 1, Service Dead

Floor 5



Loads: DL PreComp - PreComposite Dead Load
Results for LC 1, Service Dead

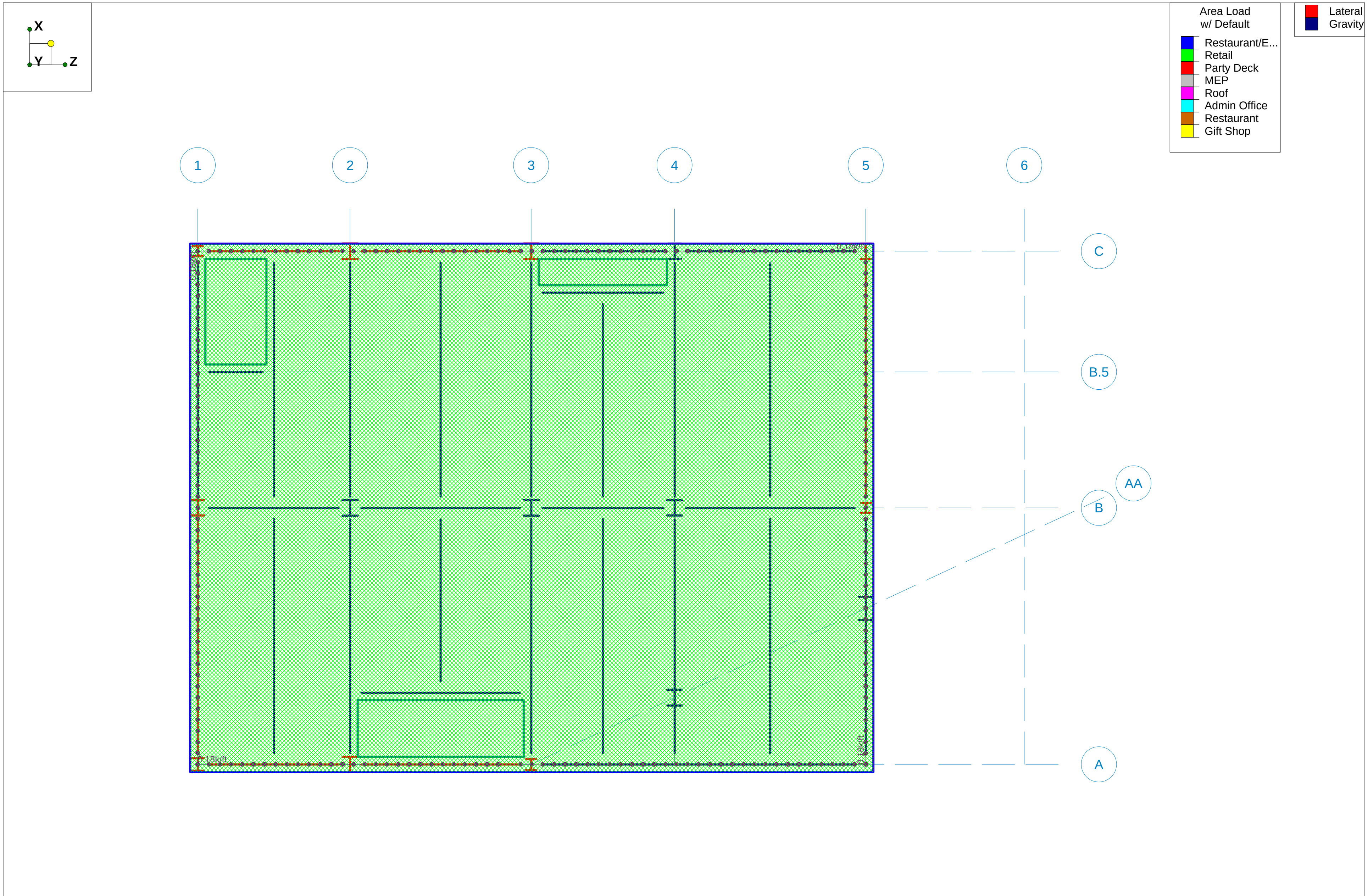
Roof



Loads: DL PostComp - PostComposite Dead Load
Results for LC 1, Service Dead

Floor 2

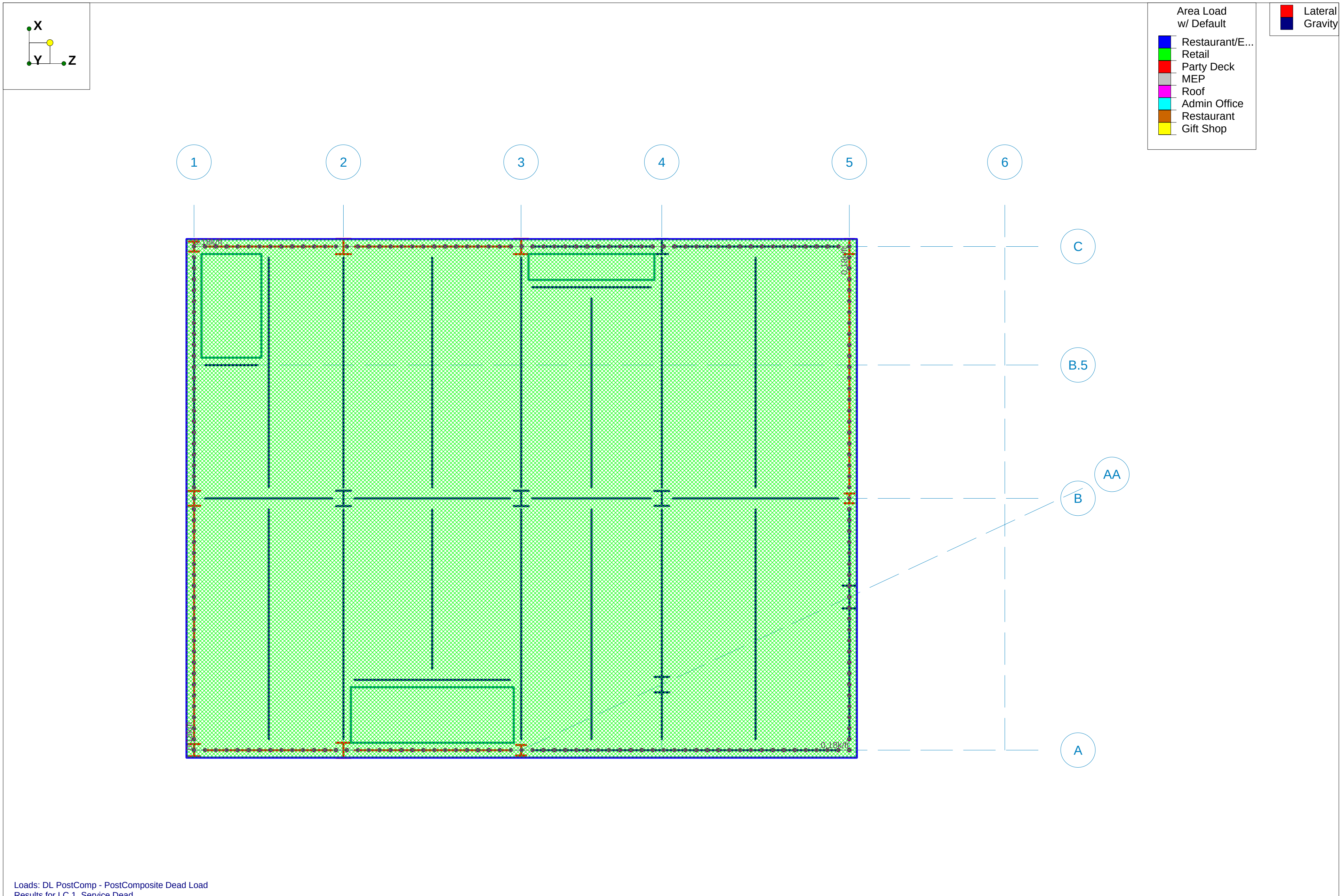
PERIMETER LINE LOADS APPLIED.
GRAPHIC COVERED BY AREA LOAD.



Loads: DL PostComp - PostComposite Dead Load
Results for LC 1, Service Dead

Floor 3

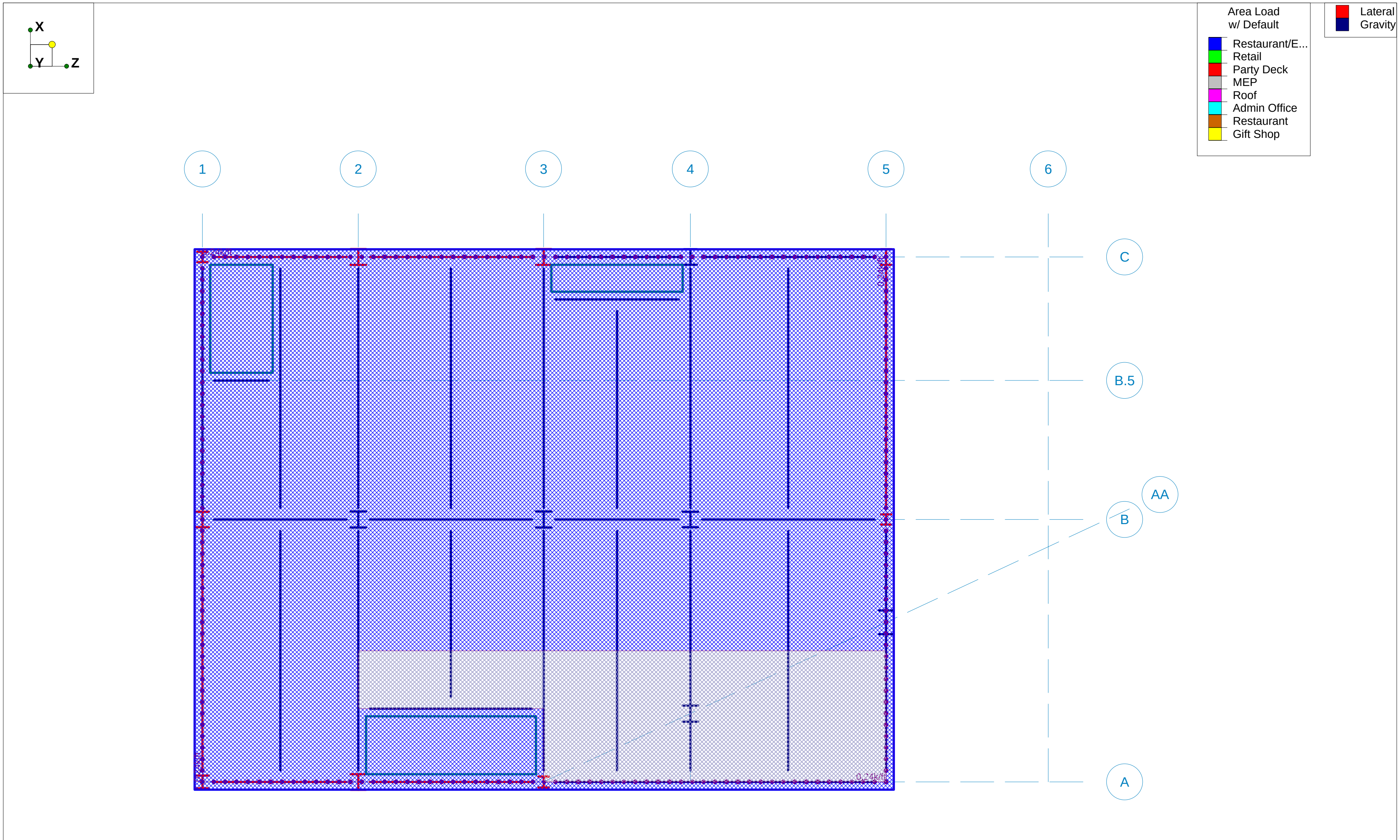
PERIMETER LINE LOADS APPLIED.
GRAPHIC COVERED BY AREA LOAD.



Loads: DL PostComp - PostComposite Dead Load
Results for LC 1, Service Dead

Floor 4

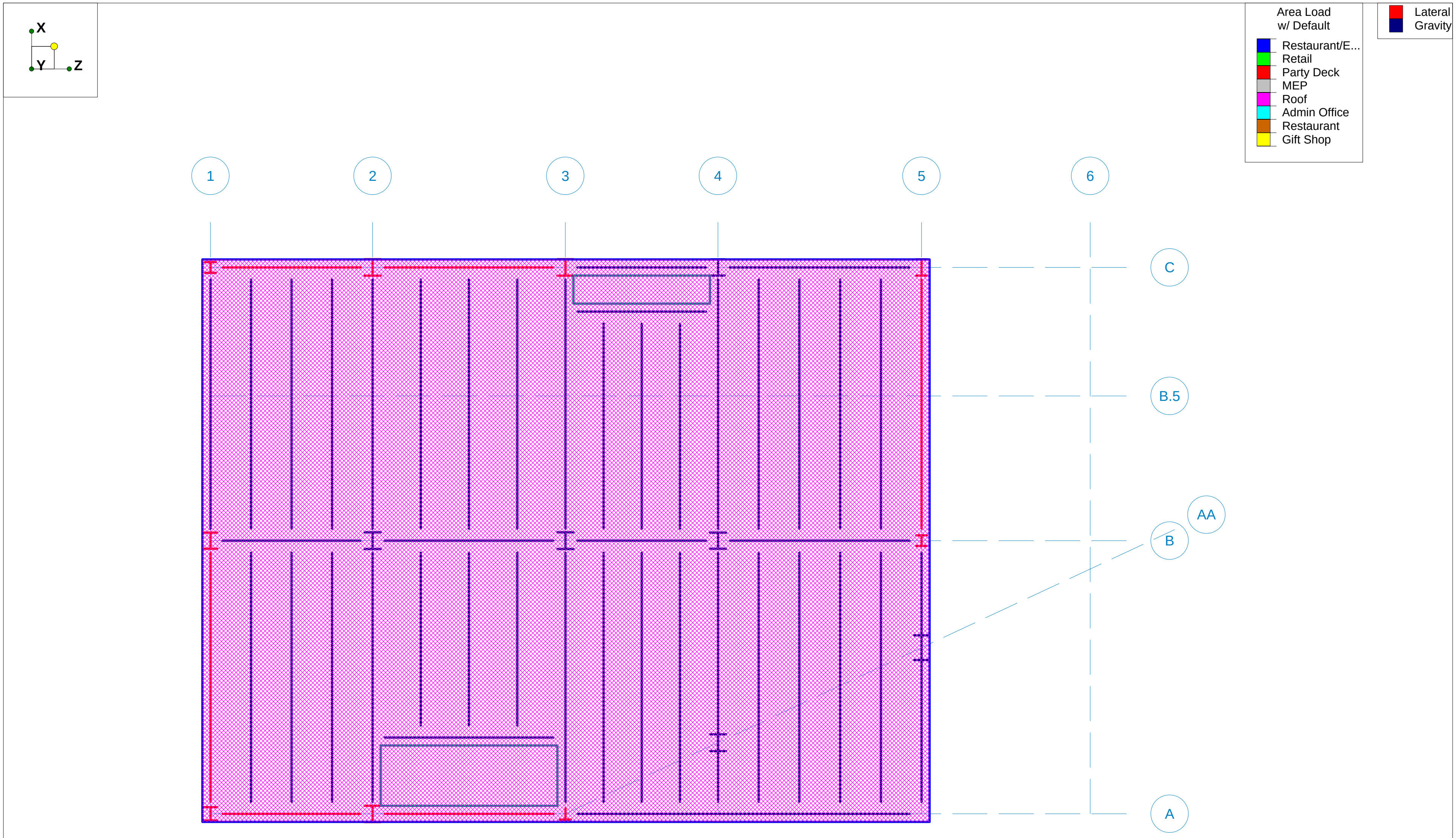
PERIMETER LINE LOADS APPLIED.
GRAPHIC COVERED BY AREA LOAD.



Loads: DL PostComp - PostComposite Dead Load
Results for LC 1, Service Dead

Floor 5

PERIMETER LINE LOADS APPLIED.
GRAPHIC COVERED BY AREA LOAD.



Loads: DL PostComp - PostComposite Dead Load
Results for LC 1, Service Dead

Roof

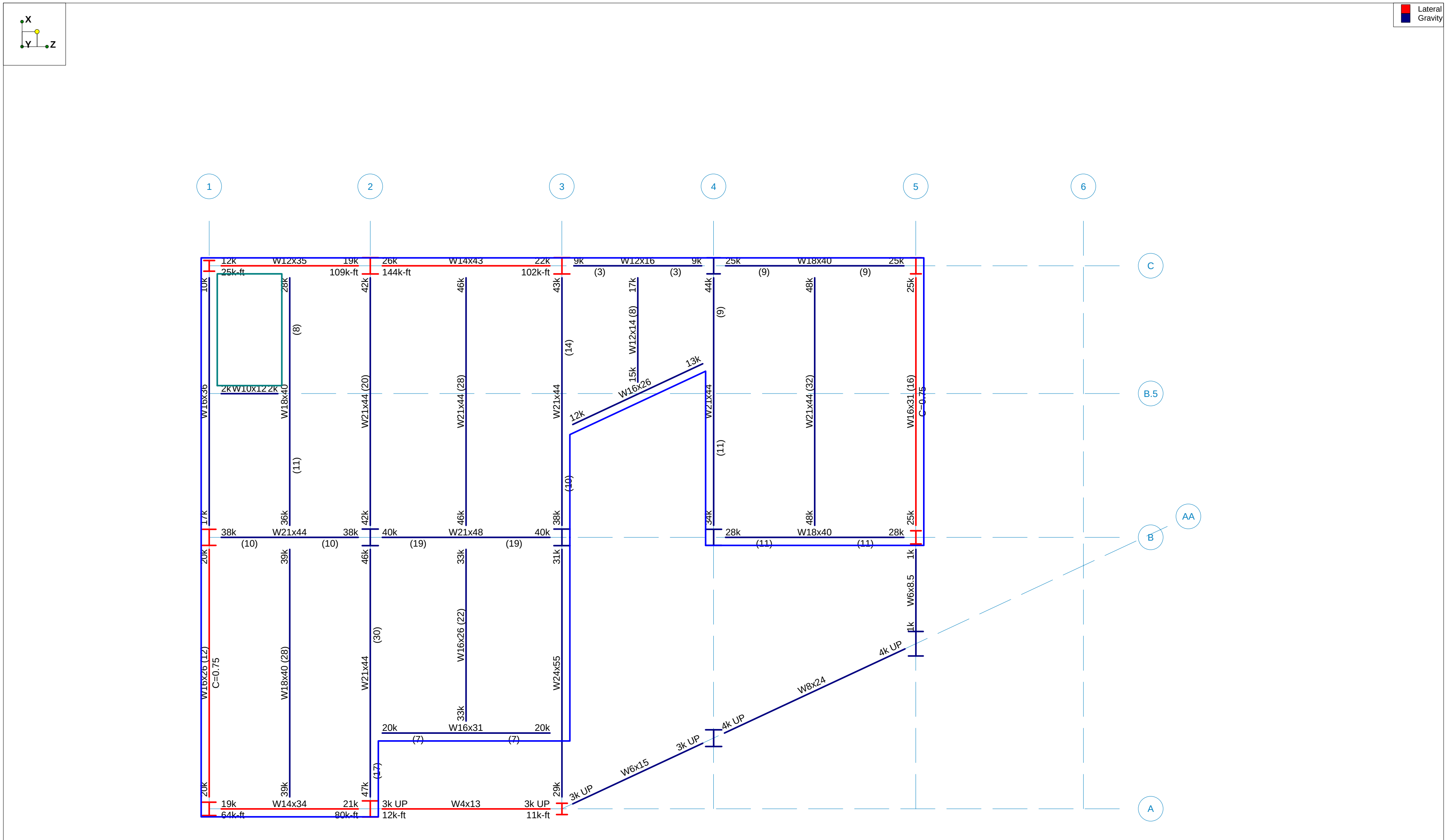
PERIMETER LINE LOADS APPLIED.
GRAPHIC COVERED BY AREA LOAD.

Uniform Area Loads

	Label	Additive	PreDL[ksf]	PostDL[ksf]	LL[ksf]	LL Type	VL[ksf]	Dyn Load[ksf]
1	Restaurant/Event				0.1	LL-Non	0.011	0.01
2	Retail				0.075	LL-Non	0.011	0.05
3	Party Deck				0.1	LL-Non	0.004	0.01
4	MEP				0.15	LL-Non	0.011	0.02
5	Roof				0.02	RLL-Non	0.011	0.01
6	Admin Office				0.065	LL-Non	0.011	
7	Restaurant				0.1	LL-Non	0.011	
8	Gift Shop				0.1	LL-Non	0.011	

	Label	Material Type	Deck	Unbraced[ft]	Max Span[ft]
1	Composite Deck	Vulcraft 3 VLI	6.5"LW 3VLI20, Conc4000LW, 1.5in, 0.75in, ...	2	13
2	Metal Deck	Verco Steel Roof Deck	22ga PLB-36	1	8

	Stack Label	Project ...	Z [ft]	X [ft]	Lift No.	Length...	Bot El. ...	Top El....	Shape	Material	Function	Design R...	Flexural L...	Shear La...
1	(A-2)	A-2	20.167	0	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
2	(B-2)	B-2	20.167	34	1	62	0	62	Wide Flan...	A992	Gravity	Typical	N/A	N/A
3	(C-2)	C-2	20.167	68	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
4	(AA-A)	AA-A	44.167	0	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
5	(B-3)	B-3	44.167	34	1	62	0	62	Wide Flan...	A992	Gravity	Typical	N/A	N/A
6	(C-3)	C-3	44.167	68	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
7	(B-4)	B-4	63.167	34	1	62	0	62	Wide Flan...	A992	Gravity	Typical	N/A	N/A
8	(C-4)	C-4	63.167	68	1	66	0	66	Wide Flan...	A992	Gravity	Typical	N/A	N/A
9	(B-5)	B-5	88.5	34	1	14	0	14	Wide Flan...	A992	Lateral	Typical	N/A	N/A
10					2	52	14	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
11	(C-5)	C-5	88.5	68	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
12	(C-1)	C-1	0	68	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
13	(B-1)	B-1	0	34	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
14	(A-1)	A-1	0	0	1	66	0	66	Wide Flan...	A992	Lateral	Typical	N/A	N/A
15	(AA-4)	AA-4	63.167	8.861	1	62	0	62	Wide Flan...	A992	Gravity	Typical	N/A	N/A
16	CS15	-	88.601	20.723	1	14	0	14	Wide Flan...	A992	Gravity	Typical	N/A	N/A
17	(AA-5)	AA-5	88.5	20.675	1	66	0	66	Wide Flan...	A992	Gravity	Typical	N/A	N/A

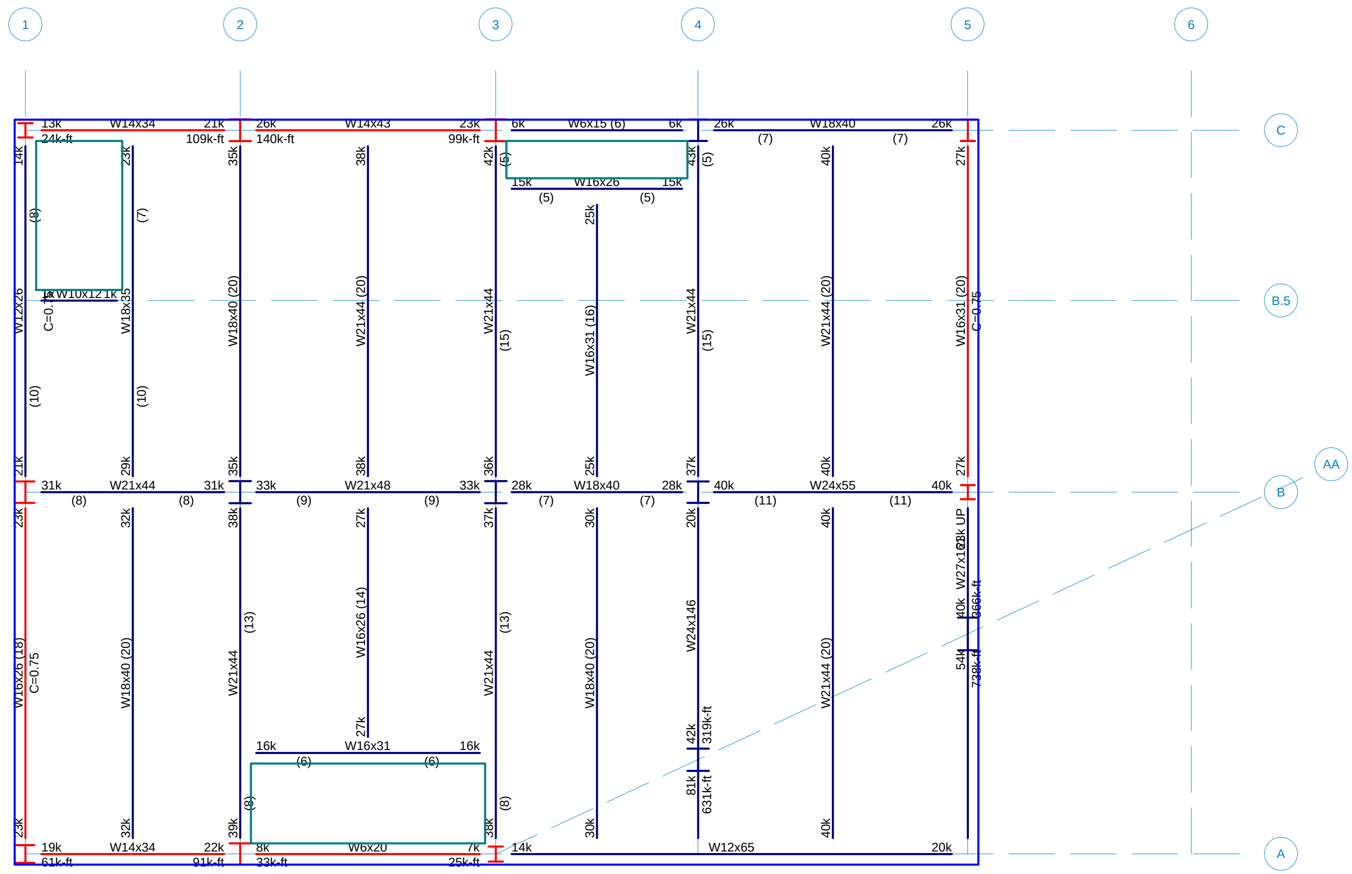


Member Camber and Reactions

Floor 2

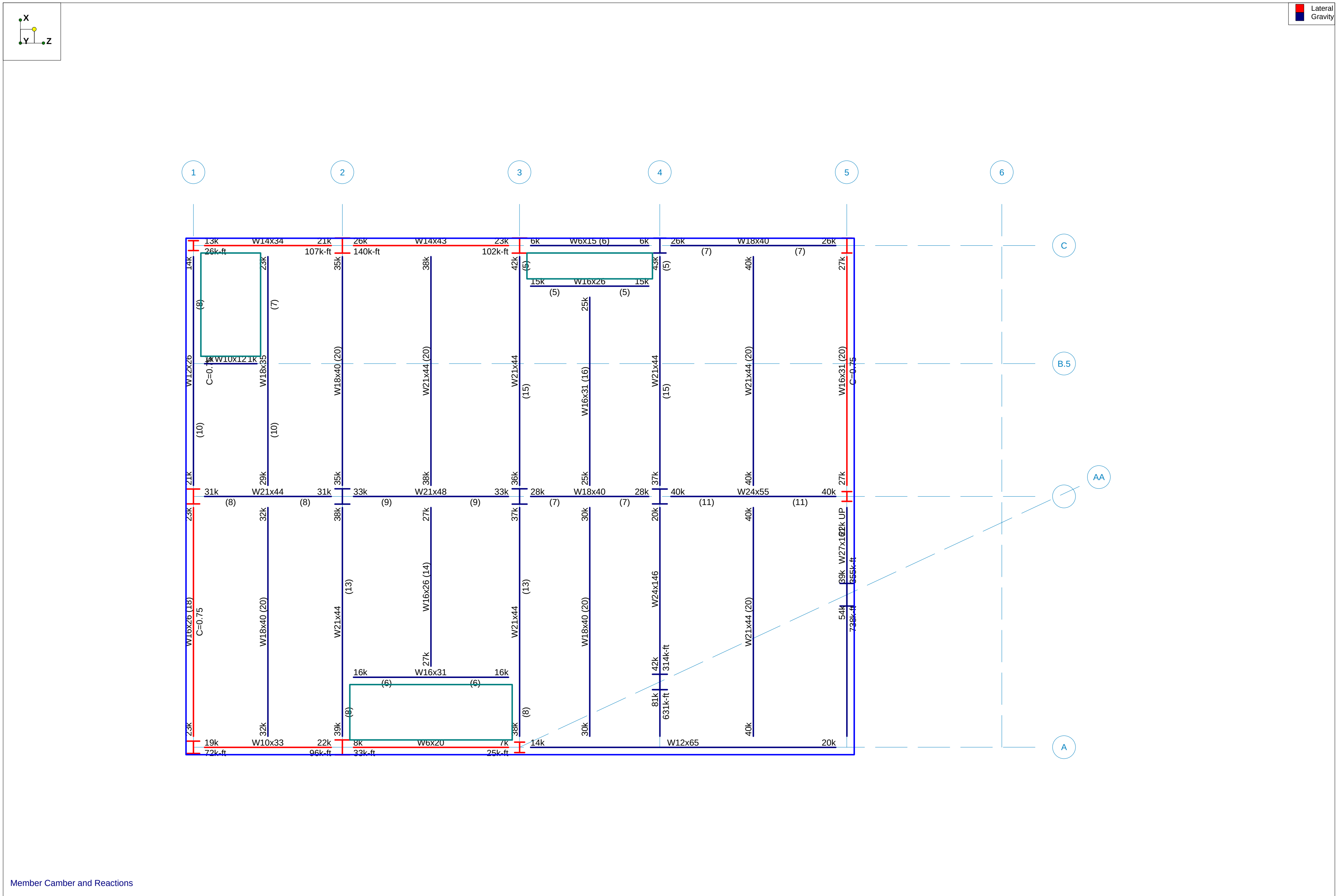
X
Y Z

Lateral
Gravity



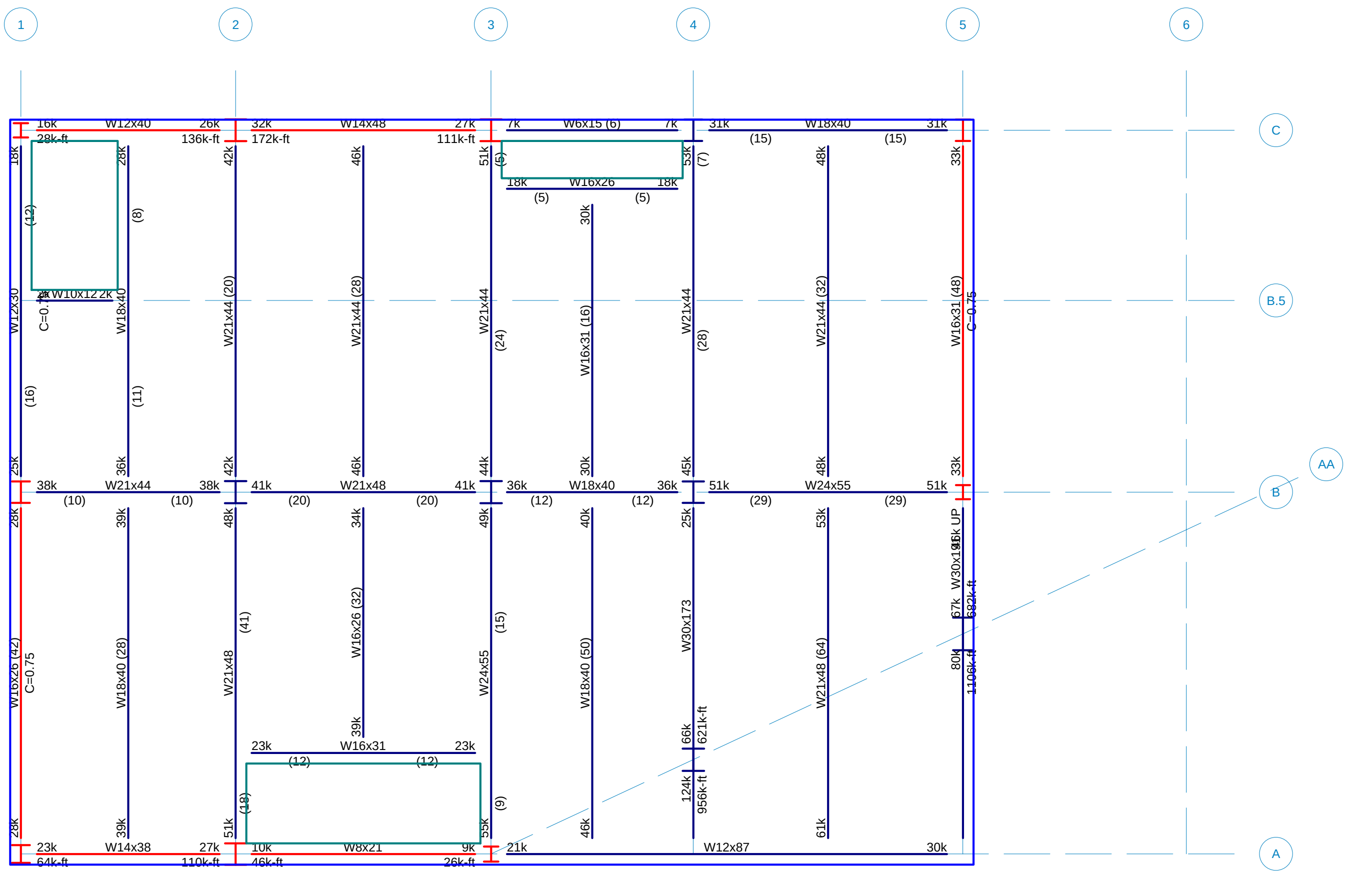
Member Camber and Reactions

Floor 3



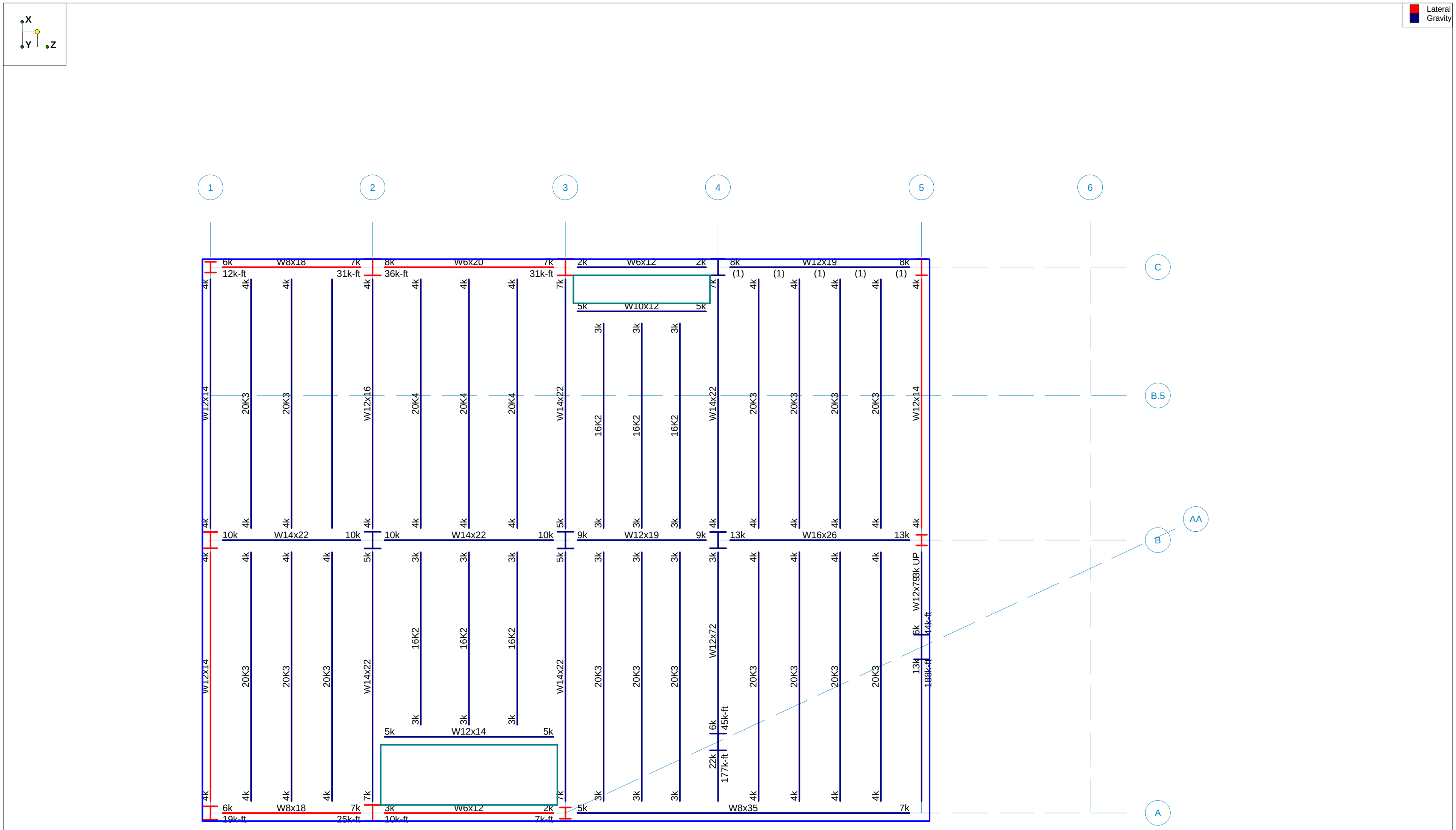
Member Camber and Reactions

Floor 4



Member Camber and Reactions

Floor 5



Member Camber and Reactions

Roof

Hot Rolled Steel Column Code Checks

	Stack	Lift	Shape	Code C...	Elev[ft]	LC	Shear C...	Elev[ft]	Dir	LC	Pnc/om ...	Pnt/om [...	Mnyy/o...	Mnzz/o...	Cb	AISC...
1		1	W12x65	0.982	14.438	8	0.038	25.438		8	484.181	571.856	106.985	236.708	1	H1-1a
2	(B-2)	1	W12x87	0.992	13.563	8	0	62		6	615.59	766.467	150.699	317.263	1	H1-1a
3	(C-2)	1	W12x72	0.933	13.75	8	0.026	25.438		8	505.311	631.737	122.754	257.281	1	H1-1a
4	(AA-A)	1	W8x48	0.923	13.75	8	0.014	49.5		8	261.8	422.156	57.136	90.943	1	H1-1a
5	(B-3)	1	W12x79	0.984	13.563	8	0	62		8	556.518	694.611	135.479	284.722	1	H1-1a
6	(C-3)	1	W12x72	0.957	14.438	8	0.044	49.5		8	536.151	631.737	122.754	264.749	1	H1-1a
7	(B-4)	1	W12x65	0.962	13.563	8	0	62		8	455.939	571.856	106.985	229.525	1	H1-1a
8	(C-4)	1	W12x53	0.962	13.75	8	0	66		11	333.761	467.066	72.605	175.138	1	H1-1a
9	(B-5)	1	W10x39	0.988	14	8	0	14		8	203.195	344.311	42.914	99.206	1	H1-1a
10		2	W8x31	0.844	25.917	8	0	66		11	188.227	273.353	35.124	68.156	1	H1-1a
11	(C-5)	1	W12x45	0.971	13.75	8	0	66		11	228.408	392.216	47.405	132.92	1	H1-1a
12	(C-1)	1	W8x31	0.939	14.438	8	0.025	61.875		6	188.227	273.353	35.124	68.156	1	H1-1a
13	(B-1)	1	W12x53	0.95	13.75	8	0	66		11	333.761	467.066	72.605	175.138	1	H1-1a
14	(A-1)	1	W10x49	0.968	14.438	8	0.041	49.5		8	341.27	431.138	70.609	143.324	1	H1-1a
15	(AA-4)	1	W12x87	0.962	26.479	8	0.244	49.729		8	652.453	766.467	150.699	329.341	2.214	H1-1a
16	(AA-5)	1	W18x86	0.917	26.125	8	0.265	49.5		8	608.387	757.485	120.758	464.072	2.214	H1-1a

RISA 3D

- MODEL NARRATIVE
- MODEL GEOMETRY
  - MEMBER LABELS AND MATERIALS
- MODEL INPUT DATA
  - BASIC LOAD CASES
  - LOAD COMBINATIONS

- MODEL OUTPUT DATA
  - MODEL MEMBER SHAPES (ELEVATION PLANS)
  - NODE DEFLECTIONS
  - STORY DRIFT
  - CODE CHECK
  - MODEL UNITY CHECK

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Model Narrative – RISA 3D

RISA 3D is a powerful tool for structural design and analysis if it is used correctly and efficiently. Although the calculation and analysis capabilities of the software are nearly indispensable when compared to designing a structural system by hand, its interface scores low for approachability and ease of use. This can result in minute input errors that do not allow for a model to be run for design purposes, often times without alluding to exactly what issues generate the error. A thorough understanding of the software's input behaviors, terminologies, and common shortcomings is vital to producing a workable model and trustworthy results.

Thanks to the built-in compatibility between RISA Floor and RISA 3D, the beams, girders, and columns that were previously earmarked for lateral design as members in Braced Frames and Moment Frames could be specially loaded directly into a 3D project. Similarly, the aforementioned RISA Floor diaphragms loaded into the RISA 3D file, complete with accurately placed Centers of Mass, Rigidity, and their corresponding 0.05B (B = Building Width) or 0.05L (L = Building Length) eccentricities as existing nodes in the model. These automatically generated nodes proved critical for proper application of lateral loads on the model. The final step in creating the applicable model geometry for simulating the lateral force resisting systems was to draw the chevron-shaped vertical braces into the designated braced frames. Care was taken to place the chevron braces symmetrically about the mid-span of the beams that they framed into.

A key factor of successful modeling in RISA 3D that is not apparent when transitioning from RISA Floor is the careful designation of member end releases and/or boundary conditions. While these concepts are fundamental to structural analysis theory, their nomenclature and the software features that enable their manipulation are not immediately obvious. For this model, it was of the utmost importance that all *nodes* in the moment frames be set to generate reactions in the X, Y, and Z directions while each *member* that framed into said nodes retained a fully pinned end release. Apart from this interface oddity, the overall concept of joints that transfer moment versus shear only remains.

Once model geometry is verified to be accurate and consistent, the application of loads takes precedence. Because the structural system design employed moment frames, a phenomenon known as Live Load Patterning had to be considered when compiling the appropriate LRFD load combinations in RISA 3D. Live Load Patterning considers both positive and negative moments that will be generated within a continuous member if/when the post-construction occupancy of the building results in an applied load on one side of a supporting column followed by the other side. In other words, if there exists a series of moment connections within a building frame, any and all configurations of loading on a bay-to-bay basis must be considered.

The general rule of thumb for Live Load Patterning states that the number of moment frames in a series multiplied by two, plus one, gives the number of live load combinations that must be designed for (2n+1 where n = *number of bays designed as moment frames in a series*). The presence of moment frames also requires that separate loading cases be considered such that each bay in series may experience full-length live load, no live load, or the entire series may experience full-length live load. For this project, the structural design team designated two bays in series as moment frames. This called for a Live Load Case A and Live Load Case B for the respective bays as well as a Total Live Load (Case A + Case B) for the gravity live loads to which the building structure would be subjected.

An important distinction to note: Even though the RISA 3D model was created for assessing lateral load conditions "only," the moments induced by Live Load Patterning from the gravity load had potential to govern the design of the moment frame members which, in turn, would affect their ability to redirect lateral forces. As a result, the gravity design of these members from RISA Floor was ultimately used for reference only and instead was looked to as a valid analysis result from RISA 3D.

Along with the additional load combinations from Live Load Patterning amidst the standard LRFD Load Combinations, each directional force from both Wind and Seismic forces had to be incorporated as well. While fundamentally similar for this model in their application, the actual modeling of said load cases was ultimately executed differently.

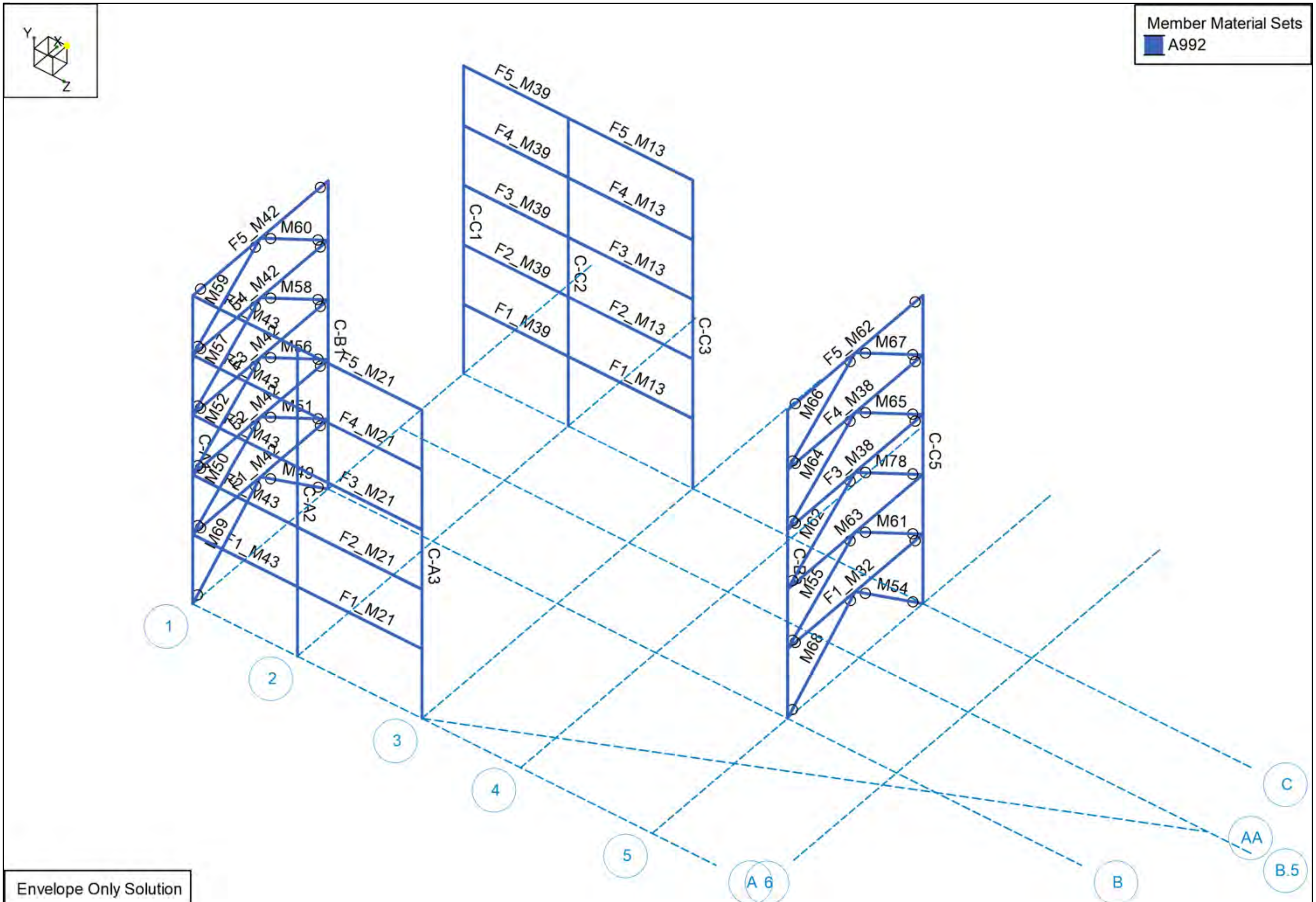
For both longitudinal and transverse Wind forces, the calculated area load (psf) per ASCE 7-16 Directional Procedure calculations (Chapter 27) was focused into a uniform distributed line load and then into an overall point load for each diaphragm elevation of the building. This point load was then applied in the corresponding longitudinal or transverse direction (North, East, South, or West) at the diaphragm's automatically generated Center of Mass for each story elevation of the building. This method resulted in the use of two separate load cases for Wind load, (longitudinal and transverse) that could be applied as both positive and negative nodal loads in the model to account for all four directions.

The Seismic forces on the building were calculated per ASCE 7-16 Equivalent Lateral Force Procedure (Chapter 12.8), ultimately yielding a distributed Base Shear value per floor, called a "Story Force." In order to properly simulate torsional effects from Seismic forces, each Story Force was applied in its corresponding longitudinal or transvers direction at two separate points for two respective load combinations: one applied at an eccentricity of 0.05B (or 0.05L) to one side of the Center of Mass and one applied to the same eccentricity on the other side. Ultimately, this method of application for the Seismic forces created the need for four separate Seismic load cases: longitudinal at "positive" eccentricity, longitudinal at "negative" eccentricity, and the same for the transverse direction.

So, even though the RISA 3D model was created for "only lateral load analysis," the necessary iterative process for accurately modeling Live Load Patterning as well as longitudinal and transverse Wind and Seismic loads resulted in a total Load Combination count of 61 load combinations.

Finally, once all load combinations are accounted for and accurately applied in the 3D model, the file can be "solved" to produce simulated deflections as well as member forces and reactions. The software can then be utilized to assess overall building drift for possible column and/or beam/girder resizing. Another major design factor that must be accounted for in a RISA 3D model is P-Delta affect. What ultimately boils down to a second-order moment analysis generated by a post-drift gravity load eccentricity can become a significant snag for RISA 3D models. For this model, P-Delta affects were only analyzed for compression, per Professor McCoy's instruction. Of course, if all geometry is modeled accurately and within the modeling requirements of the software itself to then be subject to properly calculated and applied loads, these affects should not generate model errors. One common source of P-Delta error cases for this building specifically came from the moment frame columns. More specifically, if the columns that frame the continuous bays are not rotated 90 degrees in the RISA model to account for strong axis bending, the model will regularly declare "unstable."

In the end, both RISA Floor and RISA 3D are powerful tools that streamline the structural design and analysis process for any structural designer so long as said operator is well-versed in analysis theory as well as the software-specific operations and commands. If nothing else, using the RISA software will result in a well-versed designer so long as the final model results are accurate depictions of real-world structural forces and reactions.



		10
		May 01, 2021
	MEMBER LABELS AND MATERIALS	Hellier_Sub5_Risa3d.r3d

Basic Load Cases

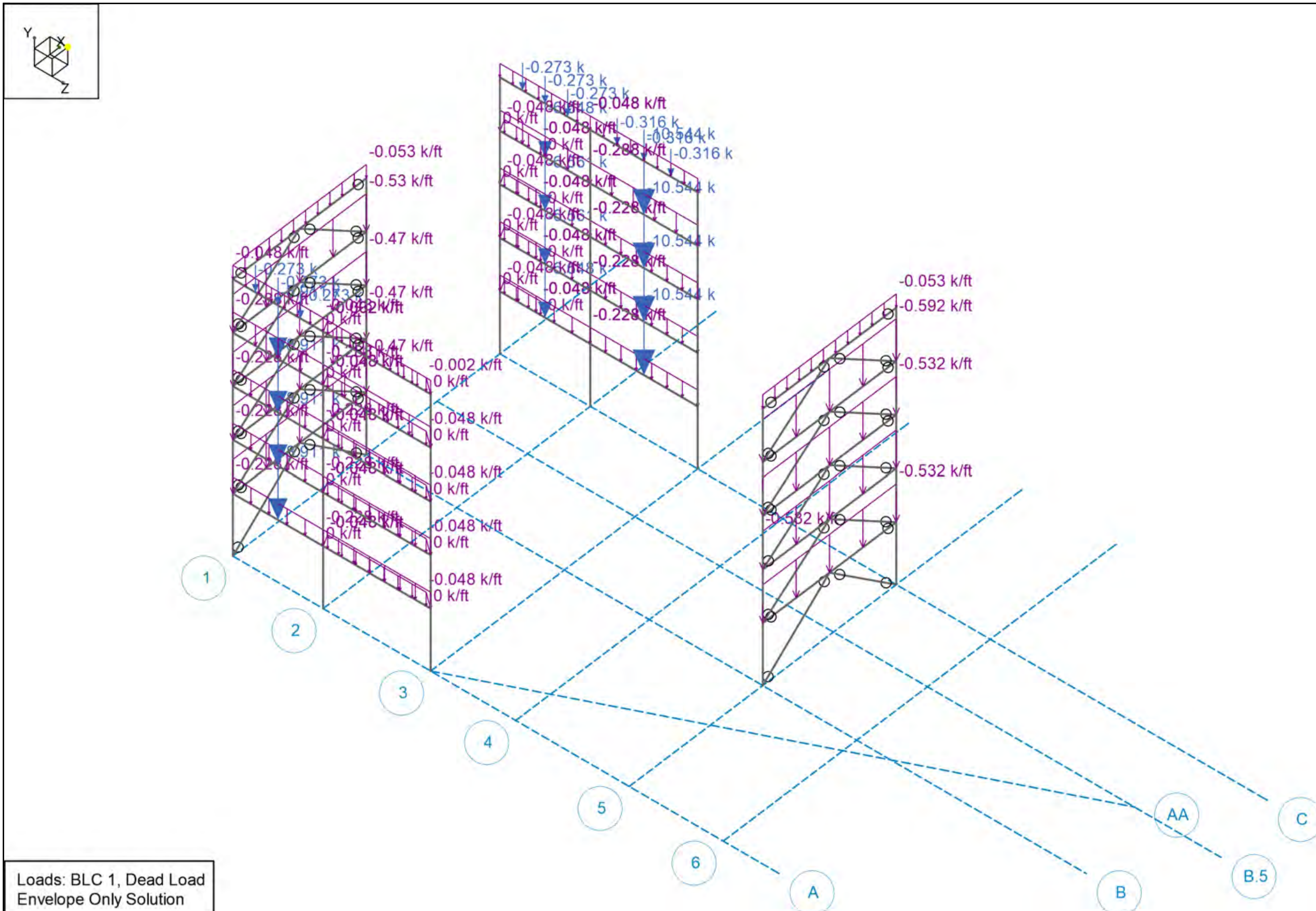
	BLC Description	Category	Y Gravity	Nodal	Point	Distributed
1	Dead Load	DL	-1	60	56	57
2	Live Load A	LL		54	20	32
3	Live Load B	LL		6	15	25
4	Roof Live Load	RLL				
5	Wind X	WLX		5		
6	Wind Z	WLZ		5		
7	Ex + e	ELX+Z		5		
8	Ex - e	ELX-Z		5		
9	Ez + e	ELZ+X		5		
10	Ez - e	ELZ-X		5		

Load Combinations

	Description	Solve	PDelta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	1.0L	Yes	C	LL	1								
2	1.4D	Yes	C	1	1.4								
3	1.2D+1.6L (All)	Yes	C	1	1.2	LL	1.6						
4	1.2D+1.6La+1.6Lra	Yes	C	1	1.2	2	1.6	4	1.6				
5	1.2D+1.6Lb+1.6Lrb	Yes	C	1	1.2	3	1.6	4	1.6				
6	1.2D+1.0W(North)+1.0L+1.0Lr (All)	Yes	C	1	1.2	5	1	LL	1	RLL	1		
7	1.2D+1.0W(South)+1.0L+1.0Lr (All)	Yes	C	1	1.2	5	-1	LL	1	RLL	1		
8	1.2D+1.0W(East)+1.0L+1.0Lr (All)	Yes	C	1	1.2	6	1	LL	1	RLL	1		
9	1.2D+1.0W(West)+1.0L+1.0Lr (All)	Yes	C	1	1.2	6	-1	LL	1	RLL	1		
10	1.2D+1.0W(North)+1.0La+1.0Lra	Yes	C	1	1.2	5	1	2	1	RLL	1		
11	1.2D+1.0W(South)+1.0La+1.0Lra	Yes	C	1	1.2	5	-1	2	1	RLL	1		
12	1.2D+1.0W(East)+1.0La+1.0Lra	Yes	C	1	1.2	6	1	2	1	RLL	1		
13	1.2D+1.0W(West)+1.0La+1.0Lra	Yes	C	1	1.2	6	-1	2	1	RLL	1		
14	1.2D+1.0W(North)+1.0Lb+1.0Lrb	Yes	C	1	1.2	5	1	3	1	RLL	1		
15	1.2D+1.0W(South)+1.0Lb+1.0Lrb	Yes	C	1	1.2	5	-1	3	1	RLL	1		
16	1.2D+1.0W(East)+1.0Lb+1.0Lrb	Yes	C	1	1.2	6	1	3	1	RLL	1		
17	1.2D+1.0W(West)+1.0Lb+1.0Lrb	Yes	C	1	1.2	6	-1	3	1	RLL	1		
18	0.9D+1.0W(North)	Yes	C	1	0.9	5	1						
19	0.9D+1.0W(South)	Yes	C	1	0.9	5	-1						
20	0.9D+1.0W(East)	Yes	C	1	0.9	6	1						
21	0.9D+1.0W(South)	Yes	C	1	0.9	6	-1						
22	1.2D+0.2(Sds)D+E(North)+L (All)+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	1	LL	0.1	SL	0.2
23	1.2D+0.2(Sds)D+E(South)+L (All)+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	-1	LL	0.1	SL	0.2
24	1.2D+0.2(Sds)D+E(East)+L (All)+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	1	LL	0.1	SL	0.2
25	1.2D+0.2(Sds)D+E(West)+L (All)+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	-1	LL	0.1	SL	0.2
26	1.2D+0.2(Sds)D+E(North)+L (All)+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	1	LL	0.1	SL	0.2
27	1.2D+0.2(Sds)D+E(South)+L (All)+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	-1	LL	0.1	SL	0.2
28	1.2D+0.2(Sds)D+E(East)+L (All)+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	1	LL	0.1	SL	0.2
29	1.2D+0.2(Sds)D+E(West)+L (All)+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	-1	LL	0.1	SL	0.2
30	1.2D+0.2(Sds)D+E(North)+La+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	1	2	0.1	SL	0.2
31	1.2D+0.2(Sds)D+E(South)+La+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	-1	2	0.1	SL	0.2
32	1.2D+0.2(Sds)D+E(East)+La+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	1	2	0.1	SL	0.2
33	1.2D+0.2(Sds)D+E(West)+La+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	-1	2	0.1	SL	0.2
34	1.2D+0.2(Sds)D+E(North)+La+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	1	2	0.1	SL	0.2
35	1.2D+0.2(Sds)D+E(South)+La+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	-1	2	0.1	SL	0.2
36	1.2D+0.2(Sds)D+E(East)+La+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	1	2	0.1	SL	0.2
37	1.2D+0.2(Sds)D+E(West)+La+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	-1	2	0.1	SL	0.2
38	1.2D+0.2(Sds)D+E(North)+Lb+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	1	3	0.1	SL	0.2
39	1.2D+0.2(Sds)D+E(South)+Lb+0.2S (+e)	Yes	C	1	1.2	1	0.051	7	-1	3	0.1	SL	0.2
40	1.2D+0.2(Sds)D+E(East)+Lb+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	1	3	0.1	SL	0.2
41	1.2D+0.2(Sds)D+E(West)+Lb+0.2S (+e)	Yes	C	1	1.2	1	0.051	9	-1	3	0.1	SL	0.2
42	1.2D+0.2(Sds)D+E(North)+Lb+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	1	3	0.1	SL	0.2
43	1.2D+0.2(Sds)D+E(South)+Lb+0.2S (-e)	Yes	C	1	1.2	1	0.051	8	-1	3	0.1	SL	0.2
44	1.2D+0.2(Sds)D+E(East)+Lb+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	1	3	0.1	SL	0.2
45	1.2D+0.2(Sds)D+E(West)+Lb+0.2S (-e)	Yes	C	1	1.2	1	0.051	10	-1	3	0.1	SL	0.2
46	0.9D+0.2(Sds)D+E(North) (+e)	Yes	C	1	0.9	1	0.051	7	1				
47	0.9D+0.2(Sds)D+E(South) (+e)	Yes	C	1	0.9	1	0.051	7	-1				
48	0.9D+0.2(Sds)D+E(East) (+e)	Yes	C	1	0.9	1	0.051	9	1				
49	0.9D+0.2(Sds)D+E(West) (+e)	Yes	C	1	0.9	1	0.051	9	-1				
50	0.9D+0.2(Sds)D+E(North) (-e)	Yes	C	1	0.9	1	0.051	8	1				
51	0.9D+0.2(Sds)D+E(South) (-e)	Yes	C	1	0.9	1	0.051	8	-1				
52	0.9D+0.2(Sds)D+E(East) (-e)	Yes	C	1	0.9	1	0.051	10	1				
53	0.9D+0.2(Sds)D+E(West) (-e)	Yes	C	1	0.9	1	0.051	10	-1				
54	SERVICE DEAD	Yes	C	1	1								
55	SERVICE LIVE	Yes	C	2	1	3	1						
56	SERVICE WIND X	Yes	C	5	1								
57	SERVICE WIND Z	Yes	C	6	1								
58	SERVICE SEISMIC X +e	Yes	C	7	1								

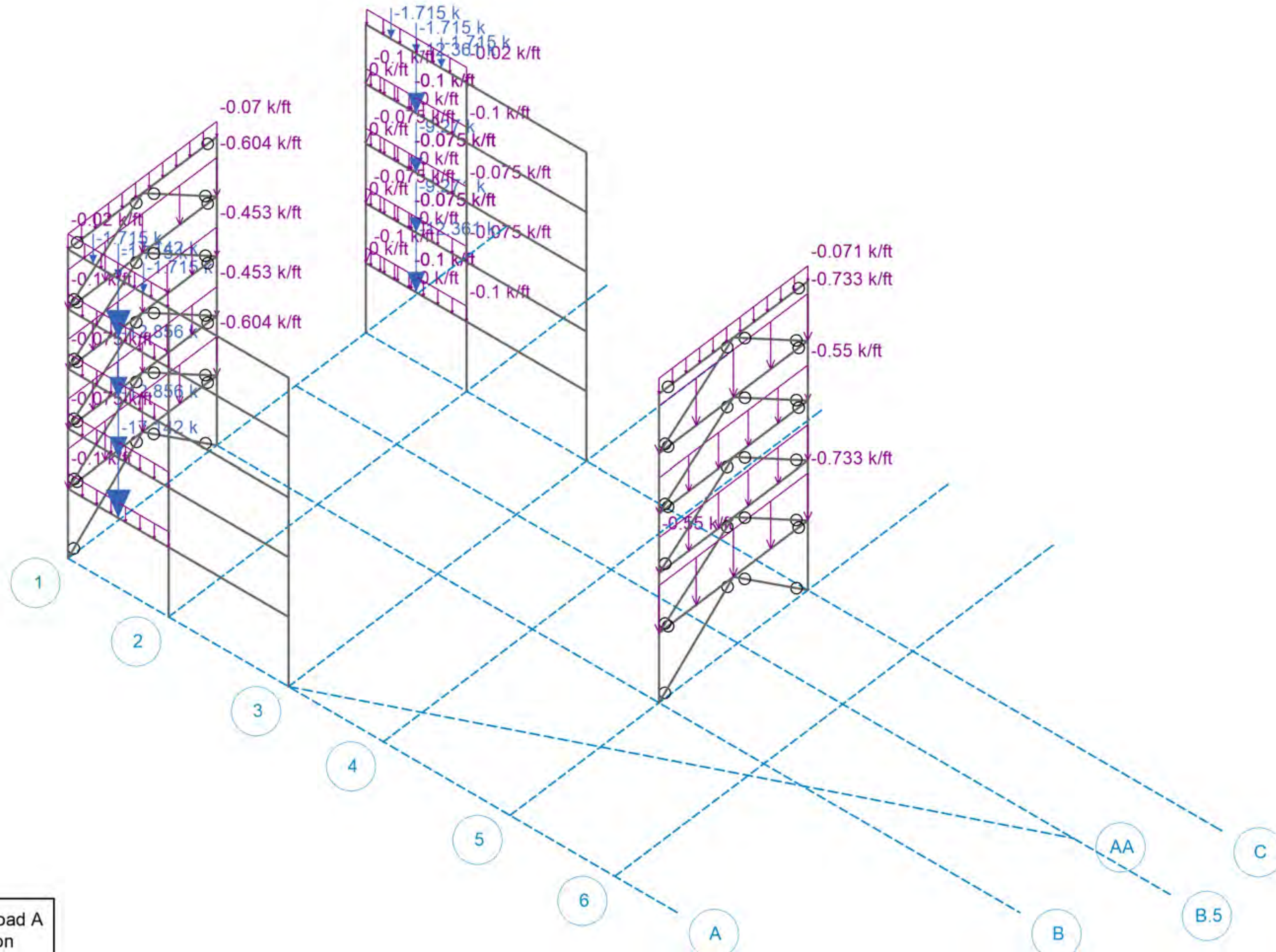
Load Combinations (Continued)

	Description	Solve	PDelta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
59	SERVICE SEISMIC X -e	Yes	C	8	1								
60	SERVICE SEISMIC Y +e	Yes	C	9	1								
61	SERVICE SEISMIC -e	Yes	C	10	1								



Loads: BLC 1, Dead Load
Envelope Only Solution

		1
		May 01, 2021
		Hellier_Sub5_Risa3d.r3d



Loads: BLC 2, Live Load A
Envelope Only Solution

		2
		May 01, 2021
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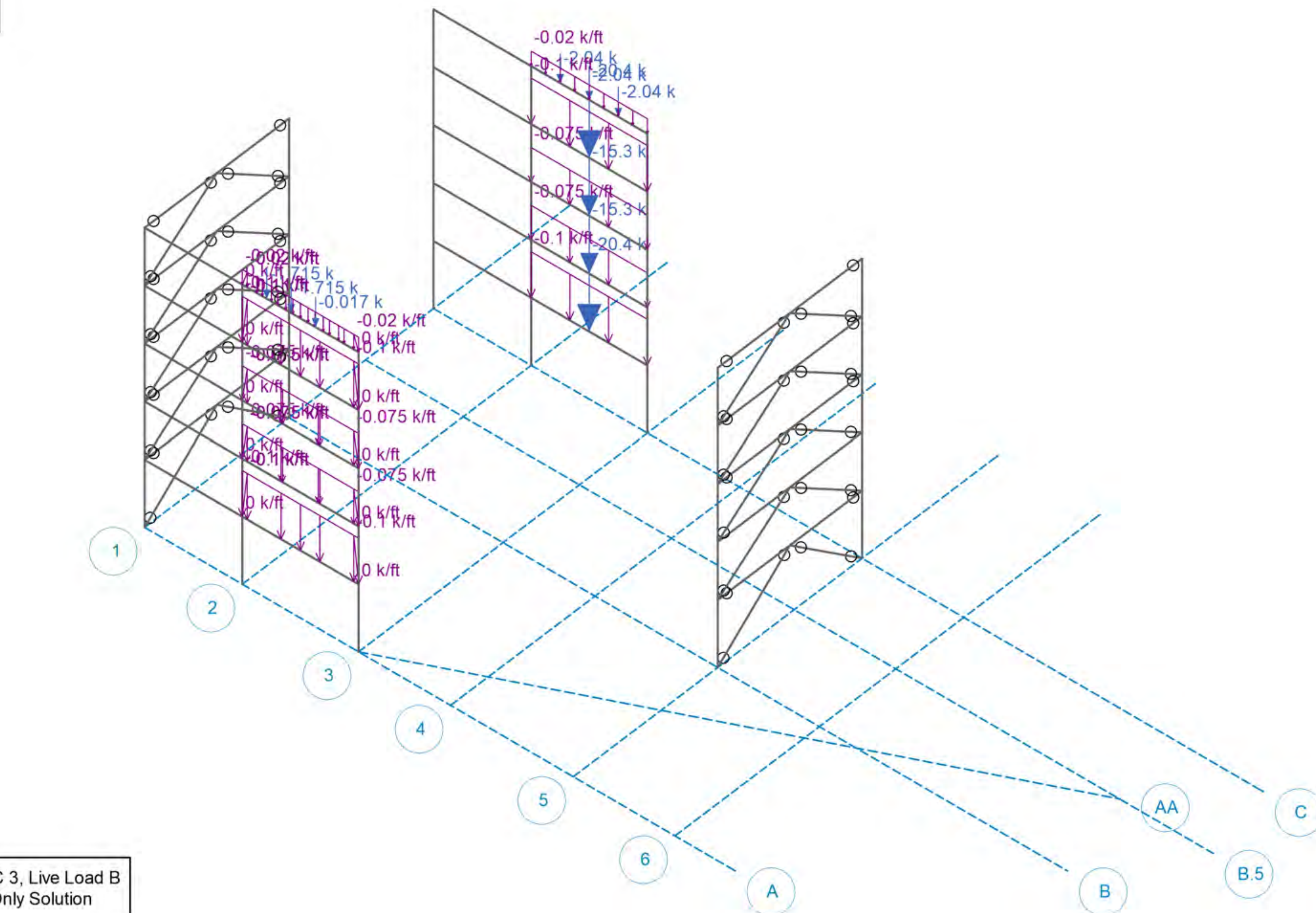

Loads: BLC 3, Live Load B
Envelope Only Solution

		3
		May 01, 2021
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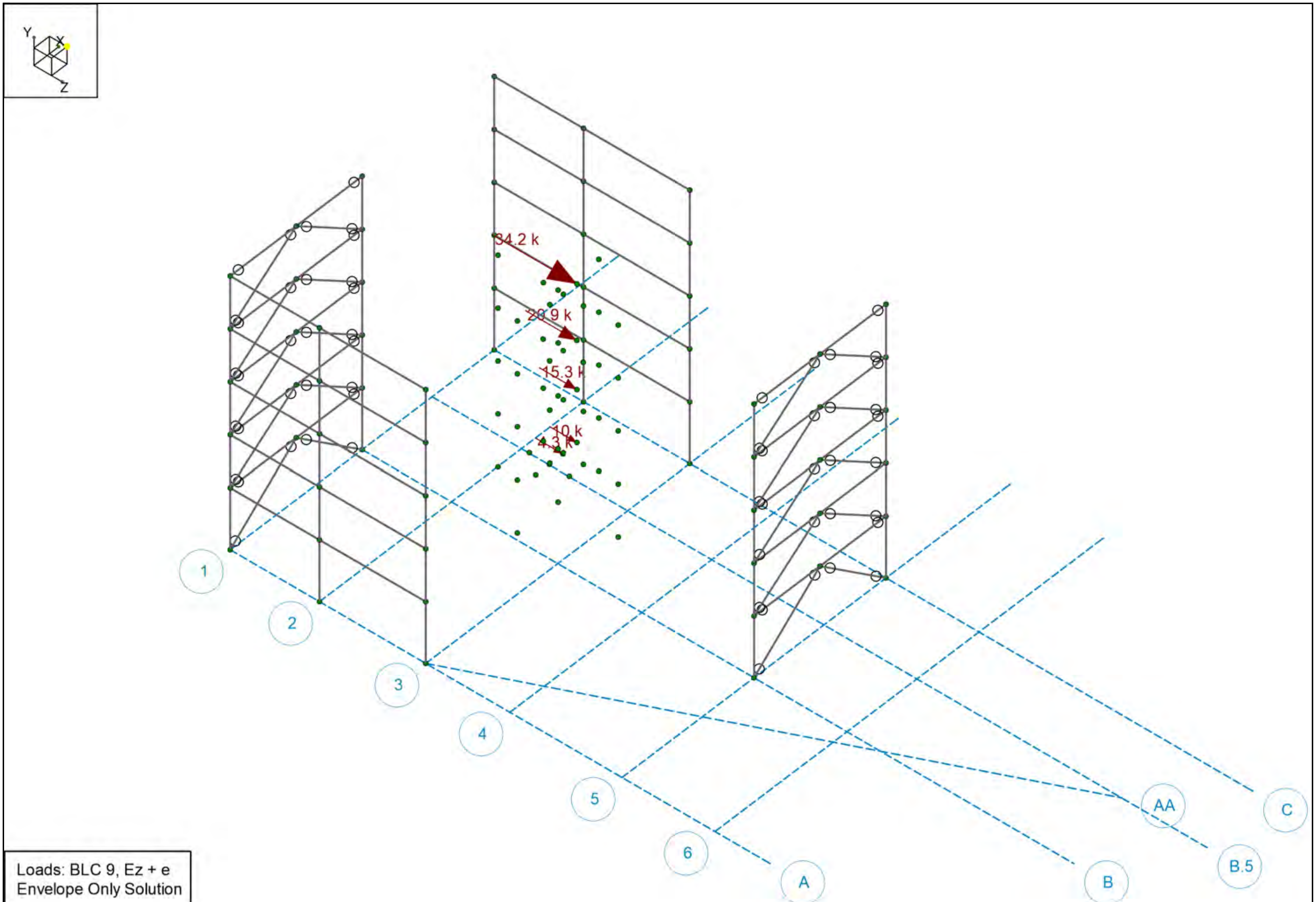
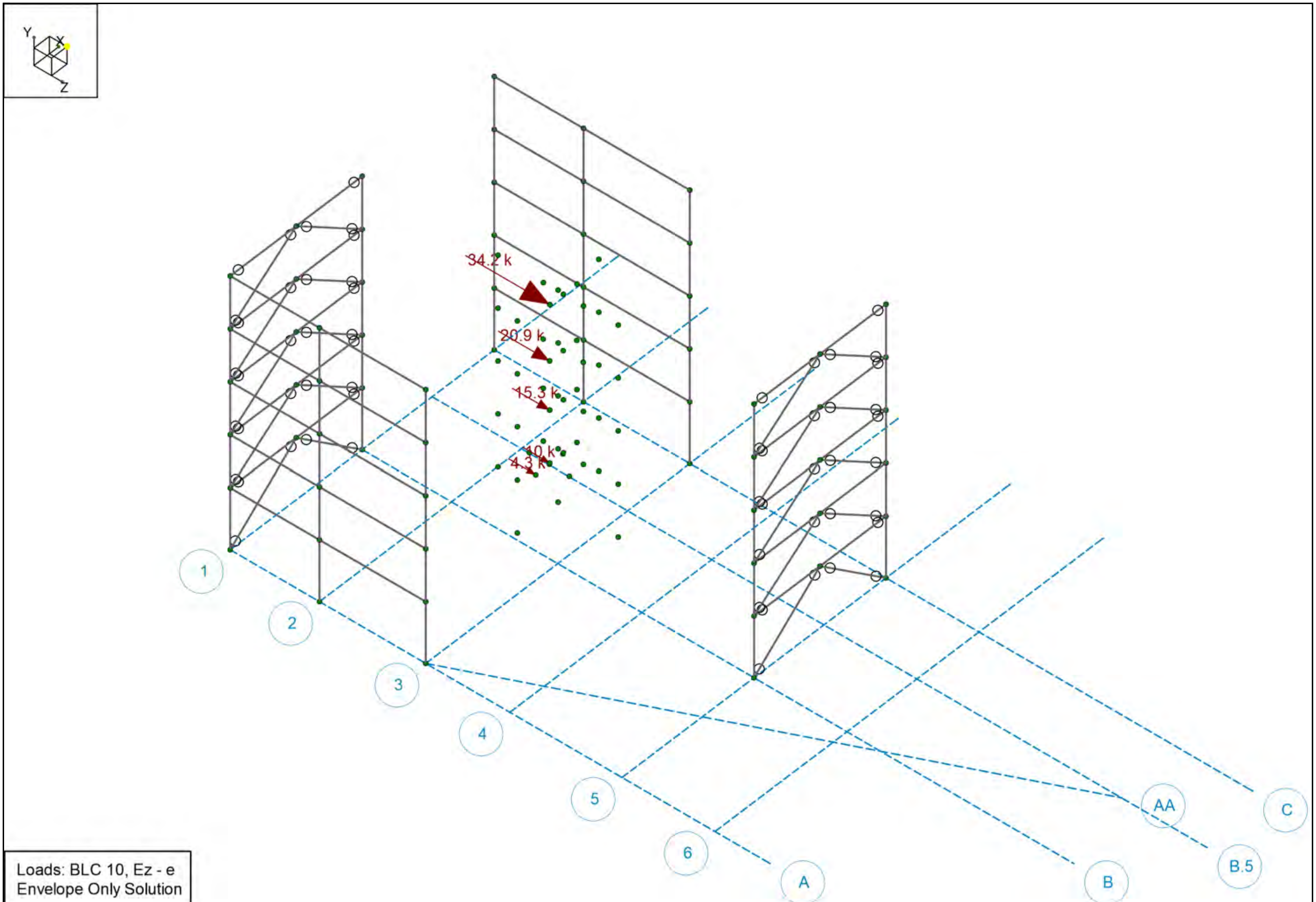


Loads: BLC 9, Ez + e
Envelope Only Solution

		8
		May 01, 2021
		Hellier_Sub5_Risa3d.r3d



Loads: BLC 10, Ez - e
Envelope Only Solution

		9
		May 01, 2021
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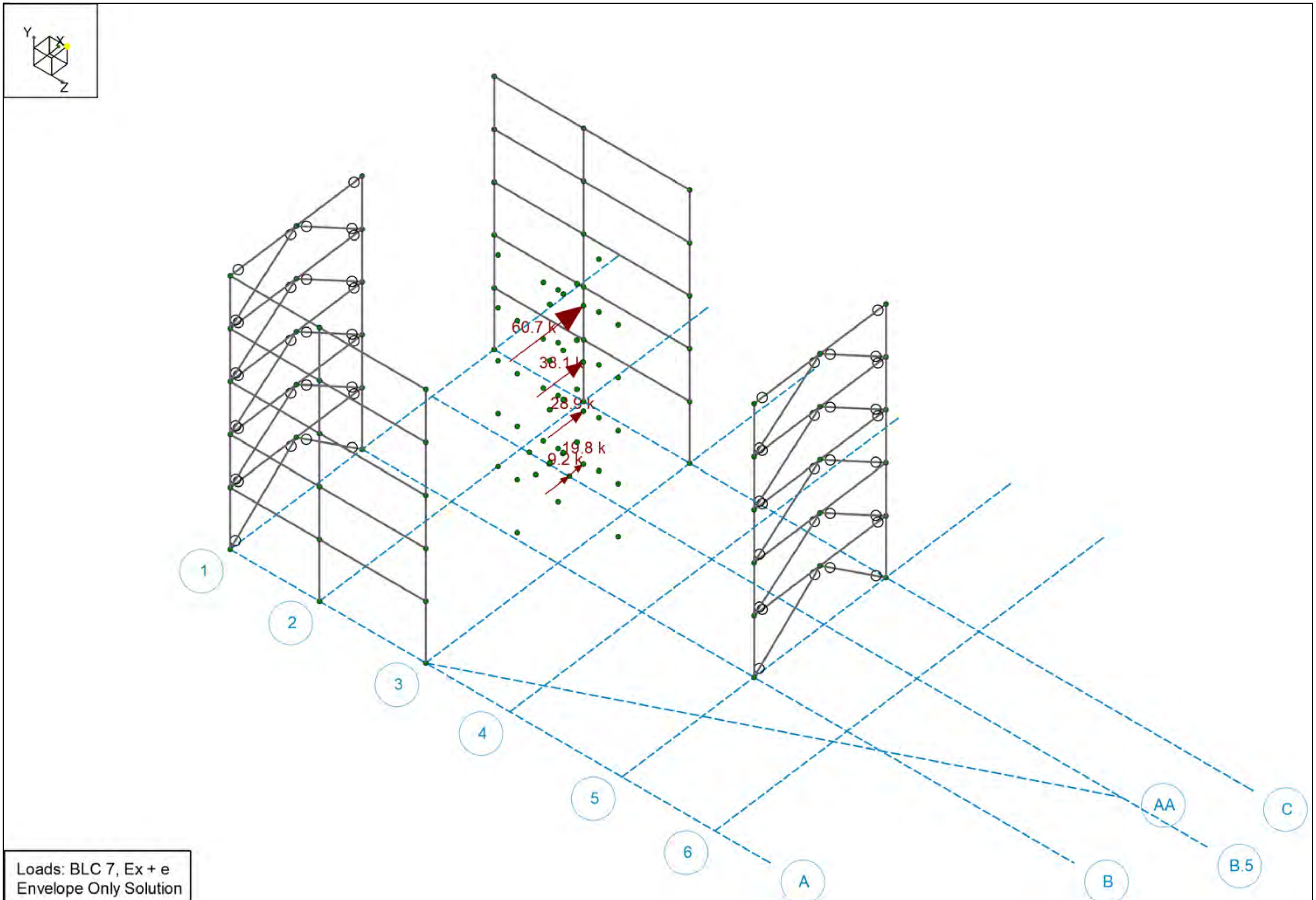

Loads: BLC 7, Ex + e
Envelope Only Solution

		6
		May 01, 2021
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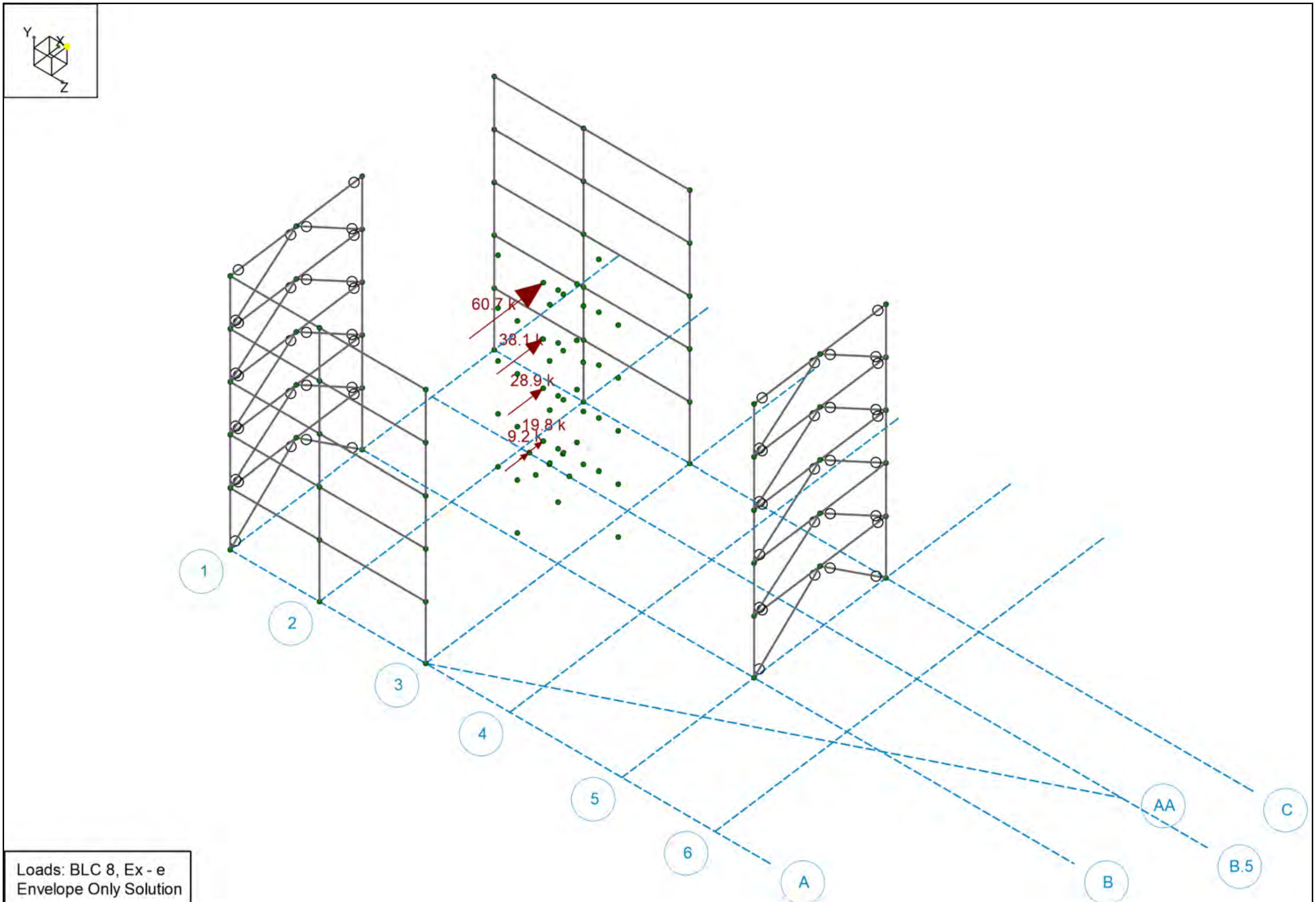
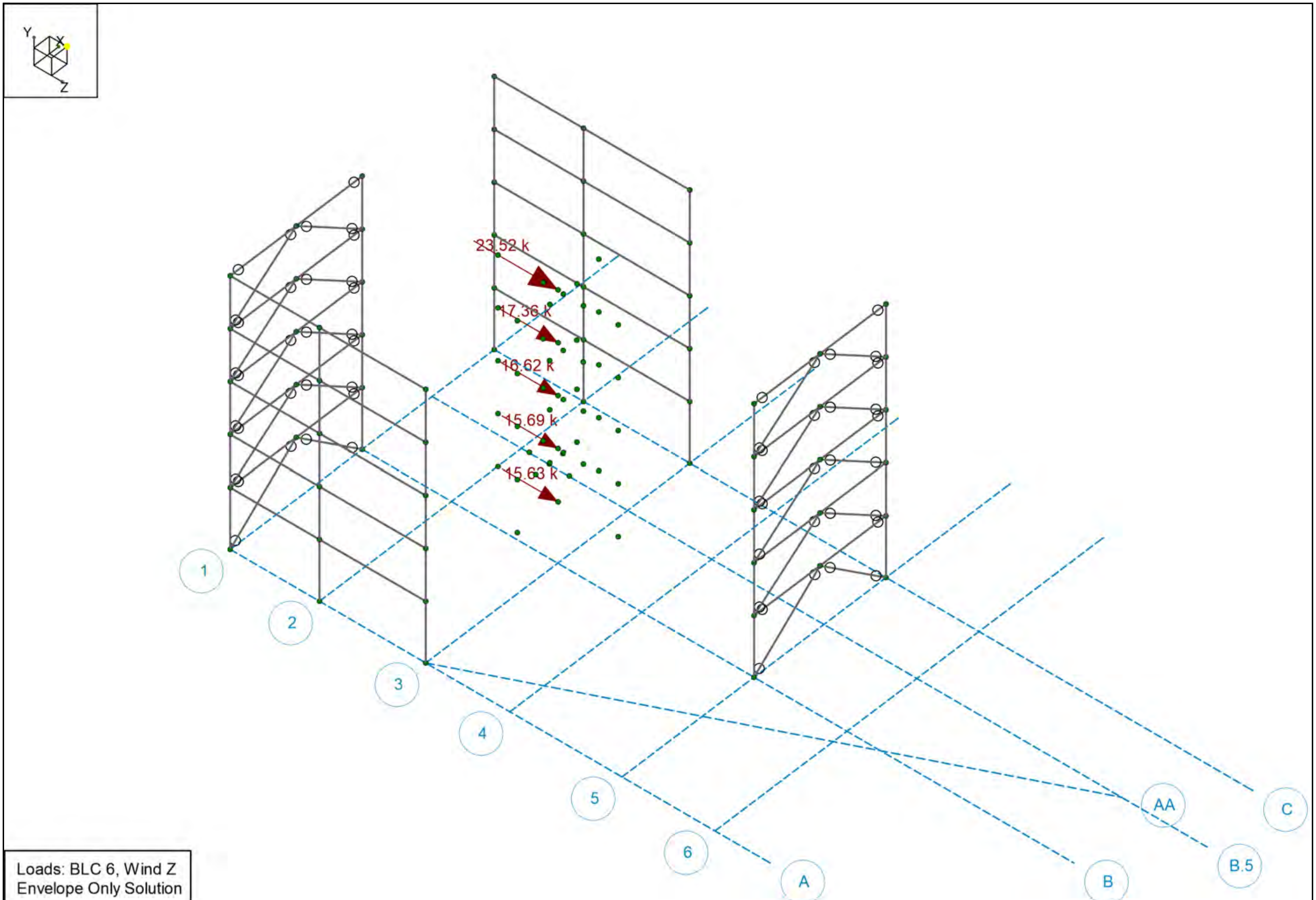


Loads: BLC 8, Ex - e
Envelope Only Solution

		7
		May 01, 2021
		Hellier_Sub5_Risa3d.r3d



Loads: BLC 6, Wind Z
Envelope Only Solution

		5
		May 01, 2021
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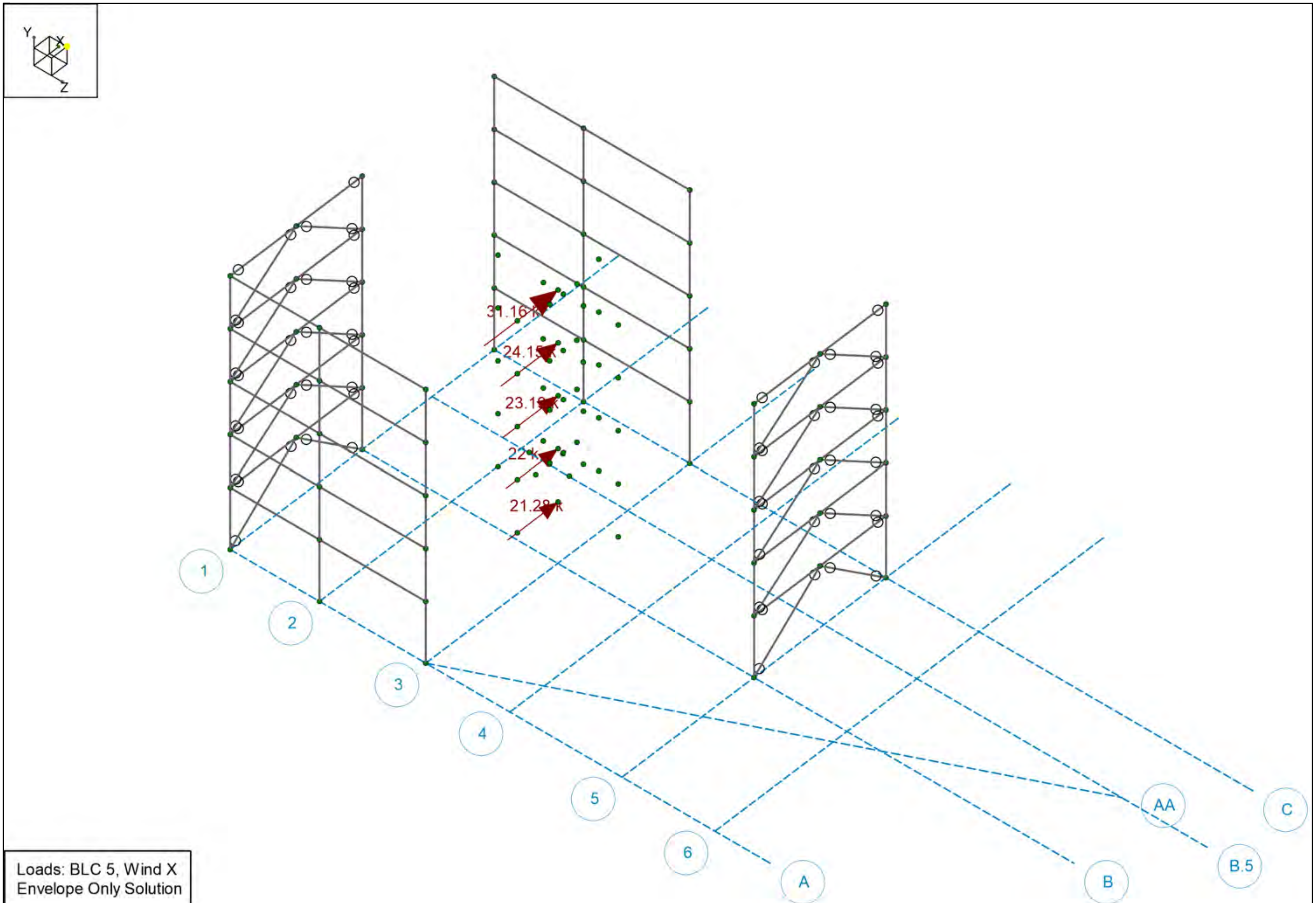

		4
		May 01, 2021
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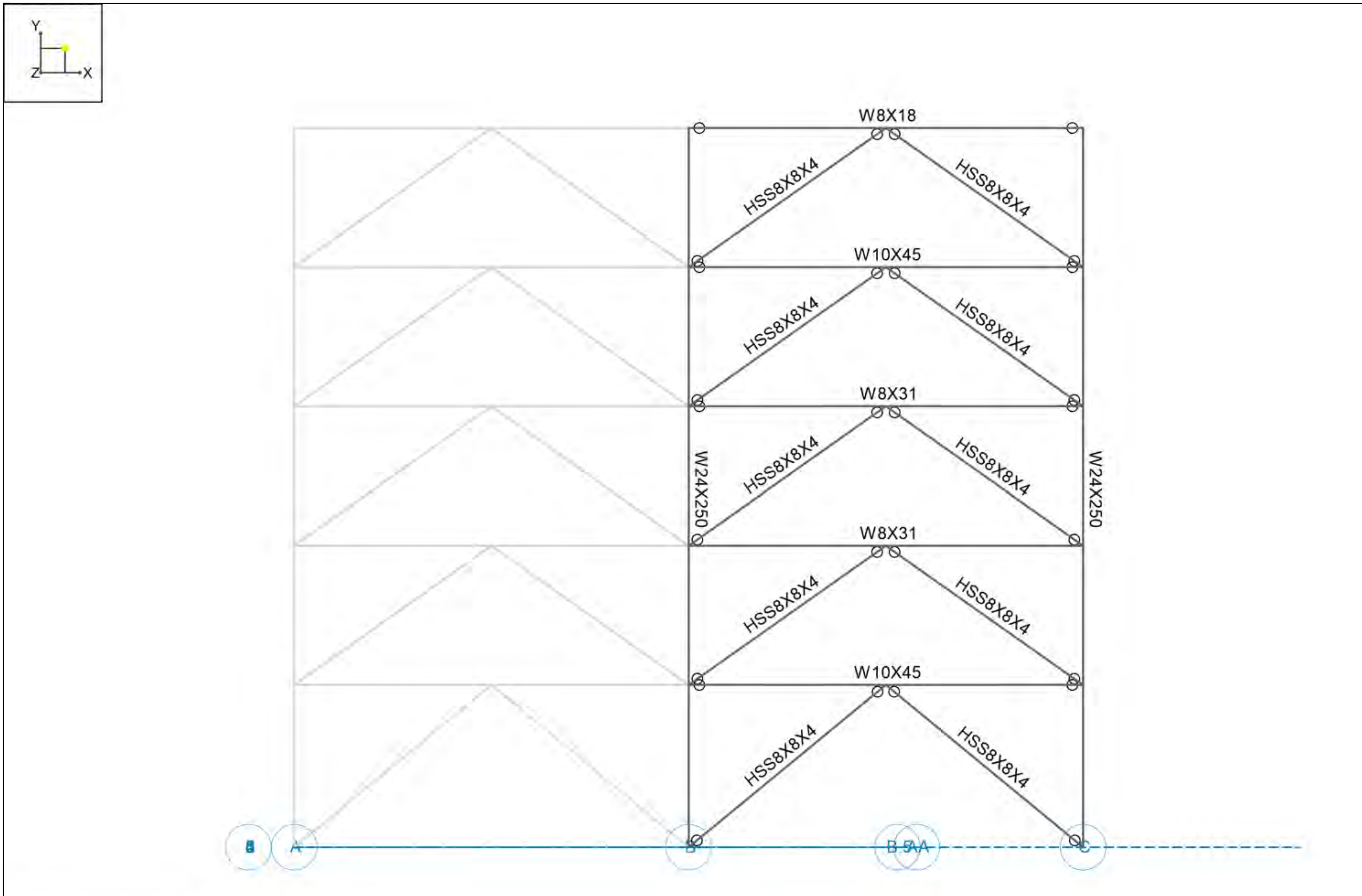
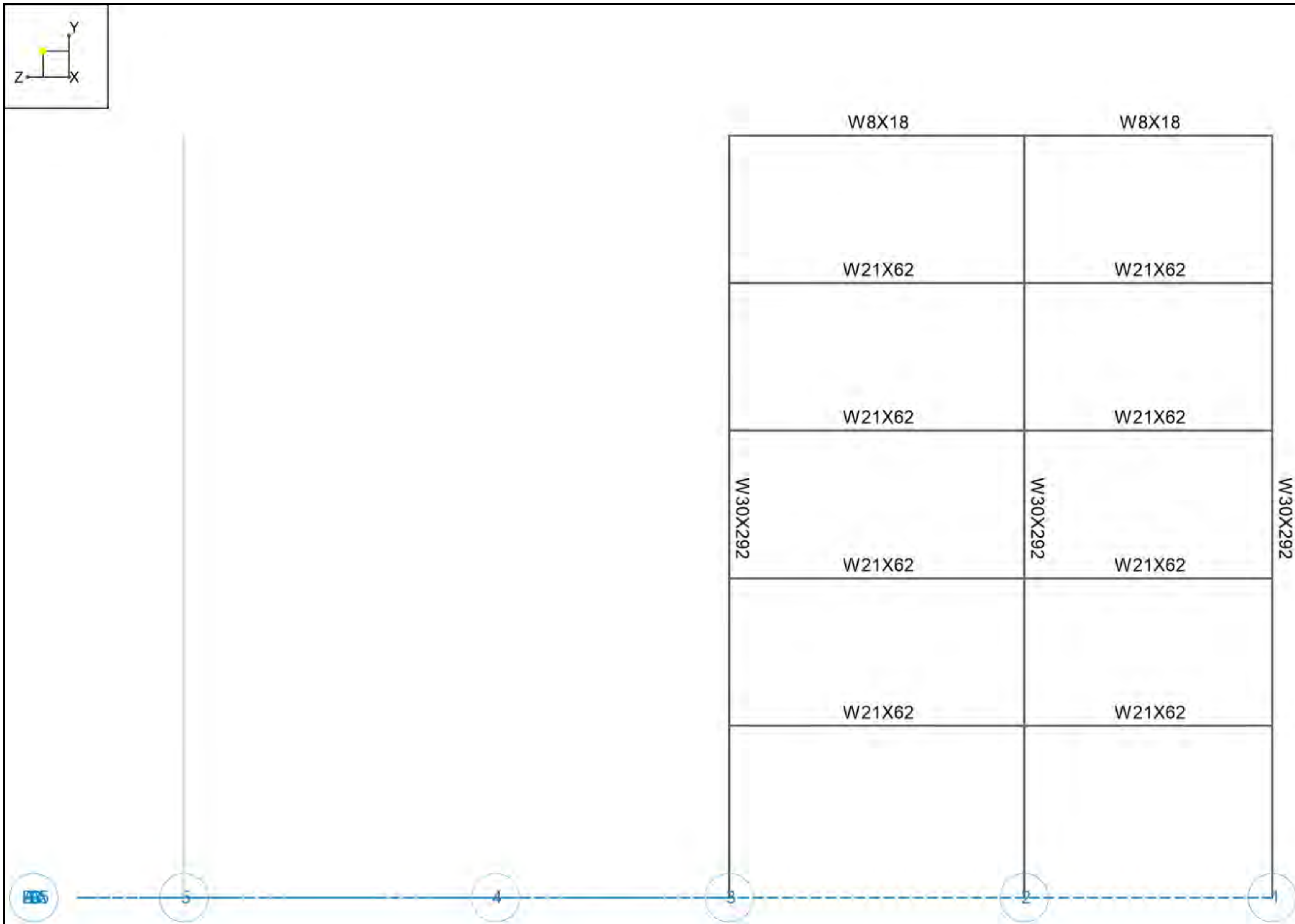


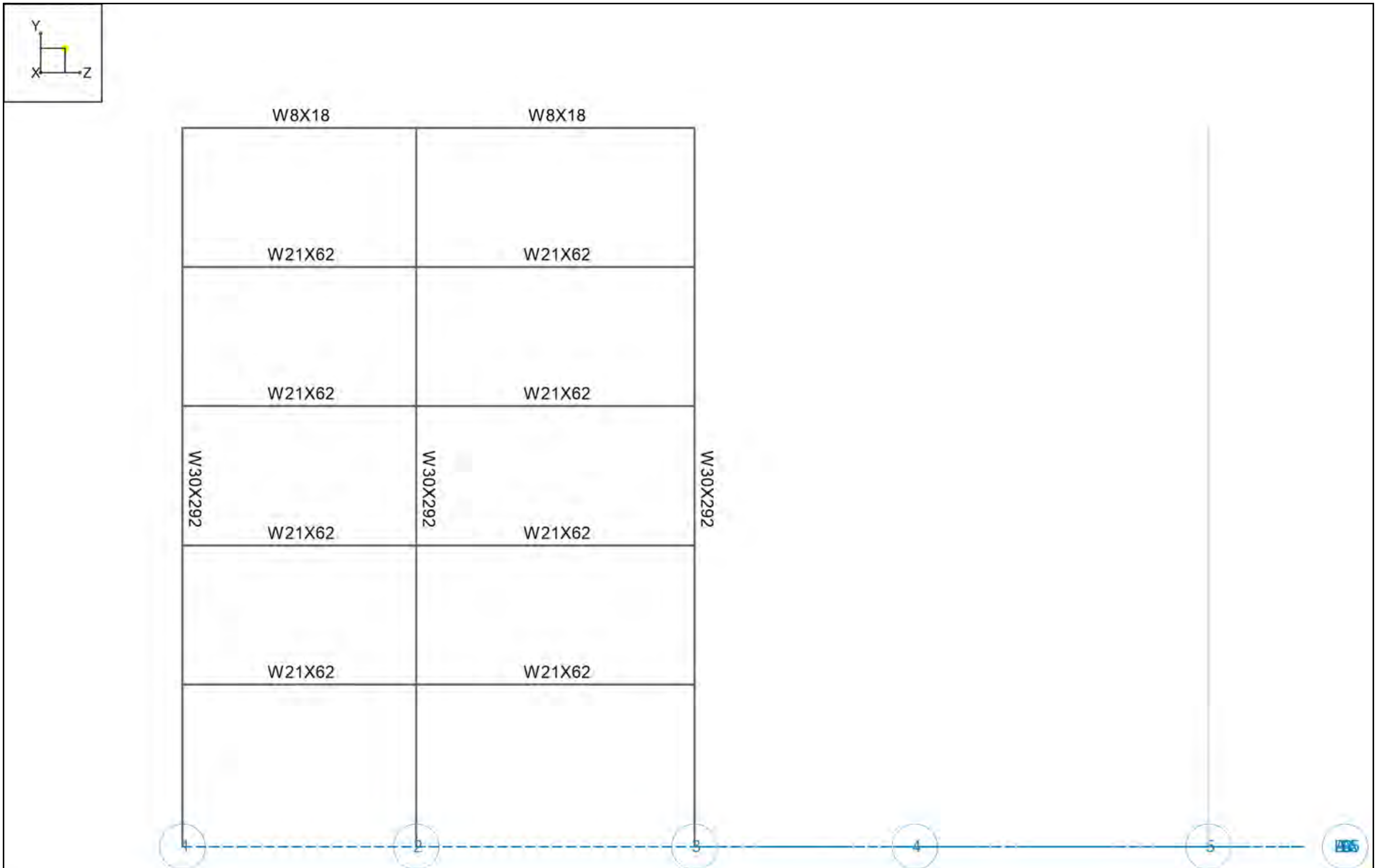
Envelope Only Solution

		18
		May 01, 2021
	EAST FRAMING ELEVATION	Hellier_Sub5_Risa3d.r3d



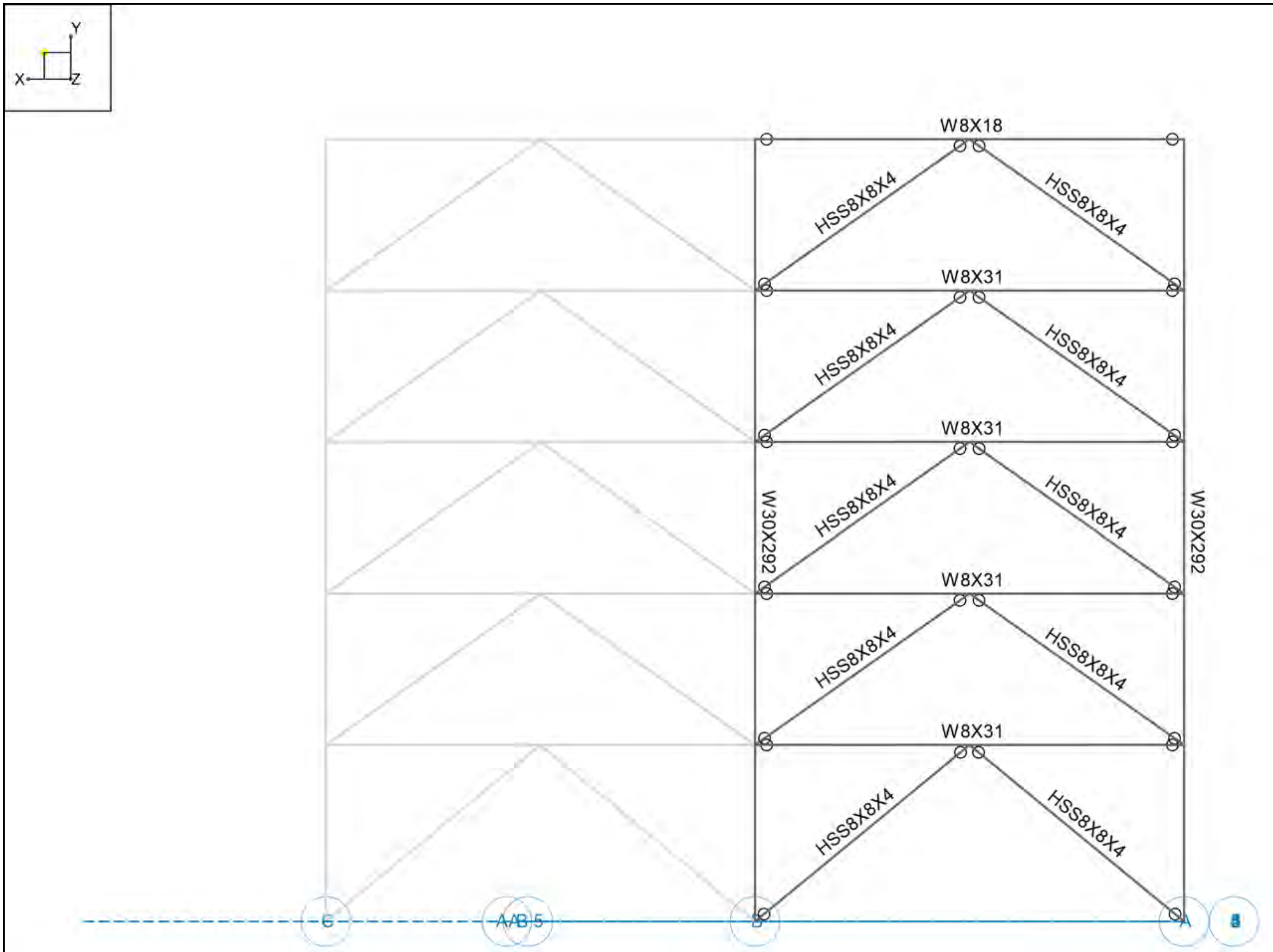
Envelope Only Solution

		20
		May 01, 2021
	NORTH FRAMING ELEVATION	Hellier_Sub5_Risa3d.r3d



Envelope Only Solution

		22
		May 01, 2021
	SOUTH FRAMING ELEVATION	Hellier_Sub5_Risa3d.r3d



Envelope Only Solution

		21
		May 01, 2021
	WEST FRAMING ELEVATION	Hellier_Sub5_Risa3d.r3d

Node Deflections:

NODE	Location: Floor	Location: Grid Int.		X (North-South) (in)	Load Case	Y (Vertical) (in)	Load Case	Z (East-West) (in)	Load Case	APPLICABLE BAY	
F5_N55	Roof	A-1	max	0.336	34	0.011	59	1.573	28		WEST BRACED FRAME
			min	-0.32	51	-0.033	9	-1.554	37	SOUTH MOMENT FRAME	
F5_N9	Roof	A-3	max	0.317	22	0	59	1.573	28		
			min	-0.303	47	-0.052	3	-1.554	37		
F5_N12	Roof	C-3	max	0.317	22	0	58	1.581	24	NORTH MOMENT FRAME	
			min	-0.303	47	-0.056	3	-1.558	33		
F5_N53	Roof	C-1	max	0.336	34	0.008	60	1.581	24		
			min	-0.32	51	-0.029	9	-1.558	33		
F5_N54	Roof	B-1	max	0.336	34	0	61	1.568	24		
			min	-0.32	51	-0.055	4	-1.547	33		
F5_N19	Roof	B-5	max	0.356	22	0.014	58	1.568	24	EAST BRACED FRAME	
			min	-0.344	47	-0.037	4	-1.547	33		
F5_N21	Roof	C-5	max	0.356	22	0	60	1.581	24		
			min	-0.344	47	-0.044	3	-1.558	33		

Envelope Story Drift - X-Direction, Strength

(North-South Transverse Direction)

	Story (Elevation)		Story Drift[in]	Loc (Z,X)	LC	Drift Ratio (%)	Loc (Z,X)	LC	2nd/1st Ratio	Loc (Z,X)	LC
1	Diaph.: 1 (62 ft)	max	0.186	88.5, 34	22	0.129	88.5, 34	22	1.015	0, 0	8
2		min	-0.17	88.5, 34	47	0.001	88.5, 34	21	0.964	0, 68	45
3	Diaph.: 2 (50 ft)	max	0.245	88.5, 34	22	0.17	88.5, 34	22	1.02	0, 0	16
4		min	-0.23	88.5, 68	47	0	88.5, 34	21	0.962	0, 0	9
5	Diaph.: 3 (38 ft)	max	0.294	88.5, 34	22	0.204	88.5, 34	22	1.044	88.5, 34	17
6		min	-0.283	88.5, 34	47	0	88.5, 34	21	0.945	0, 68	9
7	Diaph.: 4 (26 ft)	max	0.321	88.5, 68	22	0.223	88.5, 68	22	1.062	0, 0	16
8		min	-0.315	88.5, 68	47	0	88.5, 68	21	0.969	0, 68	45
9	Diaph.: 5 (14 ft)	max	0.38	88.5, 68	22	0.226	88.5, 68	22	1.041	88.5, 68	25
10		min	-0.379	88.5, 34	23	0	88.5, 68	21	0.967	88.5, 68	28

Envelope Story Drift - Z-Direction, Strength

(East-West Longitudinal Direction)

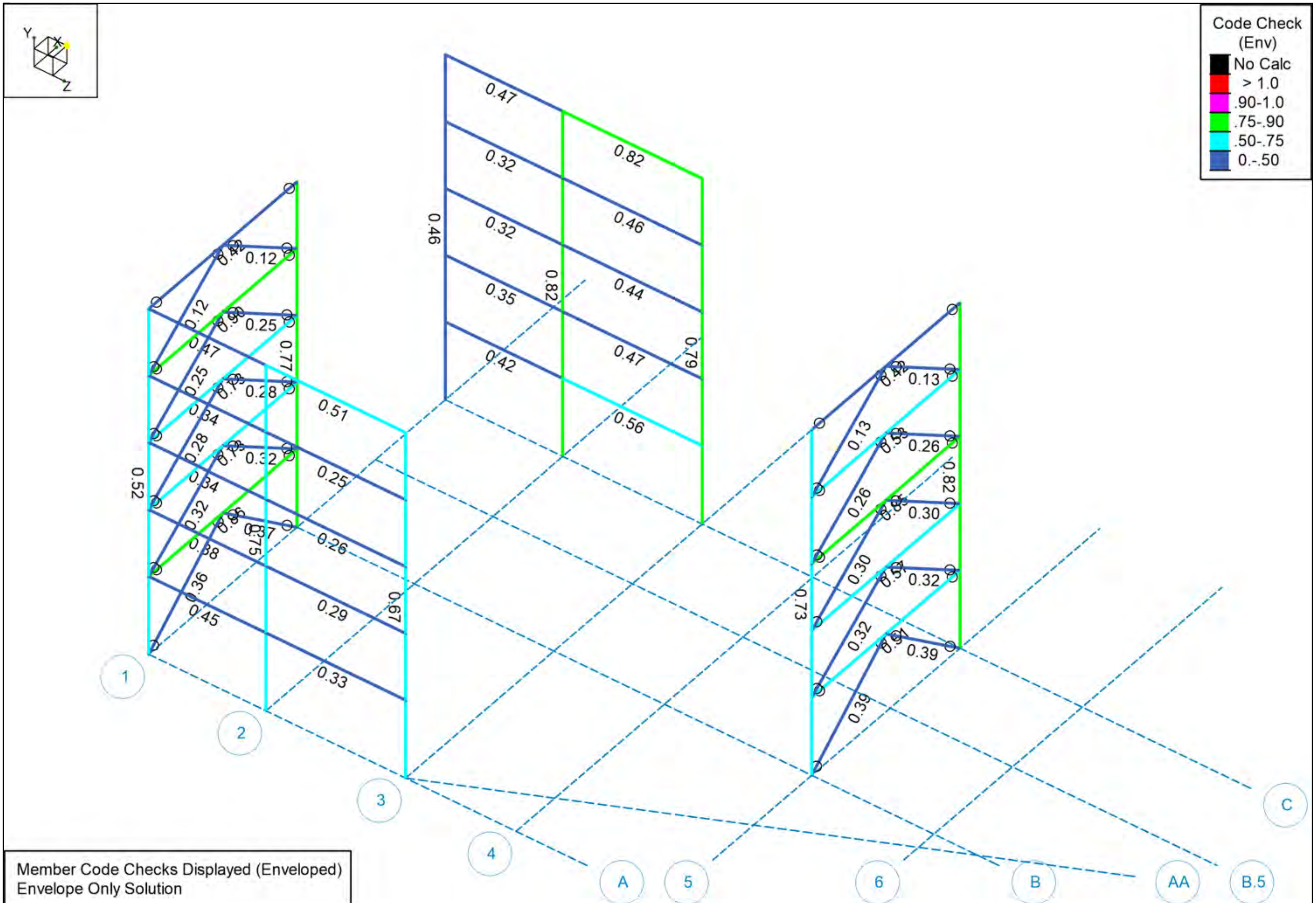
	Story (Elevation)		Story Drift[in]	Loc (Z,X)	LC	Drift Ratio (%)	Loc (Z,X)	LC	2nd/1st Ratio	Loc (Z,X)	LC
1	Diaph.: 1 (62 ft)	max	1.022	88.5, 68	24	0.71	88.5, 68	24	1.032	0, 0	9
2		min	-1.001	88.5, 68	41	0	88.5, 68	19	1	88.5, 68	19
3	Diaph.: 2 (50 ft)	max	1.039	88.5, 68	24	0.722	88.5, 68	24	1.035	44.167, 0	9
4		min	-1.019	88.5, 68	33	0	0, 68	19	1	0, 68	19
5	Diaph.: 3 (38 ft)	max	1.147	88.5, 68	24	0.797	88.5, 68	24	1.04	88.5, 68	8
6		min	-1.129	88.5, 68	33	0	0, 68	19	1	88.5, 68	47
7	Diaph.: 4 (26 ft)	max	1.31	88.5, 68	24	0.91	88.5, 68	24	1.051	88.5, 68	3
8		min	-1.294	88.5, 68	25	0	0, 68	19	0.999	0, 68	47
9	Diaph.: 5 (14 ft)	max	1.806	88.5, 68	24	1.075	88.5, 68	24	1.073	44.167, 68	3
10		min	-1.79	88.5, 68	25	0	88.5, 68	19	0.998	88.5, 68	47

Envelope AISC 15th (360-16): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	phi*Pnc [k]	phi*Pnt [k]	phi*Mn y-y [k-ft]	phi*Mn z-z [k-ft]	Cb	Eqn
1	F5_M13	W8X18	0.821	24	3	0.121	24	y	3	21.708	236.7	17.475	40.064	2.104	H1-1b
2	F5_M21	W8X18	0.508	0	3	0.104	0	y	5	21.708	236.7	17.475	48.766	2.561	H1-1b
3	F5_M42	W8X18	0.42	17	4	0.037	17	y	4	10.816	236.7	17.475	16.745	1.306	H1-1b
4	F5_M43	W8X18	0.471	0	4	0.102	0	y	4	30.744	236.7	17.475	49.379	2.102	H1-1b
5	F5_M39	W8X18	0.471	20.167	3	0.102	20.167	y	3	30.744	236.7	17.475	49.426	2.104	H1-1b
6	F4_M13	W21X62	0.464	24	8	0.119	24	y	8	156.611	823.5	81.375	455.295	2.129	H1-1b
7	F4_M21	W21X62	0.253	0	29	0.06	24	y	8	156.611	823.5	81.375	499.458	2.336	H1-1b
8	F4_M42	W8X31	0.899	17	4	0.254	17	y	3	50.349	410.85	52.791	64.621	1.3	H1-1b
9	F4_M43	W21X62	0.344	0	9	0.115	0	y	9	221.807	823.5	81.375	540	2.154	H1-1b
10	F4_M39	W21X62	0.316	20.167	9	0.104	20.167	y	9	221.807	823.5	81.375	540	2.223	H1-1b
11	F3_M13	W21X62	0.439	24	8	0.108	24	y	8	156.611	823.5	81.375	458.934	2.146	H1-1b
12	F3_M21	W21X62	0.262	24	28	0.058	24	y	8	156.611	823.5	81.375	504.457	2.359	H1-1b
13	F3_M42	W8X31	0.728	17	4	0.205	17	y	3	50.349	410.85	52.791	64.695	1.301	H1-1b
14	F3_M43	W21X62	0.339	0	9	0.107	0	y	9	221.807	823.5	81.375	540	2.173	H1-1b
15	F3_M39	W21X62	0.316	20.167	9	0.098	20.167	y	9	221.807	823.5	81.375	540	2.231	H1-1b
16	F2_M13	W21X62	0.475	24	8	0.114	24	y	8	156.611	823.5	81.375	461.332	2.157	H1-1b
17	F2_M21	W21X62	0.292	24	28	0.064	24	y	8	156.611	823.5	81.375	502.955	2.352	H1-1b
18	F2_M42	W8X31	0.728	17	3	0.205	17	y	4	50.349	410.85	52.791	64.755	1.302	H1-1b
19	F2_M43	W21X62	0.377	0	9	0.115	0	y	9	221.807	823.5	81.375	540	2.184	H1-1b
20	F2_M39	W21X62	0.354	20.167	9	0.106	20.167	y	9	221.807	823.5	81.375	540	2.237	H1-1b
21	F1_M13	W21X62	0.561	24	8	0.132	24	y	8	156.611	823.5	81.375	460.581	2.154	H1-1b
22	F1_M21	W21X62	0.334	0	29	0.074	24	y	8	156.611	823.5	81.375	492.544	2.303	H1-1b
23	F1_M42	W8X31	0.862	17	4	0.243	17	y	3	50.349	410.85	52.791	64.932	1.306	H1-1b
24	F1_M43	W21X62	0.448	0	9	0.136	20.167	y	8	221.807	823.5	81.375	540	2.182	H1-1b
25	F1_M39	W21X62	0.42	0	8	0.124	20.167	y	13	221.807	823.5	81.375	540	2.186	H1-1b
26	F5_M62	W8X18	0.423	17	3	0.037	17	y	3	10.816	236.7	17.475	16.745	1.306	H1-1b
27	F4_M38	W10X45	0.53	17	3	0.192	17	y	3	72.47	598.5	76.125	126.384	1.279	H1-1b
28	F3_M38	W8X31	0.853	17	4	0.241	17	y	3	50.349	410.85	52.791	64.671	1.301	H1-1b
29	F1_M32	W10X45	0.513	17	4	0.186	17	y	3	72.47	598.5	76.125	127.667	1.291	H1-1b
30	M49	HSS8X8X4	0.366	11.241	26	0.003	22.023	y	2	191.318	319.5	70.043	70.043	1.136	H1-1a
31	M50	HSS8X8X4	0.316	10.188	27	0.003	20.809	y	25	202.132	319.5	70.043	70.043	1.136	H1-1a
32	M51	HSS8X8X4	0.316	10.621	26	0.003	20.809	y	25	202.132	319.5	70.043	70.043	1.136	H1-1a
33	M52	HSS8X8X4	0.283	10.188	27	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
34	M56	HSS8X8X4	0.283	10.621	26	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
35	M57	HSS8X8X4	0.245	10.188	27	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
36	M58	HSS8X8X4	0.245	10.621	26	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
37	M59	HSS8X8X4	0.12	0	27	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1b*
38	M60	HSS8X8X4	0.12	20.809	34	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1b*
39	M54	HSS8X8X4	0.388	11.241	22	0.003	22.023	y	2	191.318	319.5	70.043	70.043	1.136	H1-1a
40	M55	HSS8X8X4	0.322	10.188	23	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
41	M61	HSS8X8X4	0.322	10.621	22	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a

Envelope AISC 15th (360-16): LRFD Steel Code Checks (Continued)

	Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	phi*Pnc [k]	phi*Pnt [k]	phi*Mn y-y [k-ft]	phi*Mn z-z [k-ft]	Cb	Eqn
42	M62	HSS8X8X4	0.303	10.188	23	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
43	M64	HSS8X8X4	0.265	10.188	31	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
44	M65	HSS8X8X4	0.264	10.621	22	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a
45	M66	HSS8X8X4	0.127	0	31	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1b*
46	M67	HSS8X8X4	0.127	20.809	22	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1b*
47	M68	HSS8X8X4	0.387	10.782	23	0.003	22.023	y	2	191.318	319.5	70.043	70.043	1.136	H1-1a
48	M69	HSS8X8X4	0.365	11.241	27	0.003	22.023	y	2	191.318	319.5	70.043	70.043	1.136	H1-1a
49	C-B5	W24X250	0.73	62	4	0.002	32.938	y	3	295.483	3307.5	641.25	2790	2.66	H1-1a
50	C-C5	W24X250	0.817	62	3	0.002	32.938	y	4	295.483	3307.5	641.25	2790	2.557	H1-1a
51	C-C3	W30X292	0.789	48.438	3	0.019	36.167	y	8	448.938	3870	836.25	3251.786	1.847	H1-1a
52	C-C2	W30X292	0.82	62	3	0.029	36.167	y	17	448.938	3870	836.25	3359.447	1.908	H1-1a
53	C-C1	W30X292	0.458	48.438	9	0.017	62	y	9	448.938	3870	836.25	3975	2.564	H1-1a
54	C-B1	W30X292	0.774	0	4	0.002	50.375	y	35	448.938	3870	836.25	2378.746	1.351	H1-1a
55	C-A1	W30X292	0.521	48.438	9	0.017	37.458	y	9	448.938	3870	836.25	3975	2.636	H1-1a
56	C-A3	W30X292	0.666	62	3	0.015	62	y	8	448.938	3870	836.25	3362.352	1.91	H1-1a
57	C-A2	W30X292	0.748	62	3	0.027	36.167	y	12	448.938	3870	836.25	3275.947	1.861	H1-1a
58	M63	W8X31	0.57	0	3	0.195	0	y	4	50.349	410.85	52.791	67.757	1.363	H1-1b
59	M78	HSS8X8X4	0.303	10.621	22	0.003	20.809	y	2	202.132	319.5	70.043	70.043	1.136	H1-1a



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		May 01, 2021
	UNITY CHECK - DRIFT/DEFLECTION GOVERNS	Hellier_Sub5_Risa3d.r3d