

ATC 154 Project – Steel SMF Conceptual Design: Risk Category IV

The following is a report summarizing the conceptual design of steel special moment frames for the *Risk Category IV* designated archetype for the ATC 154 Project, prepared by the AISC Steel Solutions Center (SSC). This is an additional conceptual design requested for a *Risk Category IV* archetype beyond the original three conceptual Risk Category II archetypes for steel special moment frame designs in an archetype steel structure subjected to three different levels of seismicity ranging from high to ‘ultra’ high. The designed moment frames will form the basis of advanced analytical modeling to be carried out at the University of Washington to investigate if there is a higher probability of collapse for code-designed seismic force systems when going from high seismicity to very high seismicity.

Archetype Design Criteria

The conceptual steel moment frame design prepared by the SSC for the *Risk Category IV* archetype is based on the archetype layouts and design criteria provided by John Hooper of MKA and Jim Harris of J.R. Harris & Company – who developed the preliminary archetype layouts and seismic design parameters. The layout for the *Risk Category IV* archetype is the same as the Risk Category II archetypes except for the occupancy, allowable story drift, and loading criteria.

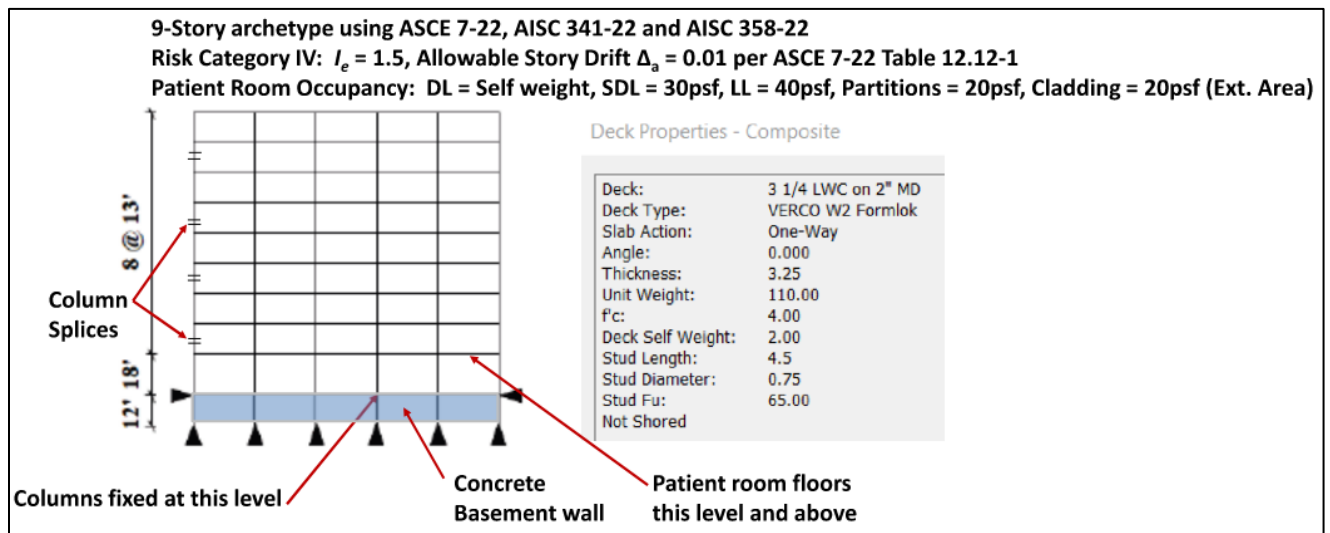


Figure 1: Elevation with Defined Loading and Base Boundary Conditions

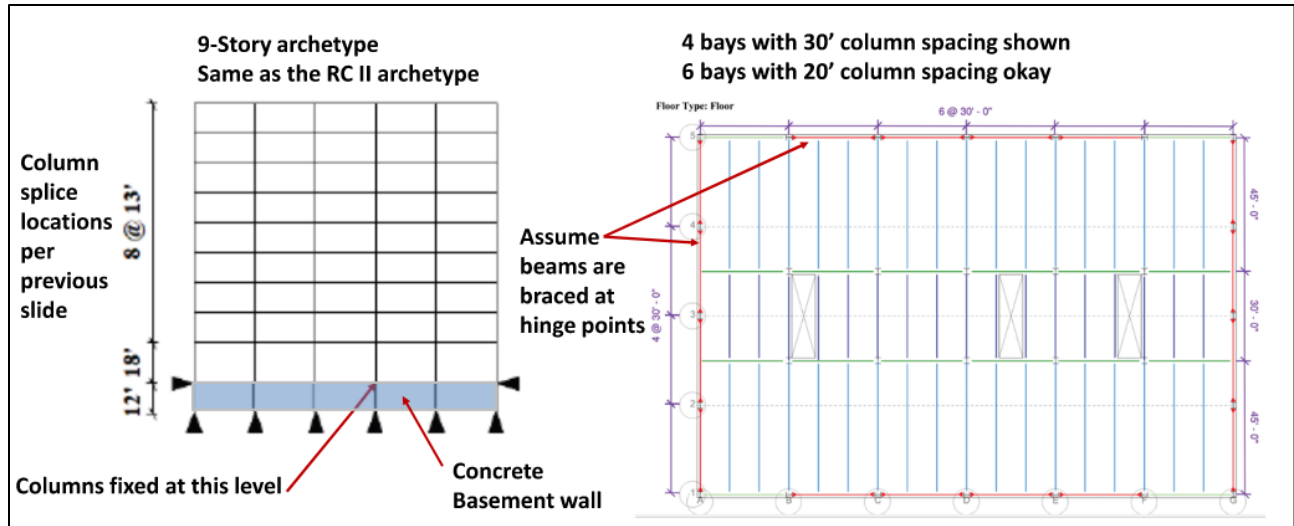


Figure 2: Elevation and Typical Floor Plan. See Appendix 1 for gravity framing sizes (Sized by MKA)

The following criteria was also given:

- Member sizes (need to meet AISC 358 prequalification criteria)
 - Columns: W14
 - Beams: up to W36
- Connections (need to meet AISC 358 prequalification criteria)
 - Either WUF-W or RBS (the ATC-154 team recommended RBS connections as WUF-W connections are not pre-qualified to the likely seismic demands from the very high and ultra-high design cases). Therefore, the SSC chose to use RBS.
- Follow AISC 341 for final sizing and detailing of beam-column joint

Seismic Design Criteria

The seismic design criteria given for each archetype is shown in the table below. The blue shading denotes the archetype design included in this report. The seismic design criteria for this archetype is the same as the *High D* archetype.

Table 1: Seismic Design Parameters for Steel Frame Archetypes

Recommendations for Archetype Designs						
Archetype Name		S_{Ms}	S_{Ds}	S_{M1}	S_{D1}	S_1
Risk Category II	High D	1.5	1.0	0.9	0.6	0.47
	Very High Seismic	2.25	1.5	1.8	1.2	0.72
	Ultra High Seismic	3.0	2.0	2.7	1.8	1.07
Risk Category IV		1.5	1.0	0.9	0.6	0.47

Note: blue shading denotes archetype design included in this report

Where,

S_{MS} = The spectral response acceleration parameter at short periods adjusted for site class effects as determined in accordance with Section 11.4.3 of ASCE 7-22 for the risk-targeted maximum considered earthquake (MCE_R), 5% damped

S_{DS} = Design earthquake spectral response acceleration parameters at short periods as determined in accordance with Section 11.4.4 of ASCE 7-22

S_{M1} = MCE_R , 5% damped, spectral response acceleration parameter at a period of 1 second adjusted for site class effects as determined in accordance with Section 11.4.3 of ASCE 7-22

S_{D1} = Design, 5% damped, spectral response acceleration parameter at a period of 1 s as defined in Section 11.4.4 of ASCE 7-22

S_1 = MCE_R , 5% damped, spectral response acceleration parameter at a period of 1 s for Site Class BC site conditions as determined in accordance with Section 11.4.3 of ASCE 7-22

Conceptual Steel Special Moment Frame Design: Very High Seismic Archetype

The SSC utilized Bentley Systems RAM Structural System and RAM Frame to perform the lateral analysis and design the steel moment frames. The study structural model is based on the structural layout provided to us in the archetype design drawings. Gravity framing included in the model was as shown in the gravity design provided by MKA (see Appendix 1), which was revised from the gravity design provided for the Risk Category II archetypes. A typical floor framing plan and frame elevations are shown in Appendix 2.

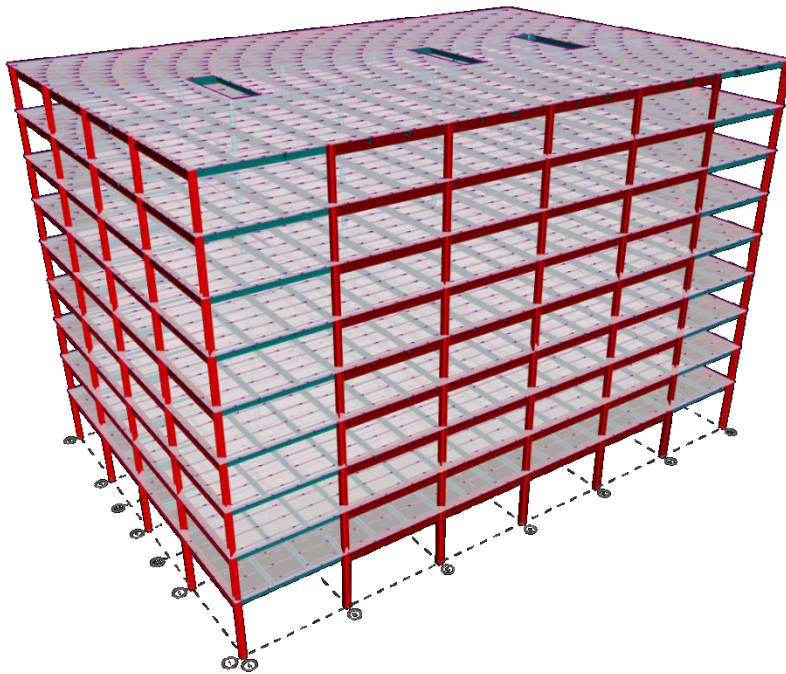


Figure 3: 3D rendering of archetype structure

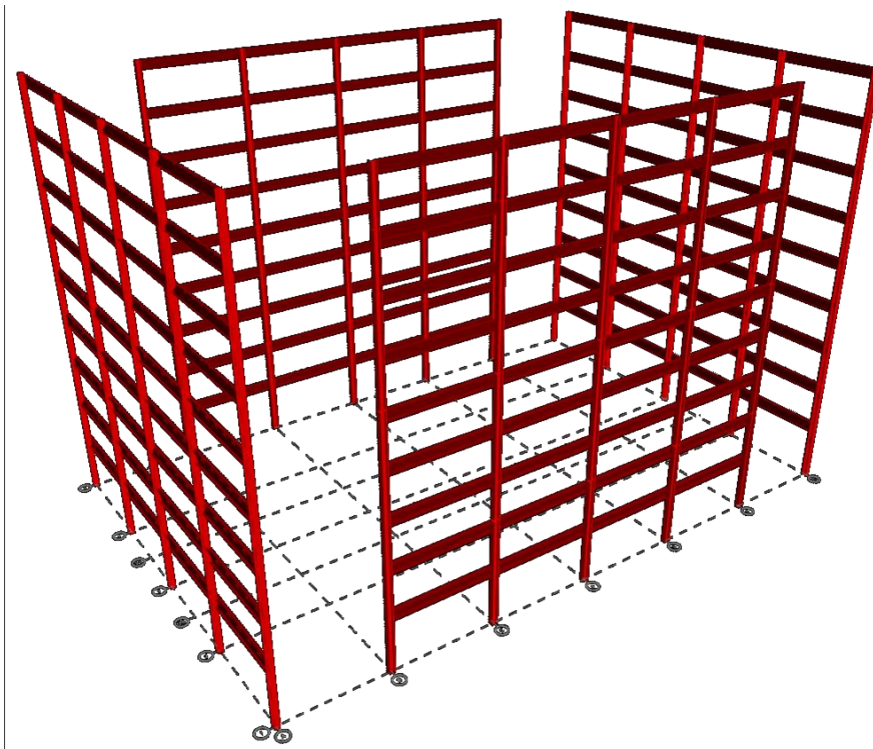


Figure 4: 3D rendering of archetype lateral frames only

Modeling Assumptions and Notes

The archetype was designed with loading and criteria per ASCE 7-22 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE 7). Modal Response Spectrum Analysis was used per Section 12.9.1 of ASCE 7, with parameters for each mode combined using the complete quadratic combination (CQC) method. As agreed to at a coordination meeting in December of 2022, design checks were made based on LRFD requirements using AISC 360-16 *Specification for Structural Steel Buildings* (AISC 360), AISC 341-16 *Seismic Provisions for Structural Steel Buildings* (AISC 341), and AISC 358 *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (AISC 358). This was done due to the current capabilities of the analysis software used by AISC staff and minimizing the time needed to complete this analysis. AISC staff did not investigate the impacts that the use of the 2022 AISC Standards would have on the overall design with the exception that sections used in the design satisfy the seismic width-to-thickness requirements for highly ductile shapes per AISC 341-22. However, it is believed that the design would be generally consistent with AISC 360-22, AISC 341-22, and AISC 358-22.

The following is a list of assumptions and notes regarding the archetype lateral structural model:

1. A separate model for drift and strength were utilized. Both models were identical with a few key differences. This allowed the SSC to take advantage of provisions in Section 12.8.6 of ASCE 7 for the determination of displacements and drifts. For strength checks, the Direct Analysis Method was used per AISC 360 using reduced stiffnesses with $\tau_b = 1.0$. Unreduced stiffnesses were used in the determination of building periods and story drifts. See Appendix 3 for the analysis criteria used in RAM Frame for drift and strength.

2. Beams were assumed to be continuously braced. Based on discussions with MKA, it is our understanding that discrete beam bracing would be provided to satisfy the lateral bracing requirements of AISC 341 and AISC 358. For simplicity, this bracing was not included in the model.
3. Columns were assumed fixed at the base (i.e. at the top of the concrete basement wall). The concrete basement wall was not included in the model.
4. Reduced Beam Section (RBS) moment connections were utilized for all beam-column connections. The reduced section properties were used in the analysis.
5. Rigid end zone effects were not included, which is typical in the design of steel moment frames.
6. P-delta effects were included in the design of the frames for both drift and strength. The SSC used procedures recommended by Bentley that can be found on their help page [here](#).
7. Rigid diaphragms were used at each level.
8. Materials:
 - a. Beams and columns: $F_y = 50$ ksi
 - b. Web plates and stiffener plates: $F_y = 50$ ksi
9. By inspection the structure is classified as regular and does not have any horizontal or vertical irregularities. (Note – the structure was checked for a torsional irregularity and the structure was found to not have a torsional irregularity). Therefore, accidental torsion was not included in the strength model per Section 12.8.4.2 of ASCE 7. Accidental torsion was included in the drift model to check for a torsional irregularity. Since the structure does meet any of the conditions listed in Section 12.5.4, the Independent Directional Procedure method per Section 12.5.1.1 of ASCE 7 was used.

Base Shear Calculation

The following is a summary of the base shear calculations for drift and strength. More detailed information can be found in Appendix 4. Base shear results are shown below for the Equivalent Lateral Force (ELF) method and Modal Response Spectrum Analysis (RSA). RSA base shear results were within 1% of ELF base shears for strength (after scaling). Unless otherwise noted, values pertain to both X and Y directions.

$$R = 8$$

$$\Omega_o = 3$$

$$C_d = 5.5$$

$$\text{Seismic Weight, } W = 22,244 \text{ kips}$$

$$\text{Period, } T = 2.186 \text{ sec (E-W or X-dir. period per RAM)}$$

$$\text{Period, } T = 2.187 \text{ sec (N-S or Y-dir. period per RAM)}$$

$$T_a = 1.307 \text{ sec}$$

$$C_u = 1.4 \text{ sec}$$

$$T\text{-used (drift)} = 2.186 \text{ sec}$$

$$C_s \text{ (drift)} = 0.051$$

$$\text{Base shear, } V \text{ (drift, ELF)} = 1,145 \text{ kips (shown for reference only)}$$

$$\text{Base shear, } V \text{ (drift, RSA)} = 1,062 \text{ kips (E-W or X-dir. per RAM)}$$

$$\text{Base shear, } V \text{ (drift, RSA)} = 1,055 \text{ kips (N-S or Y-dir. per RAM)}$$

$$\begin{aligned}T\text{-used (strength)} &= C_u * T_a = 1.83 \text{ sec} \\ C_s \text{ (strength)} &= 0.066 \\ \text{Base shear, } V \text{ (strength)} &= 1,468 \text{ kips}\end{aligned}$$

The combined response for the modal base shear using RSA, V_t in the strength model was found to be less than 100% of the calculated base shear using the ELF procedure, V for both orthogonal directions. Therefore, the RSA base shear for strength was multiplied by V/V_t in accordance with Section 12.9.1.4 of ASCE 7. Displacements did not require scaling.

Story Drift Ratio Check

Resulting displacements and story drifts for the structure at the center of mass are shown in Appendix 5. Story drifts are all within the allowable story drift ratio, $\Delta_a = 0.01$. For practicality, the story drift ratio was converted to a maximum allowable elastic drift ratio of 0.0027 (maximum allowable elastic drift ratio = allowable drift ratio * $I_e / C_d = 0.01 * 1.5 / 5.5 = 0.0027$). This ratio was then directly compared to the drift ratios reported by RAM Frame.

Stability Coefficient Check

The resulting stability coefficients for each level are shown in Appendix 6. The stability coefficients are all less than the maximum stability coefficient, $\theta_{max} = 0.091$ per Section 12.8.7 of ASCE 7. The β value used in the calculation of θ_{max} was conservatively taken as 1.0 per Section 12.8.7 of ASCE 7.

Design Capacity Ratios (DCRs)

The resulting demand-capacity ratios (DCRs) for each frame member are shown in Appendix 7. Design checks were made based on LRFD requirements using AISC 360, AISC 341, and AISC 358. The Direct Analysis Method was used per AISC 360 using reduced stiffnesses with $\tau_b = 1.0$. A P-delta analysis was used and B1 factors were applied. Strong column-weak beam requirements per AISC 341 were met for all frame members.

Reduced Beam Section (RBS) Properties

Reduced Beam Section (RBS) moment connections were used for all beam-column connections. The reduced section properties were used in the analysis. Reduced beam stiffness due to the RBS connection was therefore included in the analysis by direct modeling of the reduced section. The beam flange cut dimensions used in the analysis are shown in the figure below.

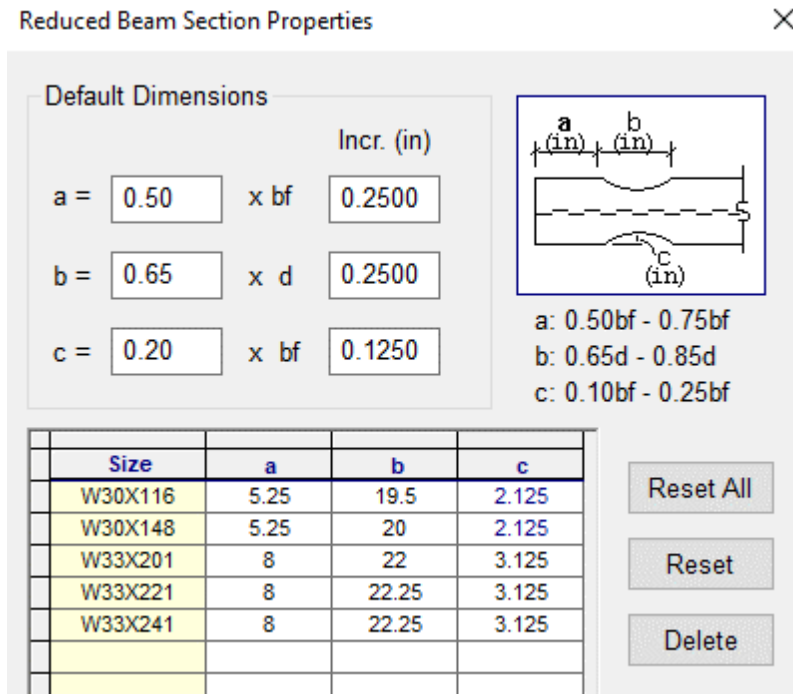


Figure 5: Reduced beam section properties

AISC Disclaimer

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List of Appendices

- Appendix 1: Gravity Design (provided by MKA)
- Appendix 2: Typical floor plan and frame elevations
- Appendix 3: Analysis criteria
- Appendix 4: Base shears, applied forces, building period
- Appendix 5: Drift checks
- Appendix 6: Stability coefficients
- Appendix 7: Frame demand capacity ratios (DCRs)

Archetype Floor Framing Study Changes

Old Office Floor Criteria:

- SDL = 15 psf
- LL = 50 psf
- Partitions = 15 psf
- Office Floor Vibration Analysis (< 16,000 MIPS)

New Patient Floor Criteria:

- SDL = 30 psf
- LL = 40 psf
- Partitions = 20 psf
- Patient Floor Vibration Analysis (< 6,000 MIPS)

Notes:

- Interior Bay beams and interior girders increase in size
- Column Sizes below Level 7 increase in size
- Connection details remain the same

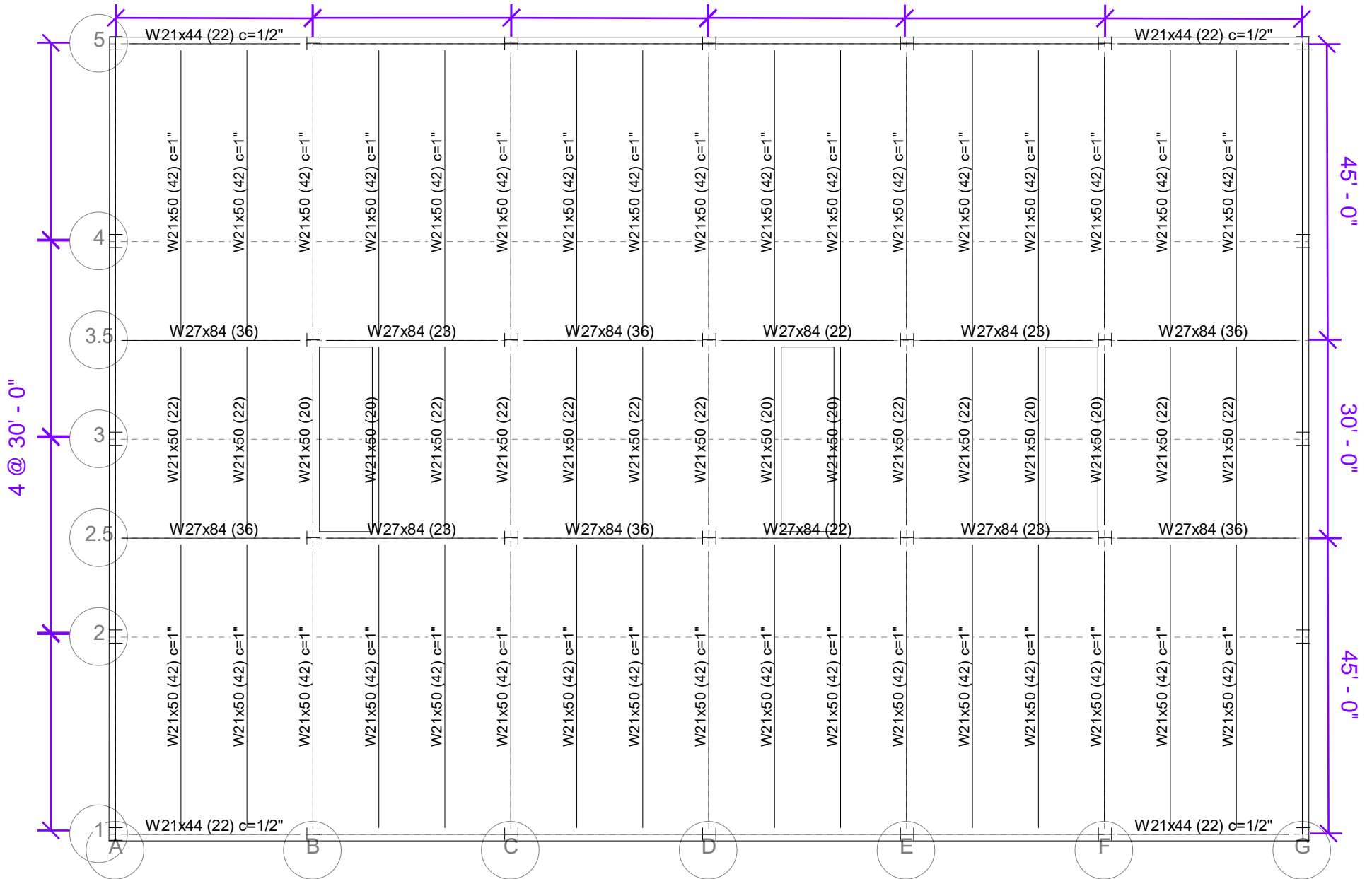
NEW PATIENT FLOOR GRAVITY DESIGN



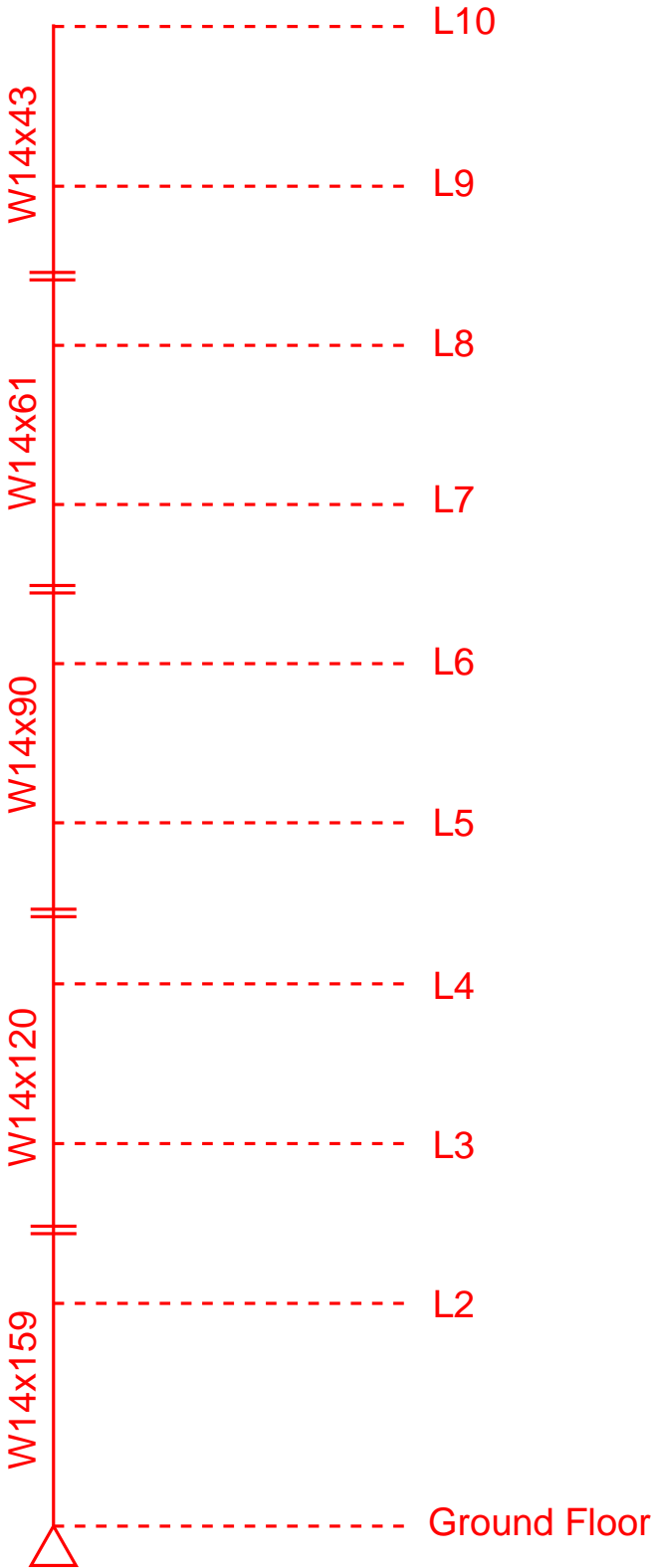
Floor Map

Floor Type: Floor

Beam Designs 6 @ 30' - 0"



Patient Floor Gravity Column Sizes



Floor Map

RAM Steel 17.04.02.12

Magnusson Klemencic Assoc.

DataBase: Floor Framing Study_Patient Floor_Archetype 1_FINAL Model

Building Code: IBC

01/27/23 11:40:39

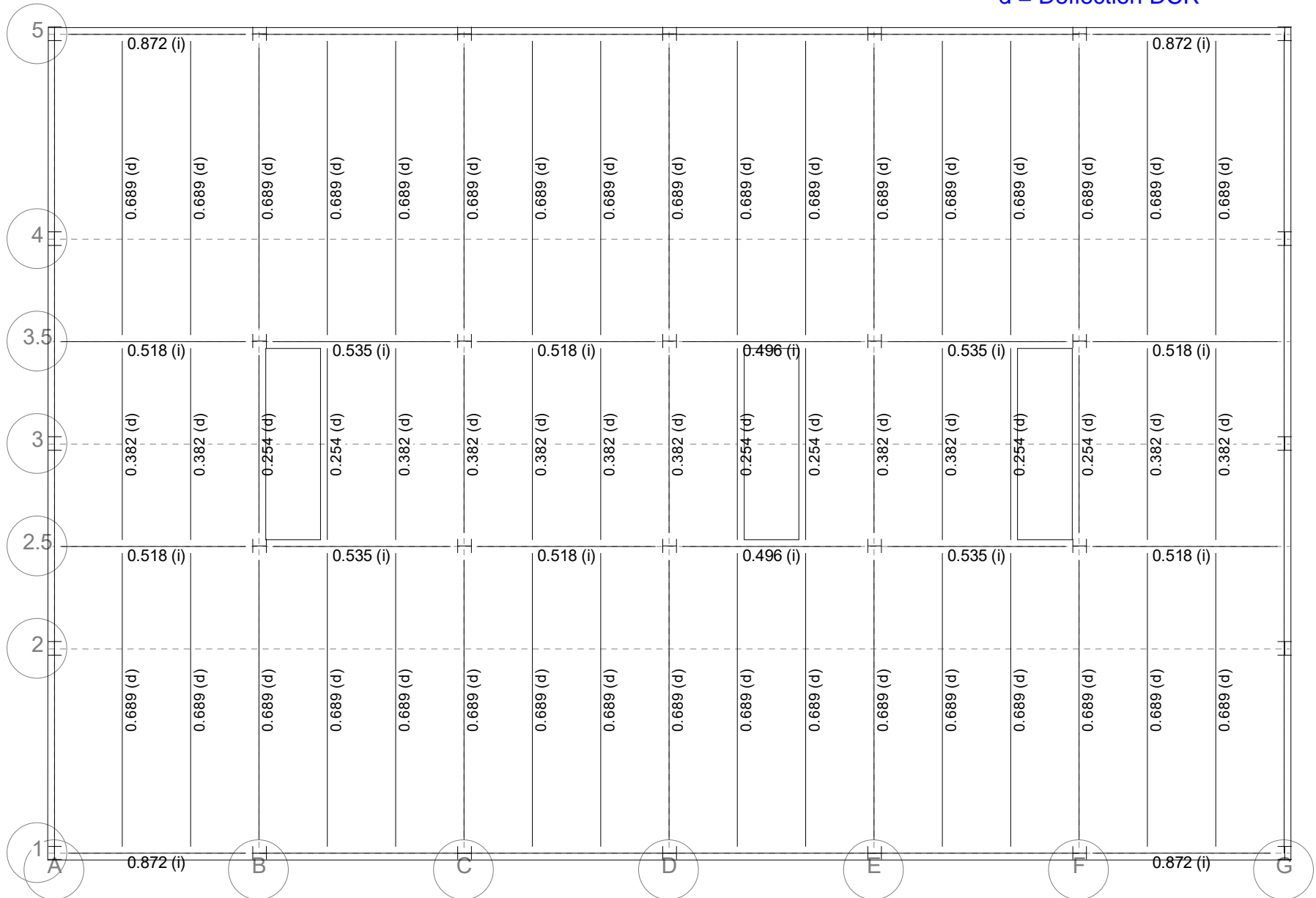
Steel Code: AISC 360-16 LRFD

Floor Type: Floor

Demand / Capacity Ratios: Controlling

i = Strength Interaction DCR

d = Deflection DCR



Gravity Column Design

RAM Steel 17.04.02.12

Magnusson Klemencic Assoc.

DataBase: PATIENT_Floor Framing Study_Archetype 1_FINAL Model

01/27/23 13:52:21

Building Code: IBC

Steel Code: AISC360-16 LRFD

Story level L2, Column Line C-3.5, Column # 38

Fy (ksi) = 50.00

Column Size = W14X159

Orientation (deg.) = 0.0

INPUT DESIGN PARAMETERS:

	X-Axis	Y-Axis
Lu (ft) _____	18.00	18.00
K _____	1	1
Braced Against Joint Translation _____	Yes	Yes
Column Eccentricity (in) Top _____	10.25	10.55
Bottom _____	0.00	0.00

CONTROLLING AXIAL COLUMN LOADS - Skip-Load Case 1:

	Dead	Live	Roof
Axial (kip) _____	795.45	358.55	0.00

DEMAND CAPACITY RATIO: (1.2DL + 1.6LL)

Pu (kip) = 1528.23	0.90Pnx (kip) = 1932.48	Pu/0.90Pnx = 0.791
	0.90Pny (kip) = 1698.37	Pu/0.90Pny = 0.900
	0.90Pn (kip) = 1698.37	Pu/0.90Pn = 0.900

DEMAND/CAPACITY LIMIT FOR STRENGTH : 1.000

CONTROLLING COMBINED COLUMN LOADS - Skip-Load Case 10:

	Dead	Live	Roof
Axial (kip) _____	795.45	353.15	0.00
Moments Top Mx (kip-ft) _____	0.47	0.24	0.00
My (kip-ft) _____	-2.11	-2.99	0.00
Bot Mx (kip-ft) _____	-0.00	0.00	0.00
My (kip-ft) _____	-0.00	-0.00	-0.00

Single curvature about X-Axis

Single curvature about Y-Axis

CALCULATED PARAMETERS: (1.2DL + 1.6LL)

Pu (kip) = 1519.59	0.90*Pn (kip) = 1698.37
Mux (kip-ft) = 0.94	0.90*Mnx (kip-ft) = 1076.25
Muy (kip-ft) = -7.31	0.90*Mny (kip-ft) = 547.50
Rm = 1.00	
Cbx = 1.67	
Cmx = 0.60	Cmy = 0.60
Pex (kip) = 11655.85	Pey (kip) = 4588.72
B1x = 1.00	B1y = 1.00

Gravity Column Design

RAM Steel 17.04.02.12

Magnusson Klemencic Assoc.

DataBase: PATIENT_Floor Framing Study_Archetype 1_FINAL Model 01/27/23 13:52:21

Building Code: IBC

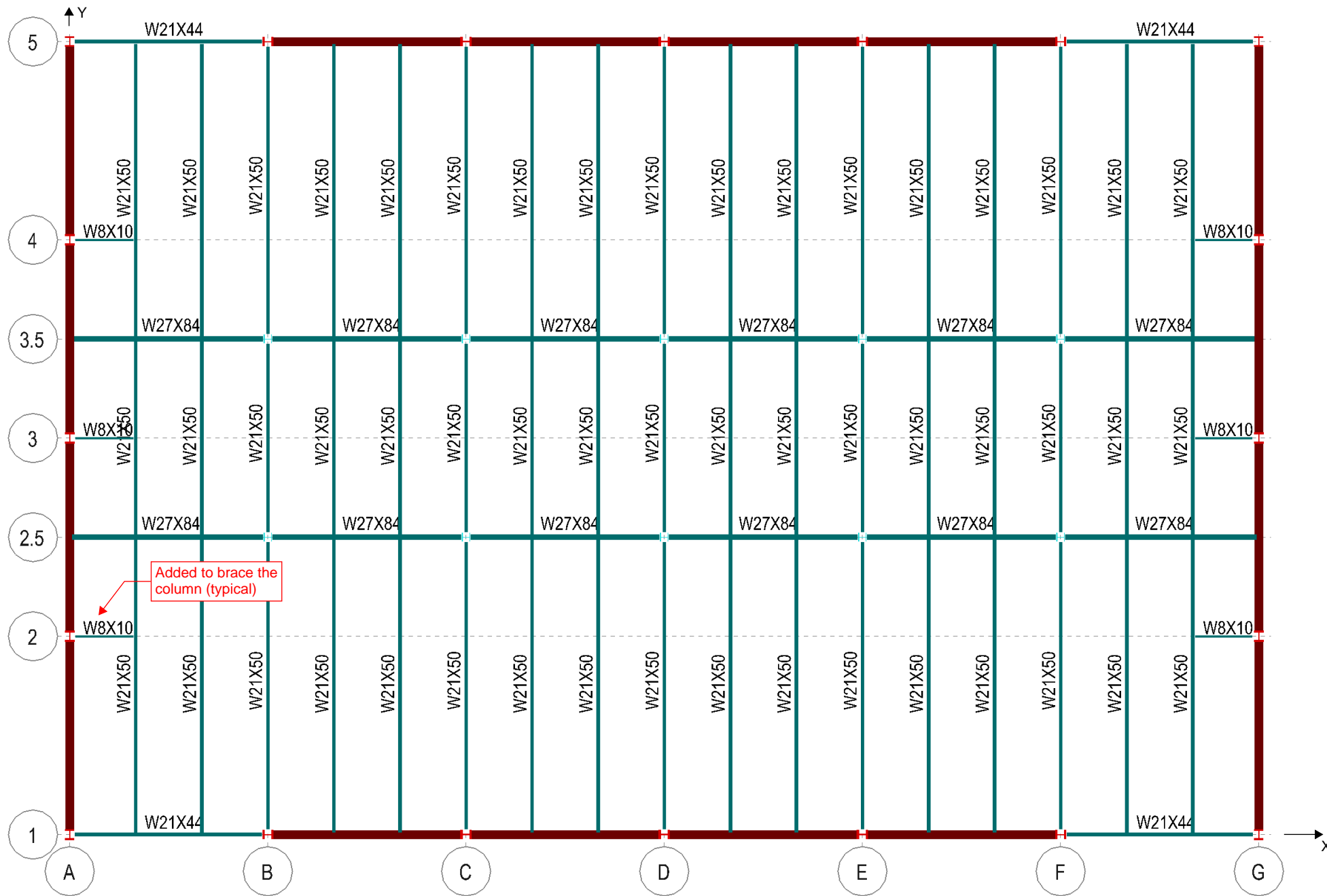
Steel Code: AISC360-16 LRFD

INTERACTION EQUATION

$$P_u/0.90 \cdot P_n = 0.895$$

$$\text{Eq H1-1a: } 0.895 + 8/9(0.001 + 0.013) = 0.907$$

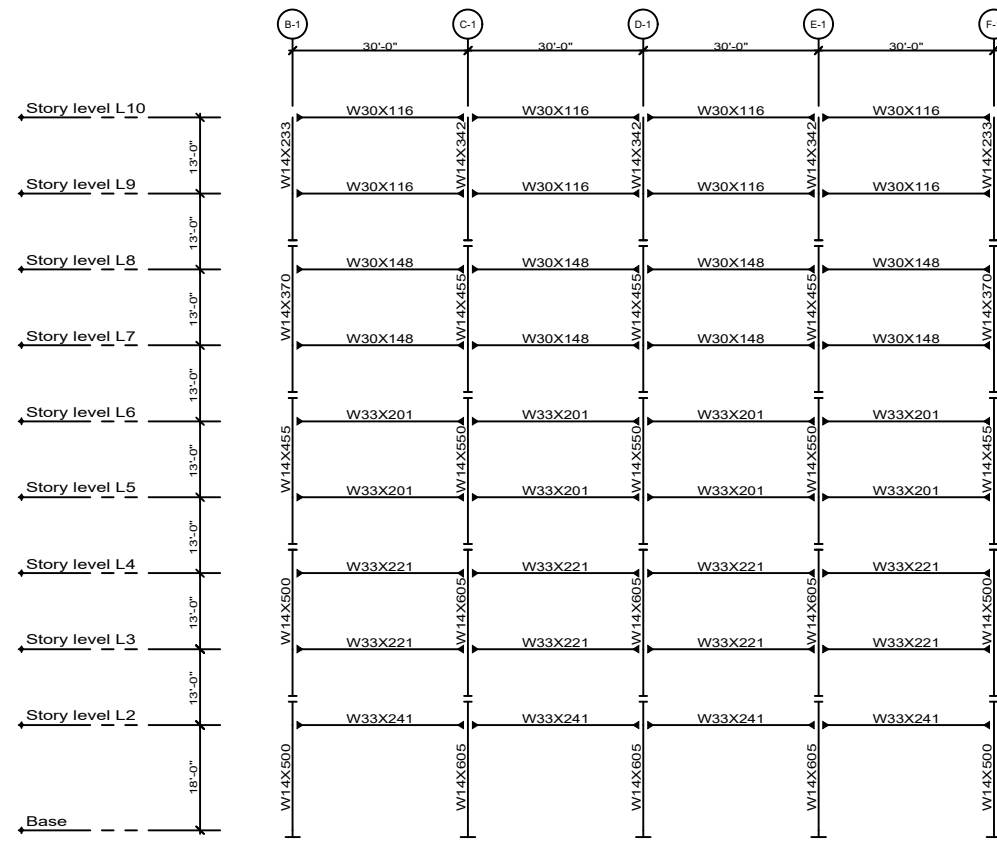
APPENDIX 2: TYPICAL FLOOR PLAN AND FRAME ELEVATIONS



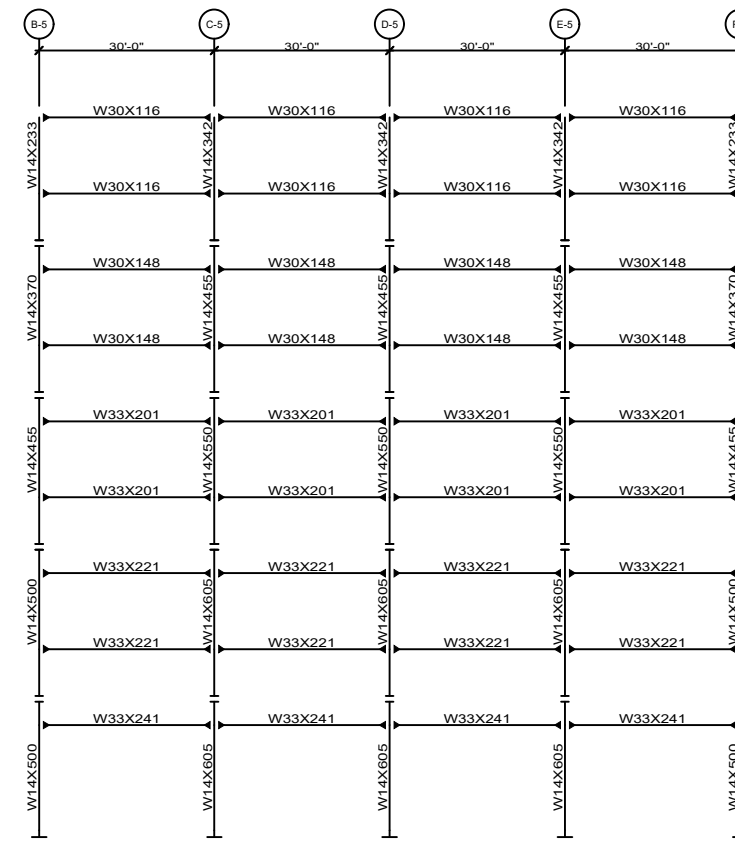
TYPICAL FLOOR PLAN



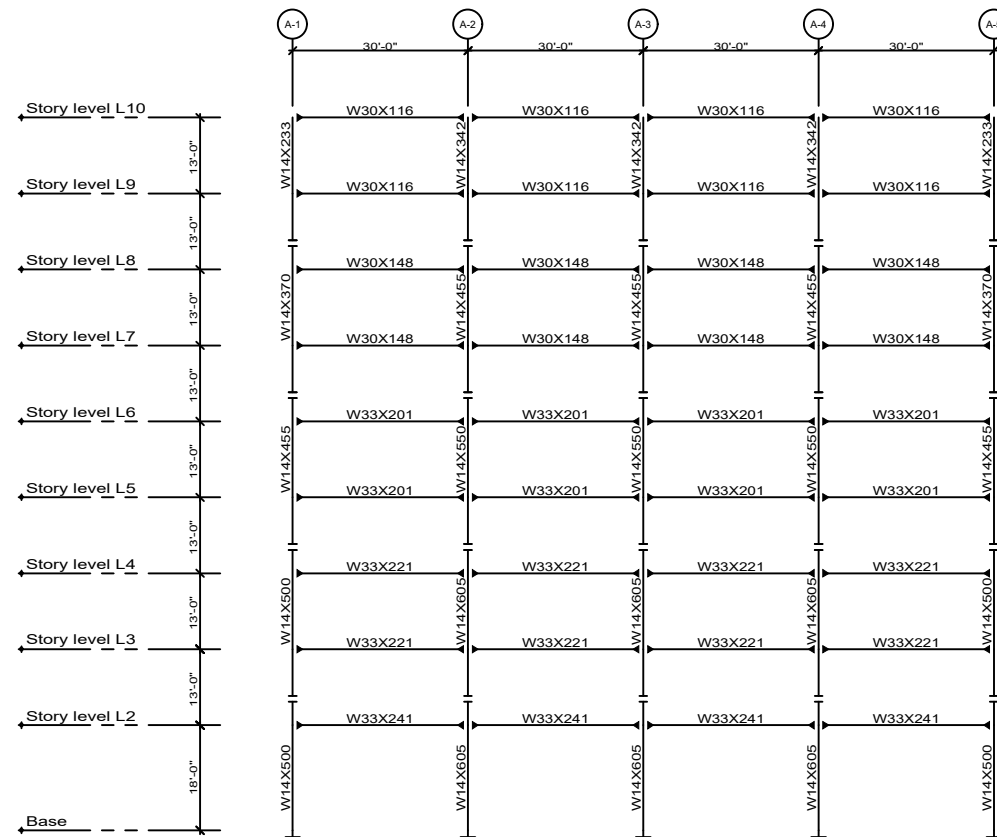
FRAME ELEVATIONS



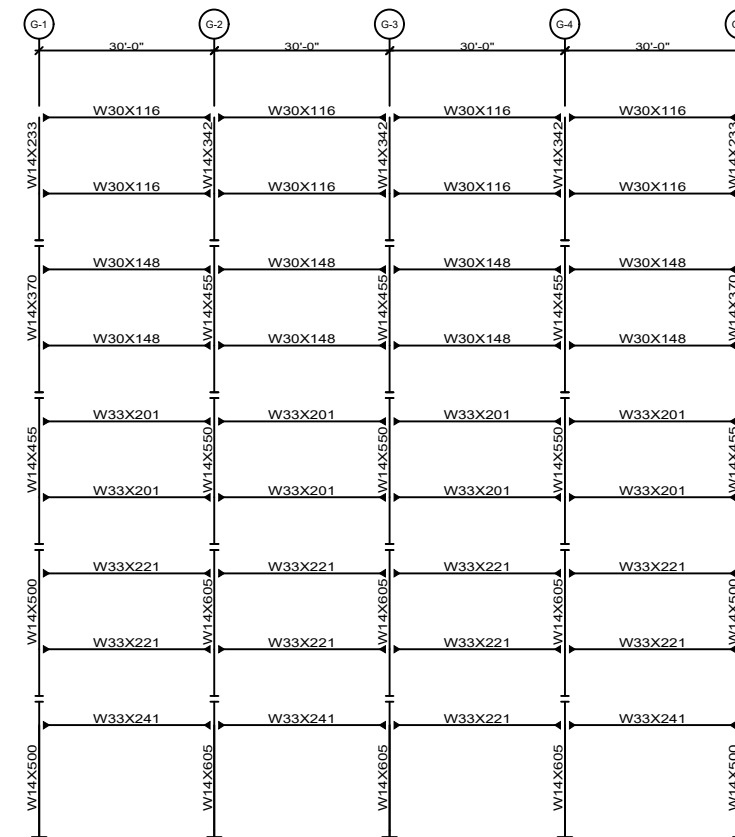
Frame along gridline 1



Frame along gridline 5



Frame along gridline A



Frame along gridline G

ANALYSIS CRITERIA FOR DRIFT:

APPENDIX 3: ANALYSIS CRITERIA

General Criteria

Rigid End Zones

- Ignore Effects
- Include Effects
- Reduction %:

Member Force Output

- At Face of Joint
- At Centerline of Joint

Response Spectra Analysis

- Consider Sign for Analysis Results
- Include nodal mass in Z-direction (applicable for semirigid diaphragms only)

Eigenvalue Analysis

- Eigen Vectors (Subspace Iteration)
- Eigen Vectors (Lanczos)
- Load Dependent Ritz Vectors

Diaphragm

- Store forces for diaphragm cross-section force calculations
- Store stresses and internal forces

P-Delta

- No
- Yes
- Use Mass Loads
- Scale Factor:
- Use Gravity Loads
- Load Scale Factors:
 - Dead: Roof:
 - Live: Snow:

Solver Type

Direct Solver

- In-Core
- Out-of-Core

Direct Sparse Solver

- In-Core
- Out-of-Core

Options

- Use Single CPU Core
- Use All Available CPU Cores

AISC 360 Direct Analysis Method

- Use Reduced Stiffness for Steel Members
- $T_b = 1.0$
- Use T_b

Wall

- Include out-of-plane stiffness (bending)
- Release rotational fixity at wall foundation nodes
- Store stresses and internal forces
- Include Rigid Link at Fixed Beam-to-Wall Locations

Buckling Restrained Braces

- Exclude Buckling Restrained Braces from the Gravity Load Case Analysis

Analytical Model

Merge Node Tolerance (in):

Mesh Controls

Max. Distance Between Nodes on Mesh Line (ft):

Geometry Tolerance (in):

OK Cancel Help

ANALYSIS CRITERIA FOR STRENGTH:

General Criteria

Rigid End Zones

- Ignore Effects
- Include Effects
- Reduction %:

Member Force Output

- At Face of Joint
- At Centerline of Joint

Response Spectra Analysis

- Consider Sign for Analysis Results
- Include nodal mass in Z-direction (applicable for semirigid diaphragms only)

Eigenvalue Analysis

- Eigen Vectors (Subspace Iteration)
- Eigen Vectors (Lanczos)
- Load Dependent Ritz Vectors

Diaphragm

- Store forces for diaphragm cross-section force calculations
- Store stresses and internal forces

P-Delta

- No
- Yes
- Use Mass Loads
- Scale Factor:
- Use Gravity Loads
- Load Scale Factors:
 - Dead: Roof:
 - Live: Snow:

Solver Type

Direct Solver

- In-Core
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Direct Sparse Solver

- In-Core
- Out-of-Core

Options

- Use Single CPU Core
- Use All Available CPU Cores

AISC 360 Direct Analysis Method

- Use Reduced Stiffness for Steel Members
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- Include out-of-plane stiffness (bending)
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- Store stresses and internal forces
- Include Rigid Link at Fixed Beam-to-Wall Locations

Buckling Restrained Braces

- Exclude Buckling Restrained Braces from the Gravity Load Case Analysis

Analytical Model

Merge Node Tolerance (in):

Mesh Controls

Max. Distance Between Nodes on Mesh Line (ft):

Geometry Tolerance (in):

OK Cancel Help

Loads and Applied Forces

RAM Frame 17.04.01.07

DataBase: ATC 154_SSC_SMF Study - xRC4_Final - **Drift**

03/02/23 15:23:40

LOAD CASE: RSA_Drift

Dynamic Response Spectra for ASCE 7-16

Damping Ratio: 0.050

Scale Factors (X-Dir): +Ecc Case: 0.1875 -Ecc Case: 0.1875

Scale Factors (Y-Dir): +Ecc Case: 0.1875 -Ecc Case: 0.1875

Design Spectral Acceleration Parameters : Use

SMS : 1.500 g SM1 = 0.900 g

SDS : 1.000 SD1: 0.600

To : 0.120 sec Ts : 0.600 sec TL : 6.000 sec

Modal Combination Technique: CQC

Ground Level: Base

Note - results were checked and verified to be consistent with ASCE 7-22

Dir Eccent

X + And -

Y + And -

DIRECTION

Type: Dyn_ASCE716_CQC_X_+E

Type: Dyn_ASCE716_CQC_X_-E

Type: Dyn_ASCE716_CQC_Y_+E

Type: Dyn_ASCE716_CQC_Y_-E

GENERATED RESPONSE SPECTRA CURVE

Period	Spectral Acceleration (S(T))
0.0000(T ₀)	0.4000 g
0.1200(T ₀)	1.0000 g
0.6000(T _s)	1.0000 g
0.6000 < T < 6.0000 (T _L)	0.6000 g/T
T > 6.0000	3.6000 g/(T*T)



Loads and Applied Forces

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - **Drift**

03/02/23 15:23:40

LOAD CASE: ELF_Drift

Seismic ASCE 7-16 Equivalent Lateral Force

Importance Factor: 1.50 TL: 6.00 s

Site values are from a Ground Motion Hazard Analysis

Site Class D: Stiff Soil, Default

Ss: 0.001 g S1: 0.470 g

Use Specified: SDs: 1.000 g SD1: 0.600 g

Use Specified Seismic Design Category: D

Provisions for: Drift

Ground Level: Base

Note - results were checked and verified to be consistent with ASCE 7-22

Dir	Eccent	R	Ta Equation			Building Period-T			
X	+ And -	8.00	Std,Ct=0.028,x=0.80			Calculated			
Y	+ And -	8.00	Std,Ct=0.028,x=0.80			Calculated			
Dir	Ta	Cu	T	T-used	Cs	Cs(max)	Cs(min)	Cs-used	k
					Eq12.8-2	Eq12.8-3			
X	1.307	1.400	2.186	2.186	0.188	0.051	---	0.051	1.843
Y	1.307	1.400	2.187	2.187	0.188	0.051	---	0.051	1.844

Total Building Weight (kips) = 22243.55

APPLIED DIAPHRAGM FORCES

Applied forces are shown for ELF method for comparison.

Type: EQ_ASCE716_X_+E_Drft

Level	Diaph.#	Ht	Fx	Fy	X	Y
		ft	kips	kips	ft	ft
Story level L10	1	122.00	291.85	0.00	89.87	66.10
Story level L9	1	109.00	241.32	0.00	89.88	66.10
Story level L8	1	96.00	193.54	0.00	89.88	66.10
Story level L7	1	83.00	149.08	0.00	89.88	66.10
Story level L6	1	70.00	110.67	0.00	89.88	66.10
Story level L5	1	57.00	76.21	0.00	89.88	66.10
Story level L4	1	44.00	47.64	0.00	89.88	66.10
Story level L3	1	31.00	25.07	0.00	89.88	66.10
Story level L2	1	18.00	9.59	0.00	89.86	66.10

APPLIED STORY FORCES

Type: EQ_ASCE716_X_+E_Drft

Level	Ht	Fx	Fy
	ft	kips	kips
Story level L10	122.00	291.85	0.00
Story level L9	109.00	241.32	0.00



Loads and Applied Forces

RAM Frame 17.04.01.07

Page 3/5



DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

03/02/23 15:23:40

Story level L8	96.00	193.54	0.00
Story level L7	83.00	149.08	0.00
Story level L6	70.00	110.67	0.00
Story level L5	57.00	76.21	0.00
Story level L4	44.00	47.64	0.00
Story level L3	31.00	25.07	0.00
Story level L2	18.00	9.59	0.00
		<u>1144.97</u>	0.00

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_X_-E_Drft

Level	Diaph.#	Ht ft	Fx kips	Fy kips	X ft	Y ft
Story level L10	1	122.00	291.85	0.00	89.87	53.90
Story level L9	1	109.00	241.32	0.00	89.88	53.90
Story level L8	1	96.00	193.54	0.00	89.88	53.90
Story level L7	1	83.00	149.08	0.00	89.88	53.90
Story level L6	1	70.00	110.67	0.00	89.88	53.90
Story level L5	1	57.00	76.21	0.00	89.88	53.90
Story level L4	1	44.00	47.64	0.00	89.88	53.90
Story level L3	1	31.00	25.07	0.00	89.88	53.90
Story level L2	1	18.00	9.59	0.00	89.86	53.90

APPLIED STORY FORCES

Type: EQ_ASCE716_X_-E_Drft

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	291.85	0.00
Story level L9	109.00	241.32	0.00
Story level L8	96.00	193.54	0.00
Story level L7	83.00	149.08	0.00
Story level L6	70.00	110.67	0.00
Story level L5	57.00	76.21	0.00
Story level L4	44.00	47.64	0.00
Story level L3	31.00	25.07	0.00
Story level L2	18.00	9.59	0.00
		<u>1144.97</u>	0.00

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_+E_Drft

Level	Diaph.#	Ht	Fx	Fy	X	Y
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Loads and Applied Forces

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

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		ft	kips	kips	ft	ft
Story level L10	1	122.00	0.00	291.71	98.97	60.00
Story level L9	1	109.00	0.00	241.19	98.98	60.00
Story level L8	1	96.00	0.00	193.42	98.98	60.00
Story level L7	1	83.00	0.00	148.97	98.98	60.00
Story level L6	1	70.00	0.00	110.58	98.98	60.00
Story level L5	1	57.00	0.00	76.13	98.98	60.00
Story level L4	1	44.00	0.00	47.59	98.98	60.00
Story level L3	1	31.00	0.00	25.04	98.98	60.00
Story level L2	1	18.00	0.00	9.57	98.96	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_+E_Drft

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	0.00	291.71
Story level L9	109.00	0.00	241.19
Story level L8	96.00	0.00	193.42
Story level L7	83.00	0.00	148.97
Story level L6	70.00	0.00	110.58
Story level L5	57.00	0.00	76.13
Story level L4	44.00	0.00	47.59
Story level L3	31.00	0.00	25.04
Story level L2	18.00	0.00	9.57

0.00

1144.19

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_-E_Drft

Level	Diaph.#	Ht ft	Fx kips	Fy kips	X ft	Y ft
Story level L10	1	122.00	0.00	291.71	80.77	60.00
Story level L9	1	109.00	0.00	241.19	80.78	60.00
Story level L8	1	96.00	0.00	193.42	80.78	60.00
Story level L7	1	83.00	0.00	148.97	80.78	60.00
Story level L6	1	70.00	0.00	110.58	80.78	60.00
Story level L5	1	57.00	0.00	76.13	80.78	60.00
Story level L4	1	44.00	0.00	47.59	80.78	60.00
Story level L3	1	31.00	0.00	25.04	80.78	60.00
Story level L2	1	18.00	0.00	9.57	80.76	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_-E_Drft

Level	Ht	Fx	Fy
-------	----	----	----



Loads and Applied Forces

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

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	ft	kips	kips
Story level L10	122.00	0.00	291.71
Story level L9	109.00	0.00	241.19
Story level L8	96.00	0.00	193.42
Story level L7	83.00	0.00	148.97
Story level L6	70.00	0.00	110.58
Story level L5	57.00	0.00	76.13
Story level L4	44.00	0.00	47.59
Story level L3	31.00	0.00	25.04
Story level L2	18.00	0.00	9.57
		0.00	1144.19

BASE SHEAR (Dynamic Load Cases)		
LdC	Shear-X	Shear-Y
Dyn1	-1061.86	0.55
Dyn2	-1061.86	-0.55
Dyn3	0.01	-1055.10
Dyn4	-0.01	-1054.63

RSA BASE SHEAR - DRIFT



Loads and Applied Forces

RAM Frame 17.04.01.07



DataBase: ATC 154_SSC_SMF Study - xRC4_Final - **Strength**

03/02/23 15:30:07

LOAD CASE: ELF_Strength

Seismic ASCE 7-16 Equivalent Lateral Force

Importance Factor: 1.50 TL: 6.00 s

Site values are from a Ground Motion Hazard Analysis

Site Class D: Stiff Soil, Default

Ss: 0.001 g S1: 0.470 g

Use Specified: SDs: 1.000 g SD1: 0.600 g

Use Specified Seismic Design Category: D

Provisions for: Force

Ground Level: Base

Note - results were checked and verified to be consistent with ASCE 7-22

Dir	Eccent	R	Ta Equation			Building Period-T			
X	None	8.00	Std,Ct=0.028,x=0.80			User Defined			
Y	None	8.00	Std,Ct=0.028,x=0.80			User Defined			
Dir	Ta	Cu	T	T-used	Cs Eq12.8-2	Cs(max) Eq12.8-3	Cs(min) Eq12.8-5	Cs-used	k
X	1.307	1.400	2.186	1.830	0.188	0.061	0.066	0.066	1.665
Dir	Ta	Cu	T	T-used	Cs Eq12.8-2	Cs(max) Eq12.8-3	Cs(min) Eq12.8-5	Cs-used	k
Y	1.307	1.400	2.186	1.830	0.188	0.061	0.066	0.066	1.665

Total Building Weight (kips) = 22243.55

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_X_NoE_F

Level	Diaph.#	Ht ft	Fx kips	Fy kips	X ft	Y ft
Story level L10	1	122.00	353.59	0.00	89.87	60.00
Story level L9	1	109.00	298.29	0.00	89.88	60.00
Story level L8	1	96.00	244.71	0.00	89.88	60.00
Story level L7	1	83.00	193.44	0.00	89.88	60.00
Story level L6	1	70.00	148.02	0.00	89.88	60.00
Story level L5	1	57.00	105.72	0.00	89.88	60.00
Story level L4	1	44.00	69.21	0.00	89.88	60.00
Story level L3	1	31.00	38.76	0.00	89.88	60.00
Story level L2	1	18.00	16.32	0.00	89.86	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_X_NoE_F

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	353.59	0.00
Story level L9	109.00	298.29	0.00



Loads and Applied Forces

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Strength

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Story level L8	96.00	244.71	0.00
Story level L7	83.00	193.44	0.00
Story level L6	70.00	148.02	0.00
Story level L5	57.00	105.72	0.00
Story level L4	44.00	69.21	0.00
Story level L3	31.00	38.76	0.00
Story level L2	18.00	16.32	0.00

1468.07	0.00
---------	------

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_NoE_F

Level	Diaph.#	Ht ft	Fx kips	Fy kips	X ft	Y ft
Story level L10	1	122.00	0.00	353.59	89.87	60.00
Story level L9	1	109.00	0.00	298.29	89.88	60.00
Story level L8	1	96.00	0.00	244.71	89.88	60.00
Story level L7	1	83.00	0.00	193.44	89.88	60.00
Story level L6	1	70.00	0.00	148.02	89.88	60.00
Story level L5	1	57.00	0.00	105.72	89.88	60.00
Story level L4	1	44.00	0.00	69.21	89.88	60.00
Story level L3	1	31.00	0.00	38.76	89.88	60.00
Story level L2	1	18.00	0.00	16.32	89.86	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_NoE_F

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	0.00	353.59
Story level L9	109.00	0.00	298.29
Story level L8	96.00	0.00	244.71
Story level L7	83.00	0.00	193.44
Story level L6	70.00	0.00	148.02
Story level L5	57.00	0.00	105.72
Story level L4	44.00	0.00	69.21
Story level L3	31.00	0.00	38.76
Story level L2	18.00	0.00	16.32

0.00	1468.07
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BASE SHEAR (Dynamic Load Cases)		
LdC	Shear-X	Shear-Y
Dyn5	-1468.30	0.00
Dyn6	0.00	-1467.53

RSA BASE SHEAR - STRENGTH



Periods and Modes

RAM Frame 17.04.01.07



DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

03/02/23 15:28:04

CRITERIA:

Rigid End Zones: Ignore Effects
P-Delta: Yes Scale Factor (DL): 1.00 Scale Factor (LL): 0.50
Scale Factor (Roof): 1.00 Scale Factor (Snow): 0.15

Ground Level: Base

Mesh Criteria :

Max. Distance Between Nodes on Mesh Line (ft) : 4.00

Merge Node Tolerance (in) : 0.0100

Geometry Tolerance (in) : 0.0050

Walls Out-of-plane Stiffness Not Included in Analysis.

Sign considered for Dynamic Load Case Results.

Rigid Links Not Included at Fixed Beam-to-Wall Locations

Eigenvalue Analysis : Eigen Vectors (Subspace Iteration)

Load Case: Eigen Eigen Solution

FREQUENCIES AND PERIODS:

Mode	Period (T) sec	Cyclic Frequency (f) Hz	Circular Frequency (ω) rad/sec	Eigenvalue (rad/sec)**2
1	2.1871	0.4572	2.8729	8.2536
2	2.1856	0.4575	2.8749	8.2649
3	1.3478	0.7420	4.6618	21.7328
4	0.8054	1.2417	7.8015	60.8639
5	0.8045	1.2429	7.8096	60.9896
6	0.5030	1.9879	12.4904	156.0110
7	0.4497	2.2239	13.9730	195.2447
8	0.4493	2.2255	13.9834	195.5342
9	0.3008	3.3241	20.8857	436.2128
10	0.3008	3.3246	20.8888	436.3424

MODAL PARTICIPATION FACTORS:

Mode	X-Dir	Y-Dir	Rotation
1	0.0004	81.9177	-0.1263
2	81.9063	-0.0004	0.0018
3	-0.0004	0.0727	460.5391
4	0.0016	31.2544	-0.7546
5	31.2734	-0.0016	0.0028
6	0.0011	0.1336	174.5265
7	0.0023	17.8885	-1.3103
8	17.9022	-0.0023	-0.0102
9	-0.0203	-12.0983	-0.3518
10	-12.1096	0.0203	-0.0319

MODAL DIRECTION FACTORS:

Mode	X-Dir	Y-Dir	Rotation
1	0.00	100.00	0.00
2	100.00	0.00	0.00
3	0.00	0.00	100.00



Periods and Modes

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

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4	0.00	100.00	0.00
5	100.00	0.00	0.00
6	0.00	0.00	100.00
7	0.00	100.00	0.00
8	100.00	0.00	0.00
9	0.00	100.00	0.00
10	100.00	0.00	0.00

MODAL EFFECTIVE MASS FACTORS:

Mode	X-Dir		Y-Dir		Rotation	
	%Mass	%SumM	%Mass	%SumM	%Mass	%SumM
1	0.00	0.00	80.95	80.95	0.00	0.00
2	80.93	80.93	0.00	80.95	0.00	0.00
3	0.00	80.93	0.00	80.95	81.52	81.52
4	0.00	80.93	11.78	92.74	0.00	81.53
5	11.80	92.73	0.00	92.74	0.00	81.53
6	0.00	92.73	0.00	92.74	11.71	93.23
7	0.00	92.73	3.86	96.60	0.00	93.23
8	3.87	96.59	0.00	96.60	0.00	93.23
9	0.00	96.59	1.77	98.36	0.00	93.23
10	1.77	98.36	0.00	98.36	0.00	93.23



Bentley

RAM Structural System 17.04.01.07
 DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift
 Building Code: IBC

Drift

03/01/23 11:15:12
 Steel Code: IBC

CRITERIA:

Rigid End Zones: Ignore Effects
 Member Force Output: At Face of Joint
 P-Delta: Yes Scale Factor (DL): 1.00 Scale Factor (LL): 0.50
 Scale Factor (Roof): 1.00 Scale Factor (Snow): 0.15
 Ground Level: Base

LOAD CASE DEFINITIONS:

Dyn1 RSA_Drift Dyn_ASCE716_CQC_X_+E
 Dyn2 RSA_Drift Dyn_ASCE716_CQC_X_-E
 Dyn3 RSA_Drift Dyn_ASCE716_CQC_Y_+E
 Dyn4 RSA_Drift Dyn_ASCE716_CQC_Y_-E

RESULTS:

Location (ft): (89.870, 60.000)

All drift ratios less than drift ratio limit = $0.01 * 1.5 / 5.5 = 0.0027$

Story	LdC	Displacement		Story Drift		Drift Ratio	
		X in	Y in	X in	Y in	X	Y
Story level L10	Dyn1	3.3061	0.0010	0.2932	-0.0003	0.0019	0.0000
	Dyn2	3.3061	-0.0010	0.2932	0.0003	0.0019	0.0000
	Dyn3	-0.0000	3.2875	0.0000	0.2911	0.0000	0.0019
	Dyn4	0.0000	3.2873	-0.0000	0.2911	0.0000	0.0019
Story level L9	Dyn1	3.0822	0.0009	0.4047	-0.0003	0.0026	0.0000
	Dyn2	3.0822	-0.0009	0.4047	0.0003	0.0026	0.0000
	Dyn3	-0.0000	3.0651	-0.0000	0.4031	0.0000	0.0026
	Dyn4	0.0000	3.0649	0.0000	0.4035	0.0000	0.0026
Story level L8	Dyn1	2.7589	-0.0008	0.4197	0.0002	0.0027	0.0000
	Dyn2	2.7589	0.0008	0.4197	-0.0002	0.0027	0.0000
	Dyn3	-0.0000	2.7430	-0.0000	0.4168	0.0000	0.0027
	Dyn4	0.0000	2.7425	0.0000	0.4168	0.0000	0.0027
Story level L7	Dyn1	2.4046	-0.0007	0.4184	0.0002	0.0027	0.0000
	Dyn2	2.4046	0.0007	0.4184	-0.0002	0.0027	0.0000
	Dyn3	-0.0000	2.3911	-0.0000	0.4155	0.0000	0.0027
	Dyn4	0.0000	2.3905	0.0000	0.4155	0.0000	0.0027
Story level L6	Dyn1	2.0363	-0.0006	0.3815	0.0002	0.0024	0.0000
	Dyn2	2.0363	0.0006	0.3815	-0.0002	0.0024	0.0000
	Dyn3	-0.0000	2.0254	-0.0000	0.3789	0.0000	0.0024
	Dyn4	0.0000	2.0247	0.0000	0.3789	0.0000	0.0024



Bentley

Drift

RAM Structural System 17.04.01.07

DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

Building Code: IBC

All drift ratios less than drift ratio limit = $0.01 * 1.5 / 5.5 = 0.0027$

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Steel Code: IBC

Story	LdC	Displacement		Story Drift		Drift Ratio	
Story level L5	Dyn1	1.6836	-0.0006	0.3970	0.0001	0.0025	0.0000
	Dyn2	1.6836	0.0006	0.3970	-0.0001	0.0025	0.0000
	Dyn3	-0.0000	1.6752	0.0000	0.3943	0.0000	0.0025
	Dyn4	0.0000	1.6745	-0.0000	0.3943	0.0000	0.0025
Story level L4	Dyn1	1.3032	-0.0005	0.4033	0.0001	0.0026	0.0000
	Dyn2	1.3032	0.0005	0.4033	-0.0001	0.0026	0.0000
	Dyn3	-0.0000	1.2974	0.0000	0.4008	0.0000	0.0026
	Dyn4	0.0000	1.2967	-0.0000	0.4007	0.0000	0.0026
Story level L3	Dyn1	0.9065	-0.0004	0.4238	-0.0002	0.0027	0.0000
	Dyn2	0.9065	0.0004	0.4238	0.0002	0.0027	0.0000
	Dyn3	-0.0000	0.9032	-0.0000	0.4222	0.0000	0.0027
	Dyn4	0.0000	0.9026	0.0000	0.4219	0.0000	0.0027
Story level L2	Dyn1	0.4840	-0.0003	0.4840	-0.0003	0.0022	0.0000
	Dyn2	0.4840	0.0003	0.4840	0.0003	0.0022	0.0000
	Dyn3	-0.0000	0.4823	-0.0000	0.4823	0.0000	0.0022
	Dyn4	0.0000	0.4820	0.0000	0.4820	0.0000	0.0022



Drift

All less than 1.2 --> no torsional irregularity

TORSIONAL IRREGULARITY DATA:

X-Axis:

Story	LdC	Drift in	Coord ft	Drift in	Coord ft	Max/Min	Max/Ave
Story level L10	Dyn2	0.3083	(0.00 0.00)	0.2783	(0.00 120.00)	1.108	1.051
Story level L9	Dyn1	0.3837	(0.00 0.00)	0.4260	(0.00 120.00)	1.110	1.052
Story level L8	Dyn1	0.3991	(0.00 0.00)	0.4406	(0.00 120.00)	1.104	1.049
Story level L7	Dyn2	0.4389	(0.00 0.00)	0.3983	(0.00 120.00)	1.102	1.049
Story level L6	Dyn2	0.3998	(0.00 0.00)	0.3635	(0.00 120.00)	1.100	1.048
Story level L5	Dyn2	0.4163	(0.00 0.00)	0.3781	(0.00 120.00)	1.101	1.048
Story level L4	Dyn2	0.4227	(0.00 0.00)	0.3842	(0.00 120.00)	1.100	1.048
Story level L3	Dyn2	0.4441	(0.00 0.00)	0.4038	(0.00 120.00)	1.100	1.048
Story level L2	Dyn2	0.5094	(0.00 0.00)	0.4592	(0.00 120.00)	1.109	1.052

Y-Axis:

Story	LdC	Drift in	Coord ft	Drift in	Coord ft	Max/Min	Max/Ave
Story level L10	Dyn4	0.3250	(0.00 0.00)	0.2580	(180.00 0.00)	1.260	1.115
Story level L9	Dyn4	0.4527	(0.00 0.00)	0.3559	(180.00 0.00)	1.272	1.120
Story level L8	Dyn4	0.4638	(0.00 0.00)	0.3714	(180.00 0.00)	1.249	1.111
Story level L7	Dyn4	0.4615	(0.00 0.00)	0.3712	(180.00 0.00)	1.243	1.108
Story level L6	Dyn4	0.4201	(0.00 0.00)	0.3393	(180.00 0.00)	1.238	1.106
Story level L5	Dyn4	0.4376	(0.00 0.00)	0.3527	(180.00 0.00)	1.241	1.107
Story level L4	Dyn4	0.4442	(0.00 0.00)	0.3590	(180.00 0.00)	1.237	1.106
Story level L3	Dyn3	0.3785	(0.00 0.00)	0.4679	(180.00 0.00)	1.236	1.106
Story level L2	Dyn3	0.4281	(0.00 0.00)	0.5390	(180.00 0.00)	1.259	1.115

ASCE 7 Stability Coefficients



RAM Frame 17.04.01.07



DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

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CRITERIA:

Rigid End Zones: Ignore Effects
 Member Force Output: At Face of Joint
 P-Delta: Yes Scale Factor (DL): 1.00 Scale Factor (LL): 0.50
 Scale Factor (Roof): 1.00 Scale Factor (Snow): 0.15
 Ground Level: Base
 Mesh Criteria :
 Max. Distance Between Nodes on Mesh Line (ft) : 4.00
 Merge Node Tolerance (in) : 0.0100
 Geometry Tolerance (in) : 0.0050
 Walls Out-of-plane Stiffness Not Included in Analysis.
 Sign considered for Dynamic Load Case Results.
 Rigid Links Not Included at Fixed Beam-to-Wall Locations
 Eigenvalue Analysis : Eigen Vectors (Subspace Iteration)

STABILITY COEFFICIENTS:ASCE 7-10/16 Eq. (12.8-16)

$\beta = 1.00$

Cd : X-Dir = 5.50 Y-Dir = 5.50

Note that the reported drifts are unfactored elastic story drift values.

Calculated vertical load includes dead, live and roof loads. Live loads are reduced with live load reduction factors.

Calculated vertical load is the sum of the total vertical load at and above story.

Vertical Load Factors:

Dead Load : 1.00 Live Load : 0.20 Roof Load : 1.00 Snow Load : 0.20

Per Section 12.8.6.1, ASCE 7-22 - reducible live loads can be used (0.5L where L=0.4Lo --> 0.5*0.4=0.2)

LOAD CASE: ELF_Drift

All values for theta/(1+theta) less than theta-max. Theta/(1+theta) used for comparison since P-delta analysis was used.

Type : EQ_ASCE716_X_+E_Drft

Level	Diaph. #	Ht ft	Shear X kips	Shear Y kips	Drift X in	Drift Y in	Vertical Load kips
Story level L10	1	122.00	297.03	0.00	0.34	0.00	2146.20
Story level L9	1	109.00	548.49	0.00	0.51	0.00	4259.92
Story level L8	1	96.00	752.21	0.00	0.56	0.00	6409.59
Story level L7	1	83.00	910.79	0.00	0.58	0.00	8561.97
Story level L6	1	70.00	1026.69	0.00	0.53	0.00	10743.47
Story level L5	1	57.00	1111.81	0.00	0.53	0.00	12924.66
Story level L4	1	44.00	1166.24	0.00	0.52	0.00	15123.29
Story level L3	1	31.00	1199.13	-0.00	0.51	-0.00	17321.78
Story level L2	1	18.00	1201.89	-0.00	0.56	-0.00	19696.13

Level	Diaph. #	θ_x	θ_y	$\theta_x/(1+\theta_x)$	$\theta_y/(1+\theta_y)$	θ_{xmax}	θ_{ymax}
Story level L10	1	0.016	0.000	0.016	0.000	0.091	0.091
Story level L9	1	0.025	0.000	0.025	0.000	0.091	0.091
Story level L8	1	0.031	0.000	0.030	0.000	0.091	0.091
Story level L7	1	0.035	0.000	0.033	0.000	0.091	0.091



ASCE 7 Stability Coefficients

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4 Final - Drift

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Story level L6	1	0.035	0.000	0.034	0.000	0.091	0.091
Story level L5	1	0.040	0.000	0.038	0.000	0.091	0.091
Story level L4	1	0.043	0.000	0.041	0.000	0.091	0.091
Story level L3	1	0.048	0.000	0.045	0.000	0.091	0.091
Story level L2	1	0.042	0.000	0.041	0.000	0.091	0.091

Type : EQ_ASCE716_X_-E_Drft

Level	Diaph. #	Ht ft	Shear X kips	Shear Y kips	Drift X in	Drift Y in	Vertical Load kips
Story level L10	1	122.00	297.03	-0.00	0.34	-0.00	2146.20
Story level L9	1	109.00	548.49	-0.00	0.51	-0.00	4259.92
Story level L8	1	96.00	752.21	-0.00	0.56	-0.00	6409.59
Story level L7	1	83.00	910.79	-0.00	0.58	-0.00	8561.97
Story level L6	1	70.00	1026.69	-0.00	0.53	-0.00	10743.47
Story level L5	1	57.00	1111.81	-0.00	0.53	-0.00	12924.66
Story level L4	1	44.00	1166.24	-0.00	0.52	-0.00	15123.29
Story level L3	1	31.00	1199.13	0.00	0.51	0.00	17321.78
Story level L2	1	18.00	1201.89	0.00	0.56	0.00	19696.13

Level	Diaph. #	θ_x	θ_y	$\theta_x/(1+\theta_x)$	$\theta_y/(1+\theta_y)$	θ_{xmax}	θ_{ymax}
Story level L10	1	0.016	0.000	0.016	0.000	0.091	0.091
Story level L9	1	0.025	0.000	0.025	0.000	0.091	0.091
Story level L8	1	0.031	0.000	0.030	0.000	0.091	0.091
Story level L7	1	0.035	0.000	0.033	0.000	0.091	0.091
Story level L6	1	0.035	0.000	0.034	0.000	0.091	0.091
Story level L5	1	0.040	0.000	0.038	0.000	0.091	0.091
Story level L4	1	0.043	0.000	0.041	0.000	0.091	0.091
Story level L3	1	0.048	0.000	0.045	0.000	0.091	0.091
Story level L2	1	0.042	0.000	0.041	0.000	0.091	0.091

Type : EQ_ASCE716_Y_+E_Drft

Level	Diaph. #	Ht ft	Shear X kips	Shear Y kips	Drift X in	Drift Y in	Vertical Load kips
Story level L10	1	122.00	0.00	296.89	0.00	0.34	2146.20
Story level L9	1	109.00	-0.00	548.28	0.00	0.51	4259.92
Story level L8	1	96.00	-0.00	751.82	-0.00	0.56	6409.59
Story level L7	1	83.00	0.00	910.27	-0.00	0.57	8561.97
Story level L6	1	70.00	0.00	1026.07	-0.00	0.52	10743.47
Story level L5	1	57.00	0.00	1111.11	-0.00	0.53	12924.66
Story level L4	1	44.00	0.00	1165.51	0.00	0.52	15123.29
Story level L3	1	31.00	0.00	1198.51	0.00	0.51	17321.78
Story level L2	1	18.00	0.00	1201.24	0.00	0.56	19696.13

Level	Diaph. #	θ_x	θ_y	$\theta_x/(1+\theta_x)$	$\theta_y/(1+\theta_y)$	θ_{xmax}	θ_{ymax}
Story level L10	1	0.000	0.016	0.000	0.016	0.091	0.091
Story level L9	1	0.000	0.025	0.000	0.025	0.091	0.091



ASCE 7 Stability Coefficients

RAM Frame 17.04.01.07

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DataBase: ATC 154_SSC_SMF Study - xRC4_Final - Drift

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Story level L8	1	0.000	0.031	0.000	0.030	0.091	0.091
Story level L7	1	0.000	0.035	0.000	0.033	0.091	0.091
Story level L6	1	0.000	0.035	0.000	0.034	0.091	0.091
Story level L5	1	0.000	0.040	0.000	0.038	0.091	0.091
Story level L4	1	0.000	0.043	0.000	0.041	0.091	0.091
Story level L3	1	0.000	0.048	0.000	0.046	0.091	0.091
Story level L2	1	0.000	0.043	0.000	0.041	0.091	0.091

Type : EQ_ASCE716_Y_-E_Drift

Level	Diaph. #	Ht ft	Shear X kips	Shear Y kips	Drift X in	Drift Y in	Vertical Load kips
Story level L10	1	122.00	-0.00	296.90	-0.00	0.34	2146.20
Story level L9	1	109.00	0.00	548.29	0.00	0.51	4259.92
Story level L8	1	96.00	0.00	751.83	-0.00	0.56	6409.59
Story level L7	1	83.00	-0.00	910.28	0.00	0.57	8561.97
Story level L6	1	70.00	-0.00	1026.08	0.00	0.53	10743.47
Story level L5	1	57.00	-0.00	1111.12	0.00	0.53	12924.66
Story level L4	1	44.00	-0.00	1165.52	-0.00	0.52	15123.29
Story level L3	1	31.00	-0.00	1198.49	-0.00	0.51	17321.78
Story level L2	1	18.00	-0.00	1201.23	-0.00	0.56	19696.13

Level	Diaph. #	θ_x	θ_y	$\theta_x/(1+\theta_x)$	$\theta_y/(1+\theta_y)$	θ_{xmax}	θ_{ymax}
Story level L10	1	0.000	0.016	0.000	0.016	0.091	0.091
Story level L9	1	0.000	0.025	0.000	0.025	0.091	0.091
Story level L8	1	0.000	0.031	0.000	0.030	0.091	0.091
Story level L7	1	0.000	0.035	0.000	0.033	0.091	0.091
Story level L6	1	0.000	0.035	0.000	0.034	0.091	0.091
Story level L5	1	0.000	0.040	0.000	0.038	0.091	0.091
Story level L4	1	0.000	0.043	0.000	0.041	0.091	0.091
Story level L3	1	0.000	0.048	0.000	0.046	0.091	0.091
Story level L2	1	0.000	0.043	0.000	0.041	0.091	0.091

APPENDIX 7: FRAME DEMAND CAPACITY RATIOS (DCRs)

Story level L10	0.35	0.35	0.35	0.35
Story level L9	0.49 0.20	0.48 0.15	0.48 0.16	0.49 0.20
Story level L8	0.49 0.21	0.49 0.19	0.49 0.19	0.49 0.21
Story level L7	0.53 0.18	0.53 0.18	0.53 0.19	0.53 0.18
Story level L6	0.42 0.20	0.41 0.22	0.41 0.22	0.42 0.20
Story level L5	0.44 0.19	0.43 0.20	0.43 0.20	0.44 0.19
Story level L4	0.43 0.23	0.43 0.21	0.43 0.21	0.43 0.23
Story level L3	0.47 0.26	0.46 0.22	0.46 0.22	0.47 0.26
Story level L2	0.31 0.48	0.25 0.38	0.24 0.38	0.25 0.31 0.48
	B 1	C 1	D 1	E 1 F 1

FRAME ALONG GRIDLINE 1

Note: No web doubler plates required
(typical all frames)

Story level L10	0.35	0.35	0.35	0.35
Story level L9	0.49	0.48	0.48	0.49
Story level L8	0.49	0.49	0.49	0.49
Story level L7	0.53	0.53	0.53	0.53
Story level L6	0.42	0.41	0.41	0.42
Story level L5	0.44	0.43	0.43	0.44
Story level L4	0.43	0.43	0.43	0.43
Story level L3	0.47	0.46	0.46	0.47
Story level L2	0.45	0.43	0.43	0.45
	0.48	0.38	0.38	0.48
	B	C	D	E
	5	5	5	5

FRAME ALONG GRIDLINE 5

Story level L10	0.27	0.36	0.36	0.27
Story level L9	0.39	0.51	0.50	0.38
Story level L8	0.42	0.51	0.50	0.42
Story level L7	0.46	0.55	0.55	0.46
Story level L6	0.38	0.43	0.43	0.38
Story level L5	0.40	0.45	0.45	0.40
Story level L4	0.40	0.44	0.44	0.40
Story level L3	0.43	0.47	0.47	0.43
Story level L2	0.42	0.44	0.44	0.42
	0.36	0.36	0.37	0.36
	A	A	A	A
	1	2	3	4
				5

FRAME ALONG GRIDLINE A

Story level L10	0.27	0.36	0.36	0.27
Story level L9	0.39	0.51	0.51	0.39
Story level L8	0.42	0.50	0.50	0.42
Story level L7	0.46	0.55	0.55	0.46
Story level L6	0.38	0.43	0.43	0.38
Story level L5	0.40	0.45	0.45	0.40
Story level L4	0.40	0.45	0.45	0.40
Story level L3	0.43	0.46	0.46	0.43
Story level L2	0.43	0.45	0.45	0.43
	0.36	0.36	0.37	0.36
	G	G	G	G
	1	2	3	4
				5

FRAME ALONG GRIDLINE G