ATC 154 Project – Steel SMF Conceptual Design: High D Archetype

The following is a report summarizing the conceptual design of steel special moment frames for the *High D* designated archetype for the ATC 154 Project, prepared by the AISC Steel Solutions Center (SSC). This is one of three total conceptual designs 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 *High D* archetype is based on 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.

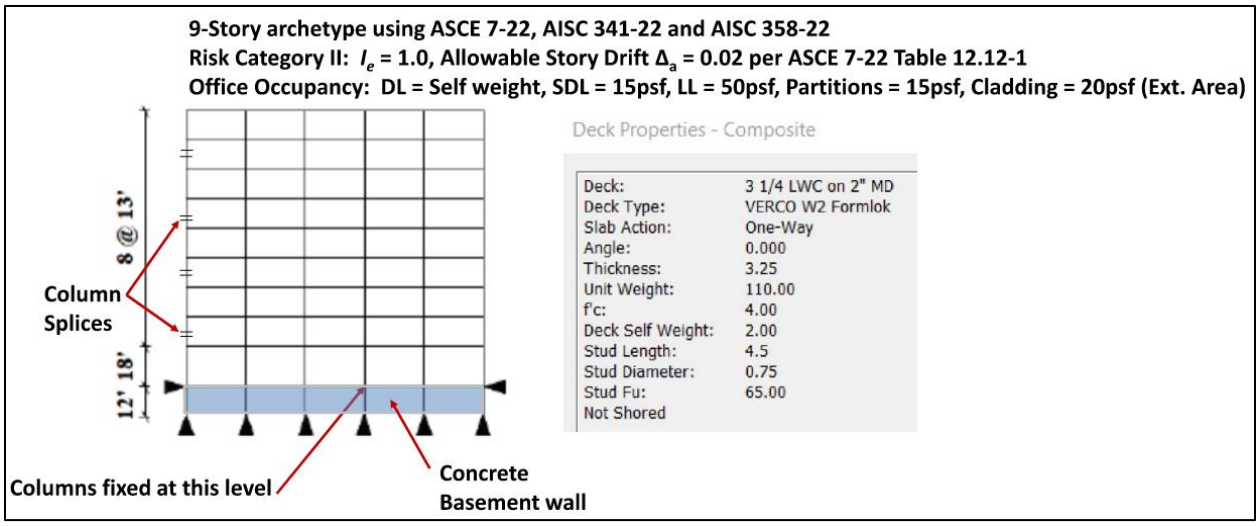


Figure 1: Elevation with Defined Loading and Base Boundary Conditions

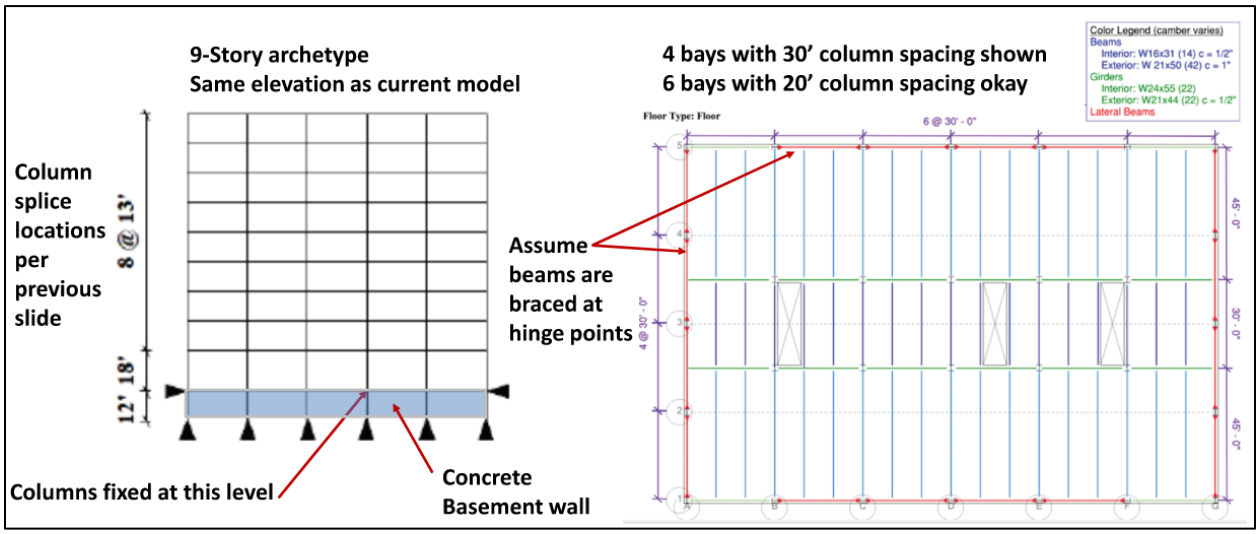


Figure 2: Elevation and Typical Floor Plan with Sized Gravity Framing (Sized by MKA)

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.

Table 1: Seismic Design Parameters for Steel Frame Archetypes

Recommendations for Archetype Designs

	S_{MS}	S_{DS}	S_{M1}	S_{D1}
High D	1.5	1.0	0.9	0.6
Very High Seismic	2.25	1.5	1.8	1.2
Ultra High Seismic	3.0	2.0	2.7	1.8

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 (MCER), 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} = MCER, 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

Conceptual Steel Special Moment Frame Design: High D 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). A typical floor framing plan and frame elevations are shown in Appendix 2.

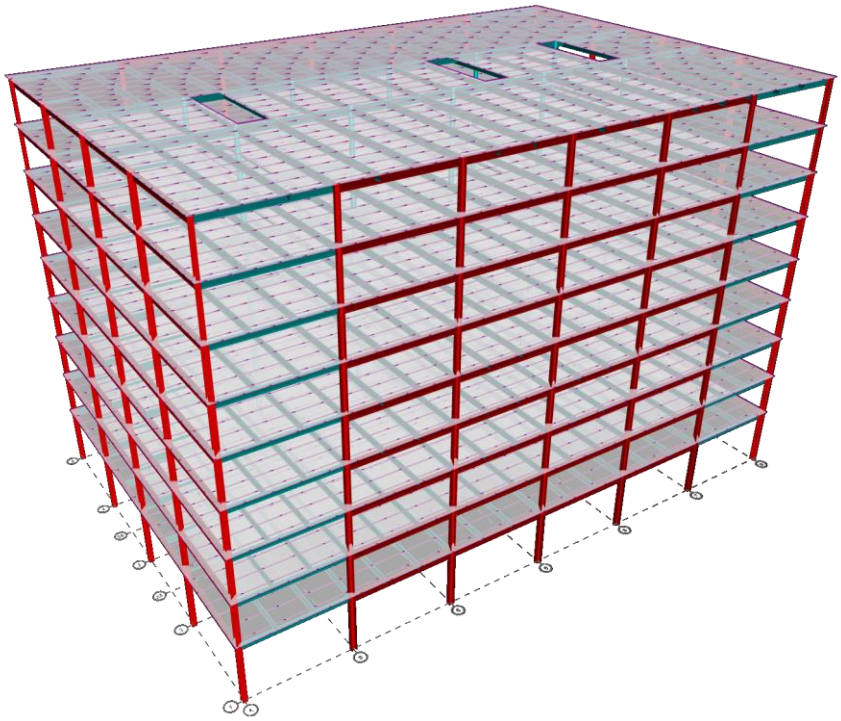


Figure 3: 3D rendering of archetype structure

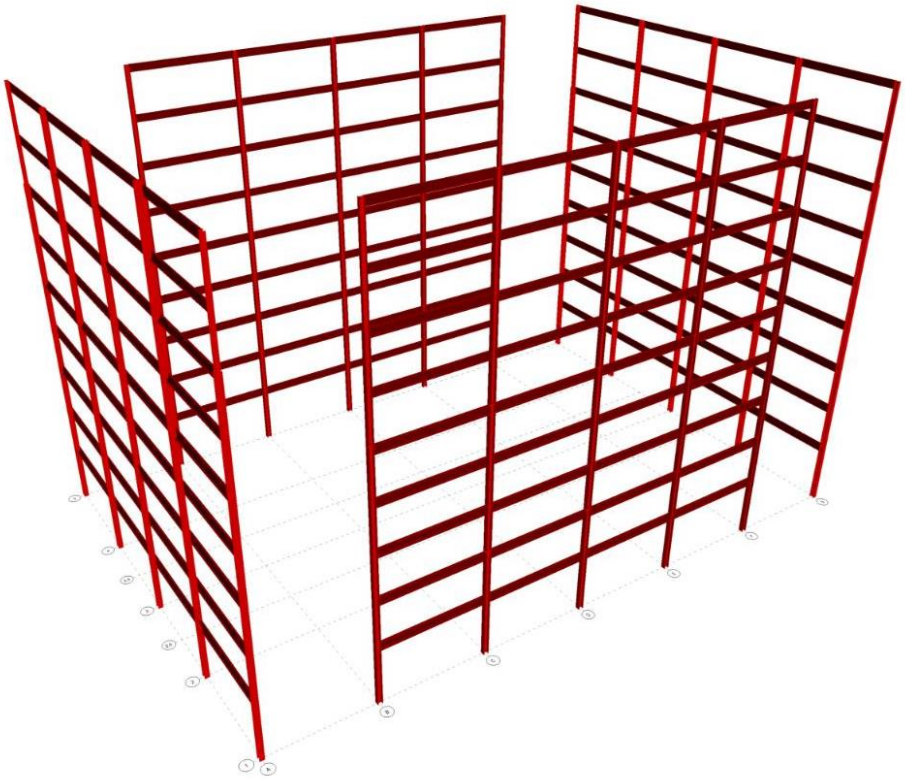


Figure 4: 3D rendering of archetype lateral frames only

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 for the Equivalent Lateral Force (ELF) method. Modal Response Spectrum Analysis (RSA) base shear results were within 1% of ELF base shears for both drift and strength (after scaling). Unless otherwise noted, values pertain to both X and Y directions.

R =	8
Ω_o =	3
C_d =	5.5
Seismic Weight, W =	17,161 kips
Period, T =	3.674 sec (E-W or X-dir. period per RAM)
Period, T =	3.674 sec (N-S or Y-dir. period from RAM)
Ta =	1.307 sec
Cu =	1.4 sec
T-used (drift) =	3.674 sec
Cs (drift) =	0.0204
Base shear, V (drift) =	350.3 kips
T-used (strength) = Cu*Ta =	1.830 sec
Cs (strength) =	0.044
Base shear, V (strength) =	755.1 kips

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, Δ_a = of 0.02. For practicality, the story drift ratio was converted to a maximum allowable elastic drift ratio of 0.0036 (maximum allowable elastic drift ratio = allowable drift ratio * Ie / Cd = 0.02*1.0/5.5 = 0.0036). 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, θ_{max} = 0.152 per Section 12.8.7 of ASCE 7. The β value used in the calculation of θ_{max} was determined at the controlling floor (Level 3) according to the procedure recommended in NIST GCR 16-917-41 *NEHRP Seismic Design Technical Brief No. 2: Seismic Design of Steel Special Moment Frames, 2nd ed.* A β value of 0.56 was calculated, which is greater than the minimum value per Section 12.8.7 of ASCE 7 which states that β shall not be less than $1.25/\Omega_o$ = 0.42. Conservatively, a β value of 0.6 was used in the calculation of θ_{max} to check stability.

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 τb = 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 utilized for all beam-column connections. The reduced section properties were used in the analysis. The beam flange cut dimensions used in the analysis are shown in the figure below.

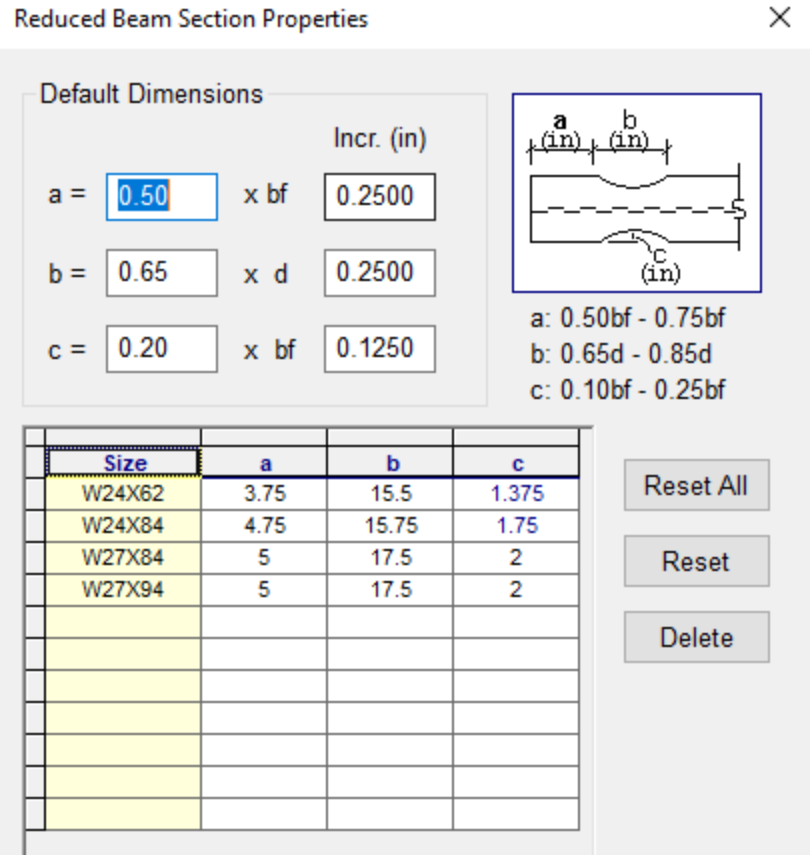


Figure 5: Reduced beam section properties

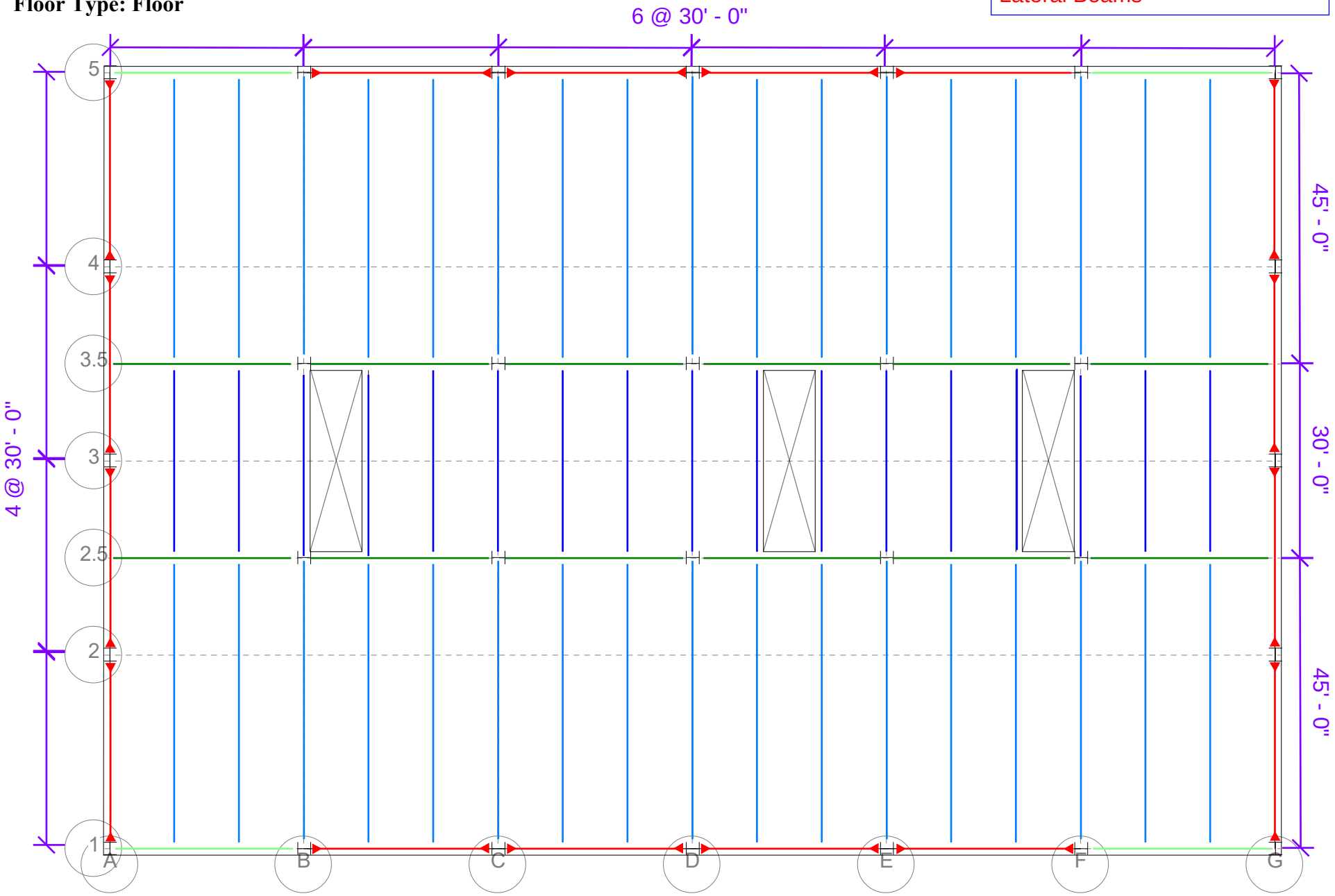
AISC Disclaimer

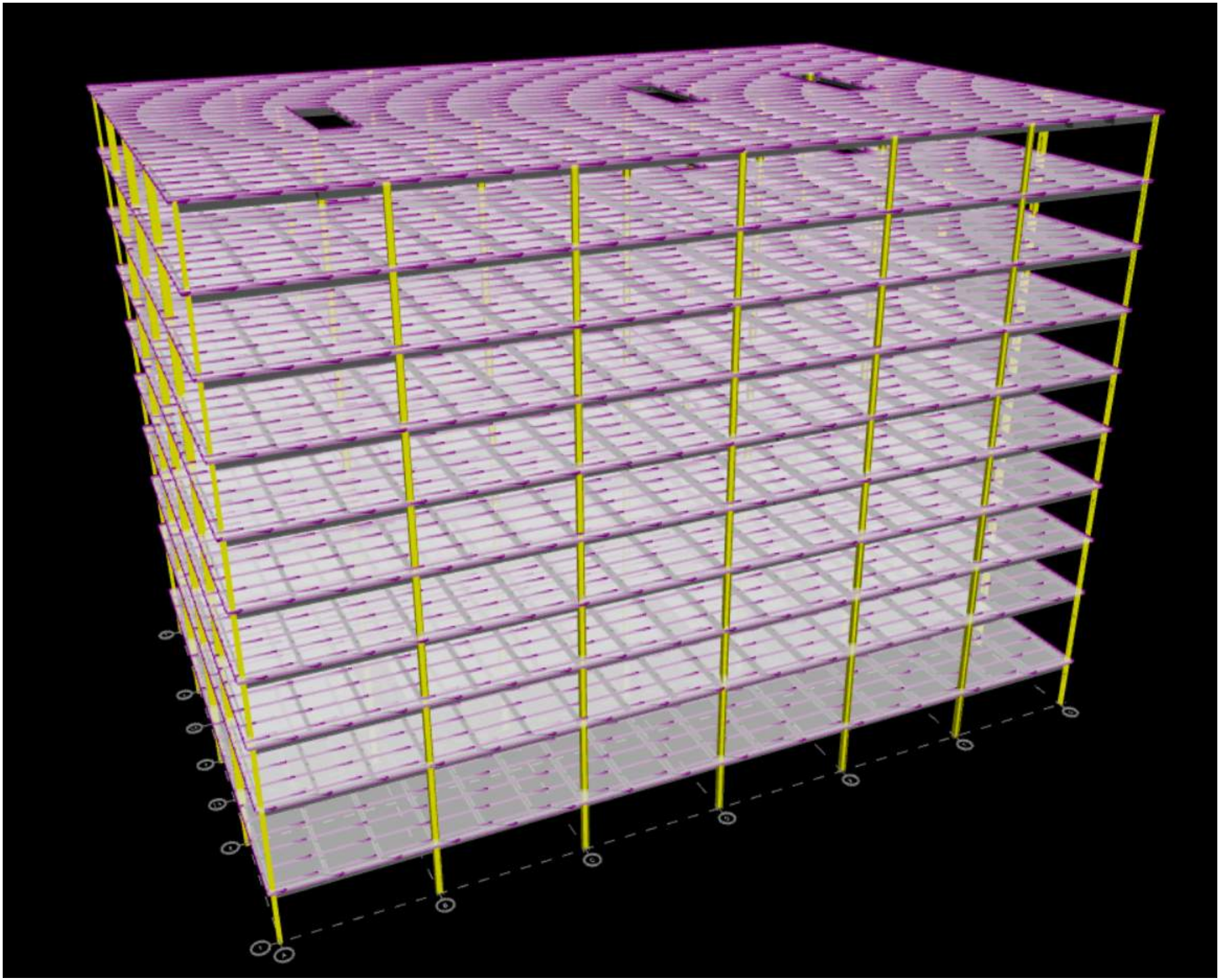
Floor Map

RAM Steel 17.04.02.12
Magnusson Klemencic Assoc.
DataBase: Floor Framing Study_Archetype 1_FINAL Model
Building Code: IBC

Color Legend (camber varies)
Beams
Interior: W16x31 (14) c = 1/2"
Exterior: W 21x50 (42) c = 1"
Girders
Interior: W24x55 (22)
Exterior: W21x44 (22) c = 1/2"
Lateral Beams

Floor Type: Floor

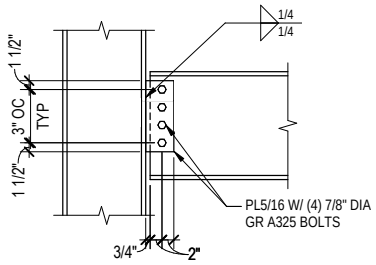




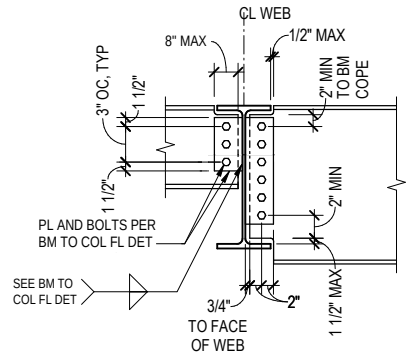
GRAVITY CONNECTIONS AND COLUMN DESIGNS

Gravity Beam Connections

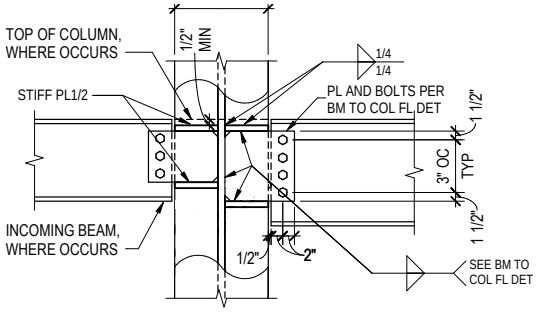
- All gravity beam connections are PL5/16 with (4) 7/8" diameter GR A325 bolts.
- See typical details below for additional information.



BEAM TO COLUMN FLANGE



BEAM TO BEAM

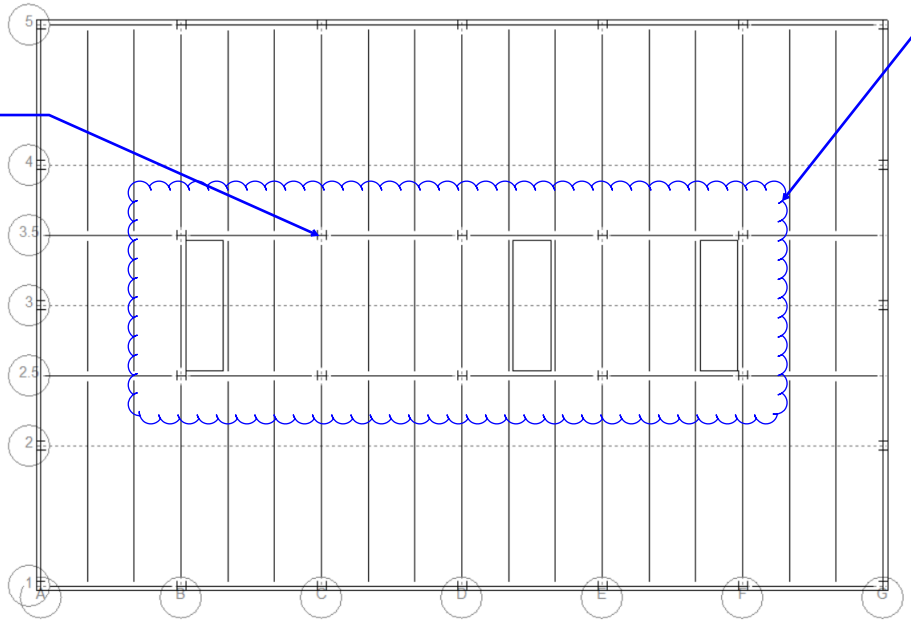


BEAM TO COLUMN WEB

Gravity Column Design

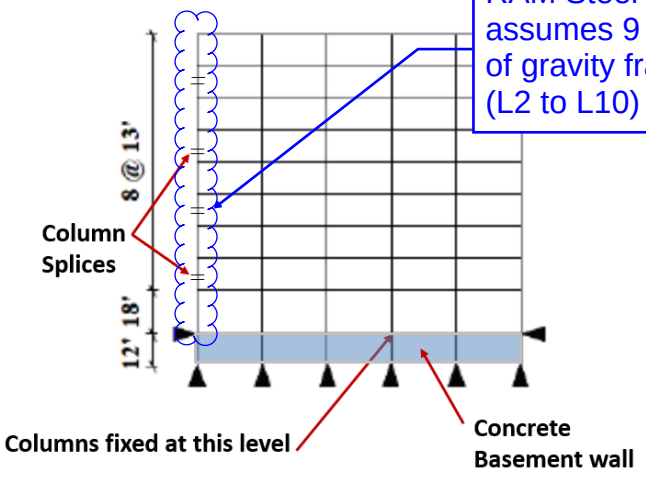
- The interior columns are designed as described below. See the column sizes on the next page.
- See the following pages for an example column design report and the gravity column design summary.

Example column design is of the worst-case column on grid C-3.5 of L2

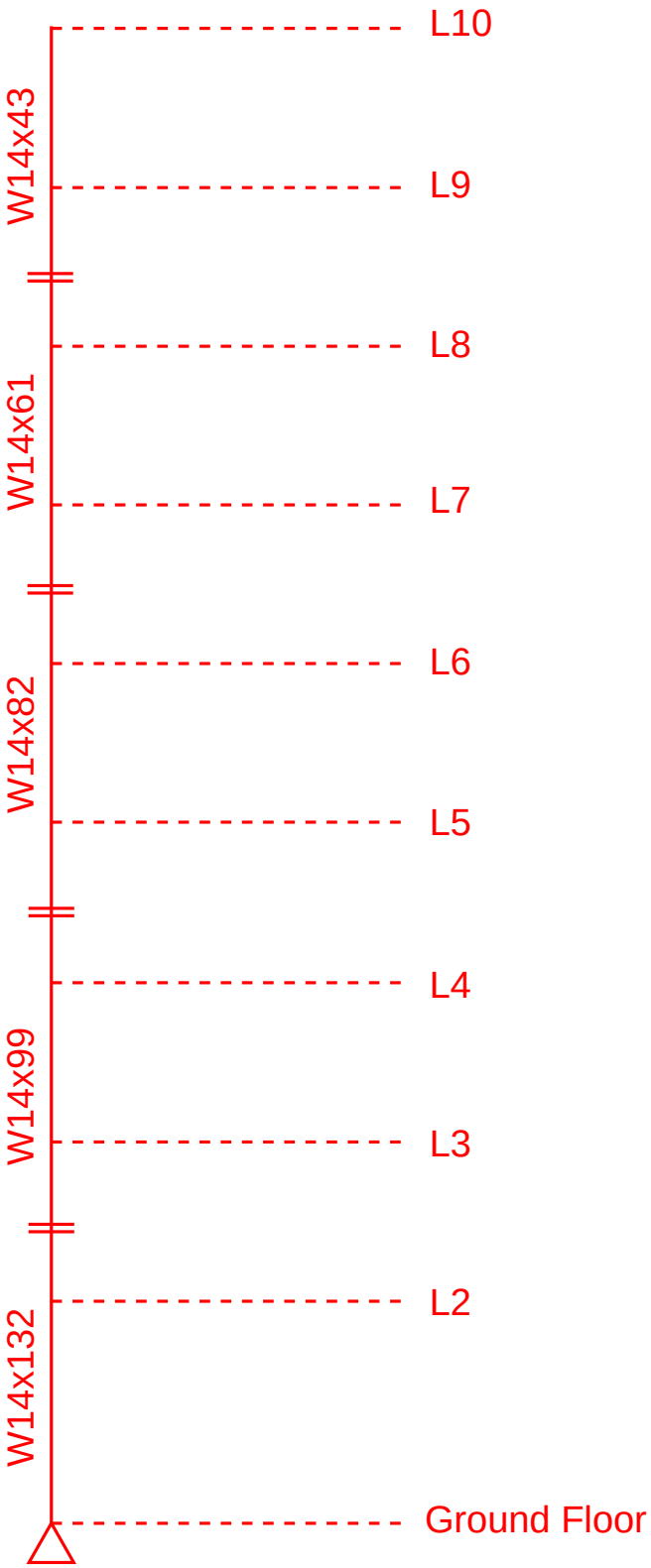


Gravity Columns Designed

RAM Steel model assumes 9 floors of gravity framing (L2 to L10)



Gravity Column Sizes (typically all gravity columns)



Gravity Column Design

RAM Steel 17.04.02.12
Magnusson Klemencic Assoc.
DataBase: Floor Framing Study_Archetype 1_FINAL Model 12/06/22 10:04:18
Building Code: IBC Steel Code: AISC360-16 LRFD

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

Fy (ksi) = 50.00 Column Size = W14X132
Orientation (deg.) = 0.0

Typical, all columns

Typical RAM Steel assumption

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	10.10	10.10
	Bottom	0.00	0.00

Live load reduced, typ

CONTROLLING AXIAL COLUMN LOADS - Skip-Load Case 1:

OK

	Dead	Live	Roof
Axial (kip)	628.97	348.59	0.00

DEMAND CAPACITY RATIO: (1.2DL + 1.6LL)

Pu (kip)	=	1312.51	0.90Pnx (kip)	=	1601.30	Pu/0.90Pnx	= 0.820
			0.90Pny (kip)	=	1371.35	Pu/0.90Pny	= 0.957
			0.90Pn (kip)	=	1371.35	Pu/0.90Pn	= 0.957

DEMAND/CAPACITY LIMIT FOR STRENGTH : 1.000

CONTROLLING COMBINED COLUMN LOADS - Skip-Load Case 10:

			Dead	Live	Roof
Axial (kip)			628.97	343.34	0.00
Moments	Top	Mx (kip-ft)	0.36	0.23	0.00
		My (kip-ft)	-1.72	-2.78	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)	=	1304.11	0.90*Pn (kip)	=	1371.35
Mux (kip-ft)	=	0.80	0.90*Mnx (kip-ft)	=	877.50
Muy (kip-ft)	=	-6.51	0.90*Mny (kip-ft)	=	423.75
Rm	=	1.00			
Cbx	=	1.67			
Cmx	=	0.60	Cmy	=	0.60
Pex (kip)	=	9386.02	Pey (kip)	=	3361.79
B1x	=	1.00	B1y	=	1.00

INTERACTION EQUATION

Pu/0.90*Pn = 0.951

Eq H1-1a: 0.951 + 8/9(0.001 + 0.015) = 0.965 OK

Gravity Column Design Summary

RAM Steel 17.04.02.12
Magnusson Klemencic Assoc.
DataBase: Floor Framing Study_Archetype 1_FINAL Model 12/06/22 10:03:14
Building Code: IBC Steel Code: AISC360-16 LRFD

DEMAND/CAPACITY LIMIT FOR STRENGTH : 1.000

Column Line B-2.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	138.5	-10.5	13.7	6	0.62 Eq H1-1a	0.0	50	W14X43
L9	274.7	-9.5	7.4	3	0.53 Eq H1-1a	0.0	50	W14X61
L8	408.5	-9.4	7.3	3	0.76 Eq H1-1a	0.0	50	W14X61
L7	545.1	-9.5	7.3	3	0.73 Eq H1-1a	0.0	50	W14X82
L6	681.7	-9.5	7.3	3	0.90 Eq H1-1a	0.0	50	W14X82
L5	818.6	-9.5	9.4	3	0.75 Eq H1-1a	0.0	50	W14X99
L4	955.5	-9.5	9.4	3	0.87 Eq H1-1a	0.0	50	W14X99
L3	1092.8	-11.3	11.0	3	0.74 Eq H1-1a	0.0	50	W14X132
L2	1226.0	-1.4	7.9	6	0.91 Eq H1-1a	0.0	50	W14X132

Column Line B-3.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	138.5	-10.5	-13.7	11	0.62 Eq H1-1a	0.0	50	W14X43
L9	274.7	-9.5	-7.4	4	0.53 Eq H1-1a	0.0	50	W14X61
L8	408.5	-9.4	-7.3	4	0.76 Eq H1-1a	0.0	50	W14X61
L7	545.1	-9.5	-7.3	4	0.73 Eq H1-1a	0.0	50	W14X82
L6	681.7	-9.5	-7.3	4	0.90 Eq H1-1a	0.0	50	W14X82
L5	818.6	-9.5	-9.4	4	0.75 Eq H1-1a	0.0	50	W14X99
L4	955.5	-9.5	-9.4	4	0.87 Eq H1-1a	0.0	50	W14X99
L3	1092.8	-11.3	-11.0	4	0.74 Eq H1-1a	0.0	50	W14X132
L2	1226.0	-1.4	-7.9	10	0.91 Eq H1-1a	0.0	50	W14X132

Column Line C-2.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	144.3	10.1	11.4	7	0.61 Eq H1-1a	0.0	50	W14X43
L9	292.0	9.1	6.0	2	0.55 Eq H1-1a	0.0	50	W14X61
L8	435.7	9.0	6.0	2	0.79 Eq H1-1a	0.0	50	W14X61
L7	581.4	9.2	6.0	2	0.77 Eq H1-1a	0.0	50	W14X82
L6	727.0	9.2	6.0	2	0.94 Eq H1-3b	0.0	50	W14X82
L5	872.9	9.1	7.7	2	0.79 Eq H1-1a	0.0	50	W14X99
L4	1018.8	9.1	7.7	2	0.92 Eq H1-1a	0.0	50	W14X99
L3	1165.3	10.9	9.0	2	0.79 Eq H1-1a	0.0	50	W14X132
L2	1304.1	0.8	6.5	6	0.97 Eq H1-1a	0.0	50	W14X132

Column Line C-3.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	144.3	10.1	-11.4	10	0.61 Eq H1-1a	0.0	50	W14X43
L9	292.0	9.1	-6.0	5	0.55 Eq H1-1a	0.0	50	W14X61
L8	435.7	9.0	-6.0	5	0.79 Eq H1-1a	0.0	50	W14X61
L7	581.4	9.2	-6.0	5	0.77 Eq H1-1a	0.0	50	W14X82
L6	727.0	9.2	-6.0	5	0.94 Eq H1-3b	0.0	50	W14X82

L5	872.9	9.1	-7.7	5	0.79 Eq H1-1a	0.0	50	W14X99
L4	1018.8	9.1	-7.7	5	0.92 Eq H1-1a	0.0	50	W14X99
L3	1165.3	10.9	-9.0	5	0.79 Eq H1-1a	0.0	50	W14X132
L2	1304.1	0.8	-6.5	10	0.97 Eq H1-1a	0.0	50	W14X132

Column Line D-2.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	139.5	-11.1	11.4	6	0.60 Eq H1-1a	0.0	50	W14X43
L9	283.4	-10.1	6.0	3	0.54 Eq H1-1a	0.0	50	W14X61
L8	422.1	-10.0	6.0	3	0.77 Eq H1-1a	0.0	50	W14X61
L7	563.2	-10.2	6.0	3	0.75 Eq H1-1a	0.0	50	W14X82
L6	704.4	-10.2	6.0	3	0.92 Eq H1-1a	0.0	50	W14X82
L5	845.8	-10.1	7.7	3	0.77 Eq H1-1a	0.0	50	W14X99
L4	987.1	-10.1	7.7	3	0.89 Eq H1-1a	0.0	50	W14X99
L3	1129.1	-12.1	9.0	3	0.76 Eq H1-1a	0.0	50	W14X132
L2	1263.4	-2.4	6.5	6	0.94 Eq H1-1a	0.0	50	W14X132

Column Line D-3.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	139.5	-11.1	-11.4	11	0.60 Eq H1-1a	0.0	50	W14X43
L9	283.4	-10.1	-6.0	4	0.54 Eq H1-1a	0.0	50	W14X61
L8	422.1	-10.0	-6.0	4	0.77 Eq H1-1a	0.0	50	W14X61
L7	563.2	-10.2	-6.0	4	0.75 Eq H1-1a	0.0	50	W14X82
L6	704.4	-10.2	-6.0	4	0.92 Eq H1-1a	0.0	50	W14X82
L5	845.8	-10.1	-7.7	4	0.77 Eq H1-1a	0.0	50	W14X99
L4	987.1	-10.1	-7.7	4	0.89 Eq H1-1a	0.0	50	W14X99
L3	1129.1	-12.1	-9.0	4	0.76 Eq H1-1a	0.0	50	W14X132
L2	1263.4	-2.4	-6.5	10	0.94 Eq H1-1a	0.0	50	W14X132

Column Line E-2.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	137.1	10.1	11.4	7	0.59 Eq H1-1a	0.0	50	W14X43
L9	279.1	9.2	6.0	2	0.53 Eq H1-1a	0.0	50	W14X61
L8	415.3	9.1	6.0	2	0.76 Eq H1-1a	0.0	50	W14X61
L7	554.2	9.3	6.0	2	0.73 Eq H1-1a	0.0	50	W14X82
L6	693.0	9.3	6.0	2	0.90 Eq H1-1a	0.0	50	W14X82
L5	832.2	9.2	7.7	2	0.76 Eq H1-1a	0.0	50	W14X99
L4	971.3	9.2	7.7	2	0.88 Eq H1-1a	0.0	50	W14X99
L3	1110.9	11.0	9.0	2	0.75 Eq H1-1a	0.0	50	W14X132
L2	1243.0	1.6	6.5	6	0.92 Eq H1-1a	0.0	50	W14X132

Column Line E-3.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	137.1	10.1	-11.4	10	0.59 Eq H1-1a	0.0	50	W14X43

L9	279.1	9.2	-6.0	5	0.53 Eq H1-1a	0.0	50	W14X61
L8	415.3	9.1	-6.0	5	0.76 Eq H1-1a	0.0	50	W14X61
L7	554.2	9.3	-6.0	5	0.73 Eq H1-1a	0.0	50	W14X82
L6	693.0	9.3	-6.0	5	0.90 Eq H1-1a	0.0	50	W14X82
L5	832.2	9.2	-7.7	5	0.76 Eq H1-1a	0.0	50	W14X99
L4	971.3	9.2	-7.7	5	0.88 Eq H1-1a	0.0	50	W14X99
L3	1110.9	11.0	-9.0	5	0.75 Eq H1-1a	0.0	50	W14X132
L2	1243.0	1.6	-6.5	10	0.92 Eq H1-1a	0.0	50	W14X132

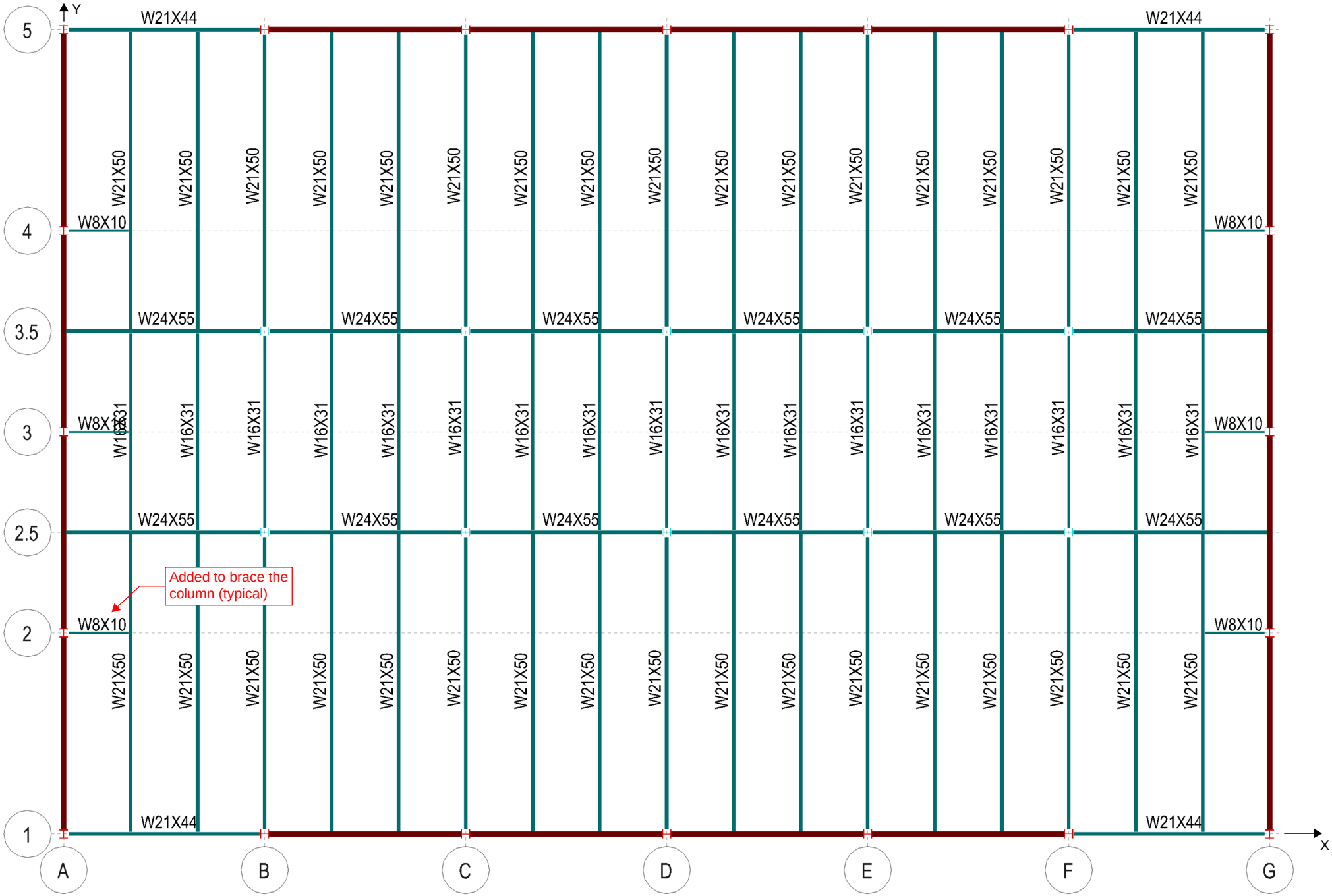
Column Line F-2.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	138.5	10.5	13.7	7	0.62 Eq H1-1a	0.0	50	W14X43
L9	274.7	9.5	7.4	2	0.53 Eq H1-1a	0.0	50	W14X61
L8	408.5	9.4	7.3	2	0.76 Eq H1-1a	0.0	50	W14X61
L7	545.1	9.5	7.3	2	0.73 Eq H1-1a	0.0	50	W14X82
L6	681.7	9.5	7.3	2	0.90 Eq H1-1a	0.0	50	W14X82
L5	818.6	9.5	9.4	2	0.75 Eq H1-1a	0.0	50	W14X99
L4	955.5	9.5	9.4	2	0.87 Eq H1-1a	0.0	50	W14X99
L3	1092.8	11.3	11.0	2	0.74 Eq H1-1a	0.0	50	W14X132
L2	1226.0	1.4	7.9	6	0.91 Eq H1-1a	0.0	50	W14X132

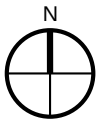
Column Line F-3.5

Level	Pu	Mux	Muy	LC	Interaction Eq.	Angle	Fy	Size
L10	138.5	10.5	-13.7	10	0.62 Eq H1-1a	0.0	50	W14X43
L9	274.7	9.5	-7.4	5	0.53 Eq H1-1a	0.0	50	W14X61
L8	408.5	9.4	-7.3	5	0.76 Eq H1-1a	0.0	50	W14X61
L7	545.1	9.5	-7.3	5	0.73 Eq H1-1a	0.0	50	W14X82
L6	681.7	9.5	-7.3	5	0.90 Eq H1-1a	0.0	50	W14X82
L5	818.6	9.5	-9.4	5	0.75 Eq H1-1a	0.0	50	W14X99
L4	955.5	9.5	-9.4	5	0.87 Eq H1-1a	0.0	50	W14X99
L3	1092.8	11.3	-11.0	5	0.74 Eq H1-1a	0.0	50	W14X132
L2	1226.0	1.4	-7.9	10	0.91 Eq H1-1a	0.0	50	W14X132

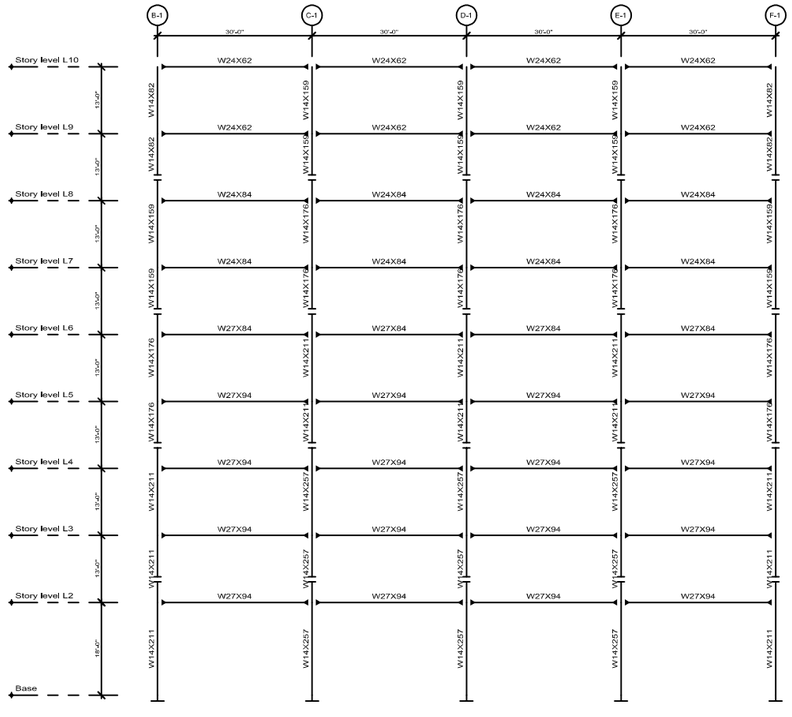
APPENDIX 2: TYPICAL FLOOR PLAN AND FRAME ELEVATIONS



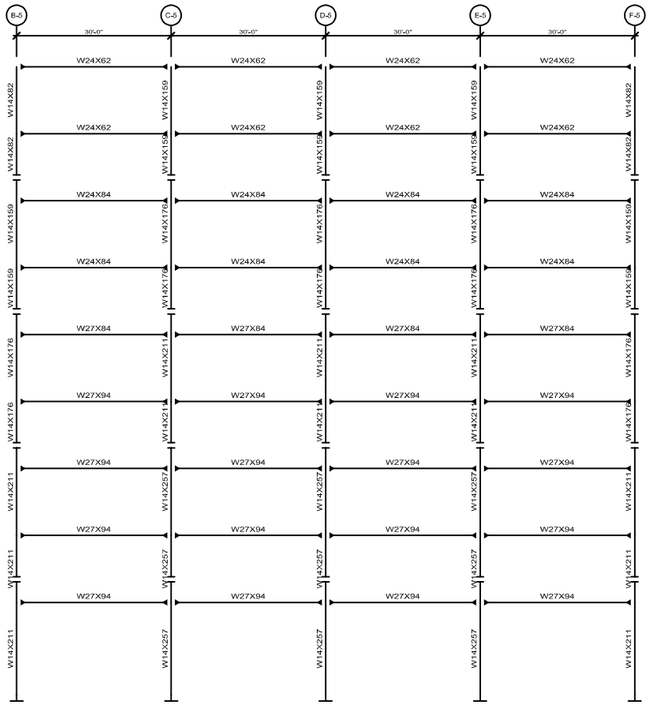
TYPICAL FLOOR PLAN



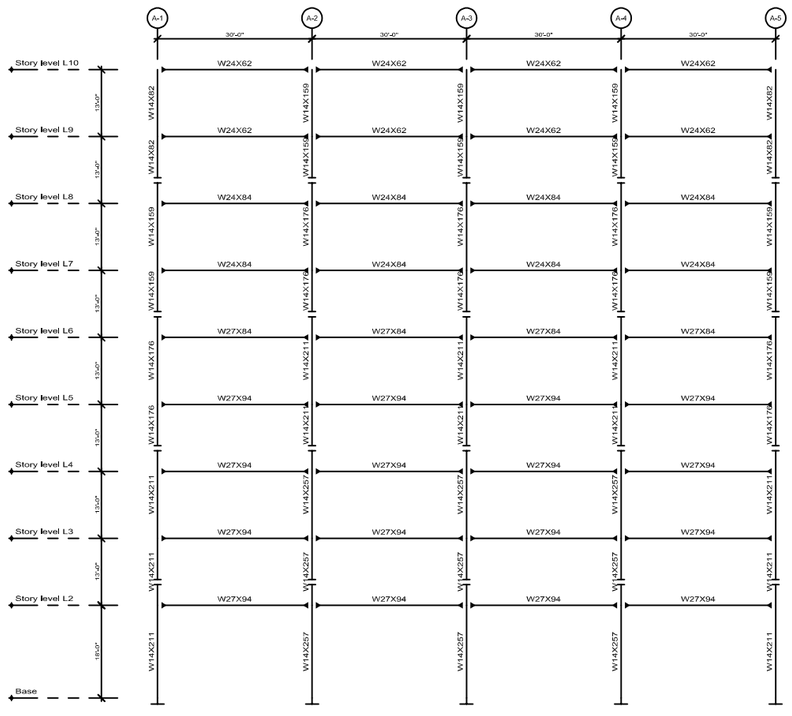
FRAME ELEVATIONS



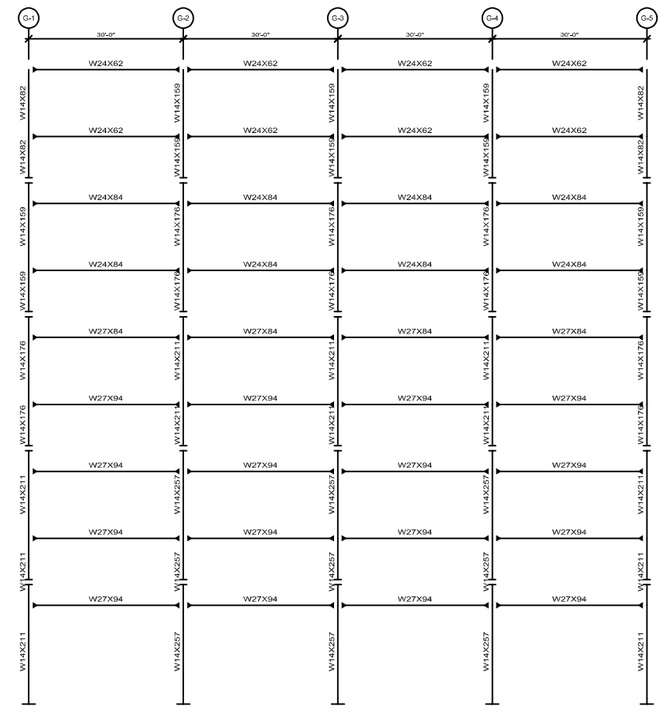
Frame along gridline 1



Frame along gridline 5

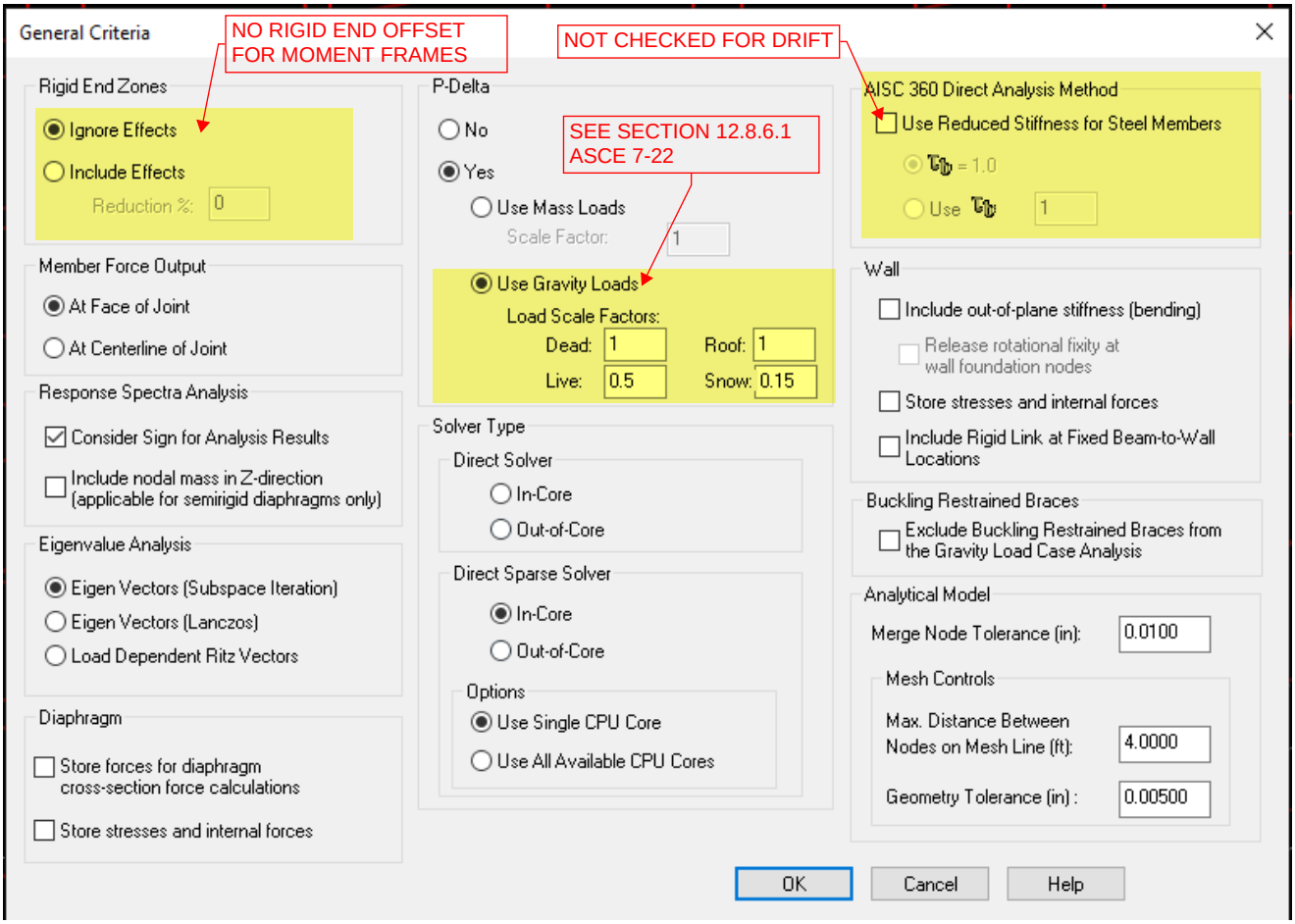


Frame along gridline A

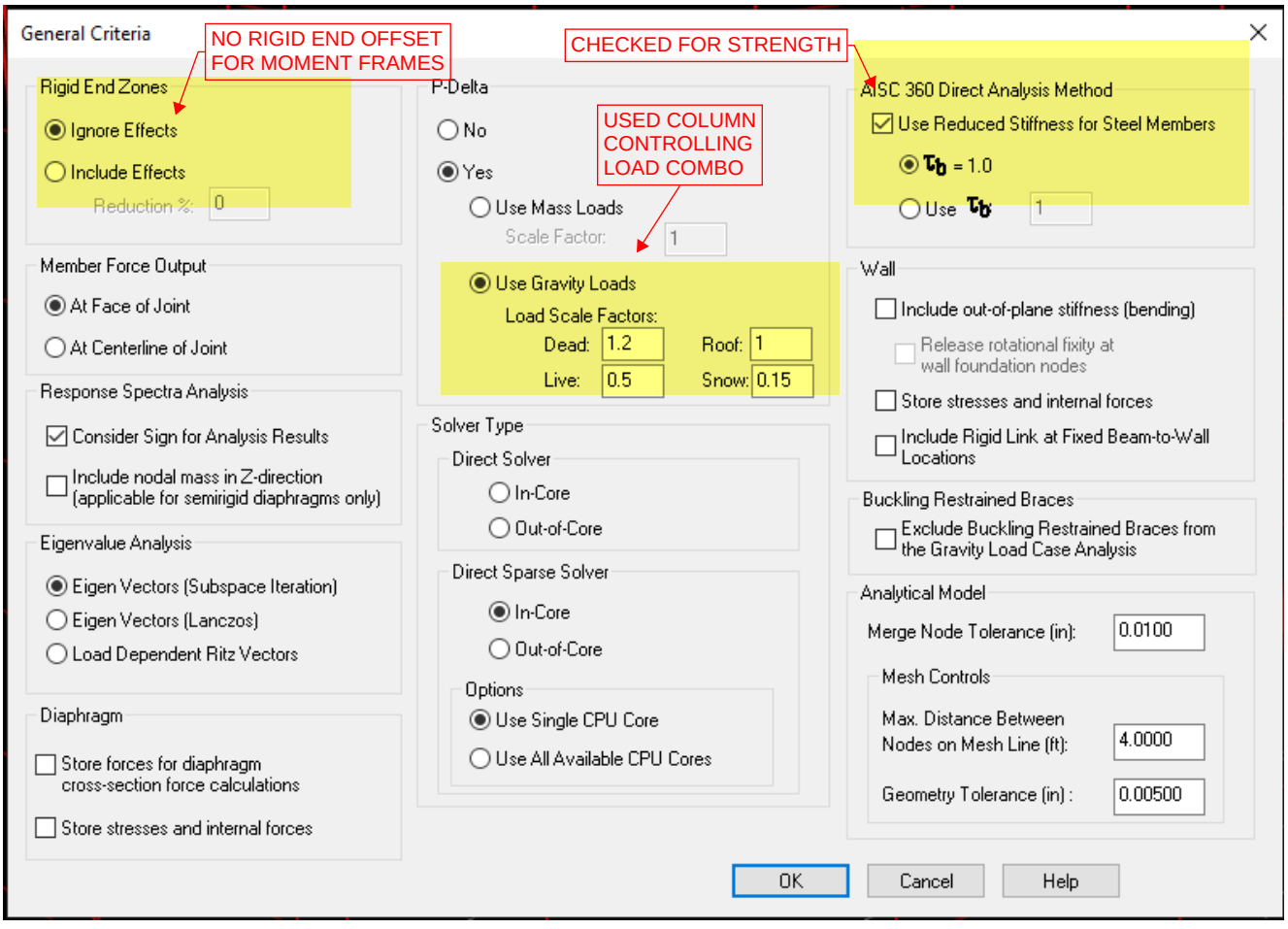


Frame along gridline G

ANALYSIS CRITERIA FOR DRIFT:



ANALYSIS CRITERIA FOR STRENGTH:



Loads and Applied Forces

RAM Frame 17.04.01.07
DataBase: ATC 154_SSC_SMF Study - High D_Final - Drift 01/05/23 12:48:34

LOAD CASE: RSA_Drift

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

Dynamic Response Spectra for ASCE 7-16
Damping Ratio: 0.050
Scale Factors (X-Dir): +Ecc Case: 0.1250 -Ecc Case: 0.1250
Scale Factors (Y-Dir): +Ecc Case: 0.1250 -Ecc Case: 0.1250
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

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(To)	0.4000 g
0.1200(To)	1.0000 g
0.6000(Ts)	1.0000 g
0.6000 < T < 6.0000 (TL)	0.6000 g/T
T > 6.0000	3.6000 g/(T*T)

LOAD CASE: ELF_Drift

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

Seismic ASCE 7-16 Equivalent Lateral Force
Importance Factor: 1.00 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

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 Eq12.8-2	Cs(max) Eq12.8-3	Cs(min)	Cs-used	k
X	1.307	1.400	3.674	3.674	0.125	0.020	---	0.020	2.000

Dir	Ta	Cu	T	T-used	Cs Eq12.8-2	Cs(max) Eq12.8-3	Cs(min)	Cs-used	k
Y	1.307	1.400	3.674	3.674	0.125	0.020	---	0.020	2.000

Total Building Weight (kips) = 17161.37

APPLIED DIAPHRAGM FORCES

Applied forces are shown for ELF method for comparison.

Type: EQ_ASCE716_X_+E_Drft

Level	Diaph.#	Ht ft	Fx kips	Fy kips	X ft	Y ft
Story level L10	1	122.00	94.65	0.00	89.87	66.10
Story level L9	1	109.00	76.39	0.00	89.87	66.10
Story level L8	1	96.00	59.80	0.00	89.87	66.10
Story level L7	1	83.00	44.86	0.00	89.87	66.10
Story level L6	1	70.00	31.99	0.00	89.87	66.10
Story level L5	1	57.00	21.32	0.00	89.88	66.10
Story level L4	1	44.00	12.75	0.00	89.88	66.10
Story level L3	1	31.00	6.35	0.00	89.88	66.10
Story level L2	1	18.00	2.23	0.00	89.88	66.10

APPLIED STORY FORCES

Type: EQ_ASCE716_X_+E_Drft

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	94.65	0.00
Story level L9	109.00	76.39	0.00

Story level L8	96.00	59.80	0.00
Story level L7	83.00	44.86	0.00
Story level L6	70.00	31.99	0.00
Story level L5	57.00	21.32	0.00
Story level L4	44.00	12.75	0.00
Story level L3	31.00	6.35	0.00
Story level L2	18.00	2.23	0.00
		350.35	0.00

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_X_-E_Drft

Level	Diaph.#	Ht	Fx	Fy	X	Y
		ft	kips	kips	ft	ft
Story level L10	1	122.00	94.65	0.00	89.87	53.90
Story level L9	1	109.00	76.39	0.00	89.87	53.90
Story level L8	1	96.00	59.80	0.00	89.87	53.90
Story level L7	1	83.00	44.86	0.00	89.87	53.90
Story level L6	1	70.00	31.99	0.00	89.87	53.90
Story level L5	1	57.00	21.32	0.00	89.88	53.90
Story level L4	1	44.00	12.75	0.00	89.88	53.90
Story level L3	1	31.00	6.35	0.00	89.88	53.90
Story level L2	1	18.00	2.23	0.00	89.88	53.90

APPLIED STORY FORCES

Type: EQ_ASCE716_X_-E_Drft

Level	Ht	Fx	Fy
	ft	kips	kips
Story level L10	122.00	94.65	0.00
Story level L9	109.00	76.39	0.00
Story level L8	96.00	59.80	0.00
Story level L7	83.00	44.86	0.00
Story level L6	70.00	31.99	0.00
Story level L5	57.00	21.32	0.00
Story level L4	44.00	12.75	0.00
Story level L3	31.00	6.35	0.00
Story level L2	18.00	2.23	0.00
		350.35	0.00

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_+E_Drft

Level	Diaph.#	Ht	Fx	Fy	X	Y

		ft	kips	kips	ft	ft
Story level L10	1	122.00	0.00	94.65	98.97	60.00
Story level L9	1	109.00	0.00	76.39	98.97	60.00
Story level L8	1	96.00	0.00	59.80	98.97	60.00
Story level L7	1	83.00	0.00	44.86	98.97	60.00
Story level L6	1	70.00	0.00	31.99	98.97	60.00
Story level L5	1	57.00	0.00	21.32	98.98	60.00
Story level L4	1	44.00	0.00	12.75	98.98	60.00
Story level L3	1	31.00	0.00	6.35	98.98	60.00
Story level L2	1	18.00	0.00	2.23	98.98	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_+E_Drft

Level	Ht	Fx	Fy
	ft	kips	kips
Story level L10	122.00	0.00	94.65
Story level L9	109.00	0.00	76.39
Story level L8	96.00	0.00	59.80
Story level L7	83.00	0.00	44.86
Story level L6	70.00	0.00	31.99
Story level L5	57.00	0.00	21.32
Story level L4	44.00	0.00	12.75
Story level L3	31.00	0.00	6.35
Story level L2	18.00	0.00	2.23
		0.00	350.35

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_-E_Drft

Level	Diaph.#	Ht	Fx	Fy	X	Y
		ft	kips	kips	ft	ft
Story level L10	1	122.00	0.00	94.65	80.77	60.00
Story level L9	1	109.00	0.00	76.39	80.77	60.00
Story level L8	1	96.00	0.00	59.80	80.77	60.00
Story level L7	1	83.00	0.00	44.86	80.77	60.00
Story level L6	1	70.00	0.00	31.99	80.77	60.00
Story level L5	1	57.00	0.00	21.32	80.78	60.00
Story level L4	1	44.00	0.00	12.75	80.78	60.00
Story level L3	1	31.00	0.00	6.35	80.78	60.00
Story level L2	1	18.00	0.00	2.23	80.78	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_-E_Drft

Level	Ht	Fx	Fy

Loads and Applied Forces

	ft	kips	kips
Story level L10	122.00	0.00	94.65
Story level L9	109.00	0.00	76.39
Story level L8	96.00	0.00	59.80
Story level L7	83.00	0.00	44.86
Story level L6	70.00	0.00	31.99
Story level L5	57.00	0.00	21.32
Story level L4	44.00	0.00	12.75
Story level L3	31.00	0.00	6.35
Story level L2	18.00	0.00	2.23
		0.00	350.35

BASE SHEAR (Dynamic Load Cases)

LdC	Shear-X	Shear-Y
Dyn1	**-351.41**	**0.28**
Dyn2	**-351.41**	**-0.28**
Dyn3	**0.00**	**-349.50**
Dyn4	**-0.00**	**-349.29**

RSA BASE SHEAR - DRIFT

Loads and Applied Forces

RAM Frame 17.04.01.07
DataBase: ATC 154_SSC_SMF Study - High D_Final - Strength 01/05/23 15:47:05

LOAD CASE: ELF_Strength

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

Seismic ASCE 7-16 Equivalent Lateral Force
Importance Factor: 1.00 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

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	3.674	1.830	0.125	0.041	0.044	0.044	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	3.674	1.830	0.125	0.041	0.044	0.044	1.665

Total Building Weight (kips) = 17161.37

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	184.15	0.00	89.87	60.00
Story level L9	1	109.00	154.35	0.00	89.87	60.00
Story level L8	1	96.00	126.08	0.00	89.87	60.00
Story level L7	1	83.00	99.31	0.00	89.87	60.00
Story level L6	1	70.00	74.99	0.00	89.87	60.00
Story level L5	1	57.00	53.53	0.00	89.88	60.00
Story level L4	1	44.00	34.91	0.00	89.88	60.00
Story level L3	1	31.00	19.56	0.00	89.88	60.00
Story level L2	1	18.00	8.23	0.00	89.88	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_X_NoE_F

Level	Ht ft	Fx kips	Fy kips
Story level L10	122.00	184.15	0.00
Story level L9	109.00	154.35	0.00

Story level L8	96.00	126.08	0.00
Story level L7	83.00	99.31	0.00
Story level L6	70.00	74.99	0.00
Story level L5	57.00	53.53	0.00
Story level L4	44.00	34.91	0.00
Story level L3	31.00	19.56	0.00
Story level L2	18.00	8.23	0.00
		755.10	0.00

APPLIED DIAPHRAGM FORCES

Type: EQ_ASCE716_Y_NoE_F

Level	Diaph.#	Ht	Fx	Fy	X	Y
		ft	kips	kips	ft	ft
Story level L10	1	122.00	0.00	184.15	89.87	60.00
Story level L9	1	109.00	0.00	154.35	89.87	60.00
Story level L8	1	96.00	0.00	126.08	89.87	60.00
Story level L7	1	83.00	0.00	99.31	89.87	60.00
Story level L6	1	70.00	0.00	74.99	89.87	60.00
Story level L5	1	57.00	0.00	53.53	89.88	60.00
Story level L4	1	44.00	0.00	34.91	89.88	60.00
Story level L3	1	31.00	0.00	19.56	89.88	60.00
Story level L2	1	18.00	0.00	8.23	89.88	60.00

APPLIED STORY FORCES

Type: EQ_ASCE716_Y_NoE_F

Level	Ht	Fx	Fy
	ft	kips	kips
Story level L10	122.00	0.00	184.15
Story level L9	109.00	0.00	154.35
Story level L8	96.00	0.00	126.08
Story level L7	83.00	0.00	99.31
Story level L6	70.00	0.00	74.99
Story level L5	57.00	0.00	53.53
Story level L4	44.00	0.00	34.91
Story level L3	31.00	0.00	19.56
Story level L2	18.00	0.00	8.23
		0.00	755.10

BASE SHEAR (Dynamic Load Cases)

LdC	Shear-X	Shear-Y
Dyn5	**-757.90**	**-0.00**
Dyn6	**0.00**	**-763.18**

RSA BASE SHEAR - STRENGTH

Periods and Modes

RAM Frame 17.04.01.07
DataBase: ATC 154_SSC_SMF Study - High D_Final - Drift 01/05/23 12:48:34

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	3.6738	0.2722	1.7103	2.9250
2	3.6738	0.2722	1.7103	2.9250
3	2.2111	0.4523	2.8416	8.0747
4	1.2746	0.7845	4.9294	24.2991
5	1.2746	0.7845	4.9294	24.2992
6	0.7818	1.2791	8.0369	64.5918

MODAL PARTICIPATION FACTORS:

Mode	X-Dir	Y-Dir	Rotation
1	-0.1082	72.5979	-0.4992
2	72.5979	0.1082	-0.0000
3	-0.0001	0.0887	405.8697
4	-0.0367	26.0352	-0.1776
5	26.0352	0.0367	0.0003
6	0.0001	-0.0296	-145.4180

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
4	0.00	100.00	0.00
5	100.00	0.00	0.00
6	0.00	0.00	100.00

MODAL EFFECTIVE MASS FACTORS:

Mode	X-Dir		Y-Dir		Rotation	
	%Mass	%SumM	%Mass	%SumM	%Mass	%SumM
1	0.00	0.00	82.41	82.41	0.00	0.00
2	82.41	82.41	0.00	82.41	0.00	0.00
3	0.00	82.41	0.00	82.41	82.88	82.88
4	0.00	82.41	10.60	93.01	0.00	82.88
5	10.60	93.01	0.00	93.01	0.00	82.88
6	0.00	93.01	0.00	93.01	10.64	93.52

Drift

RAM Structural System 17.04.01.07
DataBase: ATC 154_SSC_SMF Study - High D_Final - Drift 01/05/23 12:48:34
Building Code: IBC 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:

All drift ratios less than 0.0036

Location (ft): (89.870, 60.000)

Story	LdC	Displacement		Story Drift		Drift Ratio	
		X	Y	X	Y	X	Y
		in	in	in	in		
Story level L10	Dyn1	3.5919	-0.0029	0.2473	-0.0002	0.0016	0.0000
	Dyn2	3.5919	0.0029	0.2473	0.0002	0.0016	0.0000
	Dyn3	-0.0000	3.5717	0.0000	0.2458	0.0000	0.0016
	Dyn4	0.0000	3.5705	-0.0000	0.2458	0.0000	0.0016
Story level L9	Dyn1	3.3939	-0.0027	0.3560	-0.0003	0.0023	0.0000
	Dyn2	3.3939	0.0027	0.3560	0.0003	0.0023	0.0000
	Dyn3	-0.0000	3.3748	-0.0000	0.3539	0.0000	0.0023
	Dyn4	0.0000	3.3737	-0.0000	0.3538	0.0000	0.0023
Story level L8	Dyn1	3.1050	-0.0025	0.3993	-0.0003	0.0026	0.0000
	Dyn2	3.1050	0.0025	0.3993	0.0003	0.0026	0.0000
	Dyn3	-0.0000	3.0876	-0.0000	0.3970	0.0000	0.0025
	Dyn4	0.0000	3.0866	0.0000	0.3969	0.0000	0.0025
Story level L7	Dyn1	2.7667	-0.0022	0.4366	-0.0003	0.0028	0.0000
	Dyn2	2.7667	0.0022	0.4366	0.0003	0.0028	0.0000
	Dyn3	-0.0000	2.7512	-0.0000	0.4341	0.0000	0.0028
	Dyn4	0.0000	2.7503	0.0000	0.4340	0.0000	0.0028
Story level L6	Dyn1	2.3780	-0.0019	0.4341	-0.0003	0.0028	0.0000
	Dyn2	2.3779	0.0019	0.4341	0.0003	0.0028	0.0000
	Dyn3	-0.0000	2.3647	-0.0000	0.4317	0.0000	0.0028
	Dyn4	0.0000	2.3639	0.0000	0.4315	0.0000	0.0028

Drift

All drift ratios less than 0.0036 (typical all load cases)

Story	LdC	Displacement		Story Drift		Drift Ratio	
Story level L5	Dyn1	1.9703	-0.0016	0.4619	-0.0004	0.0030	0.0000
	Dyn2	1.9703	0.0016	0.4619	0.0004	0.0030	0.0000
	Dyn3	-0.0000	1.9593	-0.0000	0.4594	0.0000	0.0029
	Dyn4	0.0000	1.9587	0.0000	0.4592	0.0000	0.0029
Story level L4	Dyn1	1.5193	-0.0012	0.4767	-0.0004	0.0031	0.0000
	Dyn2	1.5193	0.0012	0.4766	0.0004	0.0031	0.0000
	Dyn3	-0.0000	1.5108	-0.0000	0.4740	0.0000	0.0030
	Dyn4	0.0000	1.5103	0.0000	0.4738	0.0000	0.0030
Story level L3	Dyn1	1.0456	0.0008	0.5056	-0.0004	0.0032	0.0000
	Dyn2	1.0456	-0.0008	0.5056	0.0004	0.0032	0.0000
	Dyn3	-0.0000	1.0397	-0.0000	0.5028	0.0000	0.0032
	Dyn4	0.0000	1.0394	0.0000	0.5026	0.0000	0.0032
Story level L2	Dyn1	0.5404	0.0004	0.5404	0.0004	0.0025	0.0000
	Dyn2	0.5404	-0.0004	0.5404	-0.0004	0.0025	0.0000
	Dyn3	-0.0000	0.5374	-0.0000	0.5374	0.0000	0.0025
	Dyn4	0.0000	0.5372	0.0000	0.5372	0.0000	0.0025

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	0.2587	(0.00 0.00)	0.2360	(0.00 120.00)	1.096	1.046
Story level L9	Dyn2	0.3730	(0.00 0.00)	0.3392	(0.00 120.00)	1.100	1.047
Story level L8	Dyn2	0.4180	(0.00 0.00)	0.3810	(0.00 120.00)	1.097	1.046
Story level L7	Dyn2	0.4569	(0.00 0.00)	0.4167	(0.00 120.00)	1.096	1.046
Story level L6	Dyn2	0.4537	(0.00 0.00)	0.4148	(0.00 120.00)	1.094	1.045
Story level L5	Dyn2	0.4826	(0.00 0.00)	0.4416	(0.00 120.00)	1.093	1.044
Story level L4	Dyn2	0.4978	(0.00 0.00)	0.4559	(0.00 120.00)	1.092	1.044
Story level L3	Dyn2	0.5283	(0.00 0.00)	0.4832	(0.00 120.00)	1.093	1.045
Story level L2	Dyn2	0.5671	(0.00 0.00)	0.5141	(0.00 120.00)	1.103	1.049

Y-Axis:

Story	LdC	Drift in	Coord ft	Drift in	Coord ft	Max/Min	Max/Ave
Story level L10	Dyn4	0.2716	(0.00 0.00)	0.2207	(180.00 0.00)	1.231	1.103
Story level L9	Dyn4	0.3923	(0.00 0.00)	0.3166	(180.00 0.00)	1.239	1.107
Story level L8	Dyn4	0.4390	(0.00 0.00)	0.3562	(180.00 0.00)	1.233	1.104
Story level L7	Dyn4	0.4798	(0.00 0.00)	0.3898	(180.00 0.00)	1.231	1.104
Story level L6	Dyn4	0.4759	(0.00 0.00)	0.3887	(180.00 0.00)	1.224	1.101
Story level L5	Dyn4	0.5060	(0.00 0.00)	0.4140	(180.00 0.00)	1.222	1.100
Story level L4	Dyn4	0.5216	(0.00 0.00)	0.4277	(180.00 0.00)	1.220	1.099
Story level L3	Dyn4	0.5541	(0.00 0.00)	0.4530	(180.00 0.00)	1.223	1.100
Story level L2	Dyn4	0.5978	(0.00 0.00)	0.4790	(180.00 0.00)	1.248	1.110

ASCE 7 Stability Coefficients

RAM Frame 17.04.01.07
DataBase: ATC 154_SSC_SMF Study - High D_Final - Drift 01/05/23 12:48:34

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)

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)

β = 0.60
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

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	Shear X	Shear Y	Drift X	Drift Y	Vertical Load
		ft	kips	kips	in	in	kips
Story level L10	1	122.00	98.67	0.00	0.33	0.00	1755.20
Story level L9	1	109.00	182.75	0.00	0.47	0.00	3472.68
Story level L8	1	96.00	251.17	0.00	0.55	0.00	5202.43
Story level L7	1	83.00	306.07	0.00	0.61	0.00	6938.27
Story level L6	1	70.00	345.52	0.00	0.61	0.00	8683.54
Story level L5	1	57.00	375.74	0.00	0.62	0.00	10430.69
Story level L4	1	44.00	395.02	0.00	0.61	0.00	12189.23
Story level L3	1	31.00	409.37	0.00	0.61	0.00	13951.89
Story level L2	1	18.00	401.95	0.00	0.63	0.00	15811.91

Level	Diaph. #	θx	θy	θx/(1+θx)	θy/(1+θy)	θxmax	θymax
Story level L10	1	0.037	0.000	0.036	0.000	0.152	0.152
Story level L9	1	0.058	0.000	0.055	0.000	0.152	0.152
Story level L8	1	0.073	0.000	0.068	0.000	0.152	0.152
Story level L7	1	0.089	0.000	0.082	0.000	0.152	0.152

Story level L6	1	0.098	0.000	0.089	0.000	0.152	0.152
Story level L5	1	0.111	0.000	0.100	0.000	0.152	0.152
Story level L4	1	0.120	0.000	0.107	0.000	0.152	0.152
Story level L3	1	0.134	0.000	0.118	0.000	0.152	0.152
Story level L2	1	0.115	0.000	0.103	0.000	0.152	0.152

Type : EQ_ASCE716_X_-E_Drft

Level	Diaph. #	Ht	Shear X	Shear Y	Drift X	Drift Y	Vertical Load
		ft	kips	kips	in	in	kips
Story level L10	1	122.00	98.67	-0.00	0.33	-0.00	1755.20
Story level L9	1	109.00	182.75	-0.00	0.47	-0.00	3472.68
Story level L8	1	96.00	251.17	-0.00	0.55	-0.00	5202.43
Story level L7	1	83.00	306.07	-0.00	0.61	-0.00	6938.27
Story level L6	1	70.00	345.52	-0.00	0.61	-0.00	8683.54
Story level L5	1	57.00	375.74	-0.00	0.62	-0.00	10430.69
Story level L4	1	44.00	395.02	-0.00	0.61	-0.00	12189.23
Story level L3	1	31.00	409.37	-0.00	0.61	-0.00	13951.89
Story level L2	1	18.00	401.95	-0.00	0.63	-0.00	15811.91

Level	Diaph. #	θx	θy	θx/(1+θx)	θy/(1+θy)	θxmax	θymax
Story level L10	1	0.037	0.000	0.036	0.000	0.152	0.152
Story level L9	1	0.058	0.000	0.055	0.000	0.152	0.152
Story level L8	1	0.073	0.000	0.068	0.000	0.152	0.152
Story level L7	1	0.089	0.000	0.082	0.000	0.152	0.152
Story level L6	1	0.098	0.000	0.089	0.000	0.152	0.152
Story level L5	1	0.111	0.000	0.100	0.000	0.152	0.152
Story level L4	1	0.120	0.000	0.107	0.000	0.152	0.152
Story level L3	1	0.134	0.000	0.118	0.000	0.152	0.152
Story level L2	1	0.115	0.000	0.103	0.000	0.152	0.152

Type : EQ_ASCE716_Y_+E_Drft

Level	Diaph. #	Ht	Shear X	Shear Y	Drift X	Drift Y	Vertical Load
		ft	kips	kips	in	in	kips
Story level L10	1	122.00	0.00	98.67	0.00	0.33	1755.20
Story level L9	1	109.00	0.00	182.75	0.00	0.47	3472.68
Story level L8	1	96.00	0.00	251.17	0.00	0.55	5202.43
Story level L7	1	83.00	0.00	306.07	0.00	0.61	6938.27
Story level L6	1	70.00	0.00	345.52	0.00	0.61	8683.54
Story level L5	1	57.00	0.00	375.73	0.00	0.62	10430.69
Story level L4	1	44.00	0.00	395.02	0.00	0.61	12189.23
Story level L3	1	31.00	0.00	409.36	0.00	0.61	13951.89
Story level L2	1	18.00	0.00	401.94	0.00	0.63	15811.91

Level	Diaph. #	θx	θy	θx/(1+θx)	θy/(1+θy)	θxmax	θymax
Story level L10	1	0.000	0.037	0.000	0.036	0.152	0.152
Story level L9	1	0.000	0.058	0.000	0.055	0.152	0.152

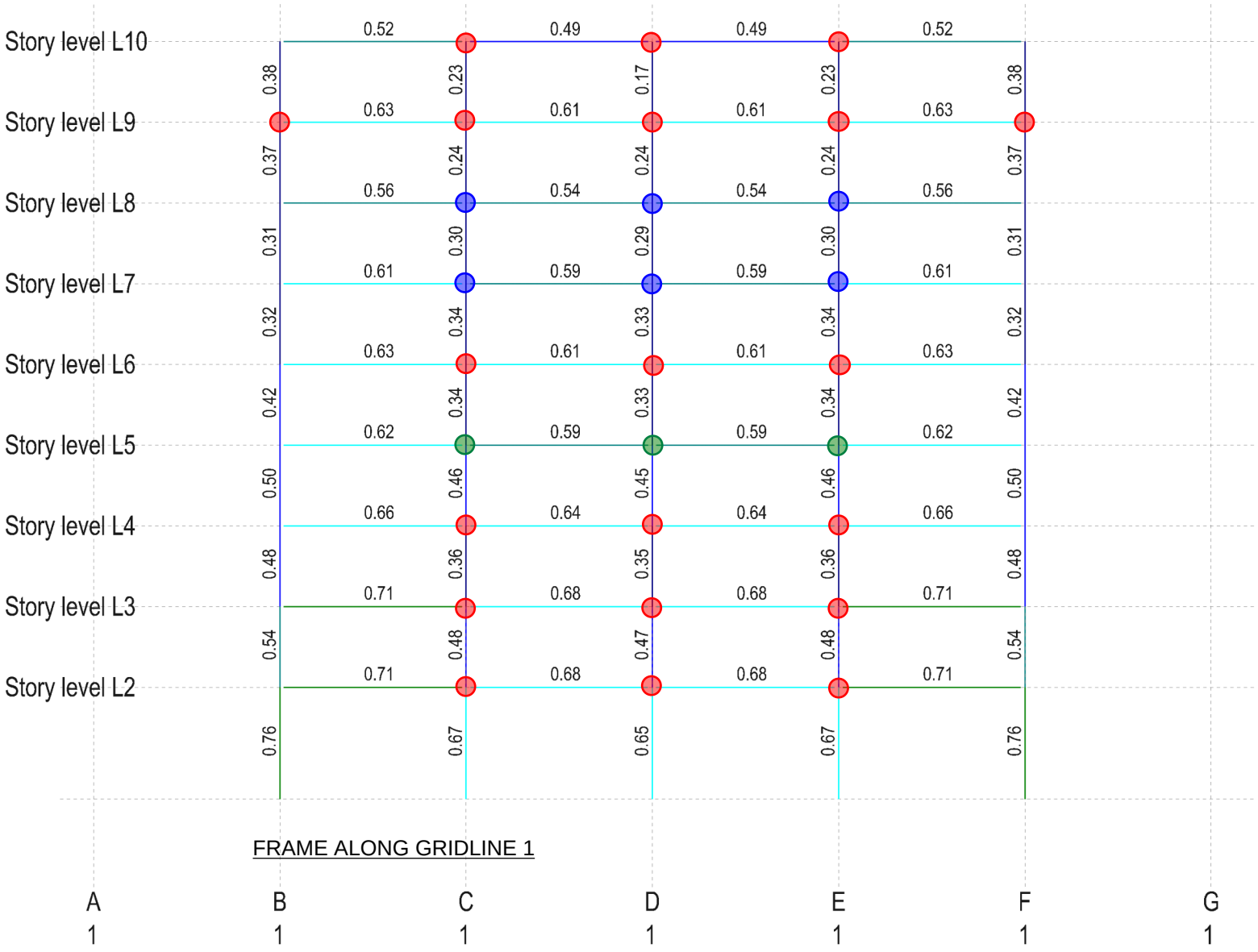
Story level L8	1	0.000	0.073	0.000	0.068	0.152	0.152
Story level L7	1	0.000	0.089	0.000	0.082	0.152	0.152
Story level L6	1	0.000	0.098	0.000	0.089	0.152	0.152
Story level L5	1	0.000	0.111	0.000	0.100	0.152	0.152
Story level L4	1	0.000	0.120	0.000	0.107	0.152	0.152
Story level L3	1	0.000	0.134	0.000	0.118	0.152	0.152
Story level L2	1	0.000	0.115	0.000	0.103	0.152	0.152

Type : EQ_ASCE716_Y_-E_Drft

Level	Diaph. #	Ht	Shear X	Shear Y	Drift X	Drift Y	Vertical Load
		ft	kips	kips	in	in	kips
Story level L10	1	122.00	-0.00	98.67	-0.00	0.33	1755.20
Story level L9	1	109.00	-0.00	182.75	-0.00	0.47	3472.68
Story level L8	1	96.00	-0.00	251.17	-0.00	0.55	5202.43
Story level L7	1	83.00	-0.00	306.08	-0.00	0.61	6938.27
Story level L6	1	70.00	-0.00	345.52	-0.00	0.61	8683.54
Story level L5	1	57.00	-0.00	375.74	-0.00	0.62	10430.69
Story level L4	1	44.00	-0.00	395.03	-0.00	0.61	12189.23
Story level L3	1	31.00	-0.00	409.37	-0.00	0.61	13951.89
Story level L2	1	18.00	-0.00	401.95	-0.00	0.63	15811.91

Level	Diaph. #	θx	θy	θx/(1+θx)	θy/(1+θy)	θxmax	θymax
Story level L10	1	0.000	0.037	0.000	0.036	0.152	0.152
Story level L9	1	0.000	0.058	0.000	0.055	0.152	0.152
Story level L8	1	0.000	0.073	0.000	0.068	0.152	0.152
Story level L7	1	0.000	0.089	0.000	0.082	0.152	0.152
Story level L6	1	0.000	0.098	0.000	0.089	0.152	0.152
Story level L5	1	0.000	0.111	0.000	0.100	0.152	0.152
Story level L4	1	0.000	0.120	0.000	0.107	0.152	0.152
Story level L3	1	0.000	0.134	0.000	0.118	0.152	0.152
Story level L2	1	0.000	0.115	0.000	0.103	0.152	0.152

APPENDIX 7: FRAME DEMAND CAPACITY RATIOS (DCRs)



FRAME ALONG GRIDLINE 1

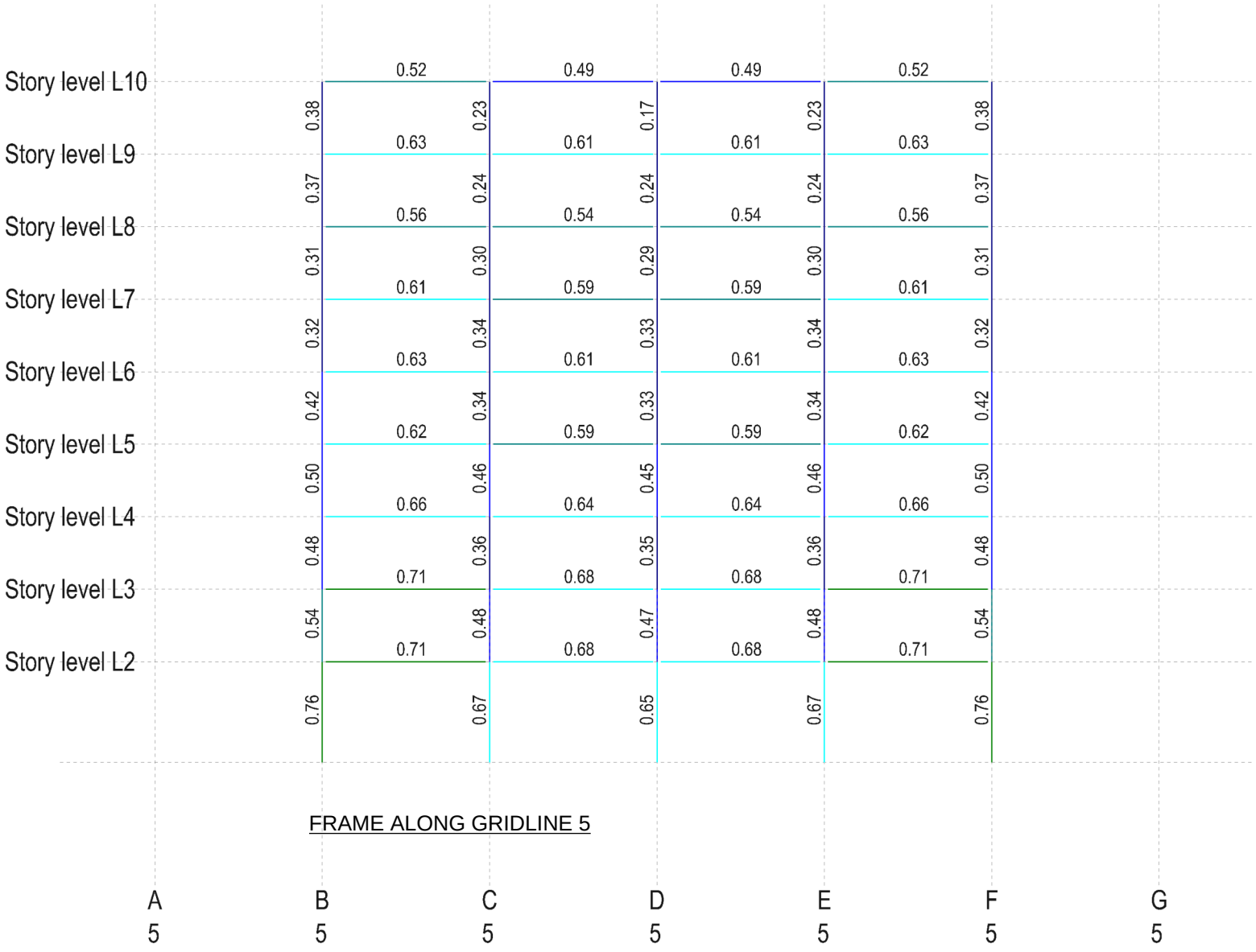
Web doubler plate thickness (total):

- 0.5 in.
- 0.75 in.
- 0.83 in. (column web thickness)

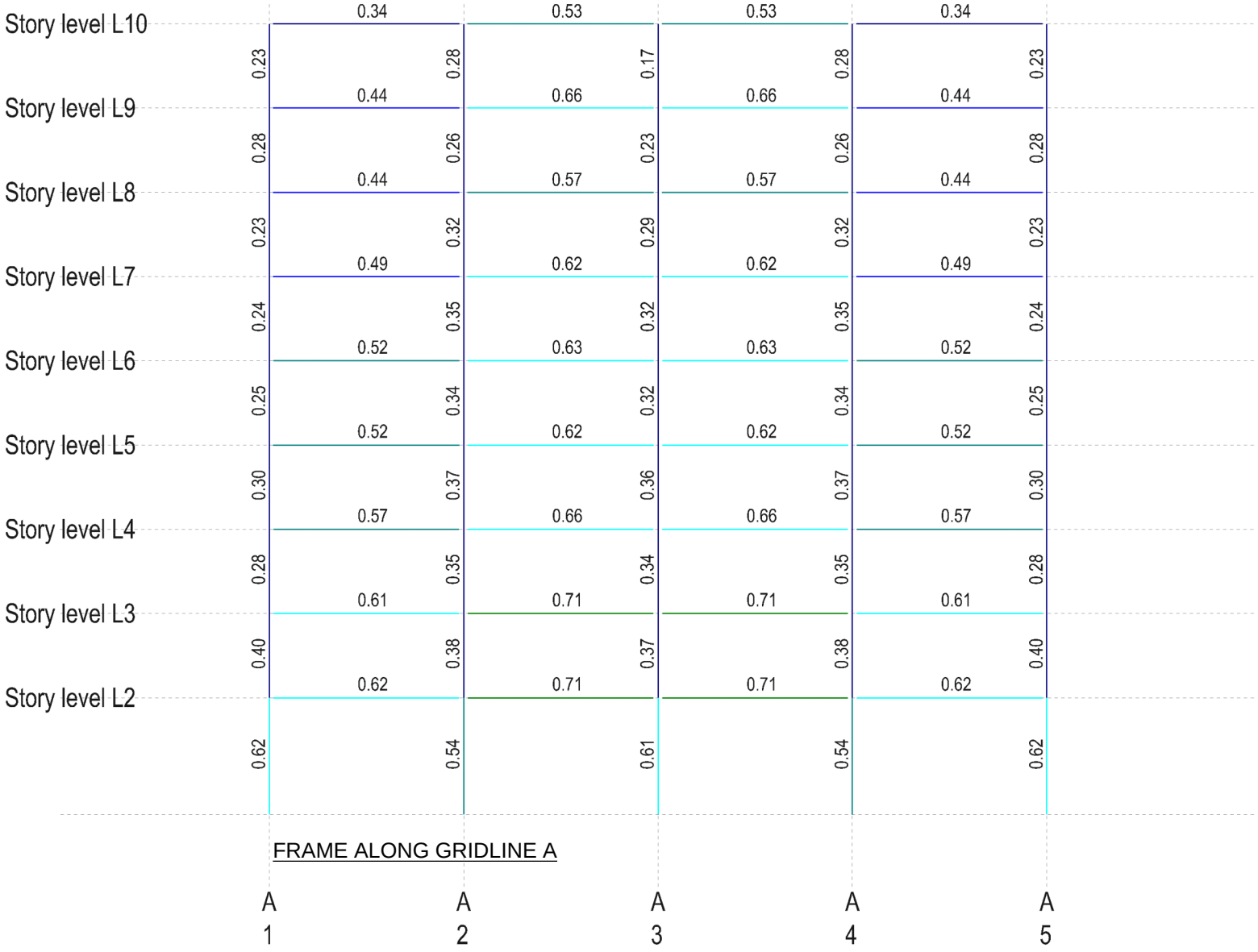
Notes:

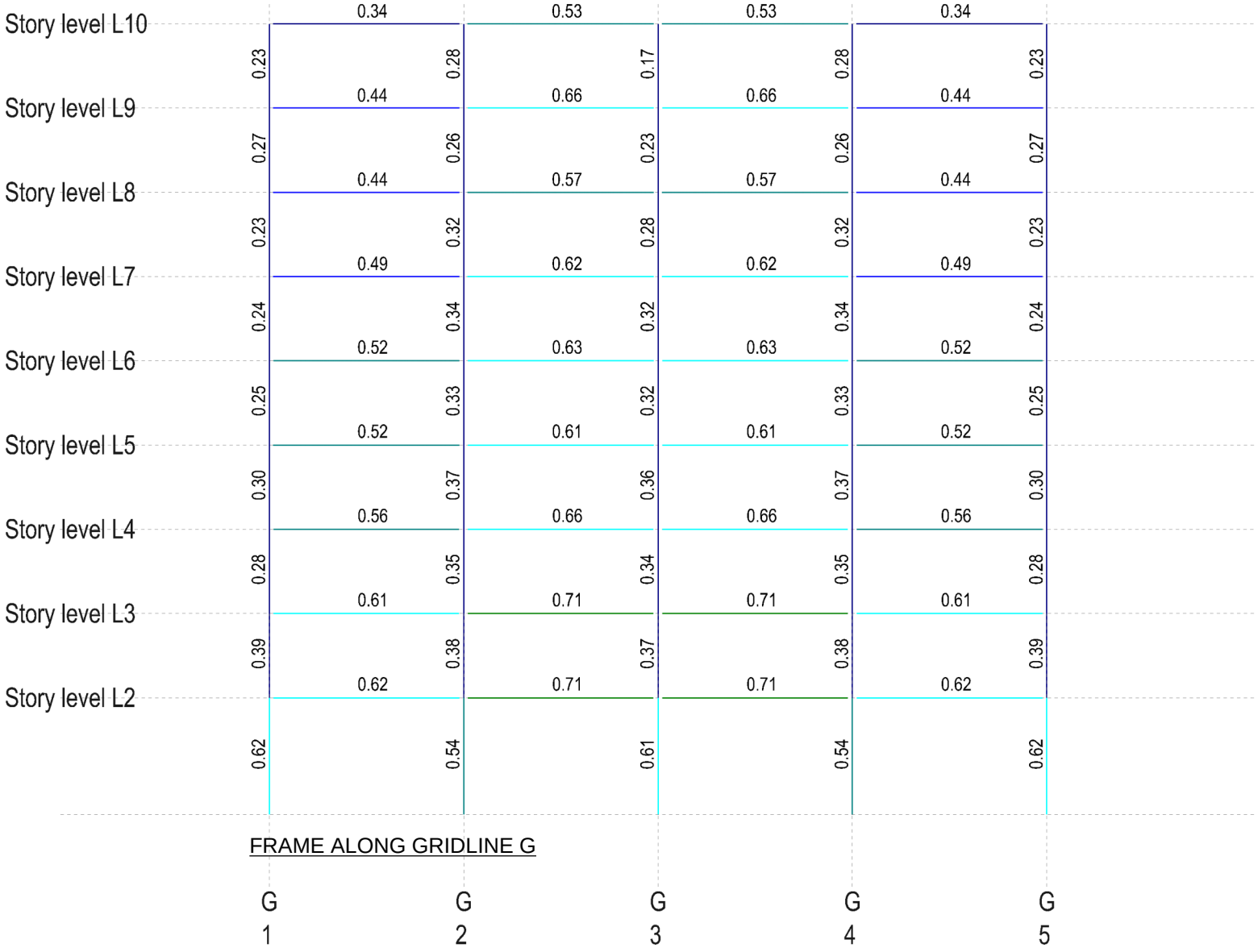
1. Total doubler plate thickness is shown. This doubler could be provided on one side only, or smaller thicknesses could be provided on both sides (0.5 in. total, or 0.25 in. NS/FS for example)

2. Web doubler plate requirements are the same for each frame and therefore not shown on the other frames.



FRAME ALONG GRIDLINE 5


Story level L10
Story level L9
Story level L8
Story level L7
Story level L6
Story level L5
Story level L4
Story level L3
Story level L2
0.34 0.53 0.53 0.34
0.44 0.66 0.66 0.44
0.44 0.57 0.57 0.44
0.49 0.62 0.62 0.49
0.52 0.63 0.63 0.52
0.52 0.62 0.62 0.52
0.57 0.66 0.66 0.57
0.61 0.71 0.71 0.61
0.62 0.71 0.71 0.62
0.23 0.28 0.17 0.28 0.23
0.28 0.26 0.23 0.26 0.28
0.23 0.32 0.29 0.32 0.23
0.24 0.35 0.32 0.35 0.24
0.25 0.34 0.32 0.34 0.25
0.30 0.37 0.36 0.37 0.30
0.28 0.35 0.34 0.35 0.28
0.40 0.38 0.37 0.38 0.40
0.62 0.54 0.61 0.54 0.62
FRAME ALONG GRIDLINE A
A 1
A 2
A 3
A 4
A 5


Story level L10
Story level L9
Story level L8
Story level L7
Story level L6
Story level L5
Story level L4
Story level L3
Story level L2
0.34 0.53 0.53 0.34
0.44 0.66 0.66 0.44
0.44 0.57 0.57 0.44
0.49 0.62 0.62 0.49
0.52 0.63 0.63 0.52
0.52 0.61 0.61 0.52
0.56 0.66 0.66 0.56
0.61 0.71 0.71 0.61
0.62 0.71 0.71 0.62
0.23 0.28 0.17 0.28 0.23
0.27 0.26 0.23 0.26 0.27
0.23 0.32 0.28 0.32 0.23
0.24 0.34 0.32 0.34 0.24
0.25 0.33 0.32 0.33 0.25
0.30 0.37 0.36 0.37 0.30
0.28 0.35 0.34 0.35 0.28
0.39 0.38 0.37 0.38 0.39
0.62 0.54 0.61 0.54 0.62
FRAME ALONG GRIDLINE G
G 1
G 2
G 3
G 4
G 5