Design Details of Building Archetypes with Dual Steel Special Moment Frames and Concentrically Braced Frames

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This document demonstrates the details and key design parameters of the building archetypes used in the study. In summary, the buildings design process is dipected in the flow chart of Fig. 1.

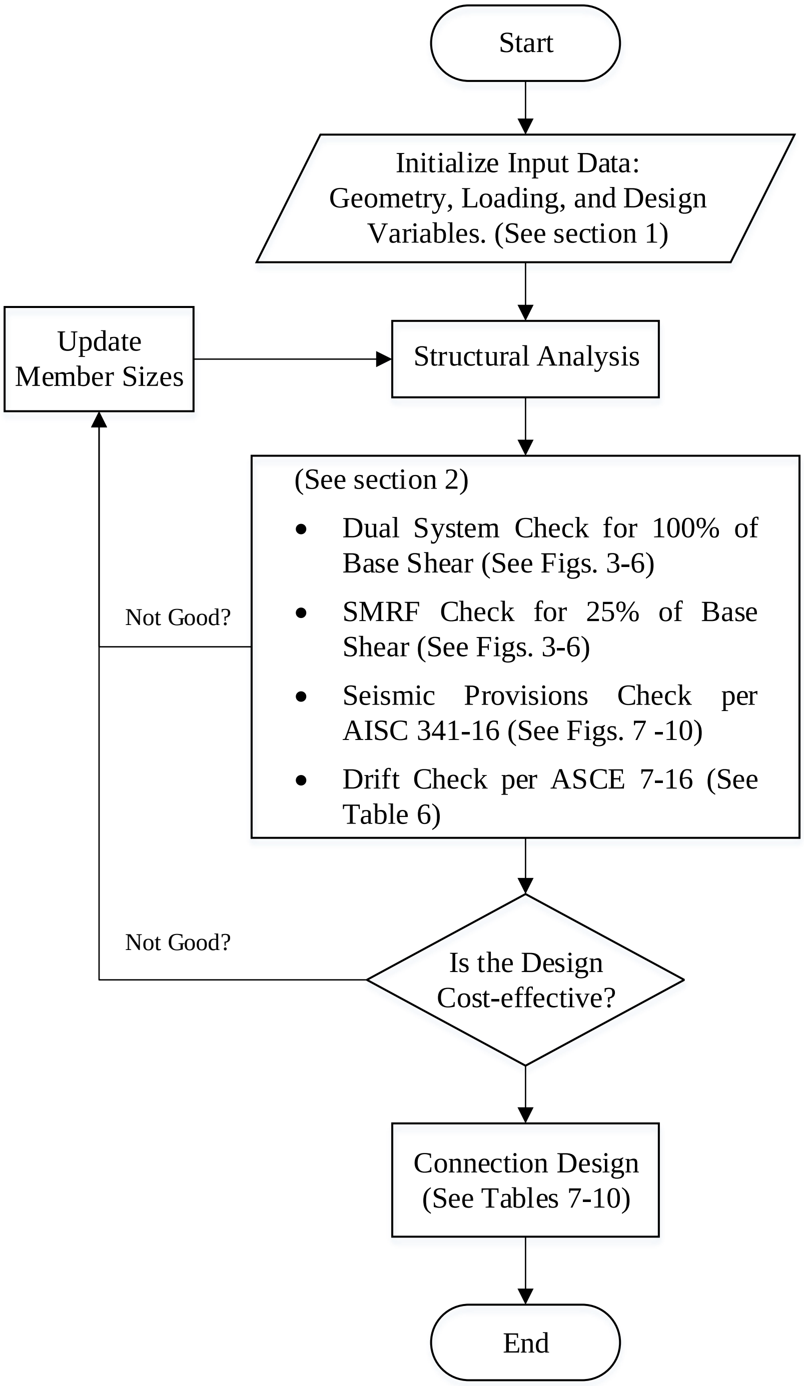
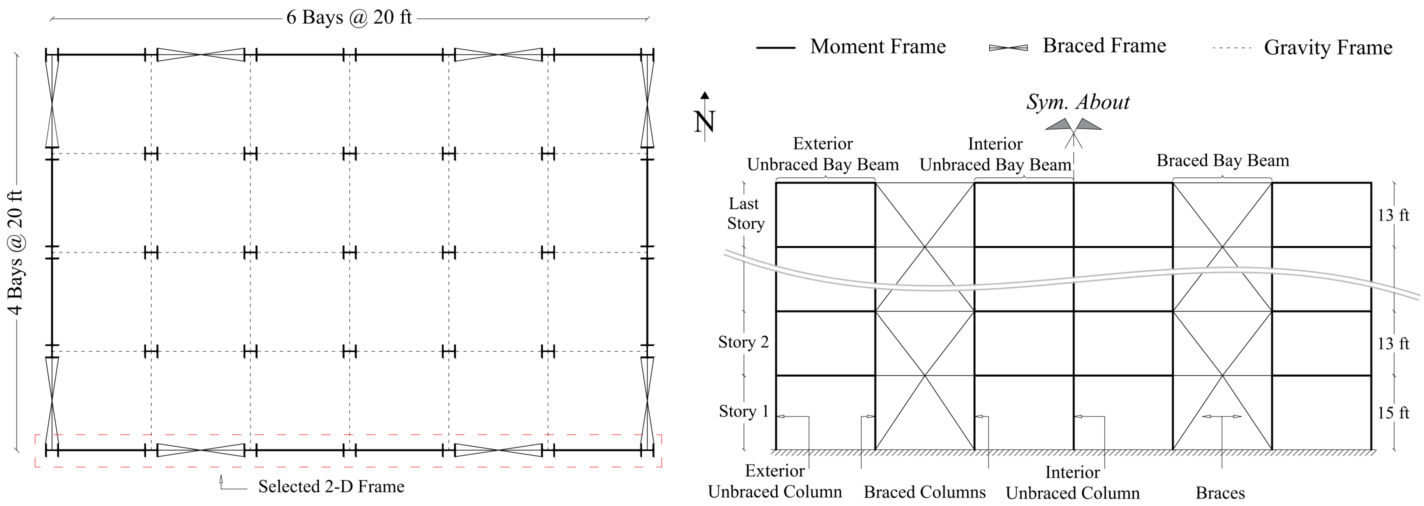


Fig. 1: Flow chart of the design process

General properties of building archetypes

The required general information to design of building archetypes are as follows:

- Typical plan and elevation view of building archetypes are shown in Fig. 2. It should be noted that the plan is based on the NIST project [1] in which the bay length of all frames is 20 ft, the height of the first floor is 15 ft, and the other floors are 13 ft. Four braced frames with two-story X bracing configurations are symmetrically considered, and due to the symmetry of the plan and geometric property of using seismic force-resisting system, all building archetypes are modeled as a 2D frame.



(a) (b)

Fig. 2: Typical plan and elevation view of building archetypes; a) plan, b) elevation

- The building archetypes are analyzed and designed in Sap2000, ver. 20.0 [2].
- The following codes were used to analyze and design all building archetypes:
  1. ASCE 7-16: *Minimum Design loads for Buildings and Other Structures* [3].
  2. AISC 360-16: *Specification for Structural Steel Builings* [4].
  3. AISC 341-16: *Seismic Provisions for Structural Steel Buildings* [5].
- A summary of the design gravity loads are presented in Table 1.
  Note: It is assumed in this study that there is no snow load on the building archetypes.

Table 1: Design Gravity Loads

Load	Load Type	Magnitude (psf)
Dead, D	Dead	90
Exterior Cladding Wall, D	Dead	25
Unreduced Design Floor Live, L_o	Floor Live	50
Unreduced Roof Live, L_o	Roof Live	20

- Strength and deflection load combinations for strength design and serviceability verifications are provided in Table 2.
  Note: It is assumed that the wind load does not control the design.

Table 2: Design Load Combinations

Type of Load Combination	List of Load Combinations*
Strength	$1.4D$
	$1.2D + 1.6L + 0.5L_r$
	$1.2D + 1.6L_r + 0.5L$
	$(1.2 + 0.2S_{DS})D + 0.5L \pm 1.0E$
	$(0.9 - 0.2S_{DS})D \pm 1.0E$
Deflection	$1.0D$
	$1.0D + 1.0L$

*Load Cases: D: Dead Load, L: Floor Live Load, L_r: Roof Live Load, E: Earthquake

- Risk category, importance factor and soil class of the building archetypes were assumed II (office), 1.0 and D respectively.
- Spectral response acceleration parameters are shown in Table 3.

Table 3: Spectral Response Acceleration Parameters

SDC	S_s (g)	S_1 (g)	F_a	F_v	S_{MS} (g)	S_{M1} (g)	S_{DS} (g)	S_{D1} (g)	T_S (s)
D_{max}	1.5	0.599	1.0	1.7	1.5	1.02	1.0	0.68	0.68

- The seismic analysis and design parameters for each building archetype are indicated in Table 4 for the E-W direction.

Table 4: Seismic Analysis and Design Parameters

Building Archetypes	2-Story	8-Story	12-Story	16-Story
Analysis Procedure	RSA	RSA	RSA	RSA
R, Ω_0, C_d	7, 2.5, 5.5	7, 2.5, 5.5	7, 2.5, 5.5	7, 2.5, 5.5
C_uT_a (sec.)	0.341	0.925	1.248	1.545
T_1^* (sec.)	0.400	1.291	1.958	2.632
C_s	0.143	0.105	0.078	0.063
W (kips)	984	3966	5954	7942
V_b ELF (kips)	140.7	416.4	464.4	500.3
V_b RSA (kips)	130.5	229.0	260.2	260.7
RSA Scaling Factor	1.078	1.818	1.785	1.919
V_b Design (kips)	140.7	416.4	464.4	500.3
V_b Drift (kips)	130.1	248.8	276.6	340.3

*Computed from first-order eigenvalue analysis

- The following material types and corresponding nominal properties were assumed in design:
    i. Wide-flange sections: A992 Grade 50, F_y = 50 ksi, R_y = 1.1
    ii. HSS sections: A500 Grade B, F_y = 46 ksi, R_y = 1.4
    iii. Connections: A572 Grade 50, F_y = 50 ksi, R_y = 1.1
    iv. E = 29000 ksi, G = 11154 ksi, υ = 0.3
- The second order effects were considered through "General 2nd Order" method.
- The "Direct Analysis Method" (DAM) was used to check/design the steel members.
- The P-Δ effects of interior gravity frames were considered through a leaning column with large flexural and axial stiffness, but a pin was introduced at the bottom of the column in each story.
- All nodes in each floor were constrained as a rigid diaphragm.

Design outputs and seismic controls

The design outputs and controlled seismic requirements provided by AISC 341-16 are as follows:

- All columns, braces, and beams (except beams of braced frames) satisfy the requirements of AISC 341-16 § D1.1 for highly ductile members. Beams of braced frames, however, satisfy the requirements for moderately ductile members in § D1.2a of AISC 341-16.
- All brace members have a slenderness ratio less than 200.
- The panel zones were assumed to be elastic, and were designed such that their shear strength was higher than the required shear force calculated in AISC 360-16. They also satisfy the seismic requirements per AISC 341-16 § E3.6e.

- The designed cross-sections of all building archetypes are shown in Table 5, and their P-M ratio are depicted in Fig. 3 through Fig. 6.

Table 5: Designed cross-sections of building archetypes

Archetype ID	Story Number	Braced Column	Unbraced Column		Braced Beam	Unbraced Beam		Braces
			Interior	Exterior		Interior	Exterior	
2-Story	1	W8×58	W8×67	W8×58	W16×57	W10×26	W12×22	HSS5.0×5.0×0.313
	2	W8×58	W8×67	W8×58	W10×26	W12×19	W8×21	HSS4.0×4.0×0.250
8-Story	1	W14×176	W12×120	W10×88	W16×77	W18×40	W18×40	HSS6.0×6.0×0.500
	2	W14×176	W12×120	W10×88	W16×77	W18×46	W18×46	HSS6.0×6.0×0.375
	3	W12×120	W12×120	W10×77	W14×48	W18×46	W18×46	HSS6.0×6.0×0.375
	4	W12×120	W12×120	W10×77	W10×45	W18×40	W18×40	HSS5.5×5.5×0.313
	5	W10×77	W10×100	W10×77	W10×39	W18×35	W18×35	HSS5.5×5.5×0.313
	6	W10×77	W10×100	W10×77	W10×45	W16×31	W16×31	HSS5.0×5.0×0.313
	7	W8×67	W10×77	W8×67	W14×53	W14×26	W14×26	HSS5.0×5.0×0.313
	8	W8×67	W10×77	W8×67	W10×26	W12×19	W8×21	HSS4.0×4.0×0.250
12-Story	1	W14×283	W12×152	W12×96	W12×45	W18×40	W18×40	HSS6.0×6.0×0.500
	2	W14×283	W12×152	W12×96	W16×77	W18×50	W18×46	HSS6.0×6.0×0.500
	3	W14×211	W12×152	W10×100	W16×57	W18×60	W18×50	HSS6.0×6.0×0.500
	4	W14×211	W12×152	W10×100	W16×77	W18×60	W18×46	HSS6.0×6.0×0.375
	5	W12×170	W12×152	W10×88	W14×48	W18×55	W18×46	HSS6.0×6.0×0.375
	6	W12×170	W12×152	W10×88	W10×45	W18×50	W18×40	HSS5.5×5.5×0.313
	7	W12×120	W12×120	W10×77	W10×39	W18×46	W18×40	HSS5.5×5.5×0.313
	8	W12×120	W12×120	W10×77	W10×45	W18×40	W18×35	HSS5.0×5.0×0.313
	9	W10×77	W12×96	W10×77	W10×39	W18×35	W16×31	HSS5.5×5.5×0.313
	10	W10×77	W12×96	W10×77	W10×45	W16×31	W14×26	HSS5.0×5.0×0.313
	11	W8×67	W10×77	W8×67	W16×57	W14×26	W14×26	HSS4.5×4.5×0.375
	12	W8×67	W10×77	W8×67	W10×26	W12×19	W12×19	HSS4.0×4.0×0.250
16-Story	1	W14×398	W12×190	W12×136	W12×45	W18×40	W18×40	HSS6.0×6.0×0.500
	2	W14×398	W12×190	W12×136	W16×77	W18×60	W18×60	HSS6.0×6.0×0.500
	3	W14×311	W12×190	W12×120	W16×57	W18×65	W18×65	HSS6.0×6.0×0.500
	4	W14×311	W12×190	W12×120	W16×77	W18×65	W18×65	HSS6.0×6.0×0.375
	5	W14×257	W12×190	W12×106	W16×77	W18×65	W18×55	HSS6.0×6.0×0.500
	6	W14×257	W12×190	W12×106	W16×77	W18×65	W18×60	HSS5.5×5.5×0.375
	7	W14×193	W12×170	W10×100	W14×48	W18×65	W18×50	HSS6.0×6.0×0.375
	8	W14×193	W12×170	W10×100	W14×53	W18×65	W18×50	HSS5.5×5.5×0.313
	9	W12×152	W12×170	W10×88	W14×48	W18×65	W18×46	HSS5.5×5.5×0.375
	10	W12×152	W12×170	W10×88	W10×45	W18×55	W18×40	HSS5.0×5.0×0.313
	11	W12×106	W12×120	W10×77	W10×39	W18×46	W18×40	HSS5.5×5.5×0.313
	12	W12×106	W12×120	W10×77	W10×45	W18×40	W18×35	HSS5.0×5.0×0.313
	13	W10×77	W10×100	W10×77	W10×39	W18×35	W16×31	HSS5.0×5.0×0.313
	14	W10×77	W10×100	W10×77	W10×45	W16×31	W14×26	HSS4.5×4.5×0.313
	15	W10×77	W10×77	W8×67	W12×50	W14×26	W12×22	HSS4.5×4.5×0.313
	16	W10×77	W10×77	W8×67	W10×26	W12×19	W12×19	HSS4.0×4.0×0.250

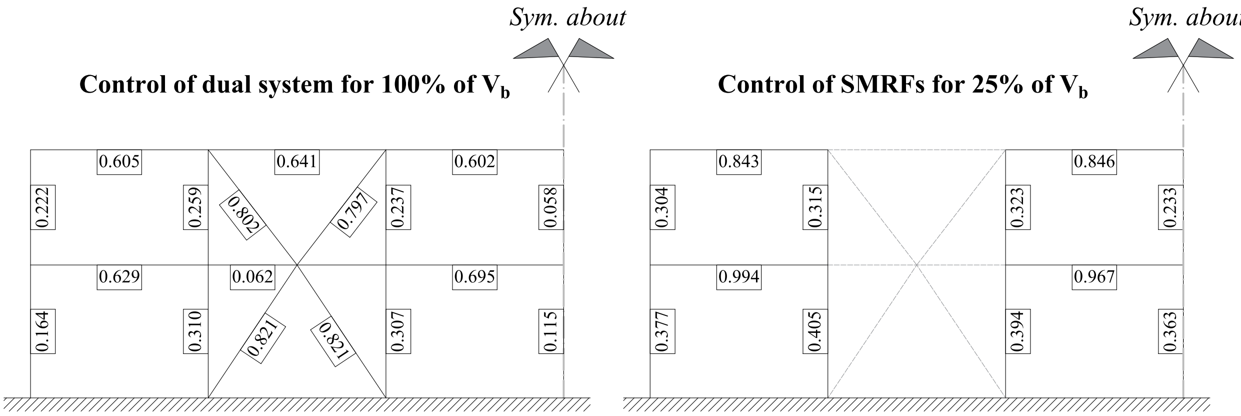


Fig. 3: The P-M ratio of designed cross-sections of 2-Story building archetype

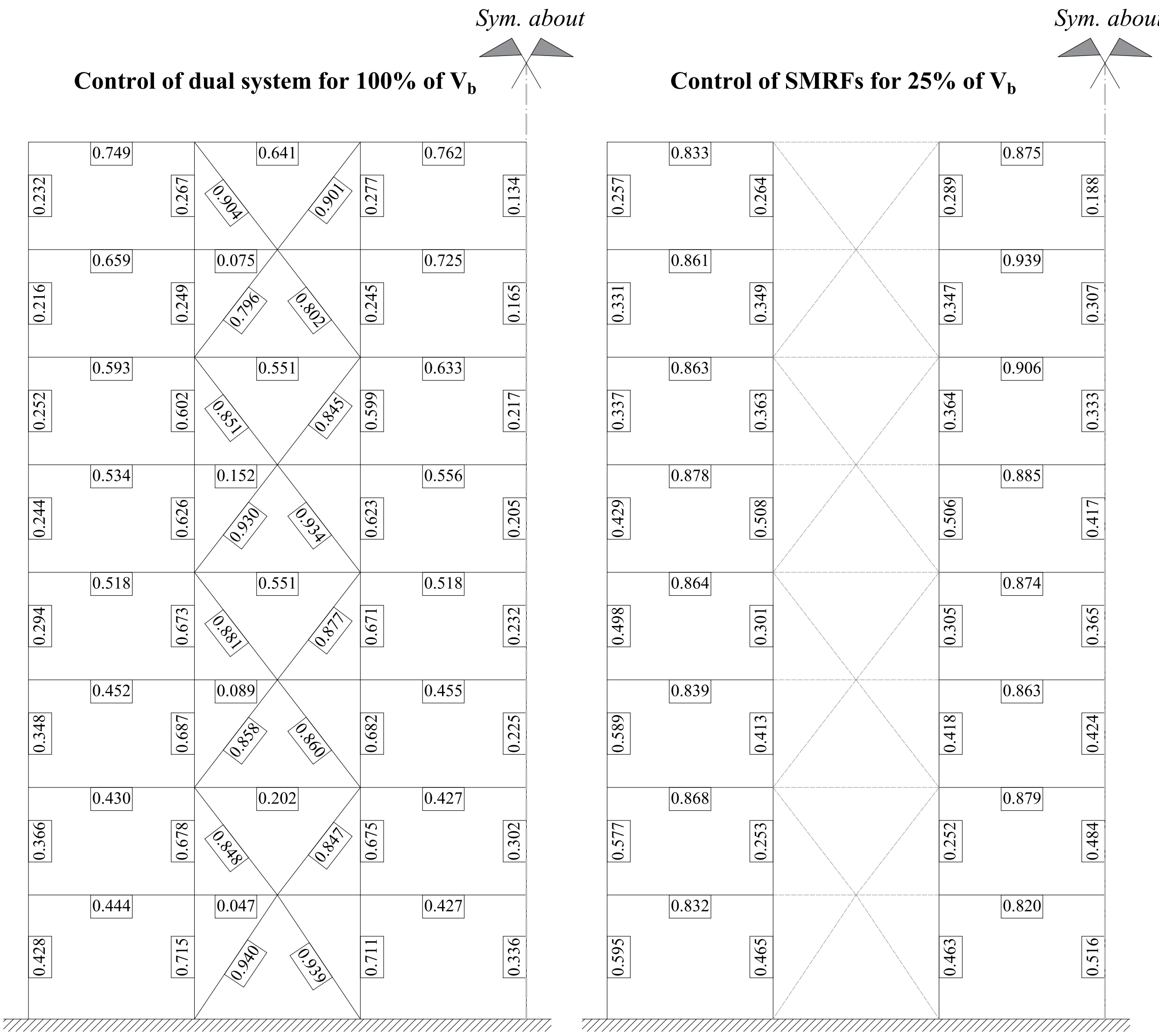


Fig. 4: The P-M ratio of designed cross-sections of 8-Story building archetype

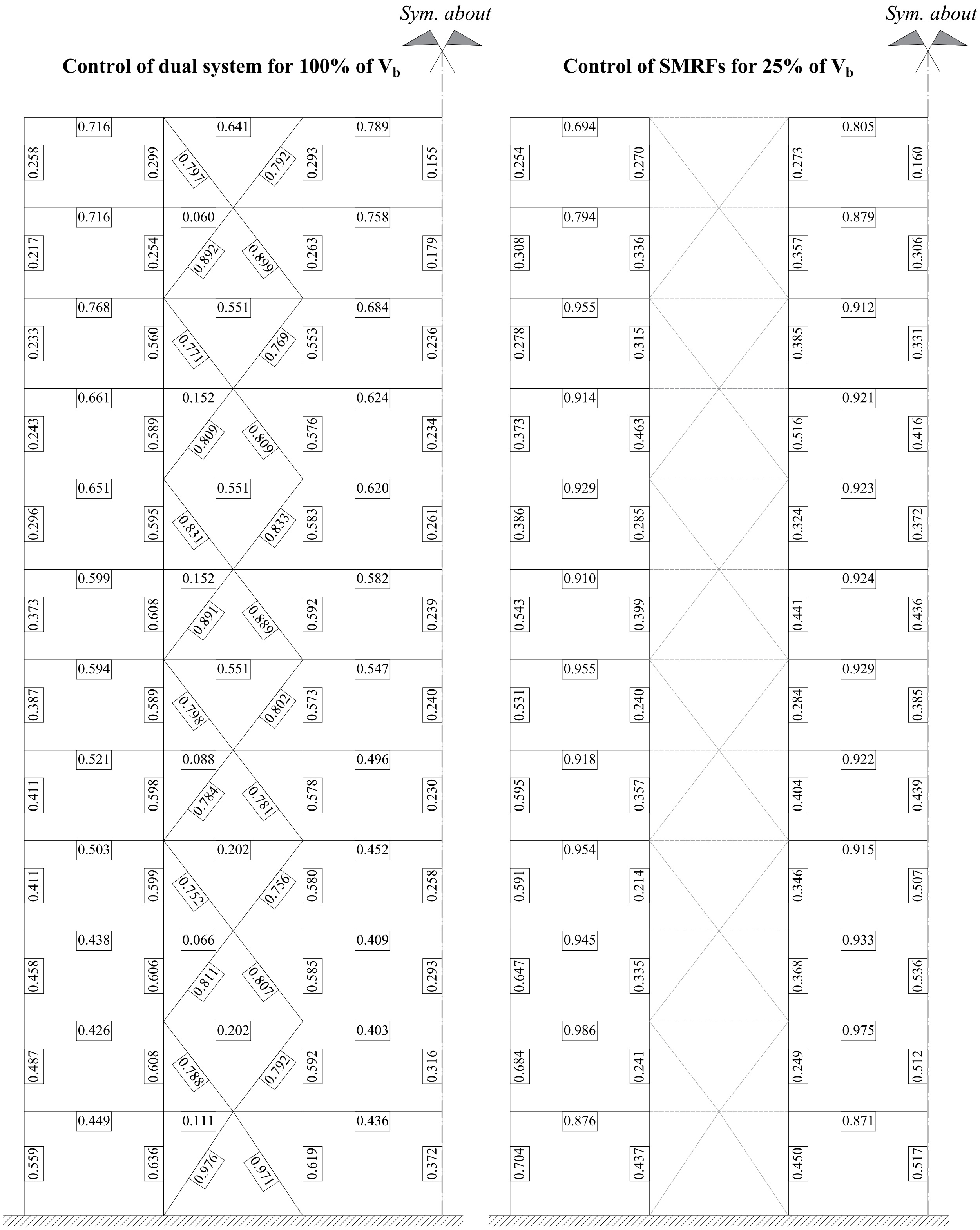


Fig. 5: The P-M ratio of designed cross-sections of 12-Story building archetype

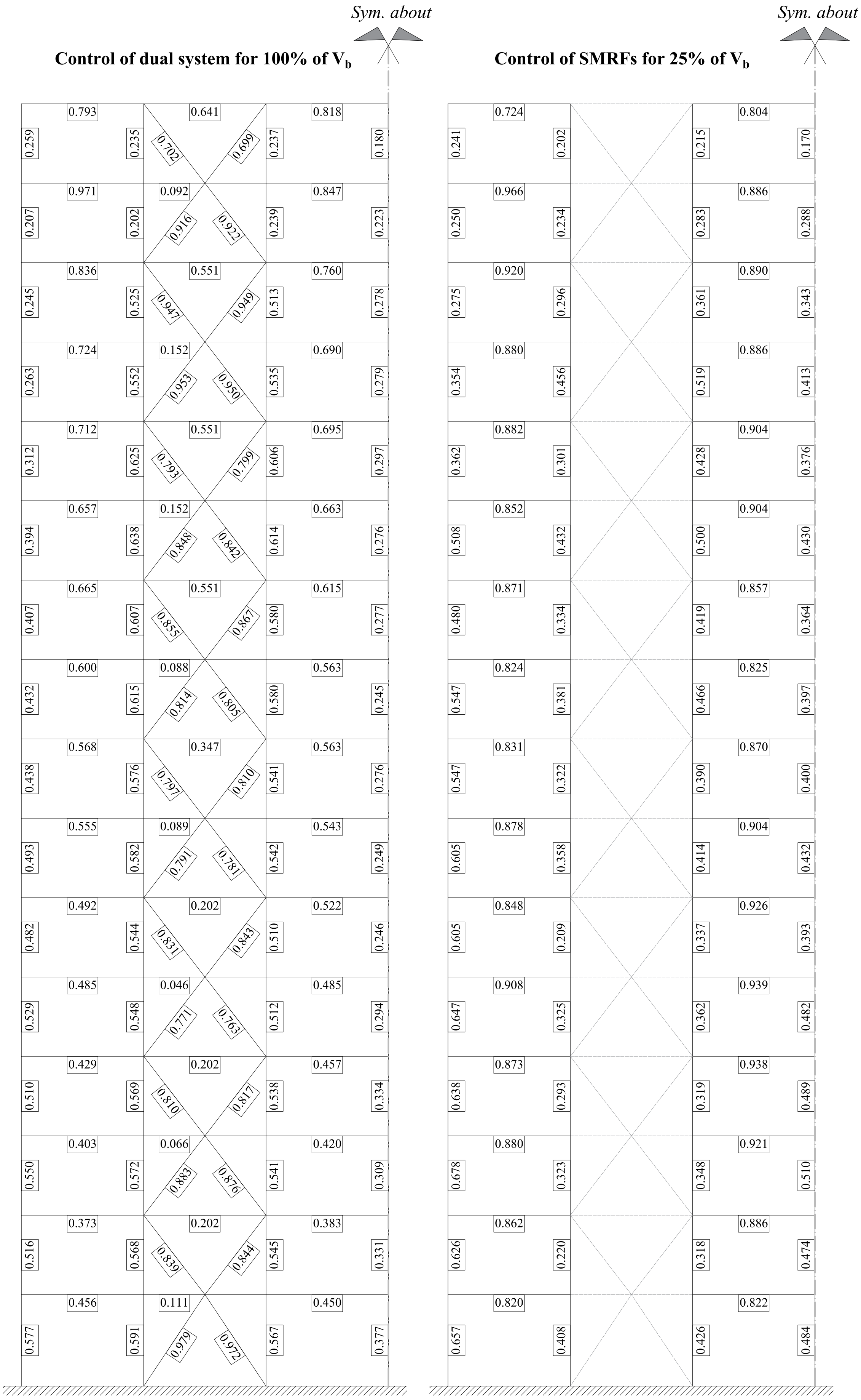


Fig. 6: The P-M ratio of designed cross-sections of 16-Story building archetype

- All beam-to-column connections of SMRFs satisfy the requirements of AISC 341-16 § E3.4 for strong-column/weak-beam criteria.
- The required strength of columns and beams in SCBFs was determined using the capacity-limited seismic load effects. For this purpose, a code in Tcl/Tk language programming was developed according to provisions per AISC 341-16 § F2.3.
- Control of SMRFs for strong-column/weak-beam criteria, and the P-M ratio of SCBF members for capacity-limited seismic load effects are shown in Fig. 7 through Fig. 10.

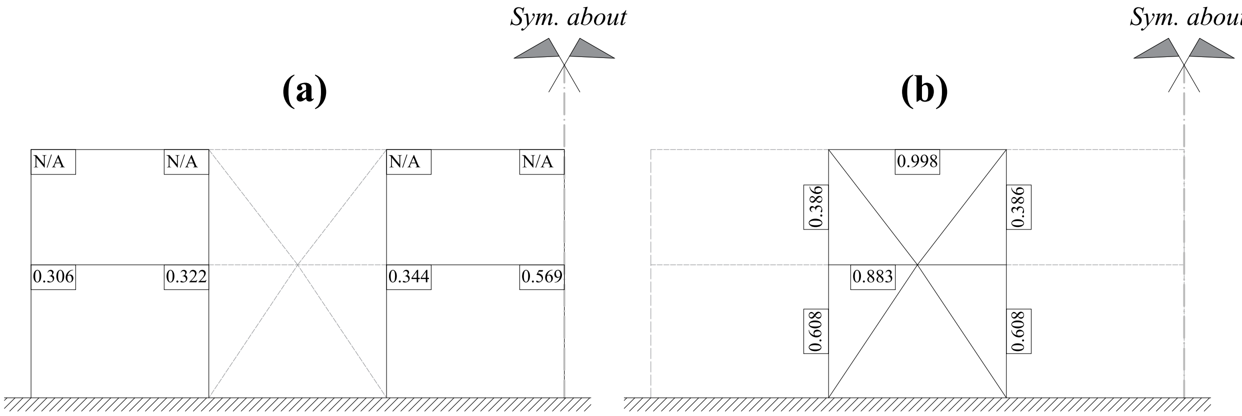


Fig. 7: Seismic provisions check per AISC 341-16 for 2-Story building archetype; a) strong-column/weak-beam criteria, b) capacity-limited seismic load effects

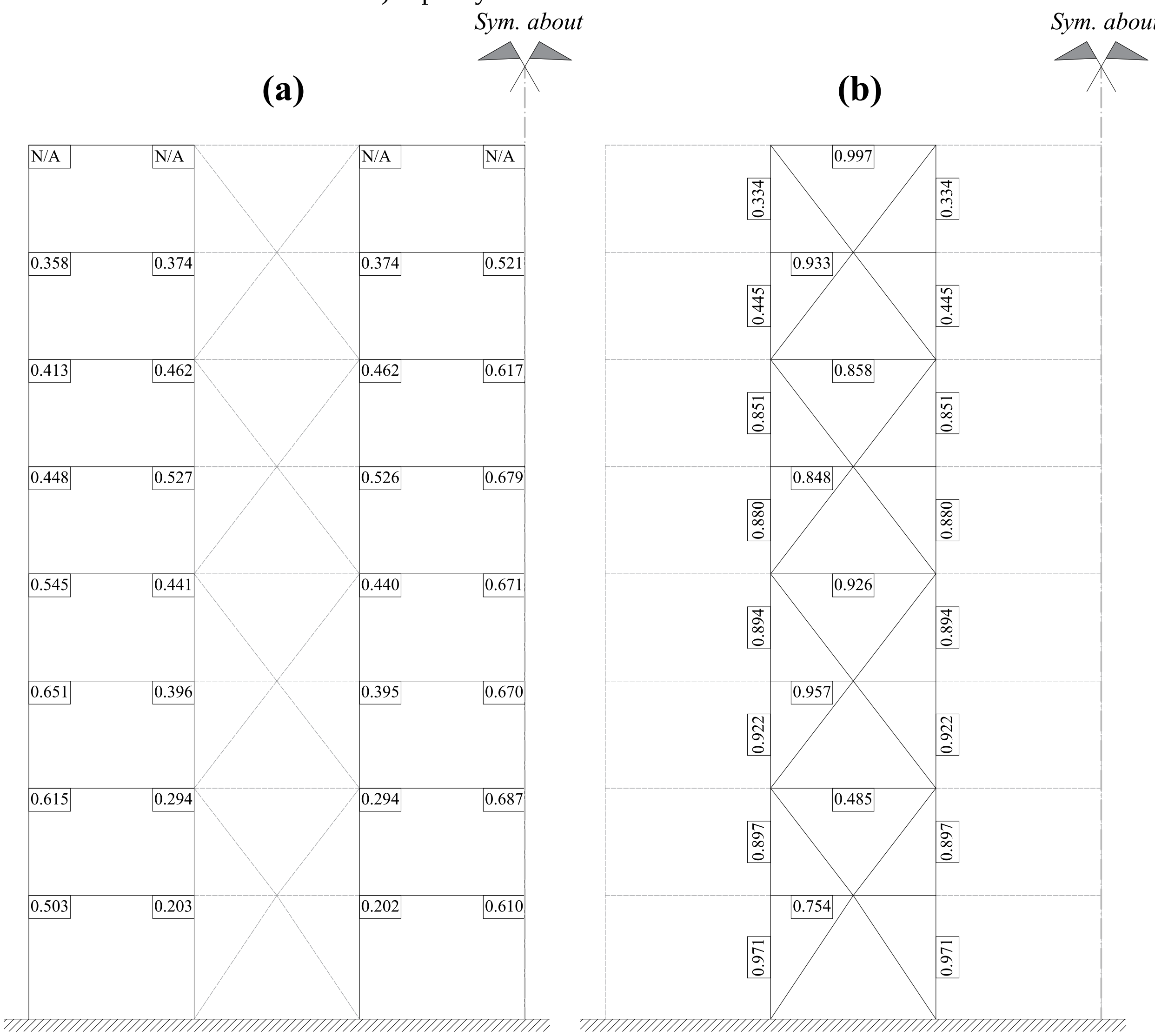


Fig. 8: Seismic provisions check per AISC 341-16 for 8-Story building archetype; a) strong-column/weak-beam criteria, b) capacity-limited seismic load effects

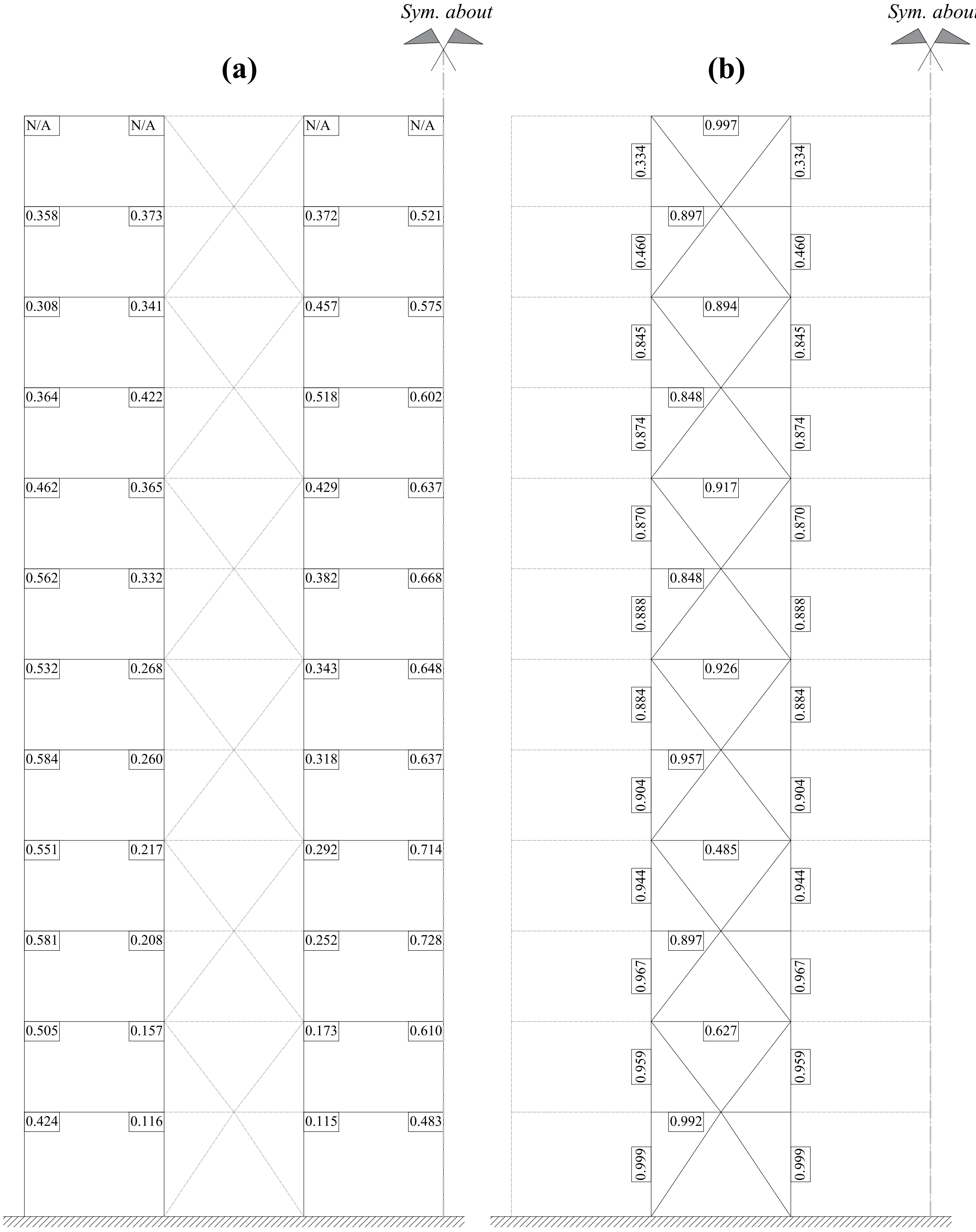


Fig. 9: Seismic provisions check per AISC 341-16 for 12-Story building archetype; a) strong-column/weak-beam criteria, b) capacity-limited seismic load effects

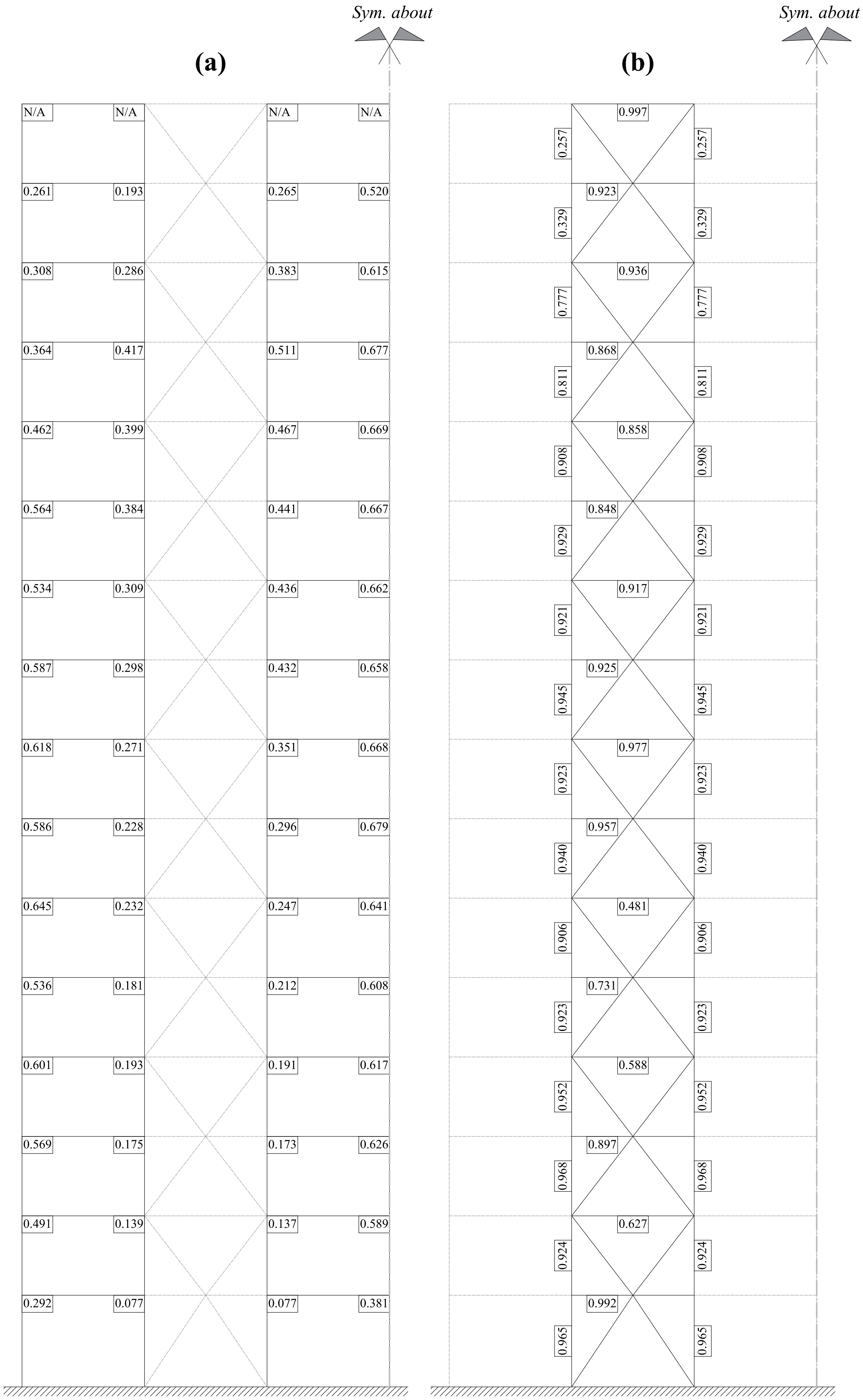


Fig. 10: Seismic provisions check per AISC 341-16 for 16-Story building archetype; a) strong-column/weak-beam criteria, b) capacity-limited seismic load effects

- The allowable drift compliance verification of all building archetypes are also illustrated in Table 6.

Table 6: Verification of design story drifts for building archetypes

Archetype ID	Story Number	δ_{xe} (in)	$\delta_x = \delta_{xe}.C_d/I_e$ (in)	Δ_i (in)	$\Delta_i/h_{sx} < 2\%$
2-Story	1	0.14	0.78	0.78	0.43
	2	0.27	1.49	0.71	0.46
8-Story	1	0.14	0.75	0.75	0.42
	2	0.33	1.82	1.07	0.68
	3	0.52	2.88	1.06	0.68
	4	0.77	4.25	1.37	0.88
	5	1.02	5.61	1.36	0.87
	6	1.29	7.09	1.48	0.95
	7	1.54	8.49	1.40	0.90
	8	1.79	9.85	1.36	0.87
12-Story	1	0.14	0.77	0.77	0.43
	2	0.31	1.70	0.93	0.60
	3	0.48	2.62	0.92	0.59
	4	0.69	3.80	1.18	0.76
	5	0.91	4.99	1.19	0.76
	6	1.16	6.40	1.40	0.90
	7	1.42	7.81	1.41	0.90
	8	1.70	9.33	1.52	0.98
	9	1.97	10.83	1.50	0.96
	10	2.26	12.42	1.59	1.02
	11	2.54	13.97	1.55	0.99
	12	2.82	15.48	1.51	0.97
16-Story	1	0.16	0.88	0.88	0.49
	2	0.36	1.96	1.08	0.69
	3	0.55	3.04	1.08	0.69
	4	0.80	4.37	1.34	0.86
	5	1.02	5.63	1.25	0.80
	6	1.30	7.13	1.51	0.96
	7	1.57	8.63	1.50	0.96
	8	1.88	10.32	1.69	1.08
	9	2.18	11.96	1.64	1.05
	10	2.51	13.79	1.82	1.17
	11	2.84	15.63	1.84	1.18
	12	3.20	17.57	1.95	1.25
	13	3.56	19.57	2.00	1.28
	14	3.94	21.65	2.07	1.33
	15	4.31	23.70	2.05	1.31
	16	4.66	25.66	1.96	1.26

δ_{xe}: elastic absolute displacement; δ_x: inelastic absolute displacement; Δ_i: inelastic drift; Δ_i/h_{sx}: inelastic drift ratio

- Gusset plates are tapered plates, which have been designed using the method presented by Astaneh-Asl et al. [6]. The required strength of gusset plates has been determined using the capacity-limited seismic load effects, and the design process has been done using the developed MATLAB code. Fig. 11 demonstrates the geometric details of gusset plates, and their calculated dimensions using the code mentioned above are shown in Table 7 through Table 10.

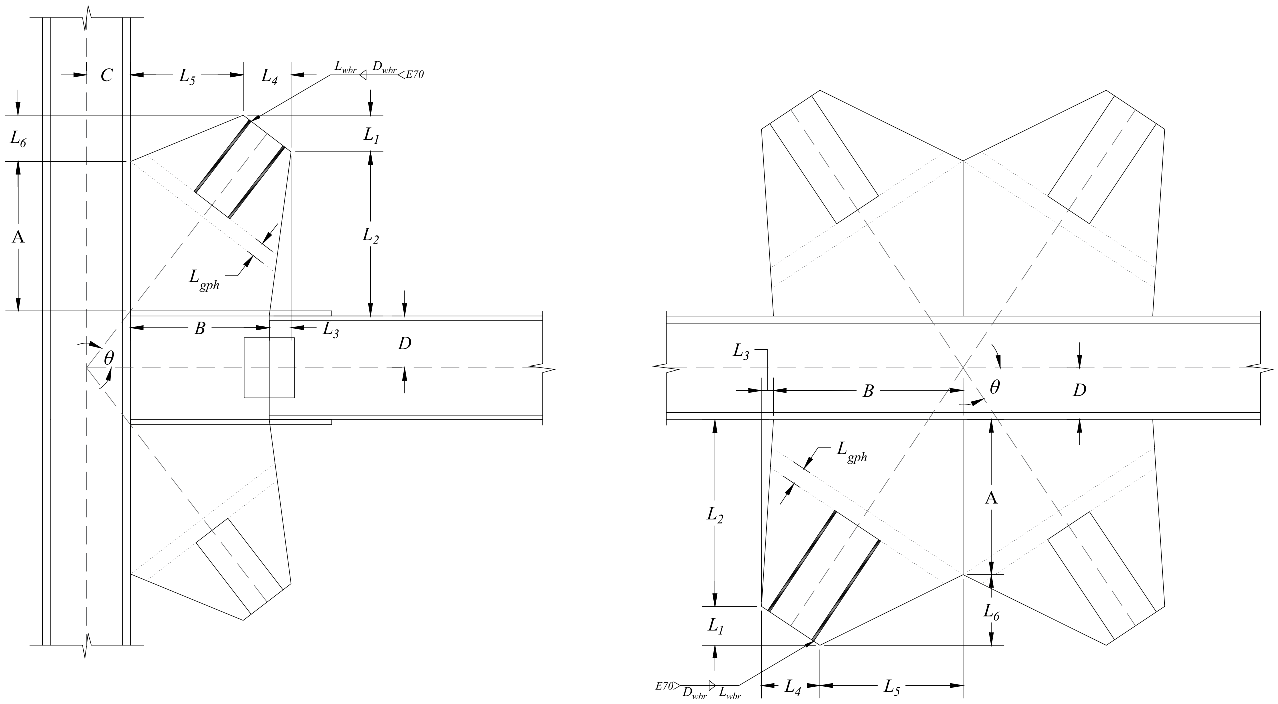


Fig. 11: Geometric parameters of gusset plates

Table 7: Gusset plates details of 2-Story building archetype

Level		Dimentions *A*, *B*, and L_1 to L_6 for gusset plates (all dimensions are in inches)										Weld properties	
		L_1	L_2	L_3	L_4	L_5	L_6	A	B	t_g	L_{gph}	L_{wbr}	D_{wbr}
3	Lower	3.66	16.35	2.17	4.76	11.21	4.63	15.39	13.79	0.5	1.5	8	0.31
2	Upper	3.66	12.02	1.60	4.76	14.59	6.02	9.65	17.75	0.5	1.5	8	0.31
2	Lower	3.88	15.56	1.0	5.82	14.23	7.04	12.40	19.05	0.5	1.5	11	0.38
1	Upper	3.88	29.95	1.93	5.82	13.97	6.91	26.92	17.87	0.5	1.5	11	0.38

t_g: gusset plate thickness

Table 8: Gusset plates details of 8-Story building archetype

Level		Dimentions *A*, *B*, and L_1 to L_6 for gusset plates (all dimensions are in inches)										Weld properties	
		L_1	L_2	L_3	L_4	L_5	L_6	A	B	t_g	L_{gph}	L_{wbr}	D_{wbr}
9	Lower	3.66	16.52	2.19	4.76	11.21	4.63	15.55	13.77	0.50	1.5	8	0.31
8	Upper	3.66	12.02	1.60	4.76	13.63	5.63	10.05	16.79	0.50	1.5	8	0.31
8	Lower	4.27	15.45	2.05	5.55	16.11	6.65	13.07	19.60	0.50	1.5	11	0.38
7	Upper	4.27	22.04	2.93	5.55	14.41	5.95	20.36	17.03	0.50	1.5	11	0.38
7	Lower	4.27	22.04	2.93	5.55	14.41	5.95	20.36	17.03	0.50	1.5	11	0.38
6	Upper	4.27	15.45	2.05	5.55	14.57	6.01	13.71	18.06	0.50	1.5	11	0.38
6	Lower	4.57	16.74	2.22	5.94	15.48	6.39	14.92	19.20	0.50	1.5	12	0.38
5	Upper	4.57	25.17	3.34	5.94	15.48	6.39	23.36	18.08	0.50	1.5	12	0.38
5	Lower	4.57	25.17	3.34	5.94	15.48	6.39	23.36	18.08	0.50	1.5	12	0.38
4	Upper	4.57	16.60	2.21	5.94	16.86	6.96	14.21	20.60	0.50	1.5	12	0.38
4	Lower	4.88	16.02	2.13	6.34	16.34	6.74	14.16	20.55	0.75	2.0	11	0.50
3	Upper	4.88	22.74	3.02	6.34	14.94	6.17	21.45	18.26	0.75	2.0	11	0.50
3	Lower	4.88	22.74	3.02	6.34	14.94	6.17	21.45	18.26	0.75	2.0	11	0.50
2	Upper	4.88	16.02	2.13	6.34	17.39	7.18	13.73	21.60	0.75	2.0	11	0.50
2	Lower	4.44	19.36	1.25	6.66	16.56	8.19	15.60	21.97	0.75	2.0	13	0.56
1	Upper	4.44	39.03	2.52	6.66	16.56	8.19	35.28	20.70	0.75	2.0	13	0.56

t_g: gusset plate thickness

Table 9: Gusset plates details of 12-Story building archetype

Level		Dimentions *A*, *B*, and L_1 to L_6 for gusset plates (all dimensions are in inches)										Weld properties	
		L_1	L_2	L_3	L_4	L_5	L_6	A	B	t_g	L_{gph}	L_{wbr}	D_{wbr}
13	Lower	3.66	16.52	2.19	4.76	11.21	4.63	15.55	13.77	0.50	1.5	8	0.31
12	Upper	3.66	12.02	1.60	4.76	14.59	6.02	9.65	17.75	0.50	1.5	8	0.31
12	Lower	3.96	15.45	2.05	5.15	17.15	7.08	12.33	20.25	0.50	1.5	11	0.38
11	Upper	3.96	21.94	2.92	5.15	14.41	5.95	19.95	16.65	0.50	1.5	11	0.38
11	Lower	4.27	22.04	2.93	5.55	14.41	5.95	20.36	17.03	0.50	1.5	11	0.38
10	Upper	4.27	15.45	2.05	5.55	14.57	6.01	13.71	18.06	0.50	1.5	11	0.38
10	Lower	4.57	16.74	2.22	5.94	15.48	6.39	14.92	19.20	0.50	1.5	12	0.38
9	Upper	4.57	25.17	3.34	5.94	15.48	6.39	23.36	18.08	0.50	1.5	12	0.38
9	Lower	4.27	23.68	3.15	5.55	14.41	5.95	22.00	16.81	0.50	1.5	11	0.38
8	Upper	4.27	15.45	2.05	5.55	14.57	6.01	13.71	18.06	0.50	1.5	11	0.38
8	Lower	4.57	16.74	2.22	5.94	15.48	6.39	14.92	19.20	0.50	1.5	12	0.38
7	Upper	4.57	25.77	3.42	5.94	15.48	6.39	23.95	18.00	0.50	1.5	12	0.38
7	Lower	4.57	25.77	3.42	5.94	15.48	6.39	23.95	18.00	0.50	1.5	12	0.38
6	Upper	4.57	16.60	2.21	5.94	16.86	6.96	14.21	20.60	0.50	1.5	12	0.38
6	Lower	4.88	16.02	2.13	6.34	16.34	6.74	14.16	20.55	0.75	2.0	11	0.50
5	Upper	4.88	23.07	3.06	6.34	14.94	6.17	21.78	18.22	0.75	2.0	11	0.50
5	Lower	4.88	23.07	3.06	6.34	14.94	6.17	21.78	18.22	0.75	2.0	11	0.50
4	Upper	4.88	16.02	2.13	6.34	17.35	7.16	13.74	21.56	0.75	2.0	11	0.50
4	Lower	4.88	18.31	2.43	6.34	19.11	7.89	15.30	23.02	0.75	2.0	13	0.56
3	Upper	4.88	26.50	3.52	6.34	17.08	7.05	24.33	19.90	0.75	2.0	13	0.56
3	Lower	4.88	26.50	3.52	6.34	17.08	7.05	24.33	19.90	0.75	2.0	13	0.56
2	Upper	4.88	18.31	2.43	6.34	17.43	7.20	16.00	21.34	0.75	2.0	13	0.56
2	Lower	4.44	21.59	1.39	6.66	16.56	8.19	17.83	21.83	0.75	2.0	13	0.56
1	Upper	4.44	40.17	2.59	6.66	16.56	8.19	36.42	20.63	0.75	2.0	13	0.56

t_g: gusset plate thickness

Table 10: Gusset plates details of 16-Story building archetype

Level		Dimentions *A*, *B*, and L_1 to L_6 for gusset plates (all dimensions are in inches)										Weld properties	
		L_1	L_2	L_3	L_4	L_5	L_6	A	B	t_g	L_{gph}	L_{wbr}	D_{wbr}
17	Lower	3.66	17.56	2.33	4.76	11.21	4.63	16.59	13.63	0.50	1.5	11	0.38
16	Upper	3.66	12.02	1.60	4.76	12.96	5.35	10.33	16.12	0.50	1.5	10	0.44
16	Lower	3.96	15.45	2.05	5.15	15.52	6.41	13.01	18.62	0.50	1.5	10	0.44
15	Upper	3.96	21.94	2.92	5.15	14.41	5.95	19.95	16.65	0.50	1.5	11	0.38
15	Lower	3.96	21.94	2.92	5.15	14.41	5.95	19.95	16.65	0.50	1.5	11	0.38
14	Upper	3.96	15.45	2.05	5.15	14.65	6.05	13.37	17.75	0.50	1.5	10	0.50
14	Lower	4.27	15.45	2.05	5.55	14.57	6.01	13.71	18.06	0.50	1.5	10	0.50
13	Upper	4.27	23.53	3.13	5.55	14.41	5.95	21.85	16.83	0.50	1.5	10	0.44
13	Lower	4.27	23.53	3.13	5.55	14.41	5.95	21.85	16.83	0.50	1.5	10	0.44
12	Upper	4.27	15.45	2.05	5.55	14.57	6.01	13.71	18.06	0.50	1.5	11	0.50
12	Lower	4.57	14.88	1.98	5.94	14.05	5.80	13.65	18.02	0.75	2.0	11	0.50
11	Upper	4.57	23.48	3.12	5.94	13.88	5.73	22.32	16.70	0.75	2.0	10	0.50
11	Lower	4.27	24.07	3.20	5.55	14.41	5.95	22.39	16.76	0.50	1.5	10	0.50
10	Upper	4.27	15.45	2.05	5.55	16.06	6.63	13.09	19.55	0.50	1.5	13	0.56
10	Lower	4.57	14.88	1.98	5.94	15.54	6.41	13.04	19.50	0.75	2.0	13	0.56
9	Upper	4.57	22.72	3.02	5.94	13.88	5.73	21.56	16.80	0.75	2.0	11	0.50
9	Lower	4.57	22.72	3.02	5.94	13.88	5.73	21.56	16.80	0.75	2.0	11	0.50
8	Upper	4.57	14.88	1.98	5.94	15.54	6.41	13.04	19.50	0.75	2.0	13	0.56
8	Lower	4.88	16.02	2.13	6.34	16.34	6.74	14.16	20.55	0.75	2.0	13	0.56
7	Upper	4.88	23.50	3.12	6.34	14.94	6.17	22.20	18.16	0.75	2.0	13	0.56
7	Lower	4.57	22.00	2.92	5.94	13.88	5.73	20.85	16.90	0.75	2.0	13	0.56
6	Upper	4.57	14.88	1.98	5.94	16.59	6.85	12.61	20.55	0.75	2.0	13	0.56
6	Lower	4.88	18.31	2.43	6.34	19.15	7.90	15.29	23.05	0.75	2.0	13	0.56
5	Upper	4.88	26.75	3.55	6.34	17.08	7.05	24.58	19.86	0.75	2.0	11	0.38
5	Lower	4.88	23.98	3.19	6.34	14.94	6.17	22.69	18.10	0.75	2.0	10	0.44
4	Upper	4.88	16.02	2.13	6.34	17.35	7.16	13.74	21.56	0.75	2.0	10	0.44
4	Lower	4.88	18.31	2.43	6.34	19.11	7.89	15.30	23.02	0.75	2.0	11	0.38
3	Upper	4.88	27.51	3.66	6.34	17.08	7.05	25.34	19.76	0.75	2.0	11	0.38
3	Lower	4.88	27.51	3.66	6.34	17.08	7.05	25.34	19.76	0.75	2.0	10	0.50
2	Upper	4.88	18.31	2.43	6.34	17.43	7.20	16.00	21.34	0.75	2.0	10	0.50
2	Lower	4.44	21.59	1.39	6.66	16.56	8.19	17.83	21.83	0.75	2.0	10	0.44
1	Upper	4.44	41.33	2.67	6.66	16.56	8.19	37.58	20.55	0.75	2.0	10	0.44

t_g: gusset plate thickness

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