Group 5 — Design Project

CVEN 483

Hospital - Memphis, TN

Final Structural Design Report

Executive Summary

This report presents the analysis and design of a ten-story hospital in Memphis, TN. It was designed to meet both strength and serviceability requirements when subjected both to gravity loads and lateral loads. The plan of the building is 320 ft × 80 ft.

The lateral force-resisting system in the 80-ft direction is a special steel braced frame. X-bracing is used at all stories along four of the eleven frames. The bottom two stories are 20 ft tall and use 1-story X-braces; the upper stories are 15 ft tall and use 2-story X-braces.

The lateral force-resisting system in the 320-ft direction is a special steel moment frame with rigid connections for all joints in the two outer frames and for the bottom line of joints in the two interior frames. Very large, strong members were required on the lowest stories to combat the seismic forces on these taller stories.

For strength design, the Load Resistance Factor Design (LRFD) criteria were used. All standard load combinations were considered and members were designed to resist the ultimate, factored loads. Because of the extreme seismic loads, plastic yielding behavior of the structure is expected and accounted for, with plastic deflections limited to 1% story drifts. To prevent brittle failure at the beam-column connections, reduced beam sections were used in the moment-frame beams to ensure ductile failure by forcing plastic hinges to form at those locations.

For serviceability, beam deflections were limited to L/240 under service live loads and story drifts are limited to L/400 under 50-year wind conditions.

To ensure building safety, a column removal study was also conducted. A bottom-story column was removed from each exterior frame and the building's strength was analyzed to ensure life safety.

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Problem Statement and Assumptions

This report outlines the design of a ten-story steel frame hospital located in Memphis, Tennessee. The building's plan dimensions are 80 ft by 320 ft, with column spacing of 30-20-30 ft along the short dimension and 32 feet along the long dimension, as shown in Figure 1. Typical story heights are 15 ft, except for the first two stories which have heights of 20 ft each to allow for procedure rooms.

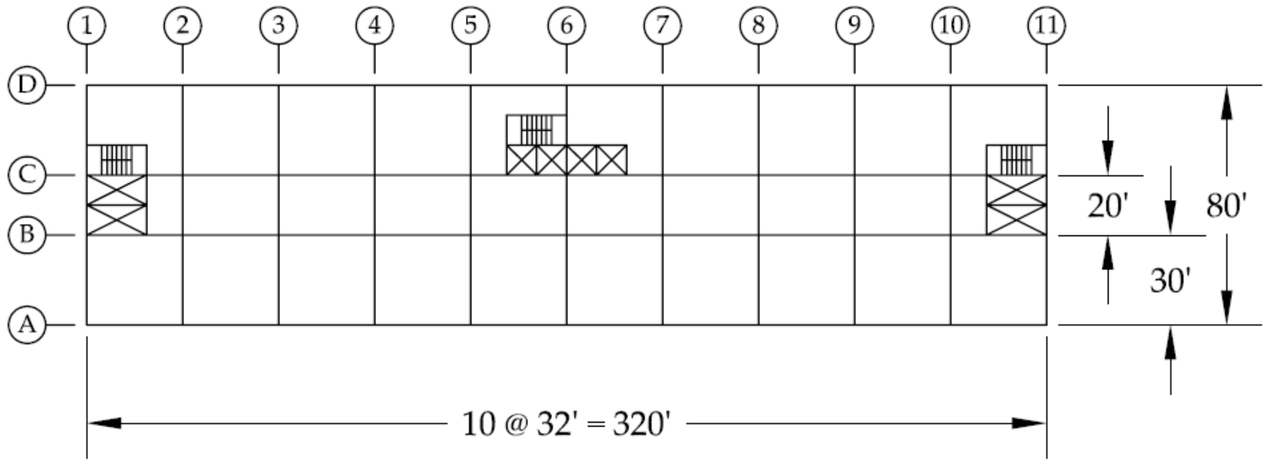


Figure 1: Plan View of Hospital

The lateral force-resisting system is comprised of braced frames along the short dimension and moment frames along the long dimension. Moment frames are employed in the 320-ft direction: the exterior frames (A and D) have all moment connections, and the interior frames have moment connections only in the first story, as shown in Figure 2. All other connections do not resist rotation, and are modeled as pinned.

Four braced frames are employed at column lines 1, 4, 8 and 11 (see Figure 3). They each consist of X-bracing along the two 30 ft wide bays, spanning two stories in the 15 ft stories, and one story in the 20 ft stories.

The floor system consists of composite metal decking; lightweight concrete is used to mitigate gravity and seismic loads by reducing weight. The decking is supported on floor beams that are designed and analyzed compositely. Analysis is conducted for unshored construction.

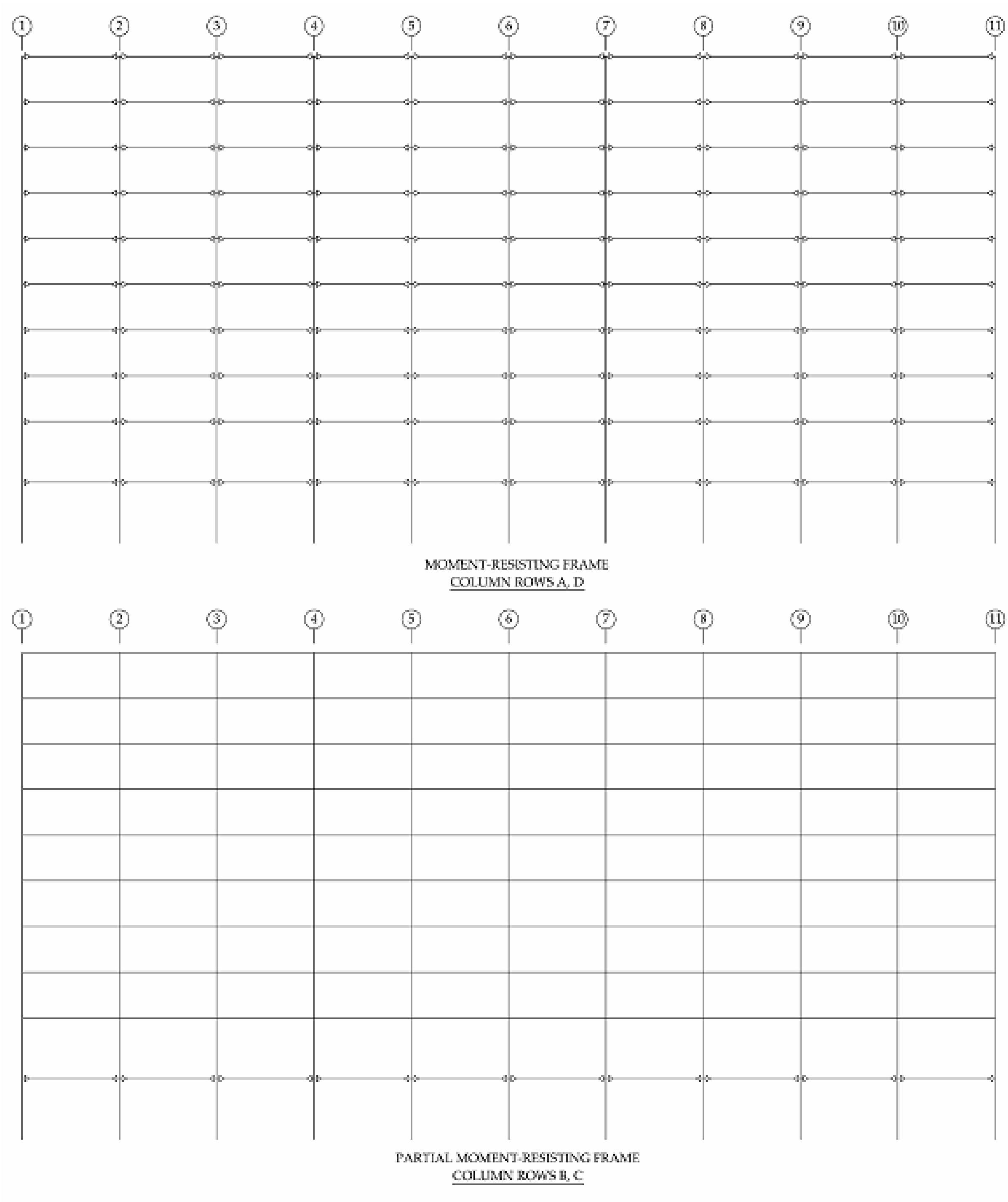


Figure 2: Elevation Views of 320-ft frames: Exterior (top) Interior (bottom)

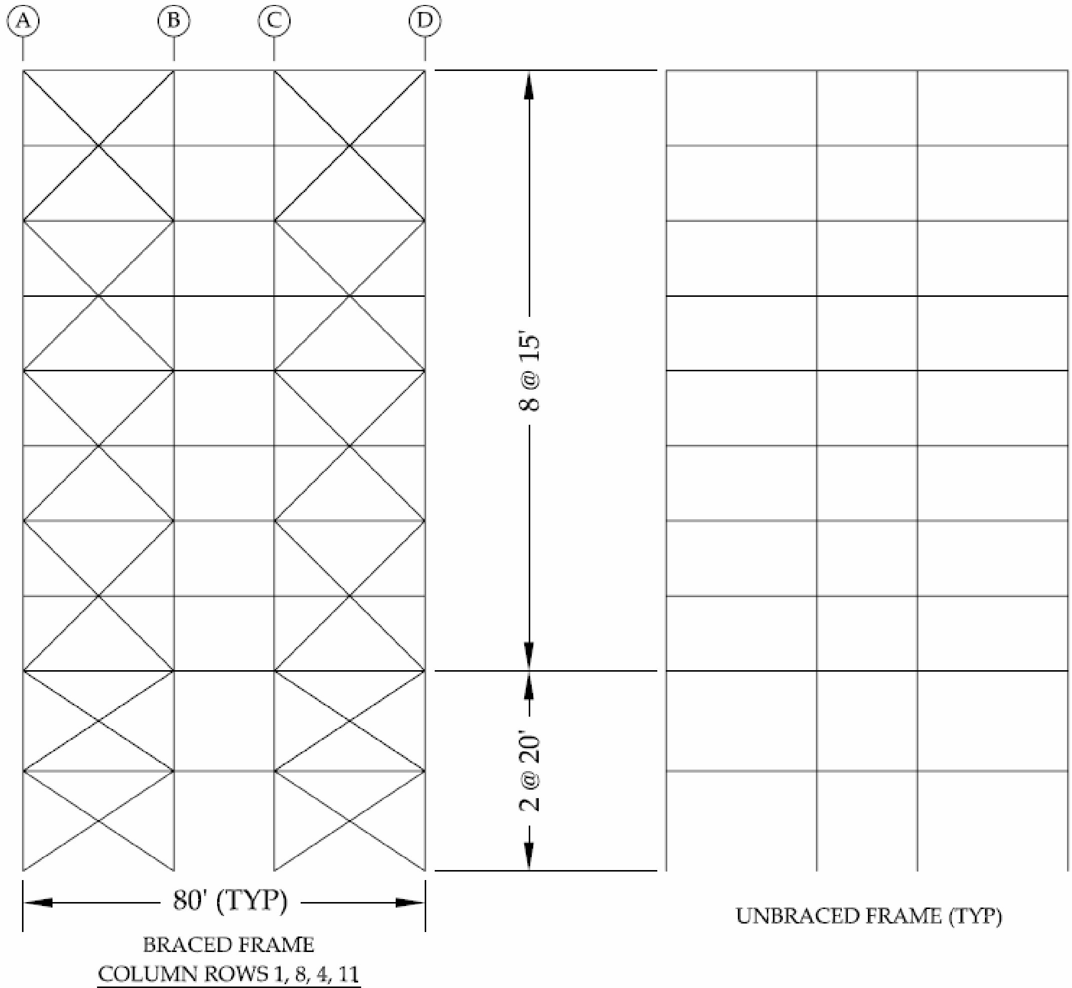


Figure 3: Elevation Views of 80-ft frames: Braced (left) and Unbraced (right)

Architectural and Structural Features

Cladding around the perimeter of each of the first two 20-ft procedure-room stories and next eight 15-ft patient room stories is cosmetic brick weighing 60psf. Initial design constraints limited the design to include only members W36 and smaller and weighing less than 300 lb/ft, with moment frames only along the exterior in the 320-ft direction, and a maximum of four lines of bracing in the 80-ft direction. The hospital contains two service elevators at each end and a bank of four public elevators in the middle, as well as stairs. Corridors run through the center of the building in the long direction.

Some design constraints must be violated to resist seismic loads. Moment connections are provided one level above grade for the interior 320-ft frames. Some W36x487 members are used in the moment frame to control story drift for earthquake loading.

Design Technique and Philosophy

Design was conducted according to ASCE-7-05 and the AISC Steel Manual 13th edition. The LRFD approach was used as a design criterion. All load combinations were entered into the model, and the combined load effects were compared to the reduced nominal strengths of the members. In addition to analyzing members under typical load effects, for seismic design, a drift criterion accounting for plastic deformation was enforced as indicated by ASCE-7.

The structure was designed for serviceability: Deflections of beams under service live load are limited to L/240 and story drifts under 50-year wind events (unfactored wind load) are limited to L/400.

A computer model was constructed in ETABS to conduct three-dimensional frame analysis of the structure. The model included only the main beams and the columns; the floor beams and decking were designed by hand. Lateral loads were applied to diaphragms at each floor; diaphragms were assumed rigid as justified by a diaphragm flexibility study.

Loading

Gravity Loads

Dead, live, roof live and snow loads were calculated in accordance with ASCE-7. Rain loads were assumed to be negligible compared to the roof live load. Ice and flood loads were not considered, as Memphis is not prone to excessive flooding or atmospheric ice loads. Calculations of gravity loads are included in Appendix A.

Dead Load

Dead loads were calculated, including the weight of all structural components (columns, main beams, floor beams, and floor system), cladding, and a superimposed dead load of 25 psf on the roof and 15 psf on all floors.

Live Load

Live loading was computed using ASCE-7. Specifically:

- Outer bays on the first and second floor are used for procedure rooms, which have a live load of 60 psf.
- Outer bays on the upper stories are used for patient rooms, which have a live load of 40 psf.
- The interior corridors have a live load of 80psf.
- A partition load of 15 psf is considered in all areas.
- Live load reduction is not used, because in no case would member design change from reduced live load.

Interior corridors include egress systems, but detailed design of these systems was not conducted, as instructed. Area loading for the designed bay, where elevators and stairs should be located, was applied uniformly over the area.

Live load patterning was used to determine extreme member forces. The concept of influence lines is used to dictate the patterns used. Specifically, the live load is considered "checkered" in each direction, as well as considered present everywhere.

Roof Live Load

The roof live load was also determined according to ASCE-7, section 4.9. The roof live load used was 20 psf. The roof live load was patterned in the same manner as the live load to maximize load effects.

Snow Loads

Snow loading was calculated to be approximately 20 psf, applied uniformly over the roof area. No drift of uneven snow loading was included.

Lateral Loads

Because Memphis lies within an area of high seismic risk, the design of the lateral system was expected to be controlled by seismic loading. Nonetheless, the proper wind and seismic loads were calculated according to ASCE-7 and included in the building model.

Seismic Load

The city of Memphis lies within the New Madrid seismic zone. Although earthquakes do not frequently occur in the area, some of the United States largest quakes have occurred in the seismic zone. Structural previsions for a hospital in a seismic-prone area are very stringent. Chapters 11, 12, and 22 in ASCE-7 were used to formulate the design of this building.

According to chapter 22, areas inside the New Madrid zone can have horizontal accelerations that peak at 300% of gravity or are sustained for a second at 100% gravity. The coordinates of the city of Memphis resulted in a 0.2-second spectral response of 125% and a 1-second response of 30%. In addition, the long-period translation period was found to be 12 seconds. Using the required calculations in ASCE-7 chapter 11 and 12, this building was determined to be designed using site class D criteria with an importance factor of 1.5. The fundamental period of the structure was estimated using the criteria ASCE-7, section 12.8.2.1 and was found to be 1 second. Since no local geotechnical criteria were provided, site-specific response was not considered. Using Table 12.2-1 in ASCE-7, the deflection amplification factor (C_d) and response modification coefficient (R) were found in both frame systems. Calculated seismic loads were reduced by the response modification coefficient for analysis and strength calculations, and the calculated deflections were amplified by the deflection calculation factor to check story drifts. The constants pertaining to each of the frames systems can be found in Table 1: Seismic Response Constants.

Table 1: Seismic Response Constants

	Deflection Amplification Factor (C_d)	Response Modification Coefficient (R)
Special steel concentrically braced frames	5	6
Special steel moment frames	5 ½	8

Lateral forces were found using base shear due to the quake and the building's weight, adjusted by the response modification coefficient. The loads in the braced-frame direction are shown in Figure 4 and the loads in the moment-frame direction are shown in Figure 5, and are calculated in Appendix C. These forces were applied on the rigid diaphragm of each story. Site category D required that lateral loads be applied in the direction of each system's resistance and at the same time, 30% of the load is applied in the other frame; in addition, eccentricities of the loads were introduced to create accidental torsion of the structure. A first-order analysis was run using ETABS. Story drifts were printed, adjusted using the deflection amplification and importance factors, and used as the basis of the design check.

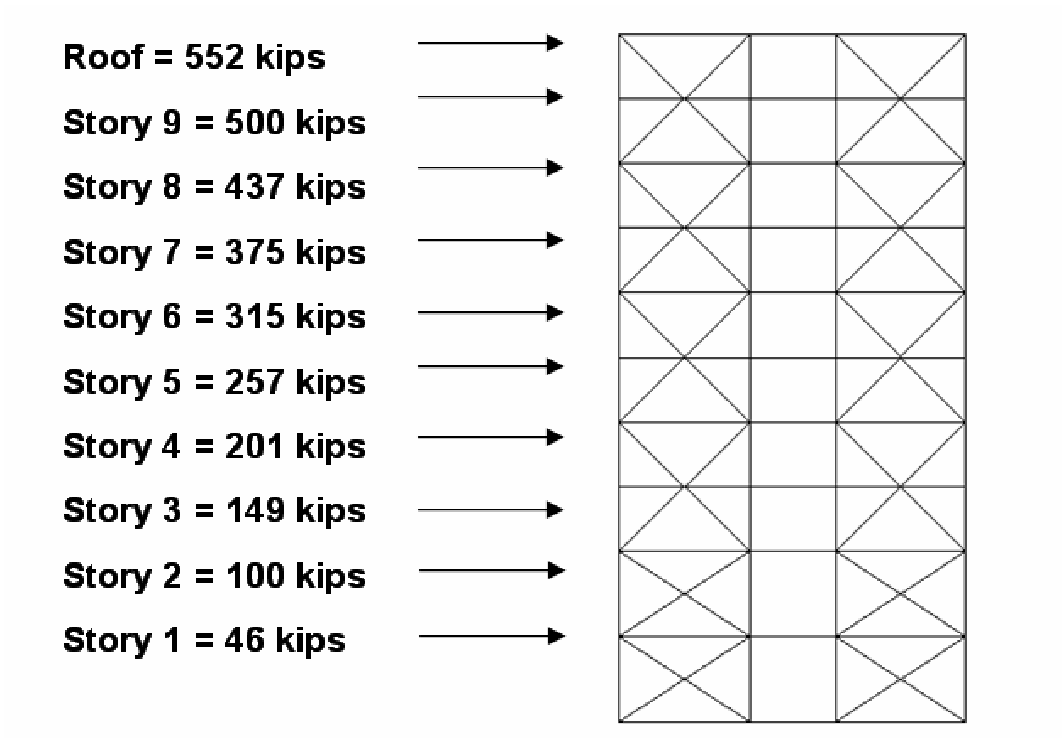


Figure 4: Ultimate Brace Frame Seismic Loads

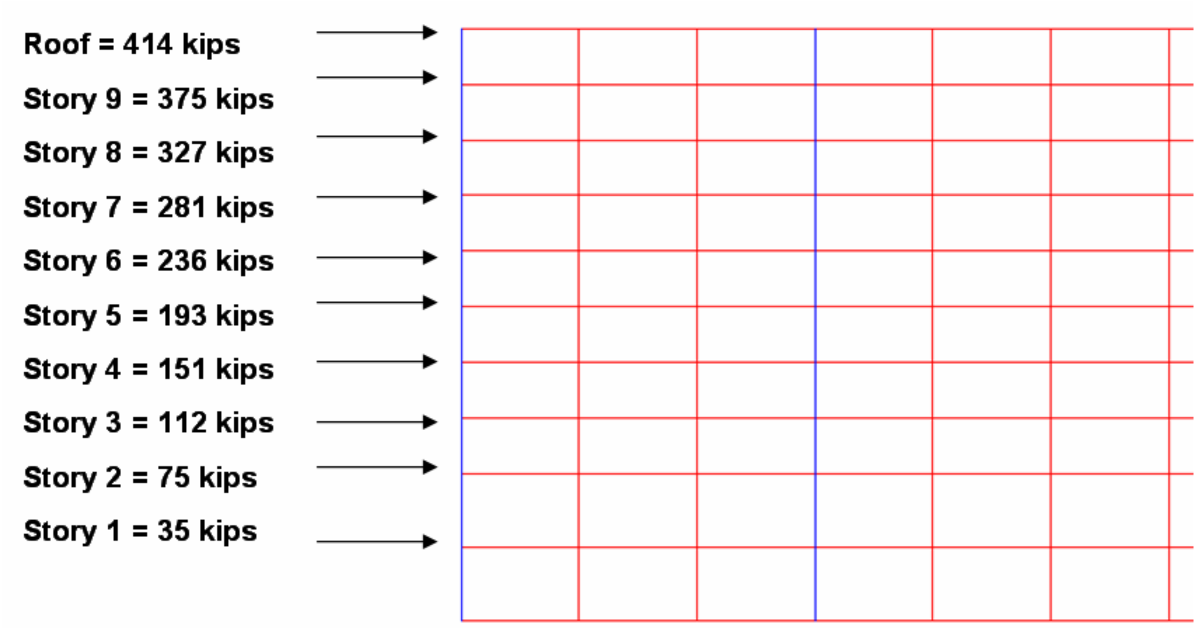


Figure 5: Ultimate Moment Frame Seismic Loading

Wind Load

Due to the intensive nature of the seismic loads, the wind loads were not expected to control in this design. Wind loading was calculated using ASCE 7, Method 2 (Analytical Procedure, Sec. 6.5) since it is not classified as a low-rise building. Memphis is located in the minimum basic wind speed zone of 90 mph, and has an importance factor of 1.15, due to the building's category IV status (its being an essential facility). Because it was assumed this hospital would be located in the urban environment of Memphis, exposure category B was used. No special topographic considerations were taken into account, and the default values of all remaining variables were used in the computation of the lateral wind loads. The building was also classified as an enclosed structure.

Once all wind pressures had been computed and applied to the proper building faces, they were summed up within the vertical tributary area of each diaphragm and the resultants were applied as concentrated loads at the diaphragm's centroid. These forces in the braced-frame direction are shown in Figure 6 and the forces in the moment-frame direction are shown in Figure 7. Two forces act along the principle axes of the diaphragm, and in some cases, a moment is applied to represent these forces applied at an eccentricity of 15% of the building width. The details of all these cases are recorded in Appendix B. No detailed design of the exterior cladding was performed.

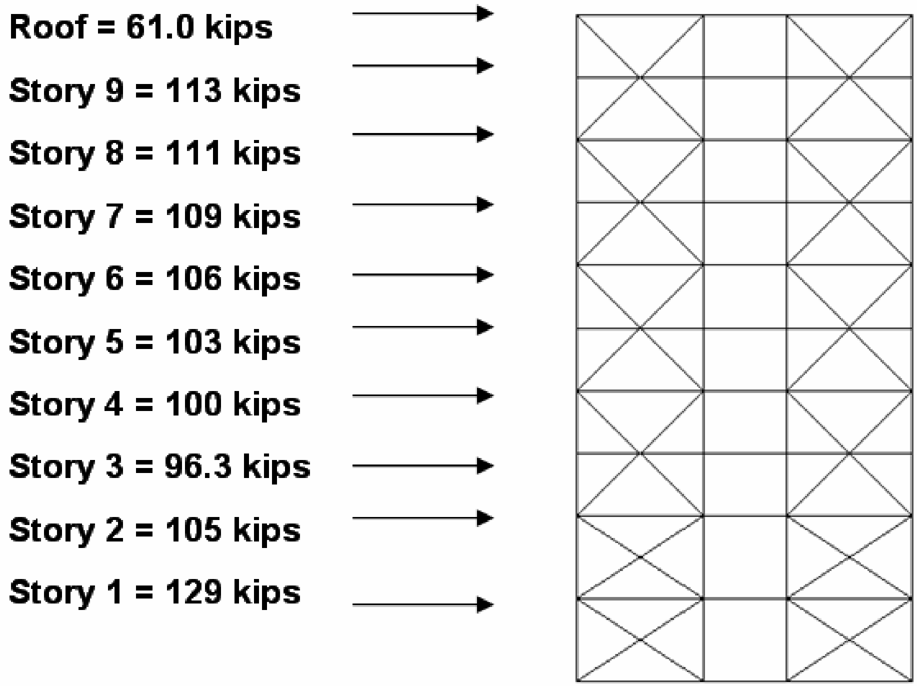


Figure 6: Ultimate Brace Frame Wind Loads

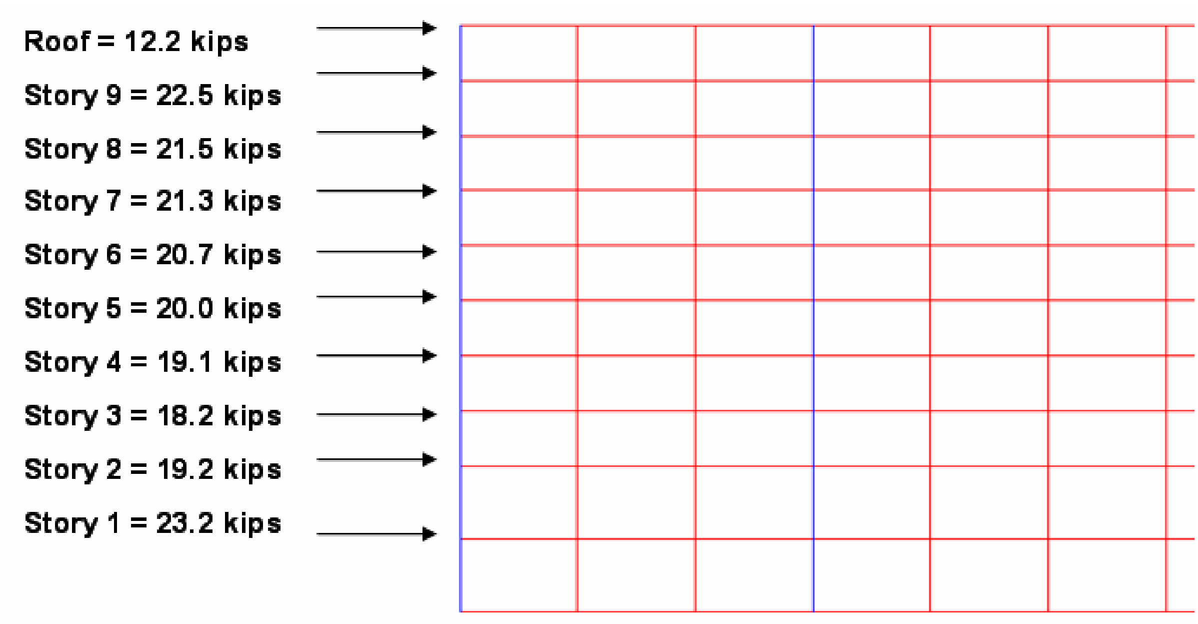


Figure 7: Ultimate Moment Frame Wind Loads

Design Process

Story drift requirements due to seismic loading controlled the design of all members in the moment frames and the braces in the braced frames. For all interior columns, compressive strength controlled proportioning. For all simply-supported beams, serviceability (live-load deflection) controlled member proportioning.

Seismic Story Drift

Lateral forces due to seismic effects were found using base shear due to the earthquake and the buildings weight due from dead loading. These forces were applied on the rigid diaphragm of each story. Site category D required that lateral loads be applied in the direction of each system's resistance and at the same time, 30% of the load is applied in the other frame. In addition, eccentricities of the loads were introduced to create accidental torsion of the structure. A first order analysis was run using ETABS. Story drifts were printed, adjusted using the deflection amplification and importance factors, and used as the basis of the design check.

Using table 12.12-1 in ASCE-7 it was determined the largest story drift for this structure should be 1% of the story height. Story drift was calculated to allow for safety during plastic yielding of the building member due to a seismic event. Reduced beam sections are used on beams in the moment resisting frames to force plastic hinge failure at a point near the end of the beam (a ductile failure) instead of allowing brittle failure of the connection. The standard dimensions for reduced beam sections in ETABS were used and are shown in Figure 8. Story drifts limits are not imposed for serviceability, but for life-safety, to account for plastic deformation and prevent collapse. Story drift design calculations can be found in the Appendix D.

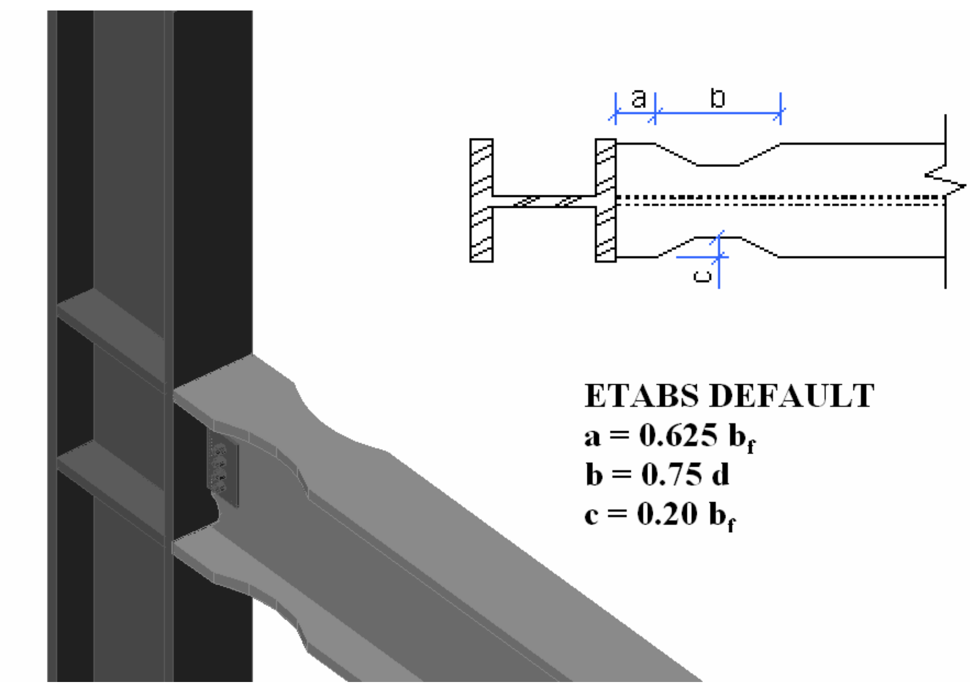


Figure 8: Reduced Beam Section Explanation

According to the results, the braced frame provided substantial resistance to story drift caused by seismic activity. The controlling factor for the braces was their compressive strength to prevent them from buckling. Four lines of bracing prevent the movement of the building in the short direction; the outer bracing structures provide the greatest resistance to the torsion loads applied to the diaphragms.

To obtain the resistance in the long direction, moment frames with very large members must be used. Initially, moment connections were restricted to be in the frames along each outer walls of the building. The outer frames assist with torsion created by the offset applied forces. It was found that only the two exterior moment frames would not create enough resistance for the taller bottom stories. Additional moment connections were added to the lowest story interior frames and the results were studied. It was determined that even with the additional planes of resistance, there was not enough stiffness using the largest allotted members of W36X282 in all 4 planes to satisfy 1% story drift. After additional research, it was determined in order to satisfy drift criteria, all four planes must be rigidly connected on the lowest story and the exterior frame must be connected on the lowest two stories. In addition, members of capacity up to W36X487 had to be used. Only a small nominal size increase (1.9" in depth from W36x256 to W36x487) is required to add the stronger, stiffer members and additional moment connections, which will not affect clearance or story heights.

It is in the best architectural interest to increase capacity using the moment frames instead of installing a bracing system in the other direction. If a bracing system was used in both directions in tandem with the moment frame, ASCE-7 requires that both systems are able to resist 70% of the ultimate load. Whichever choice is made, additional stiffness is required than can be obtained given the initial constraints.

Ultimate Load Effects

The LRFD load combinations were used to find maximum compression, tension, shear force and bending moment in all members. This strength requirement governed member selection of non-moment frame columns and braces. In these cases, the lightest members were chosen to resist loads in critical members, and member sections were repeated if reasonable. In all other cases, either story drifts or serviceability requirements governed member selection.

Serviceability

A beam deflection criterion of L/240 was used under service live load for all beams. For all simply-supported beams in the structure, this deflection limitation controlled the selection. The service wind story drift limitation of L/400 was met and did not control for any members. This is because the lateral force-resisting system was already very stiff to handle seismic loads.

Column Removal

Exterior column removal was conducted by removing the column along the moment frame which carried the highest load on the first story. The strengths of the surrounding elements were found and compared to an ultimate load using the resistance factor and load combination 1.5 $M_n > 2(D + 0.25L)$. The deflected shapes corresponding to this state are shown in Figure 9.

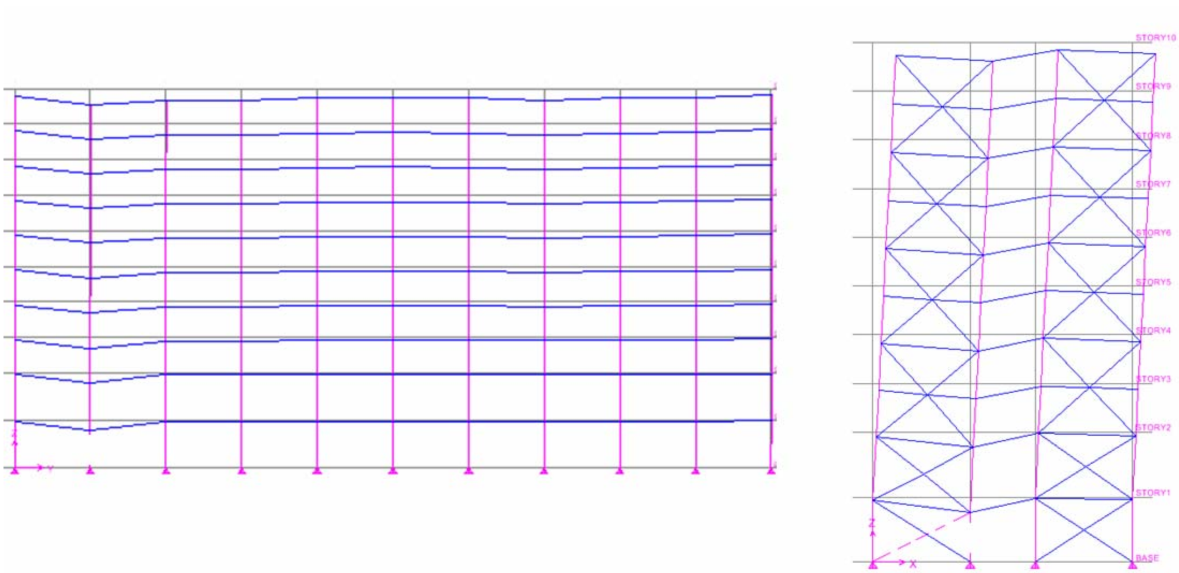


Figure 9: Deflected Shapes From Column Removal

Removing a column from the moment frame, the critical members were found to 107% overstrength, the member size controlled by seismic loads. A 1.55″ deflection was calculated at the joint where the column was removed.

Removing a column from the braced frame resulted in exceeding the compressive strength of adjacent bracing. However, if the brace fails and ceases to carry load, the load path changes in such a way that strength criteria were met by all members with at least 6% over strength. The maximum deflection calculated if the column is removed and the brace fails is 0.81″.

Final Results and Considerations

Designed Structure

The selected members and their uses are tabulated in Table 2. All beams in the moment frame use reduced beam sections—the reduced beam sections lead to larger story drifts, but members were not designed for strength corresponding to their reduced beam sections, as instructed. These members are capable of satisfying both strength and serviceability requirements. Some constructability difficulty is likely from some of the differences in member sizes, but connections are beyond the scope of this project.

Table 2: Structural Shapes Used

Member	Uses
W36×487	Beams: Bottom story long beams (moment connected) Columns: Bottom two stories (moment connected)
W36×256	Beams: exterior long frames for stories 2–roof (moment connected) Columns: exterior long frames for stories 3–roof (moment connected)
W24×68	Beams: interior long frames for stories 2–9 (moment released)
W24×55	Beams: interior long-beams on roof
W21×50	Beams: all short-frame beams not in braced frame lines
W16×67	Beams: all short-frame beams in braced frame lines
W14×136	Braces: stories 3–roof
W12×106	Braces: first two stories
W14×132	Columns: interior long frames for stories 3–roof (moment released)
W12×106	Braces: above story two
W10×60	Braces: first two stories

Additional Considerations

Because of high seismic loading, this design requires very strong, expensive members. To mitigate seismic effects, a base isolation could be utilized. Base isolation systems minimize the level of earthquake force transmitted from the ground into the building by isolating the structure using rubber bearings and viscous dampers.

Member size in the 320-ft direction could be decreased by using a braced frame or dual system to resist lateral forces. Though architecturally invasive, braced systems are highly effective for reducing deflections, and would decrease story drifts without increasing the amount of steel used.

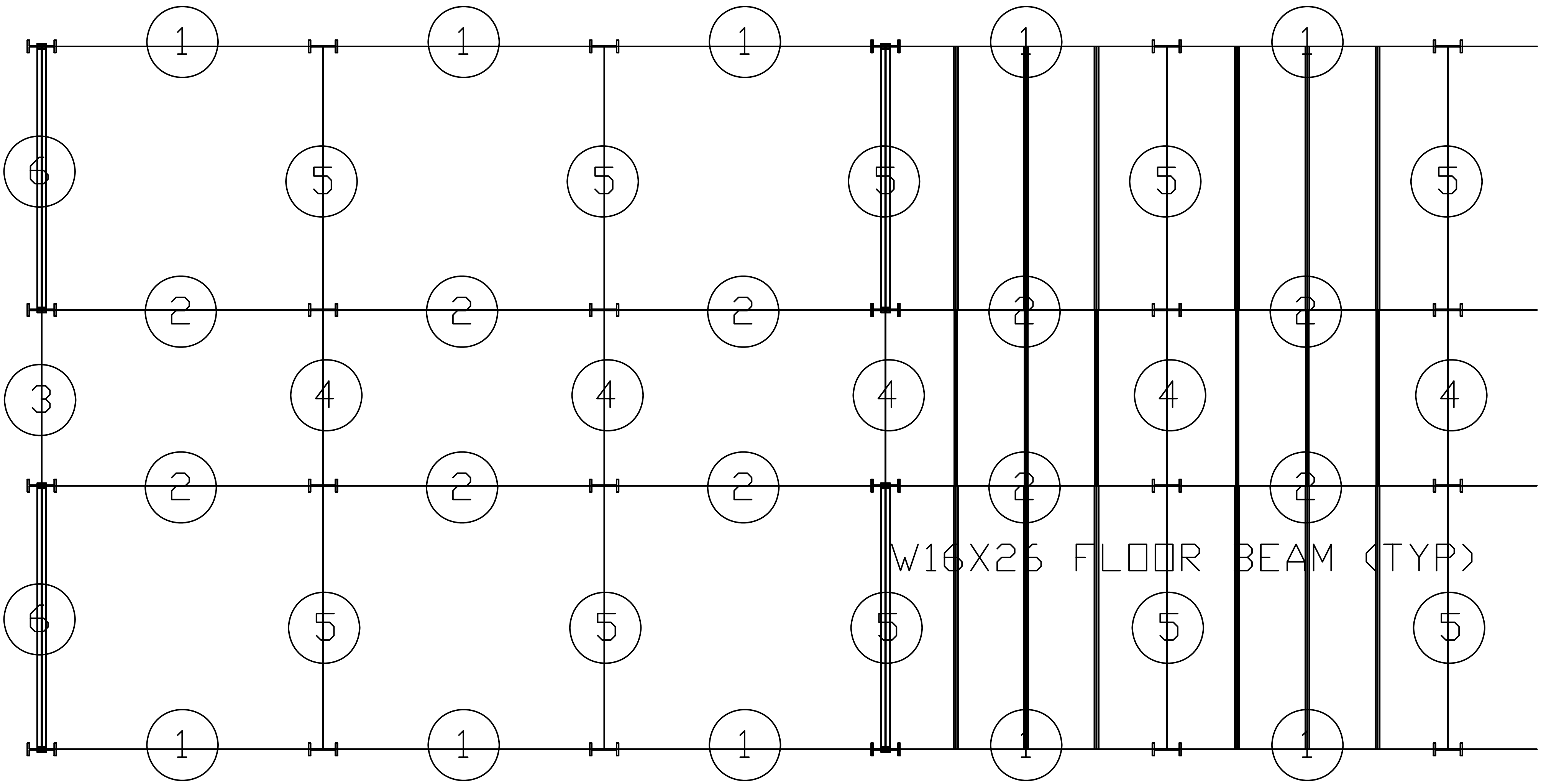
References

American Institute of Steel Construction, Inc. (2005). *Steel Construction Manual*, 13th Ed., American Institute of Steel Construction, Inc., United States of America.

American Society of Civil Engineers. (2005). *Minimum Design Loads of Buildings and Other Structures*, 2005 Ed., American Society of Civil Engineers, United States of America.

Appendix A:
Gravity Loads

TYPICAL BEAM NAMING CONVENTION



DEAD LOADING - LOWER FLOORS

Lower Floors

L-I			L-II			L-III		
Member length (ft)	32		Member length (ft)	32		Member length (ft)	20	
deck wt (psf)	51		deck wt (psf)	51		deck wt (psf)	51	
trib length (ft)	15		trib length (ft)	25		trib length (ft)	4	
w_slab	765	lb/ft	**w_slab**	1275	lb/ft	**w_slab**	204	lb/ft
No. floor beams	3		No. floor beams	3		No. floor beams	0	
wt floor beams (plf)	26		wt floor beams (plf)	22&26		wt floor beams (plf)	0	
Trib length FB (ft)	15		Trib length FB (ft)	25		Trib length FB (ft)	0	
Floor beams	36.5625	lb/ft	**Floor beams**	57.19	lb/ft	**Floor beams**	0	lb/ft
Weight cladding (psf)	60		Weight cladding (psf)	0		Weight cladding (psf)	60	
Story height (ft)	20		Story height (ft)	20		Story height (ft)	20	
Cladding	1200	lb/ft	**Cladding**	0	lb/ft	**Cladding**	1200	lb/ft
Superimposed (psf)	15		Superimposed (psf)	15		Superimposed (psf)	15	
Trib length FB (ft)	15		Trib length FB (ft)	15		Trib length FB (ft)	4	
Superimposed	225	lb/ft	**Superimposed**	225	lb/ft	**Superimposed**	60	lb/ft
TOTAL DEAD	**2226.5625**	**lb/ft**	**TOTAL DEAD**	**1557.19**	**lb/ft**	**TOTAL DEAD**	**1464**	**lb/ft**

DEAD LOADING - LOWER FLOORS (cont)

L-IV

Member length (ft)	20	
deck wt (psf)	51	
trib length (ft)	8	
w_slab	408	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Weight cladding (psf)	0	
Story height (ft)	20	
Cladding	0	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	8	
Superimposed	120	lb/ft
TOTAL DEAD	**528**	**lb/ft**

L-V

Member length (ft)	30	
deck wt (psf)	51	
trib length (ft)	8	
w_slab	408	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Weight cladding (psf)	0	
Story height (ft)	20	
Cladding	0	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	8	
Superimposed	120	lb/ft
TOTAL DEAD	**528**	**lb/ft**

L-VI

Member length (ft)	30	
deck wt (psf)	51	
trib length (ft)	4	
w_slab	204	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Weight cladding (psf)	60	
Story height (ft)	20	
Cladding	1200	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	4	
Superimposed	60	lb/ft
TOTAL DEAD	**1464**	**lb/ft**

DEAD LOADING - UPPER FLOORS

Upper Floors

U-I		
Member length (ft)	32	
deck wt (psf)	51	
trib length (ft)	15	
w_slab	765	lb/ft
No. floor beams	3	
wt floor beams (plf)	26	
Trib length FB (ft)	15	
Floor beams	36.5625	lb/ft
Weight cladding (psf)	60	
Story height (ft)	15	
Cladding	900	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	15	
Superimposed	225	lb/ft
TOTAL DEAD	**1926.5625**	**lb/ft**

U-II		
Member length (ft)	32	
deck wt (psf)	51	
trib length (ft)	25	
w_slab	1275	lb/ft
No. floor beams	3	
wt floor beams (plf)	22&26	
Trib length FB (ft)	25	
Floor beams	57.19	lb/ft
Weight cladding (psf)	0	
Story height (ft)	15	
Cladding	0	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	15	
Superimposed	225	lb/ft
TOTAL DEAD	**1557.19**	**lb/ft**

U-III		
Member length (ft)	20	
deck wt (psf)	51	
trib length (ft)	4	
w_slab	204	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Weight cladding (psf)	60	
Story height (ft)	15	
Cladding	900	lb/ft
Superimposed (psf)	15	
Trib length FB (ft)	4	
Superimposed	60	lb/ft
TOTAL DEAD	**1164**	**lb/ft**

DEAD LOADING - UPPER FLOORS (cont)

U-IV			**U-V**			**U-VI**		
Member length (ft)	20		Member length (ft)	30		Member length (ft)	30	
deck wt (psf)	51		deck wt (psf)	51		deck wt (psf)	51	
trib length (ft)	8		trib length (ft)	8		trib length (ft)	4	
w_slab	408	lb/ft	**w_slab**	408	lb/ft	**w_slab**	204	lb/ft
No. floor beams	0		No. floor beams	0		No. floor beams	0	
wt floor beams (plf)	0		wt floor beams (plf)	0		wt floor beams (plf)	0	
Trib length FB (ft)	0		Trib length FB (ft)	0		Trib length FB (ft)	0	
Floor beams	0	lb/ft	**Floor beams**	0	lb/ft	**Floor beams**	0	lb/ft
Weight cladding (psf)	0		Weight cladding (psf)	0		Weight cladding (psf)	60	
Story height (ft)	15		Story height (ft)	15		Story height (ft)	15	
Cladding	0	lb/ft	**Cladding**	0	lb/ft	**Cladding**	900	lb/ft
Superimposed (psf)	15		Superimposed (psf)	15		Superimposed (psf)	15	
Trib length FB (ft)	8		Trib length FB (ft)	8		Trib length FB (ft)	4	
Superimposed	120	lb/ft	**Superimposed**	120	lb/ft	**Superimposed**	60	lb/ft
TOTAL DEAD	**528**	**lb/ft**	**TOTAL DEAD**	**528**	**lb/ft**	**TOTAL DEAD**	**1164**	**lb/ft**

DEAD LOADING - ROOF

Roof

R-I			**R-II**			**R-III**		
Member length (ft)	32		Member length (ft)	32		Member length (ft)	20	
deck wt (psf)	51		deck wt (psf)	51		deck wt (psf)	51	
trib length (ft)	15		trib length (ft)	25		trib length (ft)	4	
w_slab	765	lb/ft	**w_slab**	1275	lb/ft	**w_slab**	204	lb/ft
No. floor beams	3		No. floor beams	3		No. floor beams	0	
wt floor beams (plf)	26		wt floor beams (plf)	22&26		wt floor beams (plf)	0	
Trib length FB (ft)	15		Trib length FB (ft)	25		Trib length FB (ft)	0	
Floor beams	36.5625	lb/ft	**Floor beams**	57.19	lb/ft	**Floor beams**	0	lb/ft
Superimposed (psf)	25		Superimposed (psf)	25		Superimposed (psf)	25	
Trib length FB (ft)	15		Trib length FB (ft)	15		Trib length FB (ft)	4	
Superimposed	375	lb/ft	**Superimposed**	375	lb/ft	**Superimposed**	100	lb/ft
TOTAL DEAD	**1176.5625**	**lb/ft**	**TOTAL DEAD**	**1707.19**	**lb/ft**	**TOTAL DEAD**	**304**	**lb/ft**

DEAD LOADING - ROOF (cont)

R-IV		
Member length (ft)	20	
deck wt (psf)	51	
trib length (ft)	8	
w_slab	408	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Superimposed (psf)	25	
Trib length FB (ft)	8	
Superimposed	200	lb/ft
TOTAL DEAD	**608**	**lb/ft**

R-V		
Member length (ft)	30	
deck wt (psf)	51	
trib length (ft)	8	
w_slab	408	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Superimposed (psf)	25	
Trib length FB (ft)	8	
Superimposed	200	lb/ft
TOTAL DEAD	**608**	**lb/ft**

R-VI		
Member length (ft)	30	
deck wt (psf)	51	
trib length (ft)	4	
w_slab	204	lb/ft
No. floor beams	0	
wt floor beams (plf)	0	
Trib length FB (ft)	0	
Floor beams	0	lb/ft
Superimposed (psf)	25	
Trib length FB (ft)	4	
Superimposed	100	lb/ft
TOTAL DEAD	**304**	**lb/ft**

Live Loads on Beams (Lower Procedure Floors)

Beam Type L1

	Exterior Beams
	A,B:1-11 & C,D:1-11
Floor	2
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Procedure Room
Table 4-1 Value (psf)	60
Bay Area	960

Beam	Exterior
Tributary Length (ft)	15
Beam Length (ft)	32
KLL (Table 4-2)	2
Tributary Area (ft2)	480
Influence Area (ft2)	960
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	60
Partition Load (psf)	15
Reduced Imposed Load Factor	0.734122918
Imposed Load on Beam (lb/ft)	900
Partiton Load on Beam (lb/ft)	225

Applied Members

A1-A2	D1-D2
A2-A3	D2-D3
A3-A4	D3-D4
A4-A5	D4-D5
A5-A6	D5-D6
A6-A7	D6-D7
A7-A8	D7-D8
A8-A9	D8-D9
A9-A10	D9-D10
A10-A11	D10-D11

Beam Type L2

	Interior Beams
	A,B: 2-10 & C,D:2-10
Floor	2
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Procedure Room
Table 4-1 Value (psf)	60
Bay Area	960
	A,B: 2-10 & C,D:2-10
Floor	2
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Beam	Interior
Tributary Length (ft)	25
Beam Length (ft)	32
KLL (Table 4-2)	2
Tributary Area (ft2)	800
Influence Area (ft2)	1600
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	60
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	0.625
Imposed Load on Beam (lb/ft)	1700
Partiton Load on Beam (lb/ft)	375

Applied Members

B1-B2	C1-C2
B2-B3	C2-C3
B3-B4	C3-C4
B4-B5	C4-C5
B5-B6	C5-C6
B6-B7	C6-C7
B7-B8	C7-C8
B8-B9	C8-C9
B9-B10	C9-C10
B10-B11	C10-C11

Beam Type L3

	Exterior Beams on Corridor
	B,C:1-1,11-11
Floor	2
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Beam	Exterior
Tributary Length (ft)	4
Beam Length (ft)	20
KLL (Table 4-2)	2
Tributary Area (ft2)	80
Influence Area (ft2)	160
ASCE 4.8.1 (400sqft)	NO Reduction
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	~~1.435854123~~
Imposed Load on Beam (lb/ft)	320
Partiton Load on Beam (lb/ft)	60

Applied Members

B1-C1

B11-C11

Live Loads on Beams (Lower Procedure Floors) (cont)

Beam Type L4

Interior Corridor Beams

B,C:2-10

Floor	2
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Floor	2
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	20
KLL (Table 4-2)	2
Tributary Area (ft2)	160
Influence Area (ft2)	320
ASCE 4.8.1 (400sqft)	NO Reduction
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	80
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	~~1.088525492~~
Imposed Load on Beam (lb/ft)	640
Partiton Load on Beam (lb/ft)	120

Applied Members

B2-C2
B3-C3
B4-C4
B5-C5
B6-C6
B7-C7
B8-C8
B9-C9
B10-C10

Beam Type L5

Interior Procedure Room Beams

A,B & C,D:2-10

Floor	2
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Procedure Room
Table 4-1 Value (psf)	60
Bay Area	960

Floor	2
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Procedure Room
Table 4-1 Value (psf)	60
Bay Area	960

Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
KLL (Table 4-2)	2
Tributary Area (ft2)	240
Influence Area (ft2)	480
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	60
Partition Load (psf)	15
Reduced Imposed Load Factor	0.934653197
Imposed Load on Beam (lb/ft)	480
Partiton Load on Beam (lb/ft)	120

Applied Members

A2-B2	C2-D2
A3-B3	C3-D3
A4-B4	C4-D4
A5-B5	C5-D5
A6-B6	C6-D6
A7-B7	C7-D7
A8-B8	C8-D8
A9-B9	C9-D9
A10-B10	C10-D10

Beam Type L6

Exterior Beams

AB,CD-1&11

Floor	2
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Procedure Rooms
Table 4-1 Value (psf)	60
Bay Area	960

Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
KLL (Table 4-2)	2
Tributary Area (ft2)	240
Influence Area (ft2)	480
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	60
Partition Load (psf)	15
Reduced Imposed Load Factor	0.934653197
Imposed Load on Beam (lb/ft)	480
Partiton Load on Beam (lb/ft)	120

Applied Members

A1-B1	C1-D1
A11-B11	C11-D11

Live Loads on Beams (Upper Patient Floors)

Beam Type U1

	Exterior Beams
	A,B:1-11 & C,D:1-11
Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Patient Rooms
Table 4-1 Value (psf)	40
Bay Area	960

Beam	Exterior
Tributary Length (ft)	15
Beam Length (ft)	32
KLL (Table 4-2)	2
Tributary Area (ft2)	480
Influence Area (ft2)	960
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	40
Partition Load (psf)	15
Reduced Imposed Load Factor	0.734122918
Imposed Load on Beam (lb/ft)	600
Partiton Load on Beam (lb/ft)	225

Applied Members

A1-A2	D1-D2
A2-A3	D2-D3
A3-A4	D3-D4
A4-A5	D4-D5
A5-A6	D5-D6
A6-A7	D6-D7
A7-A8	D7-D8
A8-A9	D8-D9
A9-A10	D9-D10
A10-A11	D10-D11

Beam Type U2

	Interior Beams
	A,B: 2-10 & C,D:2-10
Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Patient Rooms
Table 4-1 Value (psf)	40
Bay Area	960
	A,B: 2-10 & C,D:2-10
Floor	2
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Beam	Interior
Tributary Length (ft)	25
Beam Length (ft)	32
KLL (Table 4-2)	2
Tributary Area (ft2)	800
Influence Area (ft2)	1600
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	40
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	0.625
Imposed Load on Beam (lb/ft)	1400
Partiton Load on Beam (lb/ft)	375

Applied Members

B1-B2	C1-C2
B2-B3	C2-C3
B3-B4	C3-C4
B4-B5	C4-C5
B5-B6	C5-C6
B6-B7	C6-C7
B7-B8	C7-C8
B8-B9	C8-C9
B9-B10	C9-C10
B10-B11	C10-C11

Beam Type U3

	Exterior Beams on Corridor
	B,C:1-1,11-11
Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Corridor
Table 4-1 Value (psf)	80
Bay Area	640

Beam	Exterior
Tributary Length (ft)	4
Beam Length (ft)	20
KLL (Table 4-2)	2
Tributary Area (ft2)	80
Influence Area (ft2)	160
ASCE 4.8.1 (400sqft)	NO Reduction
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	~~1.435854123~~
Imposed Load on Beam (lb/ft)	320
Partiton Load on Beam (lb/ft)	60

Applied Members

B1-C1

B11-C11

Live Loads on Beams (Upper Patient Floors) (cont)

Beam Type U4

Interior Corridor Beams
B,C:2-10

Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640
Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Hospital Corridor
Table 4-1 Value (psf)	80
Bay Area	640
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	20
KLL (Table 4-2)	2
Tributary Area (ft2)	160
Influence Area (ft2)	320
ASCE 4.8.1 (400sqft)	NO Reduction
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	80
Imposed Live Load (psf) (Table 4-1)	80
Partition Load (psf)	15
Reduced Imposed Load Factor	~~1.088525492~~
Imposed Load on Beam (lb/ft)	640
Partiton Load on Beam (lb/ft)	120

Applied Members

B2-C2
B3-C3
B4-C4
B5-C5
B6-C6
B7-C7
B8-C8
B9-C9
B10-C10

Beam Type U5

Interior Procedure Room Beams
A,B & C,D:2-10

Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Patient Rooms
Table 4-1 Value (psf)	40
Bay Area	960
Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Patient Rooms
Table 4-1 Value (psf)	40
Bay Area	960
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
KLL (Table 4-2)	2
Tributary Area (ft2)	240
Influence Area (ft2)	480
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	40
Partition Load (psf)	15
Reduced Imposed Load Factor	0.934653197
Imposed Load on Beam (lb/ft)	320
Partiton Load on Beam (lb/ft)	120

Applied Members

A2-B2	C2-D2
A3-B3	C3-D3
A4-B4	C4-D4
A5-B5	C5-D5
A6-B6	C6-D6
A7-B7	C7-D7
A8-B8	C8-D8
A9-B9	C9-D9
A10-B10	C10-D10

Beam Type U6

Exterior Beams
AB,CD-1&11

Floor	3,4,5,6,7,8,9,10
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Patient Rooms
Table 4-1 Value (psf)	40
Bay Area	960
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
KLL (Table 4-2)	2
Tributary Area (ft2)	240
Influence Area (ft2)	480
ASCE 4.8.1 (400sqft)	Reduction OK
ASCE 4.8.1 (0.50Lo / 0.40Lo)	OK
Imposed Live Load (psf) (Table 4-1)	40
Partition Load (psf)	15
Reduced Imposed Load Factor	0.934653197
Imposed Load on Beam (lb/ft)	320
Partiton Load on Beam (lb/ft)	120

Applied Members

A1-B1	C1-D1
A11-B11	C11-D11

Live Loads on Beams (Roof)

Beam Type R1

	Exterior Beams
	A,B:1-11 & C,D:1-11
Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	960

Beam	Exterior
Tributary Length (ft)	15
Beam Length (ft)	32
Tributary Area (ft2)	480
R1	0.72
F (rise in / foot)	0
R2	1
Lr	14.4
Lr Check	OK
Lr used (psf)	14.4
Reduced Imposed Load Factor	0.72
Imposed Load on Beam (lb/ft)	300

Applied Members

A1-A2	D1-D2
A2-A3	D2-D3
A3-A4	D3-D4
A4-A5	D4-D5
A5-A6	D5-D6
A6-A7	D6-D7
A7-A8	D7-D8
A8-A9	D8-D9
A9-A10	D9-D10
A10-A11	D10-D11

Beam Type R2

	Interior Beams
	A,B: 2-10 & C,D:2-10
Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	960
	A,B: 2-10 & C,D:2-10
Floor	Roof
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	640

Beam	Interior
Tributary Length (ft)	25
Beam Length (ft)	32
Tributary Area (ft2)	800
R1	0.6
F (rise in / foot)	0
R2	1
Lr	12
Lr Check	OK
Lr used (psf)	12
Reduced Imposed Load Factor	0.6
Imposed Load on Beam (lb/ft)	500

Applied Members

B1-B2	C1-C2
B2-B3	C2-C3
B3-B4	C3-C4
B4-B5	C4-C5
B5-B6	C5-C6
B6-B7	C6-C7
B7-B8	C7-C8
B8-B9	C8-C9
B9-B10	C9-C10
B10-B11	C10-C11

Beam Type R3

	Exterior Beams on Corridor
	B,C:1-1,11-11
Floor	Roof
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	640

Beam	Exterior
Tributary Length (ft)	4
Beam Length (ft)	20
Tributary Area (ft2)	80
R1	1
F (rise in / foot)	0
R2	1
Lr	20
Lr Check	OK
Lr used (psf)	20
Reduced Imposed Load Factor	1
Imposed Load on Beam (lb/ft)	80

Applied Members

B1-C1

B11-C11

Live Loads on Beams (cont)

Beam Type R4

Interior Corridor Beams

B,C:2-10

Floor	Roof
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	640
Floor	Roof
Bay Width (ft)	20
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	80
Bay Area	640
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	20
Tributary Area (ft2)	160
R1	1
F (rise in / foot)	0
R2	1
Lr	20
Lr Check	OK
Lr used (psf)	20
Reduced Imposed Load Factor	1
Imposed Load on Beam (lb/ft)	160

Applied Members

B2-C2
B3-C3
B4-C4
B5-C5
B6-C6
B7-C7
B8-C8
B9-C9
B10-C10

Beam Type R5

Interior Procedure Room Beams

A,B & C,D:2-10

Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	960
Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	960
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
Tributary Area (ft2)	240
R1	0.96
F (rise in / foot)	0
R2	1
Lr	19.2
Lr Check	OK
Lr used (psf)	19.2
Reduced Imposed Load Factor	0.96
Imposed Load on Beam (lb/ft)	160

Applied Members

A2-B2	C2-D2
A3-B3	C3-D3
A4-B4	C4-D4
A5-B5	C5-D5
A6-B6	C6-D6
A7-B7	C7-D7
A8-B8	C8-D8
A9-B9	C9-D9
A10-B10	C10-D10

Beam Type R6

Exterior Beams

AB,CD-1&11

Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Area Use	Roof
Table 4-1 Value Lo (psf)	20
Bay Area	960
Beam	Interior
Tributary Length (ft)	4
Beam Length (ft)	30
Tributary Area (ft2)	120
R1	1
F (rise in / foot)	0
R2	1
Lr	20
Lr Check	OK
Lr used (psf)	20
Reduced Imposed Load Factor	1
Imposed Load on Beam (lb/ft)	80

Applied Members

A1-B1	C1-D1
A11-B11	C11-D11

Snow Load

Common Calculations

Roof Type	Flat
Roof Slope	2.5
Slope Roof Factor Cs	0
Ground Snow Load pg (Figure 7-1) (psf)	10
Terrain Category	B
Exposure	Partial
Exposure Factor Ce (Table 7-2)	1
Thermal Factor Ct (Table 7-3)	1
Importance Category	IV
Importance Factor I	1.2
Flat Roof Snow Load pf (psf)	8.4
Eq 7-1 Check (for pg<=20)	12
Eq 7-2 Check (for pg>20)	NA
Snow Load pf (psf)	12
Snow on Rain Surcharge (psf) (Balanced Ony)	5
Total Load (psf)	17

Check Ponding Instability per 7.11

Beam Type R1

	Exterior Beams A,B:1-11 & C,D:1-11
Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Bay Area	960
Bay Width (ft)	
Bay Length (ft)	
Bay Area	
Beam	Exterior
Tributary Length (ft)	15
Beam Length (ft)	32
Tributary Area (ft2)	480
Full Load (psf)	17
Full Balanced Load (psf)	12
Half Balanced Load (psf)	6
Full Load on Beam (lb/ft)	255
Full Balanced Partial Load on Beam (lb/ft)	180
Half Balanced Partial Load on Beam (lb/ft)	90

Applied Members

A1-A2	D1-D2
A2-A3	D2-D3
A3-A4	D3-D4
A4-A5	D4-D5
A5-A6	D5-D6
A6-A7	D6-D7
A7-A8	D7-D8
A8-A9	D8-D9
A9-A10	D9-D10
A10-A11	D10-D11

Snow load (cont.)

Beam Type R2

Interior Beams
A,B: 2-10 & C,D:2-10

Floor	Roof
Bay Width (ft)	30
Bay Length (ft)	32
Bay Area	960
Bay Width (ft)	20
Bay Length (ft)	32
Bay Area	640
Beam	Interior
Tributary Length (ft)	25
Beam Length (ft)	32
Tributary Area (ft2)	800
Full Load (psf)	17
Full Balanced Load (psf)	12
Half Balanced Load (psf)	6
Full Load on Beam (lb/ft)	425
Full Balanced Partial Load on Beam (lb/ft)	300
Half Balanced Partial Load on Beam (lb/ft)	150

Applied Members

B1-B2	C1-C2
B2-B3	C2-C3
B3-B4	C3-C4
B4-B5	C4-C5
B5-B6	C5-C6
B6-B7	C6-C7
B7-B8	C7-C8
B8-B9	C8-C9
B9-B10	C9-C10
B10-B11	C10-C11

Beam Type R3

Exterior Beams on Corridor
B,C:1-1,11-11

Floor	Roof
Bay Width (ft)	8
Bay Length (ft)	20
Bay Area	160
Bay Width (ft)	
Bay Length (ft)	
Bay Area	
Beam	Exterior
Tributary Length (ft)	4
Beam Length (ft)	20
Tributary Area (ft2)	80
Full Load (psf)	17
Full Balanced Load (psf)	12
Half Balanced Load (psf)	6
Full Load on Beam (lb/ft)	68
Full Balanced Partial Load on Beam (lb/ft)	48
Half Balanced Partial Load on Beam (lb/ft)	24

Applied Members

B1-C1
B11-C11

Snow load (cont.)

Beam Type R4	Interior Corridor Beams
	B,C:2-10
Floor	Roof
Bay Width (ft)	8
Bay Length (ft)	20
Bay Area	160
Bay Width (ft)	8
Bay Length (ft)	20
Bay Area	160
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	20
Tributary Area (ft2)	160
Full Load (psf)	17
Full Balanced Load (psf)	12
Half Balanced Load (psf)	6
Full Load on Beam (lb/ft)	136
Full Balanced Partial Load on Beam (lb/ft)	96
Half Balanced Partial Load on Beam (lb/ft)	48

Applied Members

B2-C2
B3-C3
B4-C4
B5-C5
B6-C6
B7-C7
B8-C8
B9-C9
B10-C10

Beam Type R5	Interior Patient Room Beams
	A,B & C,D:2-10
Floor	Roof
Bay Width (ft)	8
Bay Length (ft)	30
Bay Area	240
Bay Width (ft)	8
Bay Length (ft)	30
Bay Area	240
Beam	Interior
Tributary Length (ft)	8
Beam Length (ft)	30
Tributary Area (ft2)	240
Full Load (psf)	17
Full Balanced Load (psf)	12
Half Balanced Load (psf)	6
Full Load on Beam (lb/ft)	136
Full Balanced Partial Load on Beam (lb/ft)	96
Half Balanced Partial Load on Beam (lb/ft)	48

Applied Members

A2-B2	C2-D2
A3-B3	C3-D3
A4-B4	C4-D4
A5-B5	C5-D5
A6-B6	C6-D6
A7-B7	C7-D7
A8-B8	C8-D8
A9-B9	C9-D9
A10-B10	C10-D10

Snow load (cont.)

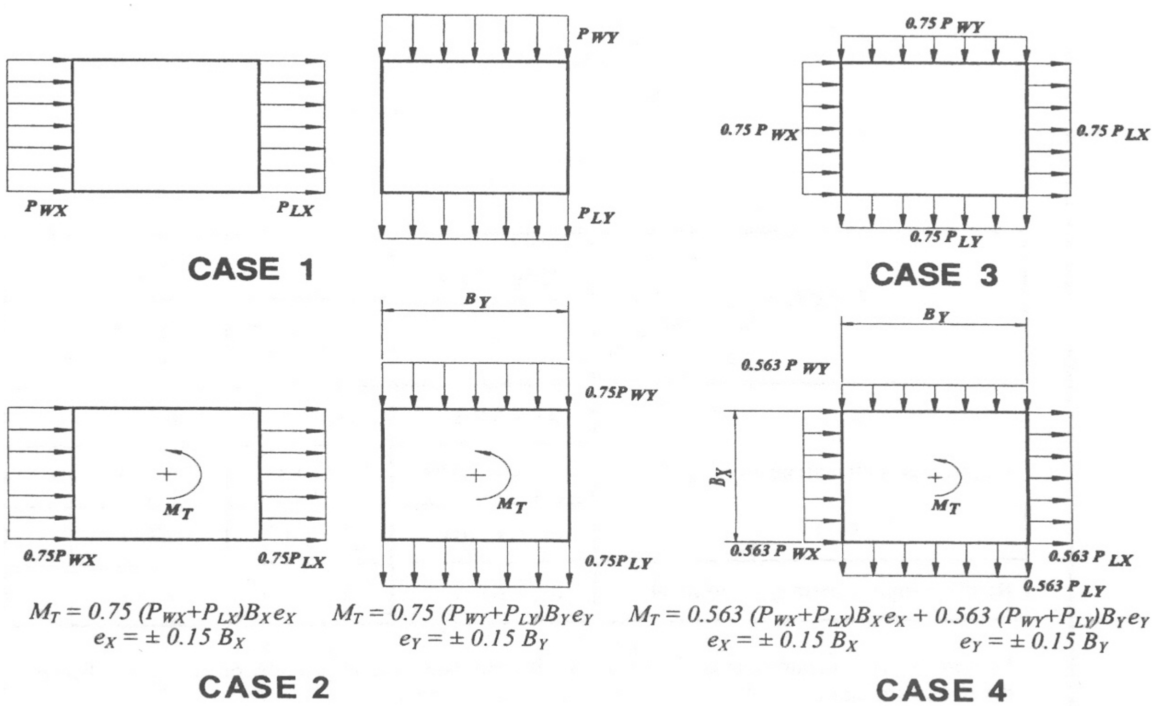
Beam Type R6		Exterior Beams AB,CD-1&11
Floor		Roof
Bay Width (ft)		8
Bay Length (ft)		30
Bay Area		240
Bay Width (ft)		
Bay Length (ft)		
Bay Area		
Beam		Exterior
Tributary Length (ft)		4
Beam Length (ft)		30
Tributary Area (ft2)		120
Full Load (psf)		17
Full Balanced Load (psf)		12
Half Balanced Load (psf)		6
Full Load on Beam (lb/ft)		68
Full Balanced Partial Load on Beam (lb/ft)		48
Half Balanced Partial Load on Beam (lb/ft)		24
Applied Members		
	A1-B1	C1-D1
	A11-B11	C11-D11

Appendix B:
Wind Loads

Wind Loads										
Diaphragm	h_T (ft)	Case 1		Case 2, Case 3				Case 4		
		F_x (kips)	F_y (kips)	(.75)F_x (kips)	M_{Tx} (k-in)	(.75)F_y (kips)	M_{Ty} (k-in)	(.563)F_x (kips)	(.563)F_y (kips)	M_T (k-in)
1	10-30	129.1	23.2	96.8	55757	17.4	2510	72.6	13.1	43700
2	31-47	104.9	19.2	78.7	45317	14.4	2076	59.0	10.8	35545
3	48-62	96.3	18.2	72.2	41589	13.6	1961	54.2	10.2	32662
4	63-77	100.0	19.1	75.0	43199	14.3	2066	56.2	10.8	33949
5	78-92	103.2	20.0	77.4	44578	15.0	2156	58.0	11.2	35050
6	93-107	106.0	20.7	79.5	45791	15.5	2235	59.6	11.6	36019
7	108-122	108.5	21.3	81.4	46880	16.0	2306	61.0	12.0	36889
8	123-137	110.8	21.9	83.1	47872	16.5	2370	62.3	12.3	37681
9	138-152	112.9	22.5	84.7	48785	16.9	2430	63.5	12.7	38411
10	153-160	61.0	12.2	45.8	26369	9.2	1319	34.3	6.9	20765

Eccentricity (320 ft face): 48 ft
Eccentricity (80 ft face): 12 ft

ASCE 7 Fig. 6-9



Case 1. Full design wind pressure acting on the projected area perpendicular to each principal axis of the structure, considered separately along each principal axis.

Case 2. Three quarters of the design wind pressure acting on the projected area perpendicular to each principal axis of the structure in conjunction with a torsional moment as shown, considered separatel for each principal axis.

Case 3. Wind loading as defined in Case 1, but considered to act simultaneously at 75% of the specified value.

Case 4. Wind loading as defined in Case 2, but considered to act simultaneously at 75% of the specified value.

Wind Loading
ASCE 7-02, Method II

Use	Hospital
Location	Memphis, TN
Topography	Flat
Terrain	Urban
Plan Dimensions	80 ft
	320 ft
Roof Height	160 ft
Roof	Flat
Framing	Steel braced frame (x), moment frame (y)
	Floor and roof slabs provide diaphragm action
Fundamental Frequency, f1	> 1 Hz

ASCE 7-02, Sec. 6.0 Wind Load

Step	Description	Value	Units	Section	Comment
1	Wind Speed, V	90	mph	Sec. 6.5.4, Fig. 6-1	
	Directionality Factor, K_d	0.85		Table 6-4	MWFRS/Buildings
2	Importance Factor, I	1.15		Sec. 6.5.5, Table 6-1	V = 85-100 mph, non-hurricane prone regions
3	Building Classification	Category IV		Table 1-1	
	Surface Roughness	B		Sec. 6.5.6.2	Urban
	Exposure	B		Sec. 6.5.6.3	Surface roughness B prevaisl upwind for 2600 ft
	Velocity Exposure Coefficient, K_z or K_h			Sec. 6.5.6.3, Table 6-3	Using equations given for unlisted heights

Diaphragm	Ht. (ft)	K_z	q_z	Windward Pressure (320 ft face)(psf)	Windward Pressure (80 ft face)(psf)
1	15	0.5747	11.6492	10.0000	10.0000
	16	0.5854	11.8660	10.0000	10.0000
	17	0.5956	12.0734	10.0000	10.0000
	18	0.6055	12.2722	10.0000	10.0000
	19	0.6149	12.4632	10.0000	10.0000
	20	0.6240	12.6472	10.0000	10.0000
	21	0.6327	12.8247	10.0000	10.0000
	22	0.6412	12.9963	10.0000	10.0000
	23	0.6494	13.1625	10.0000	10.0000
	24	0.6573	13.3235	10.0000	10.0000
	25	0.6650	13.4798	10.0000	10.0000
	26	0.6725	13.6317	10.0000	10.0000
	27	0.6798	13.7795	10.0000	10.0000
	28	0.6869	13.9234	10.0000	10.0000
	29	0.6938	14.0637	10.0000	10.0000
	30	0.7006	14.2006	10.0000	10.0000
2	31	0.7072	14.3343	10.0000	10.0000
	32	0.7136	14.4649	10.0000	10.0000
	33	0.7199	14.5926	10.0000	10.0000
	34	0.7261	14.7176	10.0000	10.0000
	35	0.7321	14.8400	10.0000	10.0000
	36	0.7381	14.9599	10.0000	10.0163
	37	0.7439	15.0775	10.0000	10.0950
	38	0.7495	15.1928	10.0000	10.1723
	39	0.7551	15.3060	10.0000	10.2480
	40	0.7606	15.4171	10.0000	10.3224
	41	0.7660	15.5263	10.0000	10.3955
	42	0.7713	15.6335	10.0517	10.4673
	43	0.7765	15.7390	10.1195	10.5379
	44	0.7816	15.8427	10.1862	10.6074
	45	0.7866	15.9448	10.2518	10.6757
	46	0.7916	16.0452	10.3164	10.7430
	47	0.7965	16.1441	10.3800	10.8092
3	48	0.8013	16.2415	10.4426	10.8744
	49	0.8060	16.3375	10.5043	10.9386
	50	0.8107	16.4320	10.5651	11.0020
	51	0.8153	16.5253	10.6251	11.0644
	52	0.8198	16.6172	10.6842	11.1260
	53	0.8243	16.7079	10.7425	11.1867
	54	0.8287	16.7974	10.8000	11.2466
	55	0.8331	16.8857	10.8568	11.3057
	56	0.8374	16.9728	10.9128	11.3640
	57	0.8416	17.0589	10.9682	11.4217
	58	0.8458	17.1438	11.0228	11.4786
	59	0.8499	17.2278	11.0768	11.5348
	60	0.8540	17.3107	11.1301	11.5903
	61	0.8581	17.3927	11.1828	11.6451
	62	0.8621	17.4737	11.2349	11.6994

Diaphragm	Ht. (ft)	K_z	q_z	Windward Pressure (320 ft face)(psf)	Windward Pressure (80 ft face)(psf)
4	63	0.8660	17.5537	11.2863	11.7530
	64	0.8699	17.6329	11.3372	11.8060
	65	0.8738	17.7112	11.3876	11.8584
	66	0.8776	17.7886	11.4373	11.9102
	67	0.8814	17.8652	11.4866	11.9615
	68	0.8851	17.9410	11.5353	12.0123
	69	0.8888	18.0160	11.5835	12.0625
	70	0.8925	18.0902	11.6313	12.1122
	71	0.8961	18.1636	11.6785	12.1613
	72	0.8997	18.2364	11.7252	12.2100
	73	0.9032	18.3084	11.7715	12.2582
	74	0.9068	18.3797	11.8174	12.3060
	75	0.9103	18.4503	11.8628	12.3533
	76	0.9137	18.5203	11.9078	12.4001
	77	0.9171	18.5896	11.9523	12.4465
5	78	0.9205	18.6582	11.9965	12.4925
	79	0.9239	18.7263	12.0402	12.5380
	80	0.9272	18.7937	12.0836	12.5832
	81	0.9305	18.8605	12.1265	12.6279
	82	0.9338	18.9267	12.1691	12.6723
	83	0.9370	18.9924	12.2114	12.7162
	84	0.9402	19.0575	12.2532	12.7598
	85	0.9434	19.1220	12.2947	12.8030
	86	0.9466	19.1861	12.3359	12.8459
	87	0.9497	19.2495	12.3767	12.8884
	88	0.9528	19.3125	12.4172	12.9305
	89	0.9559	19.3749	12.4573	12.9724
	90	0.9589	19.4369	12.4971	13.0138
	91	0.9620	19.4983	12.5367	13.0550
	92	0.9650	19.5593	12.5759	13.0958
6	93	0.9680	19.6198	12.6148	13.1363
	94	0.9709	19.6799	12.6534	13.1765
	95	0.9739	19.7395	12.6917	13.2164
	96	0.9768	19.7986	12.7297	13.2560
	97	0.9797	19.8573	12.7675	13.2953
	98	0.9825	19.9156	12.8049	13.3344
	99	0.9854	19.9735	12.8421	13.3731
	100	0.9882	20.0309	12.8791	13.4116
	101	0.9910	20.0879	12.9157	13.4497
	102	0.9938	20.1445	12.9521	13.4876
	103	0.9966	20.2008	12.9883	13.5253
	104	0.9994	20.2566	13.0242	13.5627
	105	1.0021	20.3121	13.0599	13.5998
	106	1.0048	20.3672	13.0953	13.6367
	107	1.0075	20.4219	13.1304	13.6733
7	108	1.0102	20.4762	13.1654	13.7097
	109	1.0129	20.5302	13.2001	13.7459
	110	1.0155	20.5839	13.2346	13.7818
	111	1.0181	20.6372	13.2689	13.8175
	112	1.0208	20.6901	13.3029	13.8529
	113	1.0233	20.7427	13.3367	13.8881
	114	1.0259	20.7950	13.3703	13.9232
	115	1.0285	20.8470	13.4038	13.9579
	116	1.0310	20.8986	13.4370	13.9925
	117	1.0336	20.9499	13.4699	14.0269
	118	1.0361	21.0009	13.5027	14.0610
	119	1.0386	21.0516	13.5353	14.0950
	120	1.0411	21.1020	13.5677	14.1287
	121	1.0435	21.1521	13.5999	14.1622
	122	1.0460	21.2019	13.6320	14.1956
8	123	1.0484	21.2514	13.6638	14.2287
	124	1.0509	21.3006	13.6954	14.2617
	125	1.0533	21.3496	13.7269	14.2945
	126	1.0557	21.3982	13.7582	14.3270
	127	1.0581	21.4466	13.7893	14.3594
	128	1.0604	21.4947	13.8202	14.3916
	129	1.0628	21.5426	13.8510	14.4237
	130	1.0652	21.5901	13.8816	14.4555
	131	1.0675	21.6375	13.9120	14.4872
	132	1.0698	21.6845	13.9423	14.5187
	133	1.0721	21.7313	13.9724	14.5501
	134	1.0744	21.7779	14.0023	14.5812
	135	1.0767	21.8242	14.0321	14.6123
	136	1.0790	21.8703	14.0617	14.6431
	137	1.0812	21.9161	14.0912	14.6738

Diaphragm	Ht. (ft)	K_z	q_z	Windward Pressure (320 ft face)(psf)	Windward Pressure (80 ft face)(psf)
9	138	1.0835	21.9617	14.1205	14.7043
	139	1.0857	22.0070	14.1496	14.7347
	140	1.0880	22.0522	14.1787	14.7649
	141	1.0902	22.0971	14.2075	14.7949
	142	1.0924	22.1417	14.2362	14.8248
	143	1.0946	22.1862	14.2648	14.8546
	144	1.0967	22.2304	14.2932	14.8842
	145	1.0989	22.2744	14.3215	14.9137
	146	1.1011	22.3182	14.3497	14.9430
	147	1.1032	22.3617	14.3777	14.9721
	148	1.1054	22.4051	14.4056	15.0012
	149	1.1075	22.4482	14.4333	15.0301
	150	1.1096	22.4912	14.4609	15.0588
	151	1.1117	22.5339	14.4884	15.0874
	152	1.1138	22.5764	14.5158	15.1159
10	153	1.1159	22.6188	14.5430	15.1443
	154	1.1180	22.6609	14.5701	15.1725
	155	1.1201	22.7029	14.5970	15.2006
	156	1.1221	22.7446	14.6239	15.2285
	157	1.1242	22.7862	14.6506	15.2563
	158	1.1262	22.8276	14.6772	15.2840
	159	1.1282	22.8687	14.7037	15.3116
	160	1.1303	22.9097	14.7301	15.3391
Leeward Pressure (300 ft face)	All		22.9097	-9.2063	
Leeward Pressure (80 ft face)	All		22.9097		-3.8348

4 Topographic Factor, K_{zt} 1 Sec. 6.5.9 Flat topography

5 Gust Effect Factor, G Sec. 6.5.8 Calculated from equations

G (320 ft face) 0.8037
G (80 ft face) 0.8369

6 Enclosure Classification Enclosed Sec. 6.5.9 Assume Enclosed

7 Internal pressure Coefficient, GC_{pi} = +/- 0.18 Sec. 6.5.11.1, Fig. 6-5

8 External Pressure Coefficient, C_p Sec. 6.5.11.2

C_p for Windward Wall 0.8
C_p for Leeward Wall
Perpendicular to 320 ft. face -0.5
Perpendicular to 80 ft. face -0.2

9 Velocity Pressure, q_z or q_h Sec. 6.5.10
$q_z = 0.00256K_zK_{zt}K_dV^2I$ Eq. 6-15 $q_h = q_z$ at mean roof height
$q_z = K_z$ * 20.26944 psf see table above for values of q_z

10 Design Wind Load, p Sec. 6.5.12.2
p = q(GCp)
where q = q_z for windward wall at height
z above ground. q = q_h for leeward wall

Appendix C:
Seismic Loads

Weights for seismic loads

		BOTTOM FLOOR	HIGHER FLOORS	ROOF	
Deck	Area wt. (psf)	51	51	51	
	Area (ft^2)	25600	25600	25600	
	WEIGHT (kip)	1305.6	1305.6	1305.6	
Floor beams 1	Linear wt. (plf)	26	26	26	
	Length (ft)	1800	2400	2400	
	WEIGHT (kip)	46.8	62.4	62.4	
Floor beams 2	Linear wt. (plf)	22	22	22	
	Length (ft)	600	600	600	
	WEIGHT (kip)	13.2	13.2	13.2	
Superimposed	Area wt. (psf)	30	30	25	
(incl. partitions)	Area (ft^2)	25600	25600	25600	
	WEIGHT (kip)	768	768	640	
Beams	Length (ft)	2160	2160	2160	
	Linear wt. (plf)	80	80	80	
	WEIGHT (kip)	172.8	172.8	172.8	
Columns	Length (ft)	880	660		
	Linear wt. (plf)	250	250		
	WEIGHT (kip)	220	165		
Braces	No. Bays Braced	4	4		
	Length per bay (ft)	144.222051	84.85281374		
	Linear wt. (plf)	96	80		
	WEIGHT (kip)	55.38126759	27.1529004		
Cladding	Area wt. (psf)	60	60	60	
	Story height (ft)	20	15	20	
	Permiter (ft)	800	800	800	
	WEIGHT (kip)	960	720	960	
					SUM = W
	TOTAL WT (kip)	3541.781268	3234.1529	3154	32569.004

	V
BRACED	2931.2104
MOMENT	2198.4078

Seismic Loading Calculations

Chapter 11	Variable	From	Value	Units
	Ss	Ch 20 Figures	1.25	
	S1	Ch 20 Figures	0.3	
	TL	Ch 20 Figures	12	seconds
	CAT A?	11.4.1 Design Cat A	NO	
	Site Class	11.4.2	D	
	Fa	11.4.3 Table 11.4-1	1	
	Fv	11.4.3 Table 11.4-2	1.8	
	Sms	11.4.3 Eq 11.4-1	1.25	
	Sm1	11.4.3 Eq 11.4-2	0.54	
	Sds	11.4.4 Eq 11.4-3	0.8333333	
	Sd1	11.4.4 Eq 11.4-4	0.36	
	N	Number storys	10	
	Ta	Approx Fund. Period of structure	1	seconds
	T	Fund. Period of structure	1	seconds
	T0	11.4.5	0.0864	
	Ts	11.4.5	0.432	
	Sa	If T<T0	-	
	Sa	If T0-Ts	-	
	Sa	If T>Ts, T<TL	0.36	
	Sa	if T>TL	-	
	Sa	Used Value	0.36	
		No MCE Response		
		No Site Specific Response		
	Occ Cat	11.5.2	IV	
	I	11.5.2	1.5	
	Seis Des Cat	Table 11.6-1	D	
	Seis Des Cat	11.6 (S1>0.75) E or F	NO	
	11.6 1	Ta < 0.8Ts ?	NO	
	11.6 2	Ts < T ?	Yes	
	11.6 3	Eq 12.8-2 Used to find Cs		
	11.6 4	Rigid Diaphrams 12.3.1	Yes	
		See Horiz Loading for 11.7.2 Design		
		Geotech Report required for 11.8.2 & 11.8.3		

Chapter 12						
		Simplified Design 12.14	NO			
		Table 12.2-1				
	R	Moment Frame C1	8	R	Braced Frame B3	6
	Cd	Moment Frame C1	5.5	Cd	Braced Frame B3	5
		12.8.1				
	Cs	Moment Frame	0.15625	Cs	Moment Frame	0.2083333
		12.8-3 & 12.8-4	0.0675		12.8-3 & 12.8-4	0.09
	Cs		0.0675	Cs		0.09
		Cs < 0.01?	OK		Cs < 0.01?	OK
		S1 > 0.6g? Cs	-		S1 > 0.6g? Cs	-
	Cs (used)		0.0675	Cs (used)		0.09
	k	12.8.3	1.25			

ASCE 12.8.3

floor	wx (kip)	height (ft)	hx (ft)	wx*hx^k (kip ft)	Cvx	MOMENT V (kip)	MOMENT Fx (kip)	BRACED V (kip)	BRACED Fx (kip)
1	3541.7813	20	20	149799.1093	0.015716	2198.4078	34.6	2931.21	46.1
2	3234.1529	20	40	325338.5579	0.034133	2198.4078	75.0	2931.21	100.1
3	3234.1529	15	55	484410.9035	0.050822	2198.4078	111.7	2931.21	149.0
4	3234.1529	15	70	654836.831	0.068702	2198.4078	151.0	2931.21	201.4
5	3234.1529	15	85	834707.2877	0.087573	2198.4078	192.5	2931.21	256.7
6	3234.1529	15	100	1022728.947	0.107299	2198.4078	235.9	2931.21	314.5
7	3234.1529	15	115	1217959.504	0.127782	2198.4078	280.9	2931.21	374.6
8	3234.1529	15	130	1419677.628	0.148945	2198.4078	327.4	2931.21	436.6
9	3234.1529	15	145	1627310.965	0.170729	2198.4078	375.3	2931.21	500.4
R	3154	15	160	1794781.843	0.188299	2198.4078	414.0	2931.21	551.9

	Load Case 1			Load Case 2		
Floor	Fx (kip)	Fy (kip)	M (kft)	Fx (kip)	Fy (kip)	M (kft)
1	13.82	34.55	345.50	46.07	10.37	732.47
2	30.02	75.04	750.38	100.05	22.51	1590.80
3	44.69	111.73	1117.27	148.97	33.52	2368.61
4	60.41	151.04	1510.35	201.38	45.31	3201.94
5	77.01	192.52	1925.21	256.70	57.76	4081.45
6	94.36	235.89	2358.88	314.52	70.77	5000.82
7	112.37	280.92	2809.17	374.56	84.27	5955.43
8	130.98	327.44	3274.42	436.59	98.23	6941.77
9	150.13	375.33	3753.32	500.44	112.60	7957.03
R	165.58	413.96	4139.58	551.94	124.19	8775.91

Appendix D:
Main Member Design

Seismic Story Drift

Importance Factor	1.5
Cd Moment	5.5
Cd Braced	5

Story	Moment	Braced	Braced-raw	Moment-raw	Braced-adj	Moment-adj	CAPACITY Braced Frame %	Moment Frame %
Base	1.00%	1.00%	0.0008	0.0022	0.0028	0.0080	28%	80%
1	1.00%	1.00%	0.0012	0.0020	0.0041	0.0073	41%	73%
2	1.00%	1.00%	0.0013	0.0023	0.0045	0.0086	45%	86%
3	1.00%	1.00%	0.0023	0.0022	0.0076	0.0082	76%	82%
5	1.00%	1.00%	0.0023	0.0021	0.0078	0.0076	78%	76%
6	1.00%	1.00%	0.0028	0.0019	0.0093	0.0070	93%	70%
7	1.00%	1.00%	0.0028	0.0016	0.0095	0.0060	95%	60%
8	1.00%	1.00%	0.0029	0.0014	0.0096	0.0050	96%	50%
9	1.00%	1.00%	0.0030	0.0010	0.0098	0.0037	98%	37%
10	1.00%	1.00%	0.0027	0.0006	0.0091	0.0023	91%	23%

Steel Column Design

Loading Criteria

Mmax X-X Moment (kft)	1743
Mmax Y-Y Moment (kft)	31
Max Deflection Ratio from Analysis	0
Max Shear (kips)	72
Max Compressive Axial (kips)	1019
Max Tensile Axial (kips)	0
K X-X	1
K Y-Y	1
Moment Capacity %	22%
Shear Capacity %	5%
Tensile Capacity %	0%
Compressive Capacity %	21%
Combined Capacity %	42%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W36x487
Weight (lb/ft)	487
Area {A} (in2)	143
Depth {d} (in)	39.3
Web thickness {tw} (in)	1.5
Flange Width {bf} (in)	17.1
Flange Thickness {tf} (in)	2.68
bf/2tf	3.19
h/tw	21.4
Ix (in4)	36000
Sx (in3)	1830
rx (in)	15.8
Zx (in3)	2130
Iy (in4)	2250
Sy (in3)	263
ry (in)	3.96
Zy (in3)	412
rts (in)	4.74
ho (in)	36.7
J (in4)	258
Cw (in6)	754000
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	7987.5
Y-Y Moment Capacity (kft)	1545.00
Shear Capacity (kips)	1591.65
Tensile Capacity (kips)	4504.5
Compressive Capacity (kips)	4919.393
L/240 Deflection Allowed (in)	1
L/360 Deflection Allowed (in)	0.666667
L/User Deflection Allowed (in)	0.6

Beam Notes

Story	1–2
Frame	Moment Frame
Beam Length (ft)	20
Top Braced Length {lb} (ft)	0
User Deflection L/User	400

Notes:
Seismic story drift controls

These members apply to all columns on the first and second floor

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	106500
Plastic Moment Mp Y-Y (kin)	20600
<u>Lateral Torsional X-X</u>	
c	1
rts	4.74
E	29000
Lr (in)	718.5007
Lp (in)	167.8502
Fcr (conservative)	228.25
Lb (in)	0
Lb<Lp	106500
Lp<Lb<Lr	106500
Lb>Lr	106500
Mn (kin) Lb Lp Lr Check	106500

Shear Capacity

Vn (kips)	1768.5
h/tw	21.4
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	5005
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	6506.5
Capacity (kips)	5005

Compressive Capacity

Non Slender Elements	
KL/r X-X	15.18987
KL/r Y-Y	60.60606
Fe X-X	1240.479
Fe Y-Y	77.92299
4.71sqrt(E/Fy)	113.4318
Fcr X-X	49.16355
Fcr Y-Y	38.22372
Controls	Y-Y
Pn (kips)	5465.992

Combined Capacity

Pr/Pc	0.207139
Combined Eq H1-1a	0.418944
Combined Eq H1-1b	0.34185
Combined Eq Used	0.418944

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Column Design

Loading Criteria

Mmax X-X Moment (kft)	843
Mmax Y-Y Moment (kft)	29
Max Deflection Ratio from Analysis	0
Max Shear (kips)	90
Max Compressive Axial (kips)	1241
Max Tensile Axial (kips)	0
K X-X	0.8
K Y-Y	0.8
Moment Capacity %	22%
Shear Capacity %	9%
Tensile Capacity %	0%
Compressive Capacity %	45%
Combined Capacity %	70%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W36x256
Weight (lb/ft)	256
Area {A} (in2)	75.4
Depth {d} (in)	37.4
Web thickness {tw} (in)	0.96
Flange Width {bf} (in)	12.2
Flange Thickness {tf} (in)	1.73
bf/2tf	3.53
h/tw	33.8
Ix (in4)	16800
Sx (in3)	895
rx (in)	14.9
Zx (in3)	1040
Iy (in4)	528
Sy (in3)	86.5
ry (in)	2.65
Zy (in3)	137
rts (in)	3.25
ho (in)	35.7
J (in4)	52.9
Cw (in6)	168000
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	3900
Y-Y Moment Capacity (kft)	513.75
Shear Capacity (kips)	969.408
Tensile Capacity (kips)	2375.1
Compressive Capacity (kips)	2734.133
L/240 Deflection Allowed (in)	0.75
L/360 Deflection Allowed (in)	0.5
L/User Deflection Allowed (in)	0.45

Beam Notes

Story	3-R
Frame	Moment Frame
Beam Length (ft)	15
Top Braced Length {lb} (ft)	0
User Deflection L/User	400

Notes:
Seismic story drift controls

These members apply to columns
on the exterior moment frame only.

Calculations

Flexural Calculations	
Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	52000
Plastic Moment Mp Y-Y (kin)	6850
Lateral Torsional X-X	
c	1
rts	3.25
E	29000
Lr (in)	378.7895
Lp (in)	112.324
Fcr (conservative)	239.618
Lb (in)	0
Lb<Lp	52000
Lp<Lb<Lr	52000
Lb>Lr	52000
Mn (kin) Lb Lp Lr Check	52000

Shear Capacity	
Vn (kips)	1077.12
h/tw	33.8
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity	
GSY (kips)	2639
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	3430.7
Capacity (kips)	2639

Compressive Capacity	
Non Slender Elements	
KL/r X-X	9.66443
KL/r Y-Y	54.33962
Fe X-X	3064.399
Fe Y-Y	96.9314
4.71sqrt(E/Fy)	113.4318
Fcr X-X	49.6597
Fcr Y-Y	40.29078
Controls	Y-Y
Pn (kips)	3037.925

Combined Capacity	
Pr/Pc	0.453892
Combined Eq H1-1a	0.696204
Combined Eq H1-1b	0.499547
Combined Eq Used	0.696204

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Column Design

Loading Criteria

Mmax X-X Moment (kft)	0
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	22
Max Compressive Axial (kips)	1095
Max Tensile Axial (kips)	0
K X-X	1
K Y-Y	1
Moment Capacity %	0%
Shear Capacity %	9%
Tensile Capacity %	0%
Compressive Capacity %	84%
Combined Capacity %	84%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W14X132
Weight (lb/ft)	132
Area {A} (in2)	38.8
Depth {d} (in)	14.7
Web thickness {tw} (in)	0.645
Flange Width {bf} (in)	14.7
Flange Thickness {tf} (in)	1.03
bf/2tf	7.15
h/tw	17.7
Ix (in4)	1530
Sx (in3)	209
rx (in)	6.28
Zx (in3)	234
Iy (in4)	548
Sy (in3)	74.5
ry (in)	3.76
Zy (in3)	113
rts (in)	4.23
ho (in)	13.6
J (in4)	12.3
Cw (in6)	25500
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	877.5
Y-Y Moment Capacity (kft)	423.75
Shear Capacity (kips)	256.0005
Tensile Capacity (kips)	1222.2
Compressive Capacity (kips)	1296.191
L/240 Deflection Allowed (in)	1
L/360 Deflection Allowed (in)	0.666667
L/User Deflection Allowed (in)	0.6

Beam Notes

Story	3-Roof
Frame	Interior Frame
Column Length (ft)	20
Top Braced Length {lb} (ft)	0
User Deflection L/User	400

Notes:
Compressive strength controls

These members apply to all
interior columns above the thrid floor

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	11700
Plastic Moment Mp Y-Y (kin)	5650
<u>Lateral Torsional X-X</u>	
c	1
rts	4.23
E	29000
Lr (in)	672.1675
Lp (in)	159.3729
Fcr (conservative)	201.6274
Lb (in)	0
Lb<Lp	11700
Lp<Lb<Lr	11700
Lb>Lr	11700
Mn (kin) Lb Lp Lr Check	11700

Shear Capacity

Vn (kips)	284.445
h/tw	17.7
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	1358
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	1765.4
Capacity (kips)	1358

Compressive Capacity

Non Slender Elements	
KL/r X-X	38.21656
KL/r Y-Y	63.82979
Fe X-X	195.9722
Fe Y-Y	70.25075
4.71sqrt(E/Fy)	113.4318
Fcr X-X	44.9358
Fcr Y-Y	37.11887
Controls	Y-Y
Pn (kips)	1440.212

Combined Capacity

Pr/Pc	0.844783
Combined Eq H1-1a	0.844783
Combined Eq H1-1b	0.422391
Combined Eq Used	0.844783

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria

Mmax X-X Moment (kft)	1790
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	171
Max Compressive Axial (kips)	1531
Max Tensile Axial (kips)	0
K X-X	0.8
K Y-Y	1
Moment Capacity %	22%
Shear Capacity %	11%
Tensile Capacity %	0%
Compressive Capacity %	47%
Combined Capacity %	67%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W36x487
Weight (lb/ft)	487
Area {A} (in2)	143
Depth {d} (in)	39.3
Web thickness {tw} (in)	1.5
Flange Width {bf} (in)	17.1
Flange Thickness {tf} (in)	2.68
bf/2tf	3.19
h/tw	21.4
Ix (in4)	36000
Sx (in3)	1830
rx (in)	15.8
Zx (in3)	2130
Iy (in4)	2250
Sy (in3)	263
ry (in)	3.96
Zy (in3)	412
rts (in)	4.74
ho (in)	36.7
J (in4)	258
Cw (in6)	754000
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	7987.5
Y-Y Moment Capacity (kft)	1545.00
Shear Capacity (kips)	1591.65
Tensile Capacity (kips)	4504.5
Compressive Capacity (kips)	3235.622
L/240 Deflection Allowed (in)	1.6
L/360 Deflection Allowed (in)	1.066667
L/User Deflection Allowed (in)	0.96

Beam Notes

Story	1
Frame	Moment Frame
Beam Length (ft)	32
Top Braced Length {lb} (ft)	32
User Deflection L/User	400

Notes:
Seismic story drift controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	106500
Plastic Moment Mp Y-Y (kin)	20600
<u>Lateral Torsional X-X</u>	
c	1
rts	4.74
E	29000
Lr (in)	718.5007
Lp (in)	167.8502
Fcr (conservative)	228.25
Lb (in)	3584
Lb<Lp	106500
Lp<Lb<Lr	-156853
Lb>Lr	106500
Mn (kin) Lb Lp Lr Check	106500

Shear Capacity

Vn (kips)	1768.5
h/tw	21.4
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	5005
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	6506.5
Capacity (kips)	5005

Compressive Capacity

Non Slender Elements	
KL/r X-X	19.44304
KL/r Y-Y	96.9697
Fe X-X	757.1283
Fe Y-Y	30.43867
4.71sqrt(E/Fy)	113.4318
Fcr X-X	48.63689
Fcr Y-Y	25.14081
Controls	Y-Y
Pn (kips)	3595.136

Combined Capacity

Pr/Pc	0.47317
Combined Eq H1-1a	0.67237
Combined Eq H1-1b	0.460685
Combined Eq Used	0.67237

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria

Mmax X-X Moment (kft)	1023
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	90
Max Compressive Axial (kips)	0
Max Tensile Axial (kips)	0
K X-X	0.8
K Y-Y	0.8
Moment Capacity %	26%
Shear Capacity %	9%
Tensile Capacity %	0%
Compressive Capacity %	0%
Combined Capacity %	26%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W36x256
Weight (lb/ft)	256
Area {A} (in2)	75.4
Depth {d} (in)	37.4
Web thickness {tw} (in)	0.96
Flange Width {bf} (in)	12.2
Flange Thickness {tf} (in)	1.73
bf/2tf	3.53
h/tw	33.8
Ix (in4)	16800
Sx (in3)	895
rx (in)	14.9
Zx (in3)	1040
Iy (in4)	528
Sy (in3)	86.5
ry (in)	2.65
Zy (in3)	137
rts (in)	3.25
ho (in)	35.7
J (in4)	52.9
Cw (in6)	168000
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	3900
Y-Y Moment Capacity (kft)	513.75
Shear Capacity (kips)	969.408
Tensile Capacity (kips)	2375.1
Compressive Capacity (kips)	1267.537
L/240 Deflection Allowed (in)	1.6
L/360 Deflection Allowed (in)	1.066667
L/User Deflection Allowed (in)	0.96

Beam Notes

Story	2–R
Frame	Moment Frame
Beam Length (ft)	32
Top Braced Length {lb} (ft)	32
User Deflection L/User	400

Notes:
Seismic story drift controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	52000
Plastic Moment Mp Y-Y (kin)	6850
Lateral Torsional X-X	
c	1
rts	3.25
E	29000
Lr (in)	378.7895
Lp (in)	112.324
Fcr (conservative)	239.618
Lb (in)	3584
Lb<Lp	52000
Lp<Lb<Lr	-217367
Lb>Lr	52000
Mn (kin) Lb Lp Lr Check	52000

Shear Capacity

Vn (kips)	1077.12
h/tw	33.8
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	2639
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	3430.7
Capacity (kips)	2639

Compressive Capacity

Non Slender Elements	
KL/r X-X	20.61745
KL/r Y-Y	115.9245
Fe X-X	673.3298
Fe Y-Y	21.2984
4.71sqrt(E/Fy)	113.4318
Fcr X-X	48.46987
Fcr Y-Y	18.6787
Controls	Y-Y
Pn (kips)	1408.374

Combined Capacity

Pr/Pc	0
Combined Eq H1-1a	0.233162
Combined Eq H1-1b	0.262308
Combined Eq Used	0.262308

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria		Beam Criteria		Beam Notes	
Mmax X-X Moment (kft)	571	W Shape	W24x68	Story	2–9
Mmax Y-Y Moment (kft)	0	Weight (lb/ft)	68	Frame	Interior Frame
Max Deflection Ratio from Analysis	0	Area {A} (in2)	23.7		
Max Shear (kips)	75	Depth {d} (in)	23.7		
Max Compressive Axial (kips)	0	Web thickness {tw} (in)	0.415		
Max Tensile Axial (kips)	0	Flange Width {bf} (in)	8.97		
		Flange Thickness {tf} (in)	0.585	Beam Length (ft)	32
K X-X	0.8	bf/2tf	7.66	Top Braced Length {lb} (ft)	32
K Y-Y	1	h/tw	52		
		Ix (in4)	1830	User Deflection L/User	400
Moment Capacity %	86%	Sx (in3)	154		
Shear Capacity %	28%	rx (in)	9.55	Notes:	
Tensile Capacity %	0%	Zx (in3)	177	LL deflection controls	
Compressive Capacity %	0%	Iy (in4)	70.4		
Combined Capacity %	86%	Sy (in3)	15.7		
L/240 Deflection %	0%	ry (in)	1.87		
L/360 Deflection %	0%	Zy (in3)	24.5		
L/User Deflection %	0%	rts (in)	2.3		
		ho (in)	23.1		
Moment Capacity Check	PASS	J (in4)	1.87		
Shear Capacity Check	PASS	Cw (in6)	9430		
Tensile Capacity Check	PASS				
Compressive Capacity Check	PASS	Fy Yield Strength (ksi)	50		
Combined Capacity	PASS	X-X Moment Capacity (kft)	663.75		
L/240 Deflection Check	PASS	Y-Y Moment Capacity (kft)	91.88		
L/360 Deflection Check	PASS	Shear Capacity (kips)	265.5585		
L/User Deflection Check	PASS	Tensile Capacity (kips)	746.55		
		Compressive Capacity (kips)	126.9723		
		L/240 Deflection Allowed (in)	1.6		
		L/360 Deflection Allowed (in)	1.066667		
		L/User Deflection Allowed (in)	0.96		

Calculations

Flexural Calculations		Compressive Capacity	
Cb (Chapter F Conservative choice)	1	Non Slender Elements	
Doubly Symmetric Assumption		KL/r X-X	32.16754
Plastic Moment Mp X-X (kin)	8850	KL/r Y-Y	205.3476
Plastic Moment Mp Y-Y (kin)	1225	Fe X-X	276.6063
Lateral Torsional X-X		Fe Y-Y	6.787635
c	1	4.71sqrt(E/Fy)	113.4318
rts	2.3	Fcr X-X	46.35666
E	29000	Fcr Y-Y	5.952756
Lr (in)	226.2677	Controls	Y-Y
Lp (in)	79.26259	Pn (kips)	141.0803
Fcr (conservative)	240.9999		
Lb (in)	3584	**Combined Capacity**	
Lb<Lp	8850	Pr/Pc	0
Lp<Lb<Lr	-73639.6	Combined Eq H1-1a	0.764679
Lb>Lr	8850	Combined Eq H1-1b	0.860264
Mn (kin) Lb Lp Lr Check	8850	Combined Eq Used	0.860264

Shear Capacity	
Vn (kips)	295.065
h/tw	52
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity	
GSY (kips)	829.5
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	1078.35
Capacity (kips)	829.5

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria

Mmax X-X Moment (kft)	350
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	46
Max Compressive Axial (kips)	0
Max Tensile Axial (kips)	0
K X-X	0.8
K Y-Y	0.8
Moment Capacity %	70%
Shear Capacity %	18%
Tensile Capacity %	0%
Compressive Capacity %	0%
Combined Capacity %	70%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W24x55
Weight (lb/ft)	55
Area {A} (in2)	16.2
Depth {d} (in)	23.6
Web thickness {tw} (in)	0.395
Flange Width {bf} (in)	7.01
Flange Thickness {tf} (in)	0.505
bf/2tf	6.94
h/tw	54.6
Ix (in4)	1350
Sx (in3)	114
rx (in)	9.11
Zx (in3)	134
Iy (in4)	29.1
Sy (in3)	8.3
ry (in)	1.34
Zy (in3)	13.3
rts (in)	1.71
ho (in)	23.1
J (in4)	1.18
Cw (in6)	3870
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	502.5
Y-Y Moment Capacity (kft)	49.80
Shear Capacity (kips)	251.694
Tensile Capacity (kips)	510.3
Compressive Capacity (kips)	69.63411
L/240 Deflection Allowed (in)	1.6
L/360 Deflection Allowed (in)	1.066667
L/User Deflection Allowed (in)	0.96

Beam Notes

Story	Roof
Frame	Interior Frames
Beam Length (ft)	32
Top Braced Length {lb} (ft)	32
User Deflection L/User	400

Notes:

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	6700
Plastic Moment Mp Y-Y (kin)	665
Lateral Torsional X-X	
c	1
rts	1.71
E	29000
Lr (in)	166.1828
Lp (in)	56.79779
Fcr (conservative)	259.4341
Lb (in)	3584
Lb<Lp	6700
Lp<Lb<Lr	-80686
Lb>Lr	6700
Mn (kin) Lb Lp Lr Check	6700

Shear Capacity

Vn (kips)	279.66
h/tw	54.6
h/tw check	53.94634
Stiffners Required? OK=NO	Chapter G

Tensile Capacity

GSY (kips)	567
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	737.1
Capacity (kips)	567

Compressive Capacity

Non Slender Elements	
KL/r X-X	33.72119
KL/r Y-Y	229.2537
Fe X-X	251.7051
Fe Y-Y	5.44584
4.71sqrt(E/Fy)	113.4318
Fcr X-X	46.01098
Fcr Y-Y	4.776002
Controls	Y-Y
Pn (kips)	77.37123

Combined Capacity

Pr/Pc	0
Combined Eq H1-1a	0.619127
Combined Eq H1-1b	0.696517
Combined Eq Used	0.696517

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria

Mmax X-X Moment (kft)	168
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	24
Max Compressive Axial (kips)	0
Max Tensile Axial (kips)	0
K X-X	1
K Y-Y	1
Moment Capacity %	41%
Shear Capacity %	11%
Tensile Capacity %	0%
Compressive Capacity %	0%
Combined Capacity %	41%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W21x50
Weight (lb/ft)	50
Area {A} (in2)	14.7
Depth {d} (in)	20.8
Web thickness {tw} (in)	0.38
Flange Width {bf} (in)	6.53
Flange Thickness {tf} (in)	0.535
bf/2tf	6.1
h/tw	49.4
Ix (in4)	984
Sx (in3)	94.5
rx (in)	8.18
Zx (in3)	110
Iy (in4)	24.9
Sy (in3)	7.64
ry (in)	1.3
Zy (in3)	12.2
rts (in)	1.64
ho (in)	20.3
J (in4)	1.14
Cw (in6)	2570
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	412.5
Y-Y Moment Capacity (kft)	45.75
Shear Capacity (kips)	213.408
Tensile Capacity (kips)	463.05
Compressive Capacity (kips)	43.30508
L/240 Deflection Allowed (in)	1.5
L/360 Deflection Allowed (in)	1
L/User Deflection Allowed (in)	0.9

Beam Notes

Story	1–Roof
Frame	Short Frame
Beam Length (ft)	30
Top Braced Length {lb} (ft)	30
User Deflection L/User	400

Notes:
LL deflection controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	5500
Plastic Moment Mp Y-Y (kin)	610
Lateral Torsional X-X	
c	1
rts	1.64
E	29000
Lr (in)	163.084
Lp (in)	55.10234
Fcr (conservative)	253.5394
Lb (in)	3360
Lb<Lp	5500
Lp<Lb<Lr	-61603.8
Lb>Lr	5500
Mn (kin) Lb Lp Lr Check	5500

Shear Capacity

Vn (kips)	237.12
h/tw	49.4
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	514.5
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	668.85
Capacity (kips)	514.5

Compressive Capacity

Non Slender Elements	
KL/r X-X	44.00978
KL/r Y-Y	276.9231
Fe X-X	147.7744
Fe Y-Y	3.732325
4.71sqrt(E/Fy)	113.4318
Fcr X-X	43.39764
Fcr Y-Y	3.273249
Controls	Y-Y
Pn (kips)	48.11676

Combined Capacity

Pr/Pc	0
Combined Eq H1-1a	0.36202
Combined Eq H1-1b	0.407273
Combined Eq Used	0.407273

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Beam Design

Loading Criteria

Mmax X-X Moment (kft)	266
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	39
Max Compressive Axial (kips)	86
Max Tensile Axial (kips)	86
K X-X	1
K Y-Y	1
Moment Capacity %	55%
Shear Capacity %	22%
Tensile Capacity %	14%
Compressive Capacity %	41%
Combined Capacity %	90%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W16x67
Weight (lb/ft)	67
Area {A} (in2)	19.7
Depth {d} (in)	16.3
Web thickness {tw} (in)	0.395
Flange Width {bf} (in)	10.2
Flange Thickness {tf} (in)	0.665
bf/2tf	7.7
h/tw	35.9
Ix (in4)	954
Sx (in3)	117
rx (in)	6.96
Zx (in3)	130
Iy (in4)	119
Sy (in3)	23.2
ry (in)	2.46
Zy (in3)	35.5
rts (in)	2.82
ho (in)	15.7
J (in4)	2.39
Cw (in6)	7300
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	487.5
Y-Y Moment Capacity (kft)	133.13
Shear Capacity (kips)	173.8395
Tensile Capacity (kips)	620.55
Compressive Capacity (kips)	207.8123
L/240 Deflection Allowed (in)	1.5
L/360 Deflection Allowed (in)	1
L/User Deflection Allowed (in)	0.9

Beam Notes

Story	1-Roof
Frame	Brace Frame
Beam Length (ft)	30
Top Braced Length {lb} (ft)	30
User Deflection L/User	400

Notes:
LL Deflection controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	6500
Plastic Moment Mp Y-Y (kin)	1775
Lateral Torsional X-X	
c	1
rts	2.82
E	29000
Lr (in)	312.3016
Lp (in)	104.2706
Fcr (conservative)	209.3497
Lb (in)	3360
Lb<Lp	6500
Lp<Lb<Lr	-31138.8
Lb>Lr	6500
Mn (kin) Lb Lp Lr Check	6500

Shear Capacity

Vn (kips)	193.155
h/tw	35.9
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	689.5
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	896.35
Capacity (kips)	689.5

Compressive Capacity

Non Slender Elements	
KL/r X-X	51.72414
KL/r Y-Y	146.3415
Fe X-X	106.9821
Fe Y-Y	13.36482
4.71sqrt(E/Fy)	113.4318
Fcr X-X	41.11636
Fcr Y-Y	11.72094
Controls	Y-Y
Pn (kips)	230.9026

Combined Capacity

Pr/Pc	0.413835
Combined Eq H1-1a	0.898849
Combined Eq H1-1b	0.752559
Combined Eq Used	0.898849

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Brace Design

Loading Criteria

Mmax X-X Moment (kft)	17
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	0
Max Compressive Axial (kips)	320
Max Tensile Axial (kips)	214
K X-X	1
K Y-Y	1
Moment Capacity %	3%
Shear Capacity %	0%
Tensile Capacity %	22%
Compressive Capacity %	88%
Combined Capacity %	90.1%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W12x106
Weight (lb/ft)	106
Area {A} (in2)	31.2
Depth {d} (in)	12.9
Web thickness {tw} (in)	0.61
Flange Width {bf} (in)	12.2
Flange Thickness {tf} (in)	0.99
bf/2tf	6.17
h/tw	15.9
Ix (in4)	933
Sx (in3)	145
rx (in)	5.47
Zx (in3)	164
Iy (in4)	301
Sy (in3)	49.3
ry (in)	3.11
Zy (in3)	75.1
rts (in)	3.52
ho (in)	11.9
J (in4)	9.13
Cw (in6)	10700
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	615
Y-Y Moment Capacity (kft)	281.63
Shear Capacity (kips)	212.463
Tensile Capacity (kips)	982.8
Compressive Capacity (kips)	365.2984
L/240 Deflection Allowed (in)	1.8
L/360 Deflection Allowed (in)	1.2
L/User Deflection Allowed (in)	1.08

Beam Notes

Story	1–2
Frame	Brace Frame
Beam Length (ft)	36
Top Braced Length {lb} (ft)	36
User Deflection L/User	400

Notes:
Seismic Story Drift Controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	8200
Plastic Moment Mp Y-Y (kin)	3755
Lateral Torsional X-X	
c	1
rts	3.52
E	29000
Lr (in)	608.3815
Lp (in)	131.8217
Fcr (conservative)	204.084
Lb (in)	4032
Lb<Lp	8200
Lp<Lb<Lr	-17375.1
Lb>Lr	8200
Mn (kin) Lb Lp Lr Check	8200

Shear Capacity

Vn (kips)	236.07
h/tw	15.9
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	1092
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	1419.6
Capacity (kips)	1092

Compressive Capacity

Non Slender Elements	
KL/r X-X	78.97623
KL/r Y-Y	138.9068
Fe X-X	45.88861
Fe Y-Y	14.83375
4.71sqrt(E/Fy)	113.4318
Fcr X-X	31.6891
Fcr Y-Y	13.0092
Controls	Y-Y
Pn (kips)	405.8871

Combined Capacity

Pr/Pc	0.875996
Combined Eq H1-1a	0.900567
Combined Eq H1-1b	0.46564
Combined Eq Used	0.900567

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Steel Brace Design

Loading Criteria

Mmax X-X Moment (kft)	3
Mmax Y-Y Moment (kft)	0
Max Deflection Ratio from Analysis	0
Max Shear (kips)	0
Max Compressive Axial (kips)	354.54
Max Tensile Axial (kips)	206.44
K X-X	1
K Y-Y	1
Moment Capacity %	0%
Shear Capacity %	0%
Tensile Capacity %	16%
Compressive Capacity %	32%
Combined Capacity %	32%
L/240 Deflection %	0%
L/360 Deflection %	0%
L/User Deflection %	0%
Moment Capacity Check	PASS
Shear Capacity Check	PASS
Tensile Capacity Check	PASS
Compressive Capacity Check	PASS
Combined Capacity	PASS
L/240 Deflection Check	PASS
L/360 Deflection Check	PASS
L/User Deflection Check	PASS

Beam Criteria

W Shape	W14x136
Weight (lb/ft)	136
Area {A} (in2)	39.9
Depth {d} (in)	13.4
Web thickness {tw} (in)	0.79
Flange Width {bf} (in)	12.4
Flange Thickness {tf} (in)	1.25
bf/2tf	4.96
h/tw	12.3
Ix (in4)	1240
Sx (in3)	186
rx (in)	5.58
Zx (in3)	214
Iy (in4)	398
Sy (in3)	64.2
ry (in)	3.16
Zy (in3)	98
rts (in)	3.61
ho (in)	12.2
J (in4)	18.5
Cw (in6)	14700
Fy Yield Strength (ksi)	50
X-X Moment Capacity (kft)	802.5
Y-Y Moment Capacity (kft)	367.50
Shear Capacity (kips)	285.822
Tensile Capacity (kips)	1256.85
Compressive Capacity (kips)	1117.207
L/240 Deflection Allowed (in)	1.060625
L/360 Deflection Allowed (in)	0.707083
L/User Deflection Allowed (in)	0.636375

Beam Notes

Story	3–R
Frame	Brace Frame
Beam Length (ft)	21.21
Top Braced Length {lb} (ft)	10.61
User Deflection L/User	400

Notes:
Seismic Story Drift Controls

Calculations

Flexural Calculations

Cb (Chapter F Conservative choice)	1
Doubly Symmetric Assumption	
Plastic Moment Mp X-X (kin)	10700
Plastic Moment Mp Y-Y (kin)	4900
Lateral Torsional X-X	
c	1
rts	3.61
E	29000
Lr (in)	757.9933
Lp (in)	133.9411
Fcr (conservative)	207.9144
Lb (in)	1187.9
Lb<Lp	10700
Lp<Lb<Lr	3623.528
Lb>Lr	10700
Mn (kin) Lb Lp Lr Check	10700

Shear Capacity

Vn (kips)	317.58
h/tw	12.3
h/tw check	53.94634
Stiffners Required? OK=NO	OK

Tensile Capacity

GSY (kips)	1396.5
% Connection Area	30%
Fu (ksi)	65
U	1
NSR (kips)	1815.45
Capacity (kips)	1396.5

Compressive Capacity

Non Slender Elements	
KL/r X-X	45.61828
KL/r Y-Y	80.5538
Fe X-X	137.5371
Fe Y-Y	44.10885
4.71sqrt(E/Fy)	113.4318
Fcr X-X	42.94258
Fcr Y-Y	31.11131
Controls	Y-Y
Pn (kips)	1241.341

Combined Capacity

Pr/Pc	0.317345
Combined Eq H1-1a	0.320668
Combined Eq H1-1b	0.162411
Combined Eq Used	0.320668

Calculation Assumptions

- All members are doubly symmetric rolled shapes.
- W sections
- Compact Flanges
- Non-Slender Elements
- Local Buckling OK because of last 2 notes.
- Minimal torsional loads.
- Conservative notes in AISC
- Connections total % area specified for tensile loading criteria
- Minor axis bending according to AISC Spec F6 (1 and 2a)

Appendix E:
Floor System Deisgn

Deck Design

Common Calculations

Effective Width

Beam Span (ft)	30
Slab Span (ft)	8
1) 1/8 Beam Span	45
2) 1/2 Slab span	48
3) Edge Dist	48
Min Effective width (in)	45

Decking Material

Vulcract Deck Model	2VLI20
Total Height (in)	6.5
Concrete Height (in)	4.5
Concrete Weight (psf)	110
Weight (psf)	51

SDI Max	
1 Span	6-11
2 Span	9-1
3 Span (used)	9-4

Clear Span (ft)	8
Live Load Allowed (psf)	260
Max Live Load (psf)	80
Deck Check	31%

Joists are designed to handle construction load without shoring

Vulcraft by Nucor
Steel Roof and Floor Decking
Code version 2001
Composite Floor Decking

Floor Joist Design - Flexural composite Members

Procedure Rooms		**Patient Rooms**		**Corridor**		**Roof 30ft**		**Roof 20ft**	
Beam Info		Beam Info		Beam Info		Beam Info		Beam Info	
Joist	W16X26	Joist	W16X26	Joist	W12X22	Joist	W16X26	Joist	W12X22
Weight	26	Weight	26	Weight	22	Weight	26	Weight	22
A	7.68	A	7.68	A	6.48	A	7.68	A	6.48
d	15.7	d	15.7	d	12.3	d	15.7	d	12.3
tw	0.25	tw	0.25	tw	0.26	tw	0.25	tw	0.26
bf	5.5	bf	5.5	bf	4.03	bf	5.5	bf	4.03
tf	0.345	tf	0.345	tf	0.425	tf	0.345	tf	0.425
h/tw	56.8	h/tw	56.8	h/tw	41.8	h/tw	56.8	h/tw	41.8
Ix	301	Ix	301	Ix	156	Ix	301	Ix	156
Zx	44.2	Zx	44.2	Zx	29.3	Zx	44.2	Zx	29.3
ΦVn	106	ΦVn	106	ΦVn	94.8	ΦVn	106	ΦVn	94.8
Non-composite member		Non-composite member		Non-composite member		Non-composite member		Non-composite member	
Joist	W16X26	Joist	W16X26	Joist	W12X22	Joist	W16X26	Joist	W12X22
Steel Strength (ksi)	50	Steel Strength (ksi)	50	Steel Strength (ksi)	50	Steel Strength (ksi)	50	Steel Strength (ksi)	50
Length (ft)	30	Length (ft)	30	Length (ft)	20	Length (ft)	30	Length (ft)	30
Lb (ft)	0	Lb (ft)	0	Lb (ft)	0	Lb (ft)	0	Lb (ft)	0
Wd (lb/ft)	528	Wd (lb/ft)	528	Wd (lb/ft)	528	Wd (lb/ft)	528	Wd (lb/ft)	528
Joist Wd (lb/ft)	26	Joist Wd (lb/ft)	26	Joist Wd (lb/ft)	22	Joist Wd (lb/ft)	26	Joist Wd (lb/ft)	22
Total Wd	554	Total Wd	554	Total Wd	550	Total Wd	554	Total Wd	550
Construction (lb/ft)	160	Construction (lb/ft)	160	Construction (lb/ft)	160	Construction (lb/ft)	160	Construction (lb/ft)	160
Total WL	160	Total WL	160	Total WL	160	Total WL	160	Total WL	160
1.4*D (lb/ft)	775.6	1.4*D (lb/ft)	775.6	1.4*D (lb/ft)	770	1.4*D (lb/ft)	775.6	1.4*D (lb/ft)	770
1.2*D+1.6*L (lb/ft)	920.8	1.2*D+1.6*L (lb/ft)	920.8	1.2*D+1.6*L (lb/ft)	916	1.2*D+1.6*L (lb/ft)	920.8	1.2*D+1.6*L (lb/ft)	916
Mu (lbft)	103590	Mu (lbft)	103590	Mu (lbft)	45800	Mu (lbft)	103590	Mu (lbft)	103050
Mu (kft)	103.59	Mu (kft)	103.59	Mu (kft)	45.8	Mu (kft)	103.59	Mu (kft)	103.05
L/240 Allow (in)	1.5	L/240 Allow (in)	1	L/240 Allow (in)	0.66666667	L/240 Allow (in)	1	L/240 Allow (in)	1
I required	67.034483	I required	100.55172	I required	29.7931034	I required	100.55172	I required	100.55172
I used	301	I used	301	I used	156	I used	301	I used	156
Actual Deflection (in)	0.3340589	Actual Deflection (in)	0.3340589	Actual Deflection (in)	0.12732095	Actual Deflection (in)	0.3340589	Actual Deflection (in)	0.6445623
Deflection Check	22%	Deflection Check	33%	Deflection Check	19%	Deflection Check	33%	Deflection Check	64%
Zx	44.2	Zx	44.2	Zx	29.3	Zx	44.2	Zx	29.3
Mn (kin)	2210	Mn (kin)	2210	Mn (kin)	1465	Mn (kin)	2210	Mn (kin)	1465
ΦMn (kft)	165.75	ΦMn (kft)	165.75	ΦMn (kft)	109.875	ΦMn (kft)	165.75	ΦMn (kft)	109.875
Cons Moment check	62%	Cons Moment check	62%	Cons Moment check	42%	Cons Moment check	62%	Cons Moment check	94%

Floor Joist Design - Flexural composite Members

Procedure Rooms

Composite Member

Joist	W16X26	
Steel Strength (ksi)	50	
Length (ft)	30	
Lb (ft)	0	
Wd (lb/ft)	528	
Joist Wd (lb/ft)	26	
Total Wd	554	
WL Proc Rm (lb/ft)	480	
WL Partition (lb/ft)	120	
Total WL	600	
1.4*D (lb/ft)	775.6	
1.2*D+1.6*L (lb/ft)	1624.8	
Mu (lbft)	182790	
Mu (kft)	182.79	
Effective Slab Width	Side1	Side2
Span/8 (in)	45	45
1/2 Beam Spacing (in)	48	48
Distance to edge	48	48
B used (in)	90	
Fully Compsite Check		
As	7.68	
Fy	50	
f'c	4	
d concrete	4.5	
Asfy (kip)	384	
0.84f'cAc (kip)	1377	
sum Qn	325.17725	
Fully Composite Case		
C	325.17725	
a	1.0626707	
t	6.5	
d steel	15.7	
y	13.818665	
ΦMn (kft)	337.01365	
Moment Check	54%	
Vu (kip)	24.372	
ΦVn	106	
h/tw	56.8	
kv	5	
1.10sqrt(KvE/Fy)	59.236813	
Cv	1	
ΦVn	117.75	
Min ΦVn	106	
Shear Check	23%	

Patient Rooms

Composite Member

Joist	W16X26	
Steel Strength (ksi)	50	
Length (ft)	30	
Lb (ft)	0	
Wd (lb/ft)	528	
Joist Wd (lb/ft)	26	
Total Wd	554	
WL Pait Rm (lb/ft)	320	
WL Partition (lb/ft)	120	
Total WL	440	
1.4*D (lb/ft)	775.6	
1.2*D+1.6*L (lb/ft)	1368.8	
Mu (lbft)	153990	
Mu (kft)	153.99	
Effective Slab Width	Side1	Side2
Span/8 (in)	45	45
1/2 Beam Spacing (in)	48	48
Distance to edge	48	48
B used (in)	90	
Fully Compsite Check		
As	7.68	
Fy	50	
f'c	4	
d concrete	4.5	
Asfy (kip)	384	
0.84f'cAc (kip)	1377	
sum Qn	325.17725	
Fully Composite Case		
C	325.17725	
a	1.0626707	
t	6.5	
d steel	15.7	
y	13.818665	
ΦMn (kft)	337.01365	
Moment Check	46%	
Vu (kip)	20.532	
ΦVn	106	
h/tw	56.8	
kv	5	
1.10sqrt(KvE/Fy)	59.236813	
Cv	1	
ΦVn	117.75	
Min ΦVn	106	
Shear Check	19%	

Corridor

Composite Member

Joist	W12X22	
Steel Strength (ksi)	50	
Length (ft)	20	
Lb (ft)	0	
Wd (lb/ft)	528	
Joist Wd (lb/ft)	22	
Total Wd	550	
WL Corrid (lb/ft)	640	
WL Partition (lb/ft)	120	
Total WL	760	
1.4*D (lb/ft)	770	
1.2*D+1.6*L (lb/ft)	1876	
Mu (lbft)	93800	
Mu (kft)	93.8	
Effective Slab Width	Side1	Side2
Span/8 (in)	30	30
1/2 Beam Spacing (in)	48	48
Distance to edge	48	48
B used (in)	60	
Fully Compsite Check		
As	6.48	
Fy	50	
f'c	4	
d concrete	4.5	
Asfy (kip)	324	
0.84f'cAc (kip)	918	
sum Qn	325.177246	
Fully Composite Case		
C	324	
a	1.58823529	
t	6.5	
d steel	12.3	
y	11.8558824	
ΦMn (kft)	288.097941	
Moment Check	33%	
Vu (kip)	18.76	
ΦVn	94.8	
h/tw	41.8	
kv	5	
1.10sqrt(KvE/Fy)	59.2368129	
Cv	1	
ΦVn	95.94	
Min ΦVn	94.8	
Shear Check	20%	

Roof 30ft

Composite Member

Joist	W16X26	
Steel Strength (ksi)	50	
Length (ft)	30	
Lb (ft)	0	
Wd (lb/ft)	528	
Joist Wd (lb/ft)	26	
Total Wd	554	
WL Roof (lb/ft)	160	
WL Partition (lb/ft)	0	
Total WL	160	
1.4*D (lb/ft)	775.6	
1.2*D+1.6*L (lb/ft)	920.8	
Mu (lbft)	103590	
Mu (kft)	103.59	
Effective Slab Width	Side1	Side2
Span/8 (in)	45	45
1/2 Beam Spacing (in)	48	48
Distance to edge	48	48
B used (in)	90	
Fully Compsite Check		
As	7.68	
Fy	50	
f'c	4	
d concrete	4.5	
Asfy (kip)	384	
0.84f'cAc (kip)	1377	
sum Qn	325.17725	
Fully Composite Case		
C	325.17725	
a	1.0626707	
t	6.5	
d steel	15.7	
y	13.818665	
ΦMn (kft)	337.01365	
Moment Check	31%	
Vu (kip)	13.812	
ΦVn	106	
h/tw	56.8	
kv	5	
1.10sqrt(KvE/Fy)	59.236813	
Cv	1	
ΦVn	117.75	
Min ΦVn	106	
Shear Check	13%	

Roof 20ft

Composite Member

Joist	W12X22	
Steel Strength (ksi)	50	
Length (ft)	20	
Lb (ft)	0	
Wd (lb/ft)	528	
Joist Wd (lb/ft)	22	
Total Wd	550	
WL Roof (lb/ft)	160	
WL Partition (lb/ft)	0	
Total WL	160	
1.4*D (lb/ft)	770	
1.2*D+1.6*L (lb/ft)	916	
Mu (lbft)	45800	
Mu (kft)	45.8	
Effective Slab Width	Side1	Side2
Span/8 (in)	30	30
1/2 Beam Spacing (in)	48	48
Distance to edge	48	48
B used (in)	60	
Fully Compsite Check		
As	6.48	
Fy	50	
f'c	4	
d concrete	4.5	
Asfy (kip)	324	
0.84f'cAc (kip)	918	
sum Qn	325.17725	
Fully Composite Case		
C	324	
a	1.5882353	
t	6.5	
d steel	12.3	
y	11.855882	
ΦMn (kft)	288.09794	
Moment Check	16%	
Vu (kip)	13.74	
ΦVn	94.8	
h/tw	41.8	
kv	5	
1.10sqrt(KvE/Fy)	59.236813	
Cv	1	
ΦVn	95.94	
Min ΦVn	94.8	
Shear Check	14%	

Floor Joist Design - Flexural composite Members

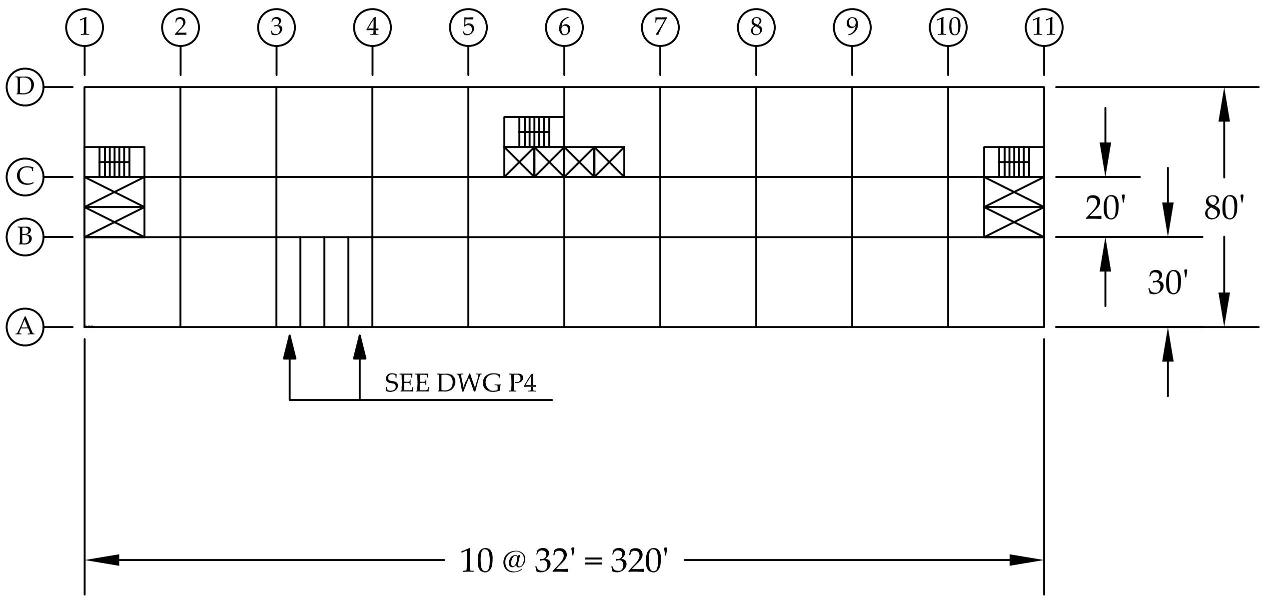
Procedure Rooms		**Patient Rooms**		**Corridor**		**Roof 30ft**		**Roof 20ft**	
Shear Studs		Shear Studs		Shear Studs		Shear Studs		Shear Studs	
Stud Diam	0.75	Stud Diam	0.75	Stud Diam	0.75	Stud Diam	0.75	Stud Diam	0.75
Stud Height	3.5	Stud Height	3.5	Stud Height	3.5	Stud Height	3.5	Stud Height	3.5
tf (in)	0.345	tf (in)	0.345	tf (in)	0.425	tf (in)	0.345	tf (in)	0.425
2.5tf	0.8625	2.5tf	0.8625	2.5tf	1.0625	2.5tf	0.8625	2.5tf	1.0625
Controlling Diam	0.75	Controlling Diam	0.75	Controlling Diam	0.75	Controlling Diam	0.75	Controlling Diam	0.75
Nr	1	Nr	1	Nr	1	Nr	1	Nr	1
wr	5	wr	5	wr	5	wr	5	wr	5
hr	2	hr	2	hr	2	hr	2	hr	2
Hs	3.5	Hs	3.5	Hs	3.5	Hs	3.5	Hs	3.5
Reduction Factor	1	Reduction Factor	1	Reduction Factor	1	Reduction Factor	1	Reduction Factor	1
wc	110	wc	110	wc	110	wc	110	wc	110
Ec (ksi)	2407.8696	Ec (ksi)	2407.8696	Ec (ksi)	2407.8696	Ec (ksi)	2407.8696	Ec (ksi)	2407.8696
Asc	0.4417865	Asc	0.4417865	Asc	0.44178647	Asc	0.4417865	Asc	0.4417865
Qn	21.678483	Qn	21.678483	Qn	21.6784831	Qn	21.678483	Qn	21.678483
Rg (AISC 16.1-87)	1	Rg (AISC 16.1-87)	1	Rg (AISC 16.1-87)	1	Rg (AISC 16.1-87)	1	Rg (AISC 16.1-87)	1
Rp (AISC 16.1-87)	0.75	Rp (AISC 16.1-87)	0.75	Rp (AISC 16.1-87)	0.75	Rp (AISC 16.1-87)	0.75	Rp (AISC 16.1-87)	0.75
RgRpAscFu	19.880391	RgRpAscFu	19.880391	RgRpAscFu	19.880391	RgRpAscFu	19.880391	RgRpAscFu	19.880391
Qn lower (kips)	19.880391	Qn lower (kips)	19.880391	Qn lower (kips)	19.880391	Qn lower (kips)	19.880391	Qn lower (kips)	19.880391
N1	16.356683	N1	16.356683	N1	16.2974662	N1	16.356683	N1	16.297466
Total Number Studs	34	Total Number Studs	34	Total Number Studs	34	Total Number Studs	34	Total Number Studs	34
Max Spacing (in)	10.588235	Max Spacing (in)	10.588235	Max Spacing (in)	7.05882353	Max Spacing (in)	10.588235	Max Spacing (in)	10.588235
Max Code Spacing (in)	36	Max Code Spacing (in)	36	Max Code Spacing (in)	36	Max Code Spacing (in)	36	Max Code Spacing (in)	36
Partial Composite		Partial Composite		Partial Composite		Partial Composite		Partial Composite	
Spacing	12	Spacing	12	Spacing	12	Spacing	12	Spacing	12
Total Studs	30	Total Studs	30	Total Studs	30	Total Studs	30	Total Studs	30
N1	15	N1	15	N1	15	N1	15	N1	15
Sum Qn	325.17725	Sum Qn	325.17725	Sum Qn	325.177246	Sum Qn	325.17725	Sum Qn	325.17725
adjusted C Vh	325.17725	adjusted C Vh	325.17725	adjusted C Vh	324	adjusted C Vh	325.17725	adjusted C Vh	324
bf steel	5.5	bf steel	5.5	bf steel	4.03	bf steel	5.5	bf steel	4.03
tf steel	0.345	tf steel	0.345	tf steel	0.425	tf steel	0.345	tf steel	0.425
Pyf	94.875	Pyf	94.875	Pyf	85.6375	Pyf	94.875	Pyf	85.6375
Net Force	194.25	Net Force	194.25	Net Force	152.725	Net Force	194.25	Net Force	152.725
PNA in Flange	Yes	PNA in Flange	Yes	PNA in Flange	Yes	PNA in Flange	Yes	PNA in Flange	Yes
t'	0.1069505	t'	0.1069505	t'	0	t'	0.1069505	t'	0
In Flange check	OK	In Flange check	OK	In Flange check	OK	In Flange check	OK	In Flange check	OK
a (in)	1.0626707	a (in)	1.0626707	a (in)	1.58823529	a (in)	1.0626707	a (in)	1.5882353
ybar calculation		ybar calculation		ybar calculation		ybar calculation		ybar calculation	
Steel A	7.68	Steel A	7.68	Steel A	6.48	Steel A	7.68	Steel A	6.48
Steel Y	7.85	Steel Y	7.85	Steel Y	6.15	Steel Y	7.85	Steel Y	6.15
Steel AY	60.288	Steel AY	60.288	Steel AY	39.852	Steel AY	60.288	Steel AY	39.852
Flange A	-0.588228	Flange A	-0.588228	Flange A	0	Flange A	-0.588228	Flange A	0
Flange Y	0.0534752	Flange Y	0.0534752	Flange Y	0	Flange Y	0.0534752	Flange Y	0
Flange AY	-0.031456	Flange AY	-0.031456	Flange AY	0	Flange AY	-0.031456	Flange AY	0
Sum A	7.0917725	Sum A	7.0917725	Sum A	6.48	Sum A	7.0917725	Sum A	6.48
Sum Ay	60.256544	Sum Ay	60.256544	Sum Ay	39.852	Sum Ay	60.256544	Sum Ay	39.852
ybar (in)	8.4966833	ybar (in)	8.4966833	ybar (in)	6.15	ybar (in)	8.4966833	ybar (in)	6.15
Conc MomArm (in)	8.0722984	Conc MomArm (in)	8.0722984	Conc MomArm (in)	5.35588235	Conc MomArm (in)	8.0722984	Conc MomArm (in)	5.3558824
Steel MomArm (in)	8.443208	Steel MomArm (in)	8.443208	Steel MomArm (in)	6.15	Steel MomArm (in)	8.443208	Steel MomArm (in)	6.15
Mn (kin)	2873.2541	Mn (kin)	2873.2541	Mn (kin)	1735.30588	Mn (kin)	2873.2541	Mn (kin)	1735.3059
ΦMn (kft)	215.49406	ΦMn (kft)	215.49406	ΦMn (kft)	130.147941	ΦMn (kft)	215.49406	ΦMn (kft)	130.14794
Moment Check	85%	Moment Check	71%	Moment Check	72%	Moment Check	48%	Moment Check	35%

Floor Joist Design - Flexural composite Members

	Procedure Rooms	Patient Rooms	Corridor	Roof 30ft	Roof 20ft
Deflection					
Wd (lb/ft)	528	528	528	528	528
Wconst	160	160	160	160	160
I steel	301	301	156	301	156
Delta1 Before Cure	1.1023943	1.1023943	0.42015915	1.1023943	0.4201592
Delta2 Construction	0.3340589	0.3340589	0.12732095	0.3340589	0.127321
Detla Total	1.4364532	1.4364532	0.54748011	1.4364532	0.5474801
Es	29000	29000	29000	29000	29000
Ec	2407.8696	2407.8696	2407.8696	2407.8696	2407.8696
n	13	13	13	13	13
b/n	6.9230769	6.9230769	4.61538462	6.9230769	4.6153846
Neutral Axis Comp					
Concrete A	31.153846	31.153846	20.7692308	31.153846	20.769231
Concrete y	2.25	2.25	2.25	2.25	2.25
Concrete Ay	70.096154	70.096154	46.7307692	70.096154	46.730769
Concrete I bar	52.572115	52.572115	35.0480769	52.572115	35.048077
Steel A	7.68	7.68	6.48	7.68	6.48
Steel y	14.35	14.35	12.65	14.35	12.65
Steel Ay	110.208	110.208	81.972	110.208	81.972
Steel I bar	301	301	156	301	156
Sum A	38.833846	38.833846	27.2492308	38.833846	27.249231
Sum Ay	180.30415	180.30415	128.702769	180.30415	128.70277
ybar	4.6429641	4.6429641	4.72317073	4.6429641	4.7231707
Concrete d	2.3929641	2.3929641	2.47317073	2.3929641	2.4731707
Concrete I bar +Ad^2	230.96767	230.96767	162.084603	230.96767	162.0846
Steel d	9.7070359	9.7070359	7.92682927	9.7070359	7.9268293
Steel I bar +Ad^2	1024.6599	1024.6599	563.168352	1024.6599	563.16835
Sum I bar +Ad^2 Itr	1255.6275	1255.6275	725.252955	1255.6275	725.25295
Ieff (in4)	1255.6275	1255.6275	726.286201	1255.6275	726.2862
WL (lb/ft)	600	440	760	160	160
Delta3 Live Load	0.3003032	0.2202223	0.12990034	0.0800809	0.0273474
After Cure					
2n	26	26	26	26	26
b/2n	3.4615385	3.4615385	2.30769231	3.4615385	2.3076923
Neutral Axis Comp					
Concrete A	15.576923	15.576923	10.3846154	15.576923	10.384615
Concrete y	2.25	2.25	2.25	2.25	2.25
Concrete Ay	35.048077	35.048077	23.3653846	35.048077	23.365385
Concrete I bar	26.286058	26.286058	17.5240385	26.286058	17.524038
Sum A	23.256923	23.256923	16.8646154	23.256923	16.864615
Sum Ay	215.35223	215.35223	152.068154	215.35223	152.06815
ybar	9.2597043	9.2597043	9.01699507	9.2597043	9.0169951
Concrete d	7.0097043	7.0097043	6.76699507	7.0097043	6.7669951
Concrete I bar +Ad^2	791.67304	791.67304	493.058655	791.67304	493.05865
Steel d	5.0902957	5.0902957	3.63300493	5.0902957	3.6330049
Steel I bar +Ad^2	429.90143	429.90143	154.587719	429.90143	154.58772
Sum I bar +Ad^2 Itr	1221.5745	1221.5745	647.646374	1221.5745	647.64637
Ieff (in4)	1221.5745	1221.5745	648.538757	1221.5745	648.53876
W sustained	120	120	120	120	120
Delta3 Sustained Load	0.0617349	0.0617349	0.02296941	0.0617349	0.0229694
Total Deflection (in)	1.4644324	1.3843516	0.5730289	1.2442101	0.470476
Total Cons Deflect (in)	0.3340589	0.3340589	0.12732095	0.3340589	0.127321
Allowed L/240	1.5	1.5	1	1.5	1
Deflection Check	98%	92%	57%	83%	47%

Appendix F:
Selected Technical Drawings

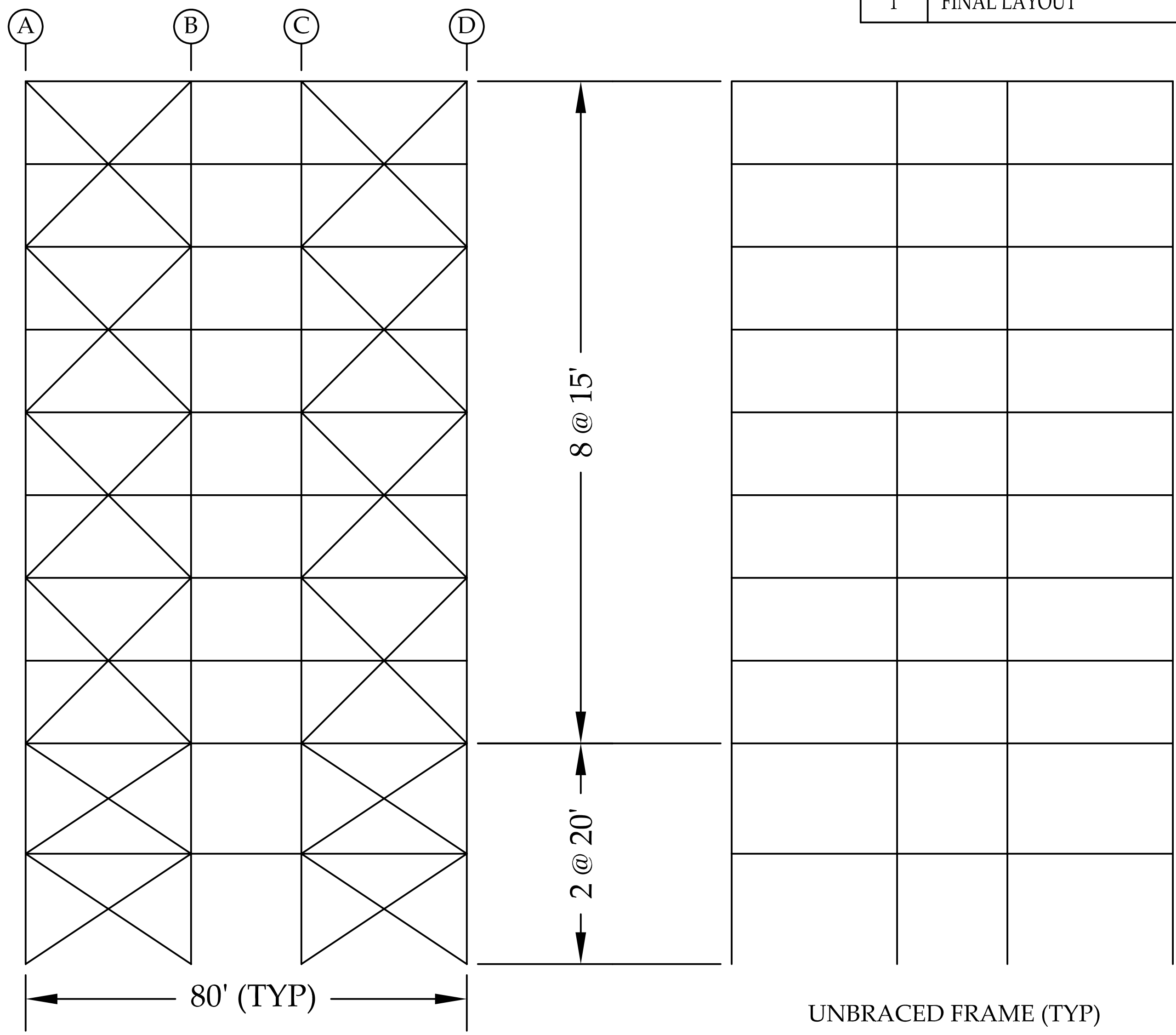
REV	DESCRIPTION	DATE
A	PRELIMINARY LAYOUT	02-20-07
1	FINAL LAYOUT	5-3-07



NOTES:
1) STAIR WELL:
2) 10'x20' ELEVATOR:
2) 10'x10' ELEVATOR:

GROUP 5 LAYOUT PLAN			
SIZE A	FSCM NO.	DWG NO. CVEN483-G5-P1	REV 1
SCALE 1/64"=1'-0"		SHEET 1 OF 1	

REV	DESCRIPTION	DATE
A	PRELIMINARY LAYOUT	02-20-07
1	FINAL LAYOUT	5-3-07



BRACED FRAME
COLUMN ROWS 1, 8, 4, 11

UNBRACED FRAME (TYP)
COLUMN ROW 2

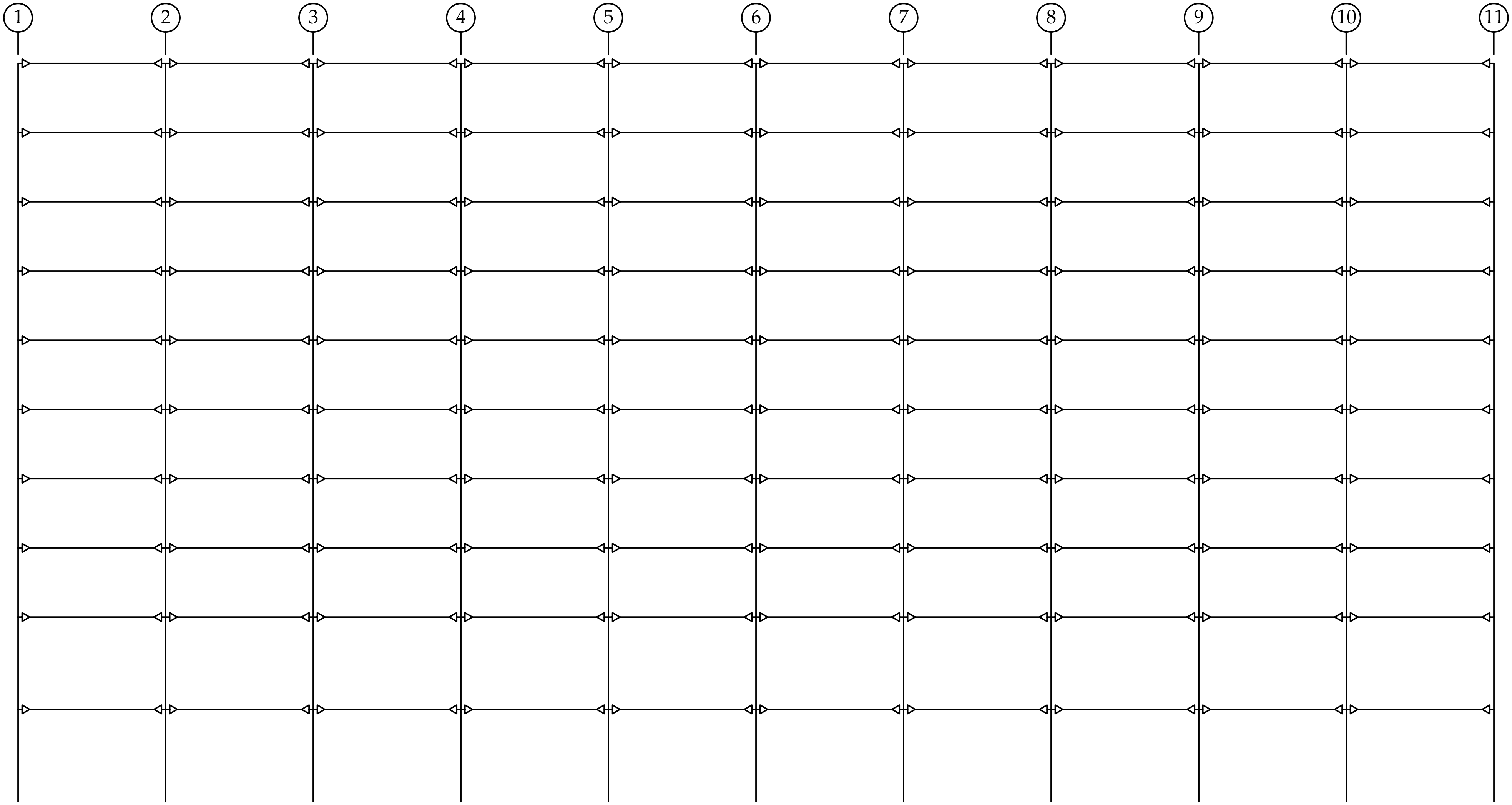
GROUP 5

LAYOUT
SECTION - BRACED FRAME

SIZE	FSCM NO.	DWG NO.	REV
A		CVEN483-G5-P2	1

SCALE		SHEET
1/32"=1'-0"		1 OF 1

REV	DESCRIPTION	DATE
A	PRELIMINARY LAYOUT	02-20-07
1	FINAL LAYOUT	5-3-07

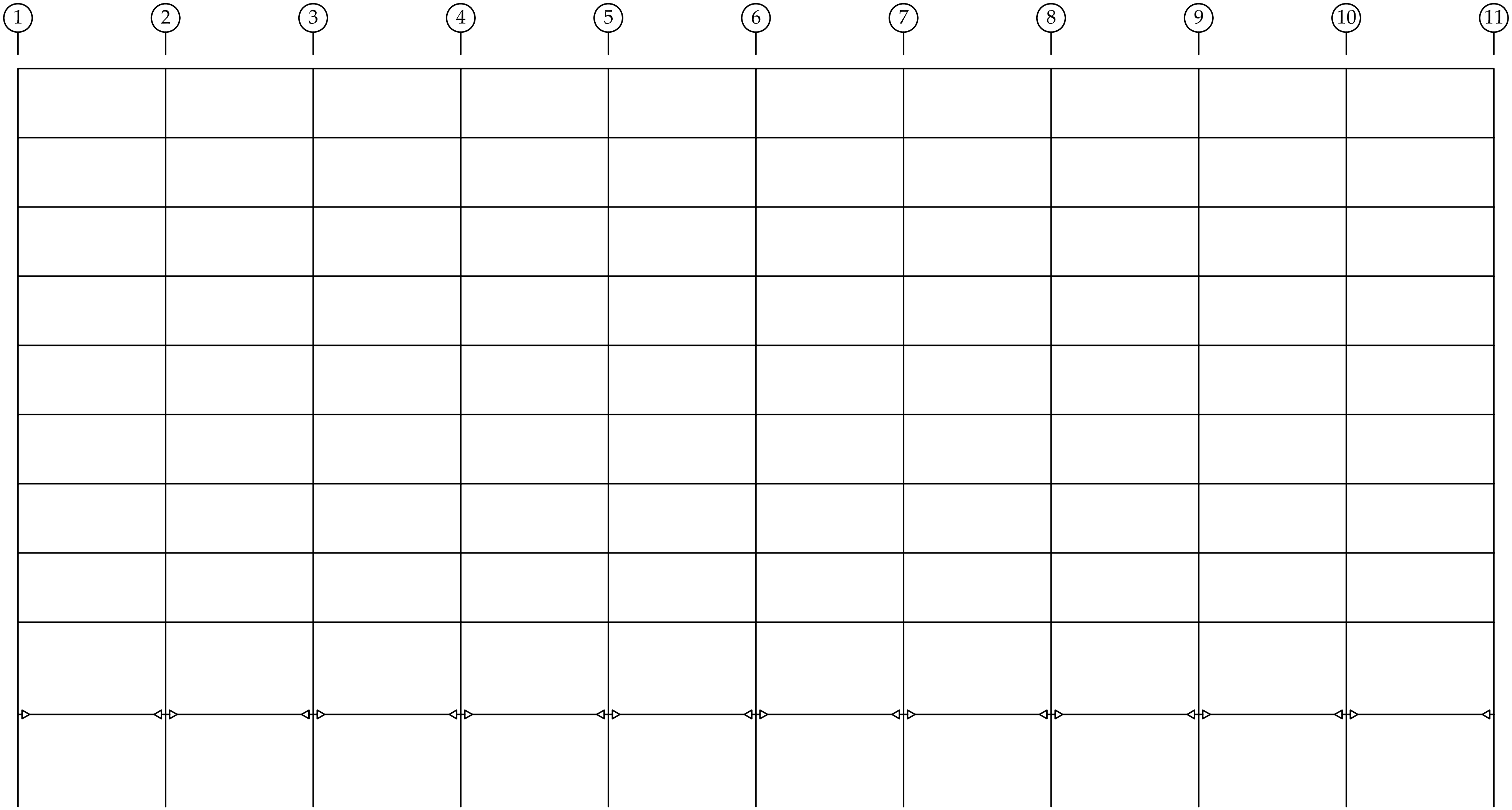


MOMENT-RESISTING FRAME
COLUMN ROWS A, D

NOTES:
1) SIGNIFIES A MOMENT-RESISTING CONNECTION

GROUP 5 LAYOUT ELEVATION - EXTERIOR MOMENT FRAME			
SIZE A	FSCM NO.	DWG NO. CVEN483-G5-P3	REV 1
SCALE 1/32"=1'-0"		SHEET 1 OF 2	

REV	DESCRIPTION	DATE
A	PRELIMINARY LAYOUT	02-20-07
1	FINAL LAYOUT	5-3-07

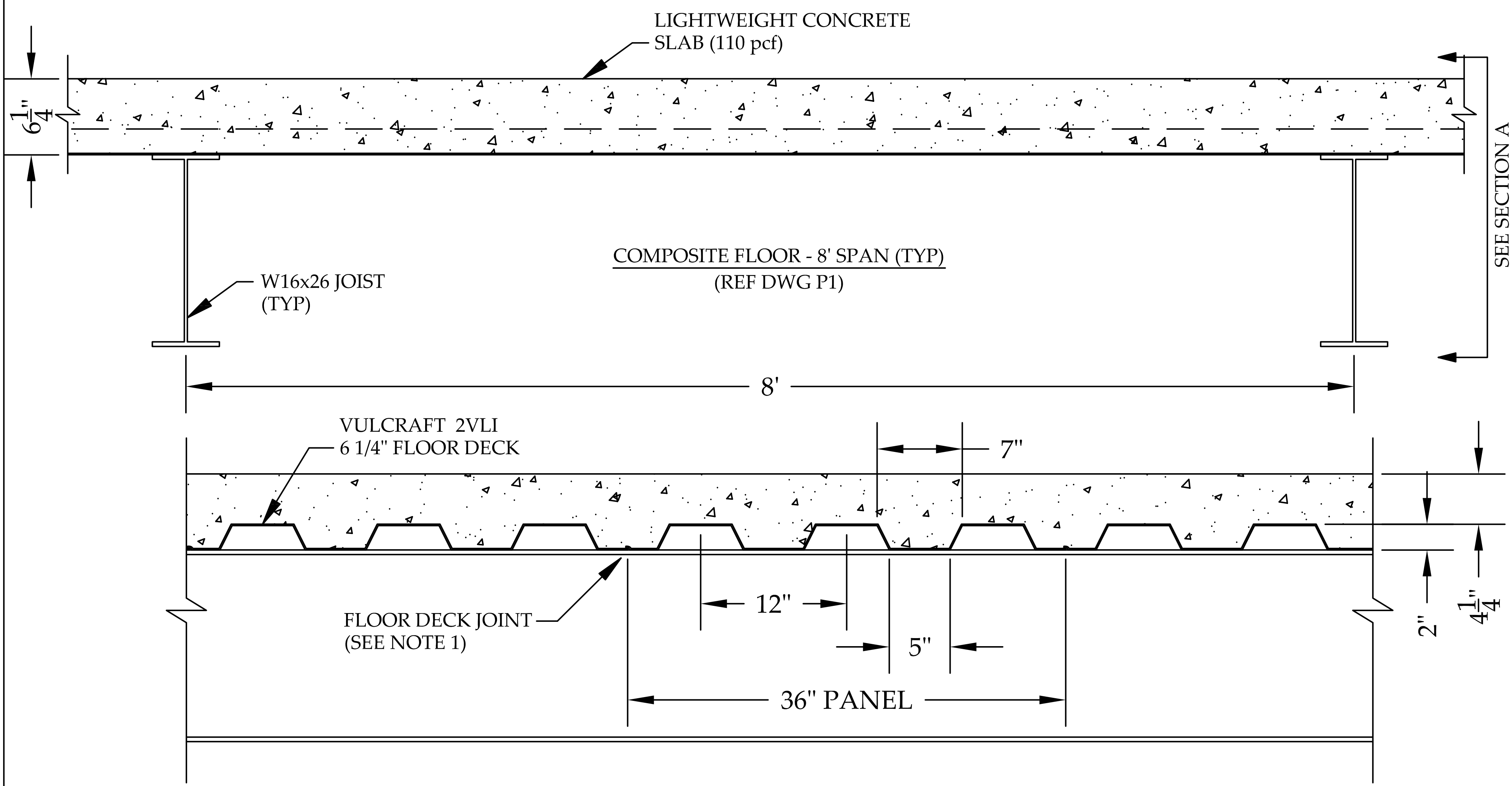


PARTIAL MOMENT-RESISTING FRAME
COLUMN ROWS B, C

NOTES:
1) SIGNIFIES A MOMENT-RESISTING CONNECTION
2) SIGNIFIES A PINNED CONNECTION

GROUP 5 LAYOUT ELEVATION - INTERIOR FRAME			
SIZE A	FSCM NO.	DWG NO. CVEN483-G5-P3	REV 1
SCALE 1/32"=1'-0"		SHEET 2 OF 2	

REV	DESCRIPTION	DATE
1	DRAWING CREATED	5-3-07



SECTION A
(TYP OF 20', 30' SPANS)

NOTES:
1) FLOOR DECK PANELS ARE 36" WIDE BY 32' LONG (TYP)

GROUP 5 COMPOSITE FLOOR PROFILE & SECTION			
SIZE A	FSCM NO.	DWG NO. CVEN483-G5-P4	REV 1
SCALE 1"=1'-0"		SHEET 1 OF 1	