SSM – St. Clare Health Center: Fenton, Missouri

Technical Report 1

Dr. Linda Hanagan, Advisor

Christopher J Brandmeier, Structural Option
9-12-2014

Executive Summary

SSM St. Clare Health Center is a 420,000 square foot hospital located in a residential area of Fenton, Missouri. The building's site was previously a golf course, and the combination of sub-par soil conditions and proximity to the New Madrid fault line make the site a seismic design category D.

Structurally, the hospital is a composite steel frame building resting on massive concrete drilled piers which are connected by grade beams. The structure is broken up into several smaller buildings isolated by construction joints. These individual buildings each contain their own lateral force resisting systems which include special moment frames (SMF), special concentrically braced frames (SCBF), special reinforced concrete shear walls (SRCSW), and ordinary concentrically braced frames (OCBF).

The building was designed in 2004 and uses the 2003 Edition of the International Building Code and ASCE 7-02 as a reference standard. Design loads were determined based on these codes, additional St. Louis County Codes and Ordinances, and practical engineering judgments.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 PURPOSE

This report provides a detailed description of the existing structural systems in SSM Health Care Center. The knowledge documented here will serve as a building block for subsequent technical reports, which require more in-depth investigations of systems in particular.

1.2 SCOPE

The major sections of this document discuss framing system elements, load determination, and connection design. The report expands on these major categories with more detailed discussions on individual building elements including typical bays, columns, lateral resisting elements, and secondary structural elements such as canopies. Relevant code requirements are also discussed. Note that Appendix A contains the structural engineering team's design routine notes for all building elements listed above (which provide a succinct overview of all code requirements and design strategies).

1.3 GENERAL BUILDING DESCRIPTION

SSM St. Clare Health Center is a 6 story, 420,000 square foot hospital surrounded by residential neighborhoods in Fenton, Missouri (part of St. Louis County). The building and parking areas sit on a 54 acre site, which was previously a 9-hole golf course with gently varying topography, large stands of trees, and a 3 acre pond. The hospital program contains a wide variety of medical use spaces, including 158 emergency supported inpatient beds, diagnostic and surgical services, administrative offices, dietary facilities, and pharmaceutical dispensaries. Budgeted at $226.8 million, the hospital was constructed with an Integrated Project Delivery method and came in well under budget at $223.5 million.

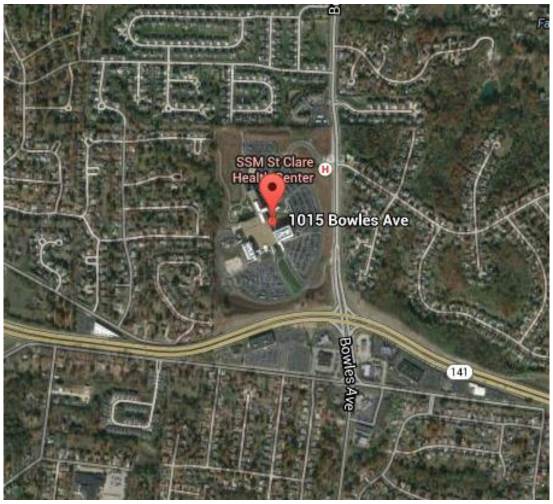

Figure 1: Aerial view courtesy of Google Maps

Figure 2: Aerial view showing proximity to residential areas

HGA Architects and Engineers were the lead architects on the project and worked closely with SSM Health Care to develop a "hospital of the future." The design team used Lean principles traditionally seen in manufacturing facilities to streamline occupant workflows with the goal of reducing errors and saving lives. Patient room mockups were created during the design process so that employees could test layout options for maximum efficiency. Overall, the layout of the building was highly program driven. The building did not receive a LEED certification.

1.4 Brief Description of Structural Framing System

SSM St. Clare Health Center is predominantly a composite steel frame structure with wide flange steel members and composite steel decking. The building foundations are a grid of reinforced concrete grade beams between concrete drilled piers; spread footings run around the perimeter.

Because of its proximity to the New Madrid fault line and poor soil conditions, the site is classified as a seismic category D and seismic loads governed the structural design. From a structural perspective, the size of the hospital and the seismic category of the site made complete building continuity an impossibility, so the building was divided into 8 isolated structures separated by construction joints as shown in Figure 2. The seismic load resisting systems are varied between the different isolated structures, but consist of special moment frames (SMF), special concentrically braced frames (SCBF), special reinforced concrete shear walls (SRCSW), and ordinary concentrically braced frames (OCBF).

This report will discuss the general structural systems of each building segment, and will provide further detail into the various lateral force resisting systems used throughout the complex.

2 Structural Framing System

This section provides detailed information about structural element types, starting with an overview of typical bays and member design criteria and then examining lateral force systems and load paths. Specific load criteria and governing design codes are covered in Section 3: Loads.

2.1 Typical Bay Framing and Floor System

Typical bays in SSM St. Clare Health Center are approximately 30 ft. square or 30 ft. by 32 ft. (as seen in Figure 3), with some variation at edges and near curved architecture. The structural grid can be seen in Figure 4. Beams are mainly W16x26 or W18x35 wide flange members, the majority of which are cambered between ¾ in. and 2 in. The girders are almost entirely 24 in. deep wide flanges with linear weights varying between 55 lbs. and 94 lbs. depending on span and loading conditions.

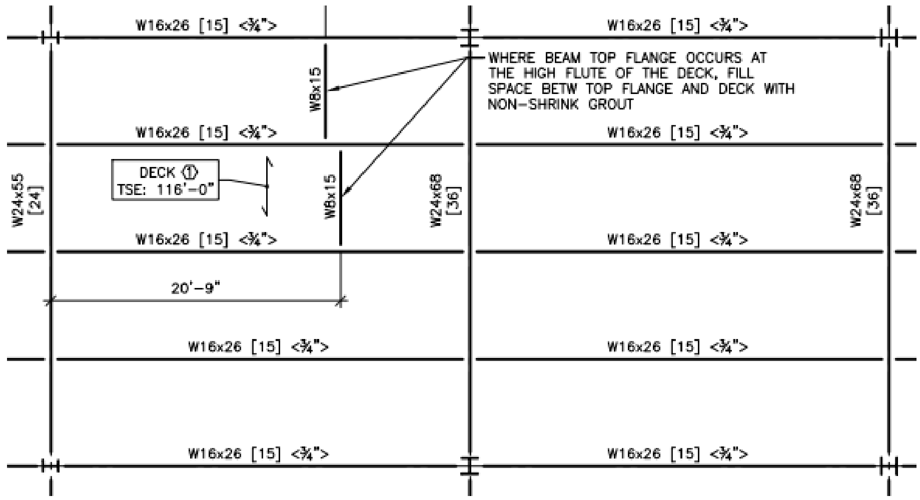

Figure 3: Typical bays from building segment A

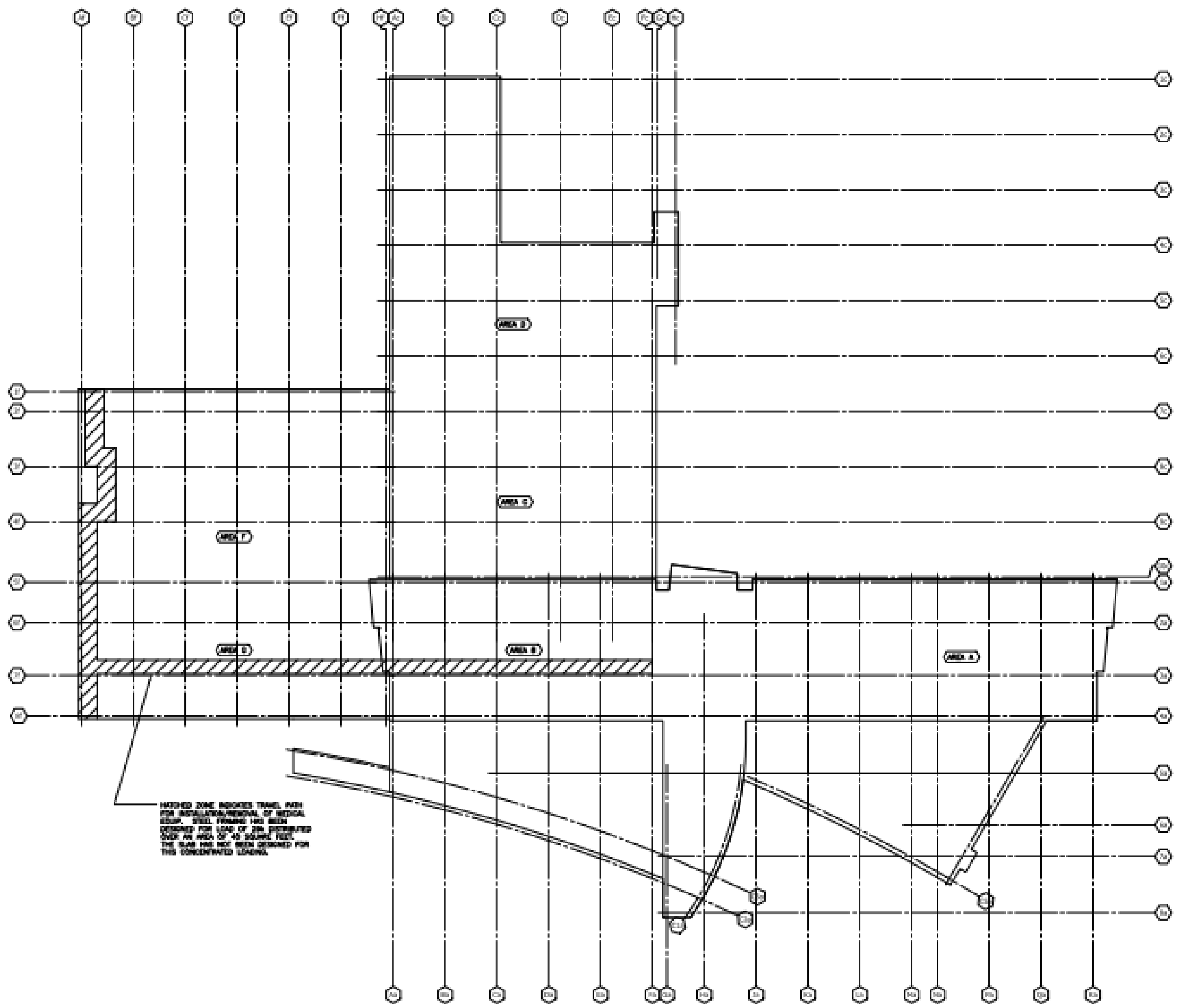

Figure 4: Column grid creating square bays

The typical floor system is 3 inch, 18 gage composite steel deck with a 3 ½ in. lightweight concrete topping that is reinforced with 6x6-W2.1xW2.1 welded wire fabric. Deck is connected to framing members with 5/8 inch diameter puddle welds, and composite action is achieved with ¾ in. diameter, 5 in. long shear studs. Rebar reinforcing is specified at geometric transitions to strengthen the diaphragm collector regions. The roof construction is a 1 ½ inch, 20 gage steel roof deck. Appendix A contains a full schedule of the 7 deck variations used throughout the building.

2.2 Foundation System

SSM St. Clare Health Center's foundations consist of a grid of drilled piers connected by grade beams with a strip footing around the perimeter to support exterior walls.

Reinforced concrete drilled piers are required to support any column bearing more than 200 kips of compressive force, thus nearly every column on the project rests on a pier. 26 different pier types are scheduled with diameters ranging from 3 ft. to 8 ft. Each pier is reinforced with spiral reinforcement at 4 in. on center to a depth of three shaft diameters below the lowest grade beam, then with #4 ties at 12 inches on center to the bottom of the pier. Figure 5 shows the approximate depths of the piers under each portion of the building based on the boring report data. The depth of piers varies between 16 ft. and 29 ft. Piers are 3000 psi concrete, have a bearing capacity of 40 ksf, and an assumed skin friction capacity for tension of 2.5 ksf.

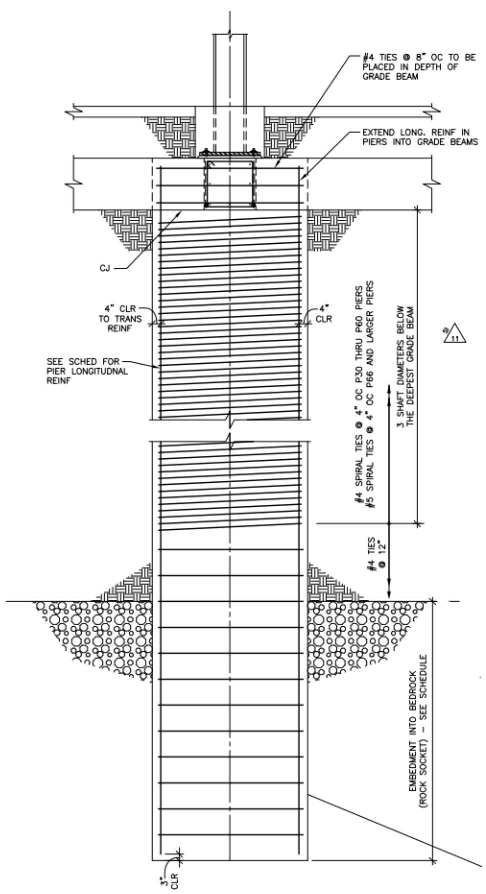

Figure 5: Drilled pier reinforcement detail

Grade beams connect the piers and assist in stabilizing the structure to resist seismic forces. 22 types of grade beams are specified with maximum dimensions of 48 in. by 24 in. and a minimum dimensions of 16 in. by 22 in. Grade beams are 4000 psi concrete.

2.3 Columns

The SSM St. Clare Health Center's columns are W14 steel wide flange members that are spliced at 4 ft. above the second and fourth levels. Figure 6 shows a typical bolted splice detail. The columns range in linear weight between 61 lbs. and 120 lbs. The columns beginning at the penthouse floor (sixth floor) are W8x24 members and are bolted to transfer girders to transfer load to the full-height columns.

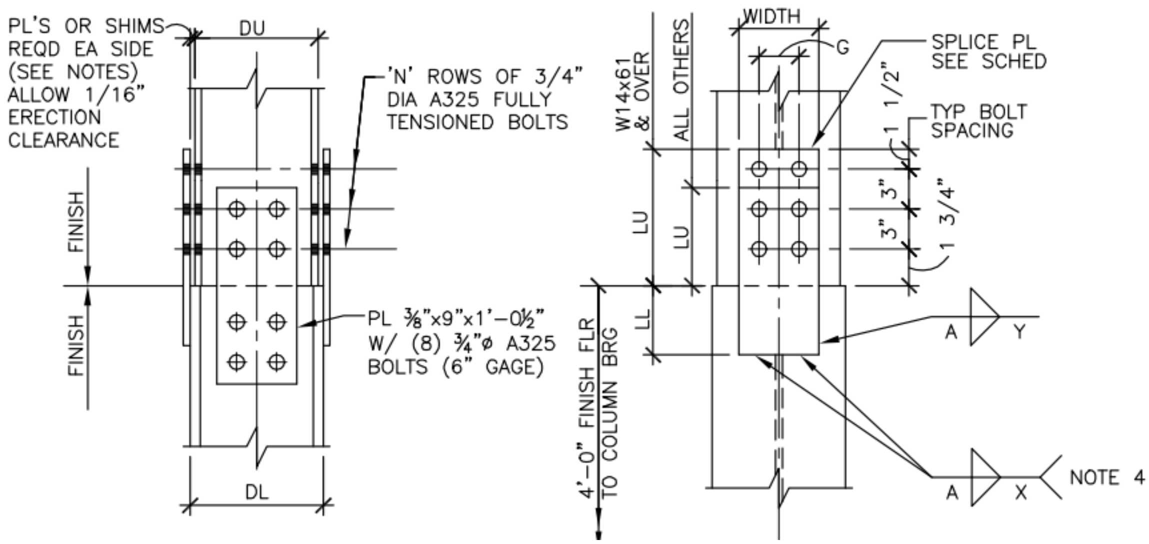

Figure 6: Typical bolted column splice connection

2.4 Secondary Structural Elements

The structure has four canopies that require special consideration for wind uplift, seismic forces, and snow drifting. These canopies are located at the main entry, ambulance drop-off, emergency department loop, and procedure clinic entrance. Figure 7 shows a typical canopy connection detail.

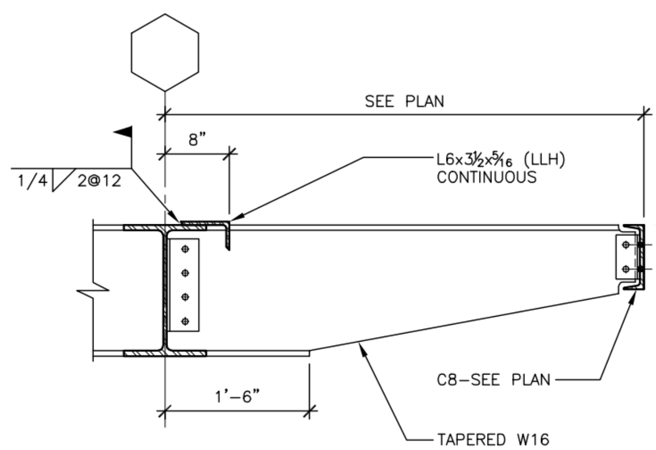

Figure 7: Typical canopy tapered beam connection

2.5 Lateral Load Resisting Elements

The main lateral force resisting elements in SSM St. Clare Health Center are special moment frames (SMF), special concentrically braced frames (SCBF), special reinforced concrete shear walls (SRCSW), and ordinary concentrically braced frames (OCBF). Table 1 below contains the seismic design criteria for each building segment and its associated lateral load resisting elements.

Table 1: Seismic Design Criteria

Seismic Design Criteria	Bed Tower	Interventional Care	Surgery	Penthouse
Ie	1.5	1.5	1.5	1.5
SUG	III	III	III	III
Site Class	D	D	D	D
SLRS N-S	SMF	SCBF	SMF	OCBF
SLRS E-W	SCBF + SRCSW	SCBF	SMF	OCBF

Figure 8 shows a plan of segment A and outlines the location of lateral elements in the plan.

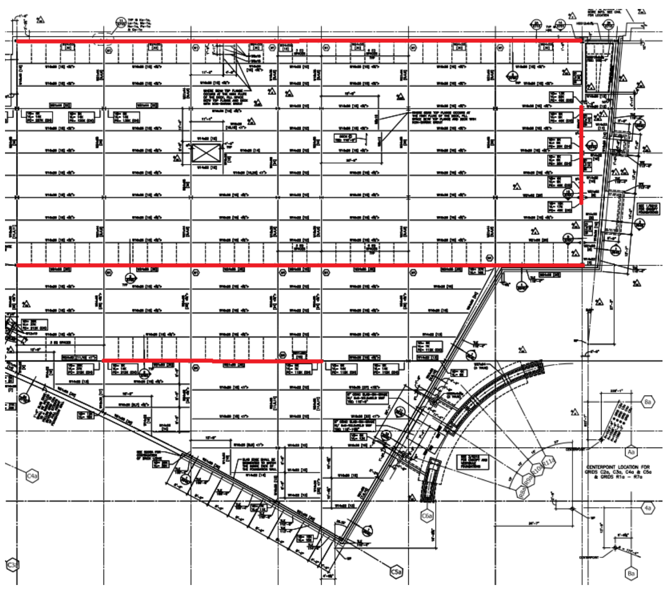

Figure 8: LFRS element location in Segment A

The “special” design designation requires more advanced member and connection detailing, specifically in the preservation of protected zones as shown in Figure 9. Protected zones in the lateral load resisting system allow for controlled yielding to occur for optimal seismic energy dissipation in a seismic event. Most beams in the lateral force resisting system have “dog bones” within the protected zones as shown in Figure 10. These areas of reduced section help protect the connections from failure and provide a region for the controlled yielding mentioned previously.

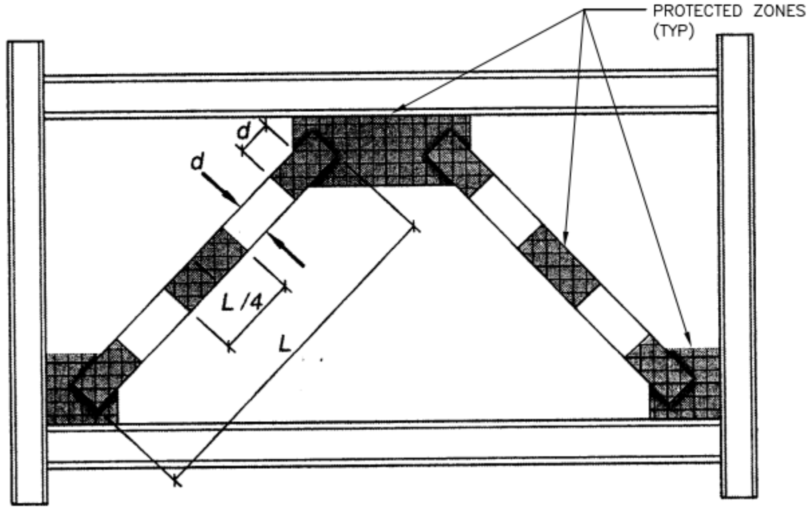

Figure 9: Protected Zones in SCBF

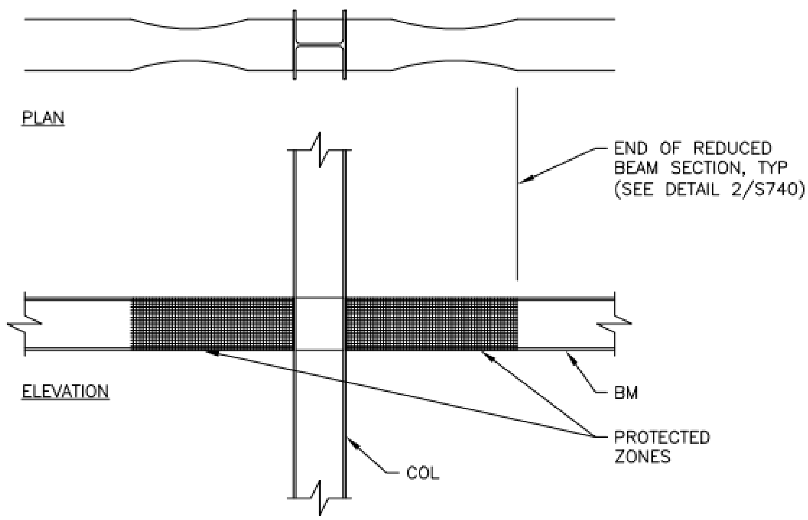

Figure 10: Dog bone section reduction typical of LFRS beams

2.6 Load Paths

Loads on the building fall into two categories: gravity and lateral.

Gravity loads such as live, dead, snow, and rain are resisted from the roof or floor diaphragms, through beams, into girders, then transferred to the foundations through vertical columns. The drilled pier foundations are socketed at least 10 ft. into limestone with a bearing capacity of approximately 40 kpf. In the gravity system, the composite deck diaphragms brace beams and girders against torsional buckling and the beams and girders brace the columns against buckling.

Lateral loads such as wind are transferred through the façade to the floor and roof diaphragms. In the case of seismic loads, the mass of the building reacting to ground accelerations causes lateral forces. The floor and roof diaphragms transfer shears to collector struts by means of welds and studs as shown in Figure 10. These collectors frame into lateral load resisting elements such as concrete shear walls, moment frames, or braced frames (depending on the building segment), which then transfer the loads to the ground by means of angled steel members in tension in the case of braced frames, or shear and flexural forces in the case of moment frames and shear walls. These forces are then transferred through the columns to the foundations and into the ground. Lateral loads create an overturning moment, which can cause uplift on the foundations. This uplift is resisted by skin friction forces in the drilled piers of approximately 2.5 kpf.

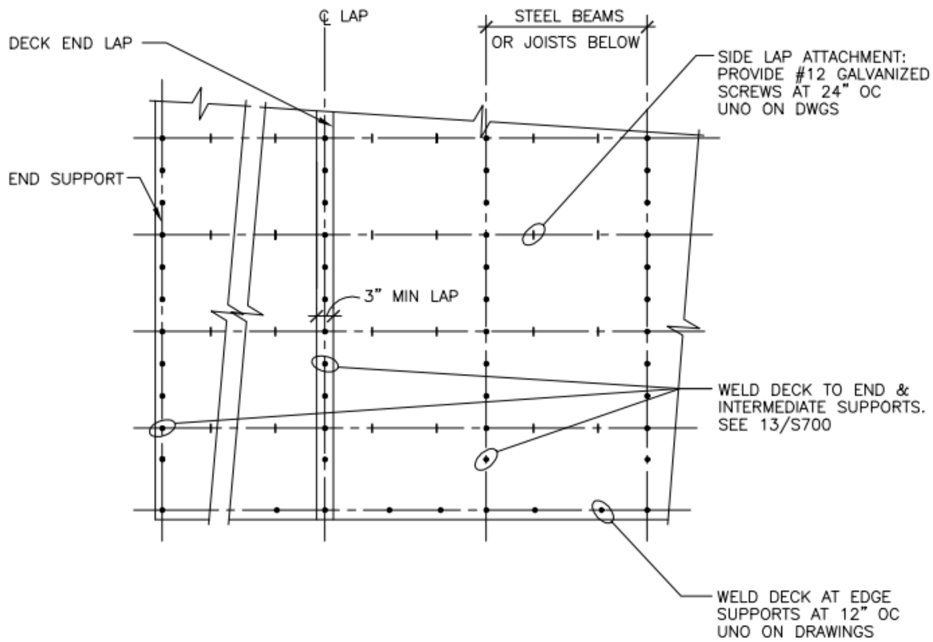

Figure 11: Typical puddle weld steel deck connections

3 LOADS

This section details the national codes and criteria used to determine loading cases on SSM St. Clare Health Center. Included in this section is a description of each building load: its formulation and application. Further load case information can be found in Appendix B.

3.1 National Codes

At the time of design in 2004, St. Luis County, Missouri had adopted the 2003 Edition of the International Building code and ASCE 7-02 as a reference standard. Minimum load values are those found in ASCE 7-02 and adjusted to the engineer's judgment. Other applicable codes can be found in Table 2.

Table 2: Applicable Codes

CODE CATEGORY	APPLICABLE CODE
Zoning	St. Louis County Codes and Ordinances
Building Code	International Building Code (IBC) 2003 Edition
Hospital Code	Title 19, Division 30, Chapter 30 for Hospitals and Ambulatory Surgical Centers
	NFPA Life Safety Code (101) 2000 Edition
	AIA Guidelines for Design and Construction of Hospitals and Healthcare Facilities
Fire Code	International Fire Code (IFC) 2003 Edition
Mechanical Code	International Mechanical Code (IMC) 2003 Edition
	International Gas and Fuel Code (IGFC) 2003 Edition
Energy Code	International Energy Conservation Code (IECC) 2003 Edition
Plumbing Code	St. Louis County Codes and Ordinances
Electrical Code	National Electric Code
Elevator Code	ANSI A17.1 Safety Code for Elevators and Escalators, 2000 Edition
State Accessibility Code	Americans with Disabilities Act (ADA)

3.2 Live

Live loads were determined from ASCE 7-02 and engineering experience. Table 3 contains a short list of ordinary loads. A full list of Live load design criteria can be found in Appendix B.

Table 3: Live Loads

Live Load	Value (psf)
Operating Room	60
Offices	50
Private Rooms	40
Corridors (1st Floor)	100
Corridors (other)	80
Stairs and Exits	100
Equipment Rooms	125

3.3 Dead

Dead loads are determined based on standard material weights, manufacturer data, and engineering experience. A full list of calculations for the values in Table 4 can be found in Appendix B.

Table 4: Dead Loads

Dead Load	Value (psf)
Hospital Floor	60
Hospital Roof	78
Power Plant Roof	133
Penthouse Floor	60
Penthouse Roof	28
Rooftop Mech. Unit Supp.	75
Piping Zone	115
MRI Zone	78
Piping and MRI Zone	103
MOB Floor	36
MOB Roof	28
Exterior Brick Wall	50
Exterior Curtain Wall	20
Exterior Metal Panel	15

3.4 Wind

Wind loads are determined from the standard load tables found in ASCE 7-02, and applied based on zones found in the "Wind Loads at Components and Cladding" zone definitions. Uplift forces are considered as part of the zone definitions found in the previously mentioned section of ASCE 7-02. The Occupancy Category and importance factor for the entire structure are IV and 1.15 respectively. The basic wind speed is 90 mph, and the wind exposure category is B.

Wind loads do not control the building design due to the poor seismic design category of the site. Wind load tables can be found in Appendix B.

3.5 Seismic

Seismic forces control lateral system design in SSM St. Clare Health Center. The SDS spectral response coefficient at short periods is 0.486, and SDI spectral response coefficient at 1 second period is 0.250. Refer to Table 1 for the seismic importance factor (Ie), seismic use group (SUG), seismic design category (SDC), and seismic site class for each of the building segments. Figure 12 shows the building segments along with their respective seismic design criteria.

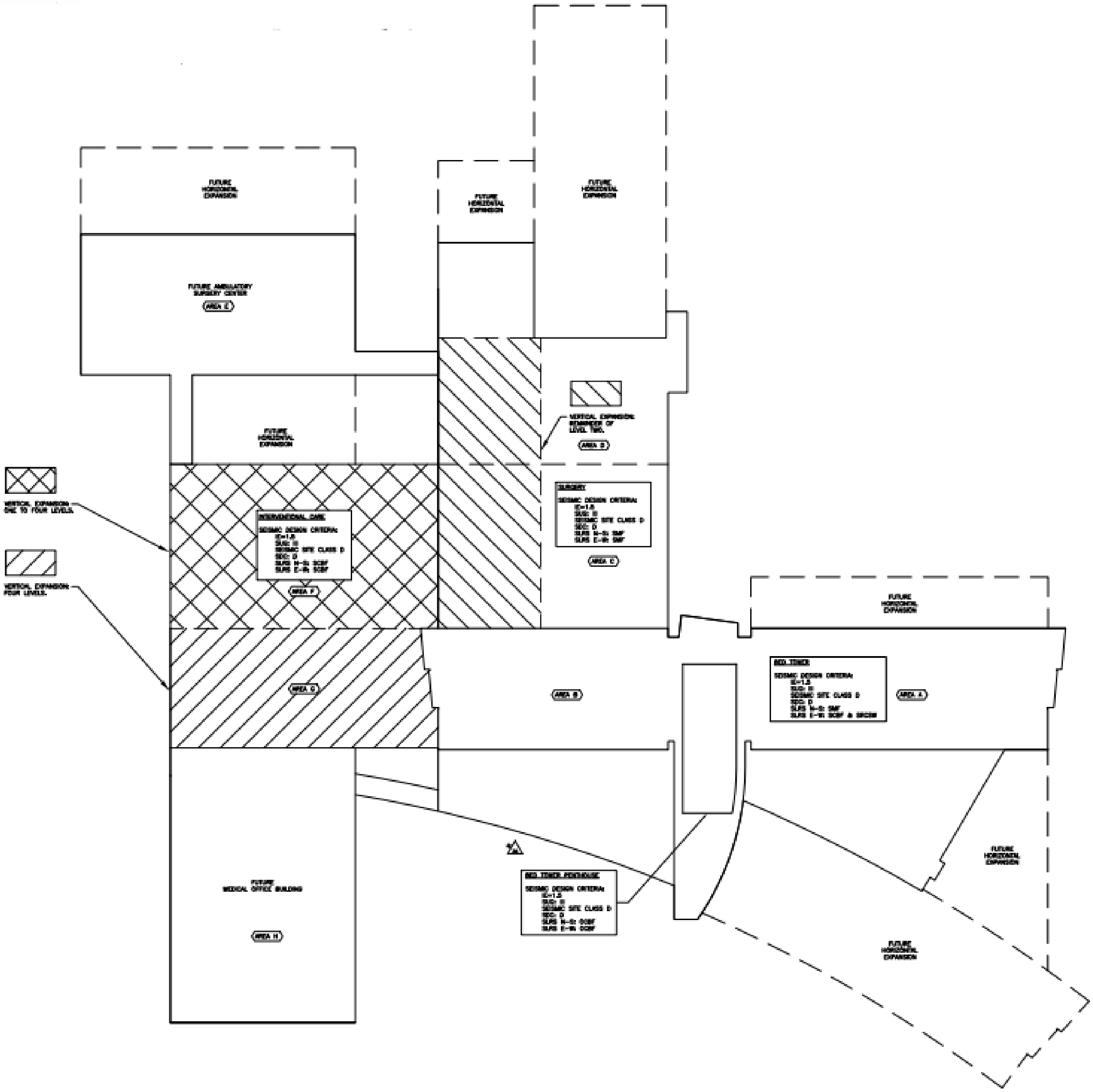

Figure 12: Seismic design building segments shown with construction joints labeled

3.6 Snow

Snow load values are based on the following snow design criteria per ASCE 7-02. The building occupancy category is IV, snow importance factor is 1.2, exposure factor is 1.0, thermal factor is 1.0, and ground snow load is 20 psf. These factors combined mean that the flat roof snow load for most of the building is 24 psf.

4 JOINT DETAILS AND CONNECTIONS

SSM St. Clare Health Center has a variety of shear, moment, and tension connections in its gravity and lateral systems. Gravity system connections are bolted connections with ¾, 7/8, or 1 inch A325 bolts. Due to the size of the building, an exhaustive description of all connections would be excessive; this section instead presents the typical connections in the building's various lateral force resisting elements. The main lateral force resisting elements are special moment frames (SMF), special concentrically braced frames (SCBF), special reinforced concrete shear walls (SRCSW), and ordinary concentrically braced frames (OCBF)

4.1 SPECIAL MOMENT FRAMES

Special moment frame connections are welded connections with welds connecting the flanges of the beam to the flanges of the column. A continuity plate runs along the web of the column and effectively creates a continuous beam flange through the column as shown in Figure XXX.

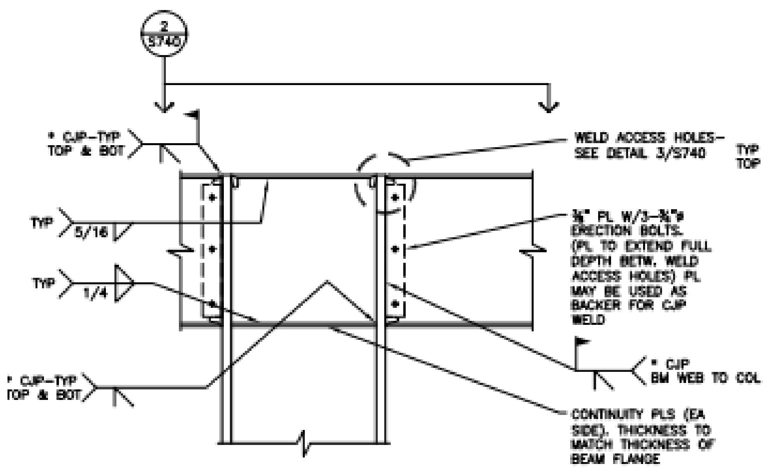

Figure 13: Special Moment Frame welded connection detail

4.2 SPECIAL CONCENTRICALLY BRACED FRAMES

SCBFs are also welded connections. The shear tab plate is held in place with erection bolts, then later welded to the beam. Braces connect to the joints through fillet welds to steel gusset plates. Occasionally the gusset plate is accompanied by a stiffener plate as shown in Figure XXX. The "special" designator comes from the close attention to protected zones and the dog bone of the beams.

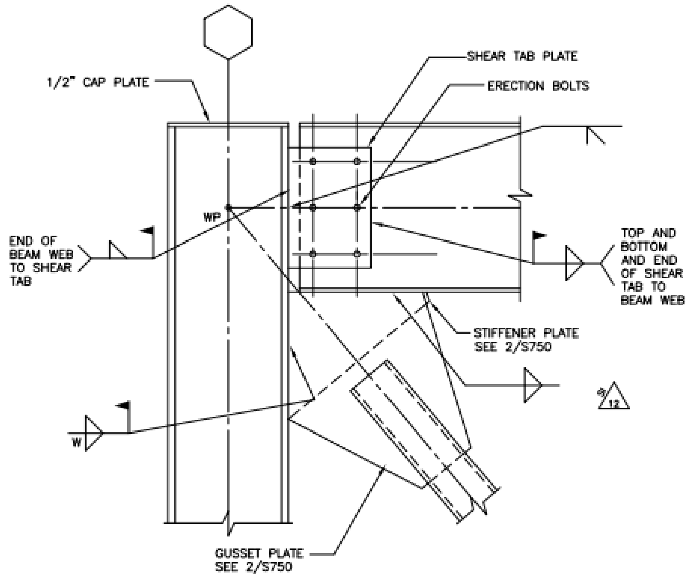

Figure 14: Special Concentrically Braced Frame connection detail

4.3 Special Reinforced Concrete Shear Walls

The SRCSWs tie directly into the composite floor diaphragm with steel reinforcement bars. A steel angle in the wall supports the steel decking until a second pour of concrete can unify the connection and bond the diaphragm to the wall. The central bar shown in Figure XXX is embedded into a drilled hole in the shear wall with epoxy, while the other bars are continuous from the first concrete pour.

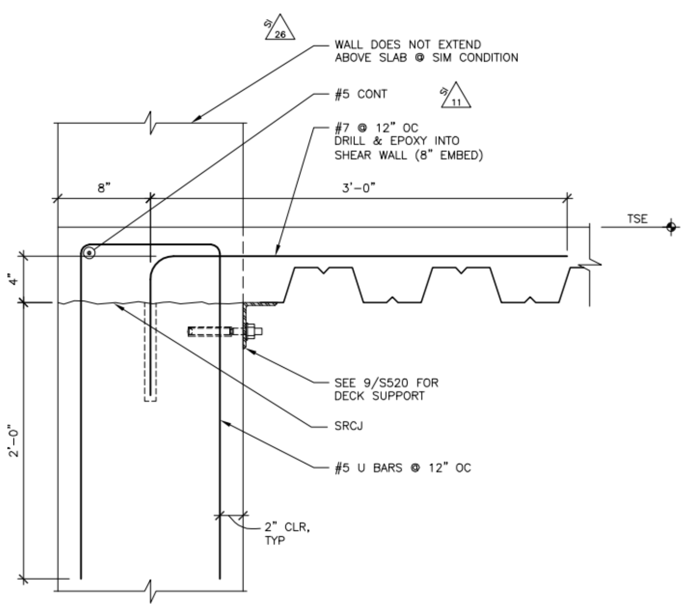

Figure 15: Special Reinforced Concrete Shear Wall connection detail

4.4 Ordinary Concentrically Braced Frames

Like SCBFs, OCBFs are welded connections with braces framing into the connection through a gusset plate. Unlike OCBFs, protected zones are not required.

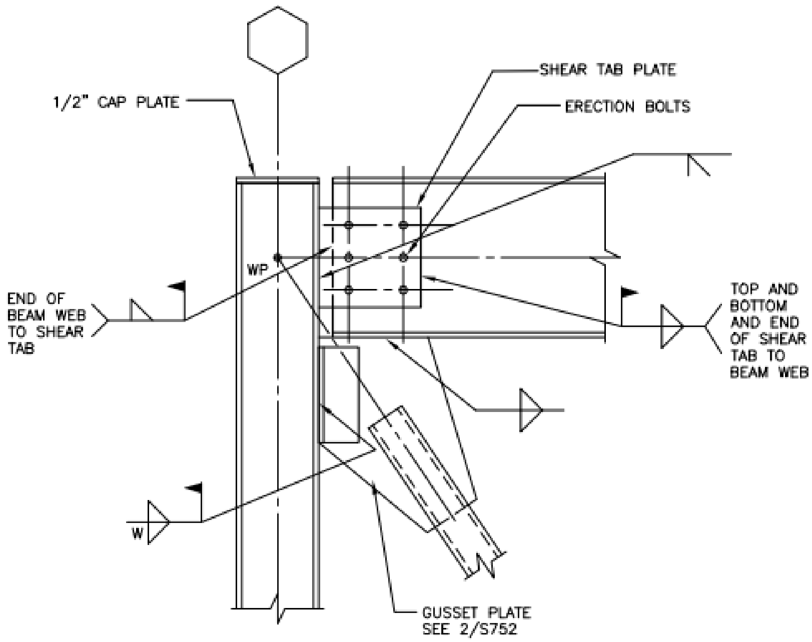

Figure 16: Ordinary Concentrically Braced Frame connection detail

5 Summary

SSM St. Clare Health Center is a 6 story, 420,000 square foot composite steel structure resting on a seismic category D site. Its structure is broken up into 8 distinct building segments that are isolated by construction joints. These segments have different occupancies, loadings, and geometries and require unique solutions for load resistance, particularly for lateral force resistance. Each independent structure has its own lateral force resisting system.

5.1 Conclusions

During the process of conducting research for and drafting this report, it has become apparent that the building is too large and complex for a complete and timely analysis study. It would be prudent to choose one portion of the building and study it in greater detail. The variation in lateral systems means that the building offers an excellent opportunity for further study. Each lateral system was selected and to suite the occupancy use and program of the building, which allows for analysis and comparison either between systems or between building segments.

The seismic-controlled design lends itself to a study of seismic design versus progressive collapse design. This building would make a good case study for the differences between the two and the strengths of each design strategy.

6 APPENDIX A: DESIGN ROUTINES

Special Concentrically Braced Frames (SCBF) Design Procedure

Brace Member Checks

* Check local buckling
AISC 341-05, Section 13.2d and Section 8.2b
* Check slenderness
AISC 341-05, Section 13.2a
* Determine compression capacity
AISC 360-05, Chapter E
> Determine tension capacity
AISC 360-05, Chapter D
Check lateral force distribution
AISC 341-05, Section 13.2c

Column Member Checks

* Check local buckling
AISC 341-05, Section 13.2d and Section 8.2b
* Determine compression capacity
AISC 360-05, Chapter E
* Determine tension capacity
AISC 360-05, Chapter D
~ Check $P_u/\Phi P_n$
AISC 341-05, Section 8.3
Column Splices
AISC 341-05, Section 8.4 and 13.5

Miscellaneous

Protected Zone
AISC 341-05, Section 7.4 and Section 13.6

* Indicates a step performed by RAM Structural Systems
> Indicates a step possibly performed by RAM Structural Systems
~ Indicates a step partially performed by RAM Structural Systems

Beam Member Checks (V-type and Inverted V-type braces)

Determine the assumed force in the tension brace
AISC 341-05, Section 13.4a (la)
Determine the assumed force in the compression brace
AISC 341-05, Section 13.4a (lb)
Determine the unbalanced vertical load on the beam, Q_b
AISC 341-05, Section 13.4a
* Determine the axial force in the beam, P_u
AISC 341-05, Section 13.4a
Determine the moments in the beam, M_u
AISC 341-05, Section 13.4a
Check local buckling of the beam
AISC 360-05, Chapter B

Check unbraced length of the beam
AISC 360-05, Chapter F
Determine flexural capacity of the beam
AISC 360-05, Chapter F
Determine compression capacity of the beam
AISC 360-05, Chapter E
Consider second-order effects
AISC 360-05, Chapter C
Check combined loading
AISC 360-05, Chapter H
Determine the shear in the beam
AISC 341-05, Section 13.4a
Check shear capacity of the beam
AISC 360-05, Chapter G
Beam shall be continuous between columns and both flanges shall be laterally braced
AISC 341-05, Section 13.4a (2)
~ Provide flange lateral bracing at the brace-beam connection
AISC 341-05, Section 13.4a (2)

Diaphragm, Chord & Collector Design Procedure

Assumptions:

- Steel framed building with concrete shear walls, braced frames, or moment frames
- Concrete on metal deck or roof deck diaphragm system

General

Collect relevant design information:

Ω_O, I, S_{DS}

Find seismic frame shears at level 'x' from lateral analysis (i.e. RAM Frame):

V_{RAM}

Calculate diaphragm design force (DDF):

ASCE 7-02, 9.5.2.6.2.7 (SDC B or C)

$F_p = 0.2*S_{DS}*I*w_p + V_{px}$

ASCE 7-02, 9.5.2.6.4.4 (SDC D, E or F)

$F_{px} = (\Sigma F_i/\Sigma w_i)*w_{px} + V_{px}$

Not to exceed $0.4*S_{DS}*I*w_{px}$

Not less than $0.2*S_{DS}*I*w_{px}$

Ratio analysis shears up to DDF:

$V = V_{RAM}*F_{px}/\Sigma V_{RAM}$

Determine loading diagram by distributing DDF in proportion to the mass distribution of the diaphragm

Find diaphragm shear and moment diagrams based on DDF distribution and ratio'd frame analysis shears

Diaphragm Design

Find maximum diaphragm shear from shear diagram

Check diaphragm shear strength

Check diaphragm connection strength to collector elements

Chord Design

Use diaphragm moment diagram and diaphragm depth to find maximum chord forces

Find required chord tension reinforcement, if applicable

ACI 318

Determine whether chord confinement reinforcement is required, design if necessary

ACI 318, 21.9.5.3

Collector Design

Determine collector gravity forces

Use diaphragm shear diagram to find collector axial force due to seismic load, amplified by Ω_O for SDC C and higher

Use load combinations to find factored forces

Check collector design for combined loading

Check collector connection design if necessary:

2006 AISC Seismic Design Manual, Example 5.2

Specific requirements per Seismic Design Category

Each design category includes requirements from lower categories as well.

A

9.5.2.6.1.1 Connections shall have a minimum axial strength of 5% of D plus live load reaction

9.5.2.6.1.2 Floors and roofs must be anchored to shear walls with a min 280 plf shear capacity

B

9.5.2.6.2.2 Diaphragm opngs: Edge elements must be able to transfer stresses into the structure

9.5.2.6.2.5 Lateral system must be redundant

9.5.2.6.2.6 Collector elements are required

9.5.2.6.2.7 Diaphragm deflection cannot exceed the permissible deflection of attached elements.
Diaphragms must resist both shear and bending stresses.
Diaphragms must have ties or struts to distribute wall anchorage forces
Diaphragm connections must be positive, mechanical or welded
Diaphragm discontinuities must be designed to handle all relevant stresses

9.5.2.6.2.8 Floors and roofs must be anchored to shear walls with the greater of:

$0.4*S_{DS}*I*Wc$ (lb)

$400*S_{DS}*I$ (plf)

280 (plf)

C

9.5.2.6.3.1 Collector elements, splices and their connections must resist special seismic loads (loads amplified by overstrength factor, Ω_O)
The seismic load need not exceed the maximum force that can be transferred to the collector by the diaphragm

9.5.2.6.3.2 See section for specific details.

D

9.5.2.6.4.1 Collector elements must handle diaphragm forces calculated using 9.5.2.6.4.4

If the building has certain plan or vertical irregularities, design forces for connections of diaphragms to vertical elements and to collectors shall be increased by 25%. See section for specific details.

Special Moment Frames (SMF) Design Procedure – Reduced Beam Section

Column Member Checks

* Determine factored loads on the column

Check column limitations

AISC 358-05, Section 5.3.2

* Check local buckling

AISC 341-05, Chapter 9.4a and Chapter 8.2b

* Check unbraced length

AISC Steel Construction Manual, Part 3, Table 3-2

* Determine K

AISC 360-05, Chapter C (commentary)

* Determine compression capacity

AISC 360-05, Chapter E

* Determine flexural capacity

AISC 360-05, Chapter F

* Consider second-order effects

AISC 360-05, Chapter C

* Check combined loading

AISC 360-05, Chapter H

* Check shear capacity

AISC 360-05, Chapter G

* Satisfy requirements for column strength when $P_u/\Phi_c P_n > 0.4$

AISC 341-05, Chapter 8.3

Beam Member Checks

* Determine factored loads on the beam

Check beam limitations

AISC 358-05, Section 5.3.1

* Check local buckling

AISC 341-05, Chapter 9.4a and Chapter 8.2b

* Check lateral bracing requirements

AISC 341-05, Chapter 9.8

* Check unbraced length

AISC Steel Construction Manual, Part 3, Table 3-2

* Determine flexural capacity at the full cross section

AISC 360-05, Chapter F

* Determine flexural capacity at the reduced beam section

AISC 358-05, Section 5.8

* Check shear capacity

AISC 360-05, Chapter G

Design lateral bracing

AISC 341-05, Chapter 9.8

AISC 360-05, Appendix 6

Beam-Column Connection Design

$ Calculate the plastic section modulus at the reduced beam section
    AISC 358-05, Section 5.8 step 2
$ Calculate the probable maximum moment at the RBS
    AISC 358-05, Section 5.8 step 3 and Section 2.4.3
$ Calculate the expected shear force at the RBS
    AISC 358-05, Section 5.8 step 4
    AISC 341-05, Chapter 9.2a (3)
$ Calculate the probable maximum moment at the column face
    AISC 358-05, Section 5.8 step 5
$ Calculate the plastic moment of the full beam based on the expected yield stress
    AISC 358-05, Section 5.8 step 6
$ Check that M_f does not exceed $\Phi_d M_{pe}$ at the column face
    AISC 358-05, Section 5.8 step 7
$ Check column-beam moment ratio
    AISC 358-05, Section 5.8 step 12 and Section 5.4
    AISC 341-05, Chapter 9.6
  Check column bracing requirements
    AISC 341-05, Chapter 9.7a
$ Check column panel-zone shear strength
    AISC 358-05, Section 5.8 step 11, Section 5.4 and Section 2.5
    AISC 341-05, Chapter 9.3a
    AISC 360-05, Chapter J, Section J10-6
$ Check minimum column web thickness or minimum doubler plate thickness (if required)
    AISC 341-05, Chapter 9.3b
  If doubler plates are required, repeat the first four steps above.
  Check if continuity plates are required
    AISC 358-05, Section 5.8 step 10 and Section 2.4.4
  Size continuity plates
    AISC 358-05, Section 5.8 step 10 and Section 2.4.4a
    AISC 341-05, Chapter 9.5
    AISC 360-05, Chapter J, Section J10
  Design connection of continuity plates to column flanges
    AISC 358-05, Section 5.8 step 10 and Section 2.4.4b
    ? AISC 360-05, Chapter J, Section J2.4 ?
  Design connection of continuity plates to column web
    AISC 358-05, Section 5.8 step 10 and Section 2.4.4b
    AISC 360-05, Chapter J, Section J2.4
  Design beam flange-to-column flange connection
    AISC 341-05, Chapter 9.2b
    AISC 358-05, Section 5.5
  Design beam web-to-column connection
    AISC 358-05, Section 5.8 steps 8 & 9 and Section 5.6
$ Check beam web strength

AISC 360-05, Chapter G

Lateral bracing at beam-column connections

AISC 341-05, Chapter 9.7

Story Drift and Stability Checks

Story Drifts – see Seismic Design Procedure

Stability Check – see Stability Check spreadsheet

Miscellaneous

Design column splices

AISC 341-05, Chapter 8.4 and Chapter 9.9

Design column baseplates

AISC 341-05, Chapter 8.5

Identify CVN requirements

AISC 341-05, Chapter 6.3 and Chapter 7.3a

Identify demand critical welds

AISC 341-05, Chapter 7.3b and Chapter 9.2c

Identify protected zones

AISC 341-05, Chapter 7.4 and Chapter n 9.2b

AISC 358-05, Section 2.6

Detail continuity and stiffener plates

AISC 341-05, Chapter 7.5 and Chapter 9.5

AISC 358-05, Section 3.6

Identify weld detailing requirements

AISC 358-05, Sections 3.3, 3.4, 3.5 and 3.6

Identify requirements for fabrication of flange cuts

AISC 358-05, Section 5.7

* Indicates a step performed by RAM Structural System

$ Indicates a step performed by Reduced Beam Section Moment Connection Design spreadsheet

Seismic Design Procedure – Seismic Design Category D

Collect Seismic Information

1. Determine Seismic Use Group (SUG), Site Class and Importance Factor
2. Determine S_S and S_1
3. Calculate S_{DS} and S_{D1} and determine Seismic Design Category (SDC)
4. Determine Seismic Force-Resisting System and collect the following
    a. Response Modification Coefficient (R)
    b. System Over-Strength Factor (Ω_o)
    c. Deflection Amplification Factor (C_d)
5. Determine applicable codes
    a. IBC 2003
    b. AISC 02 - LRFD
    c. ASCE7-02

RAM Modeler, Beam Design and Column Design

1. Built model for building with gravity loads only
2. Design beams for gravity loads only
3. Design columns for gravity loads only

RAM Frame – Set Up

1. Assign lateral framing property for desired beams and columns (done easiest in modeler)
2. Assign frame numbers (done easiest in modeler)
3. Assign beam and column fixities (done easiest in modeler)
    a. Beams: strong axis fixed, weak axis pinned, torsion fixed
    b. Columns (top): All fixed
    c. Columns (bottom): strong axis fixed, weak axis pinned, torsion fixed
4. Assign beam and column sizes to those required for gravity design (done easiest in modeler)
5. Criteria - General Criteria
    a. Rigid End Zones: Set to "Ignore Effects". This will satisfy ASCE7-02, 9.5.5.7-2.
    b. P-Delta: Set to "Yes" and determine appropriate scale factor. See RAM Frame manual (version 10.0), section 5.17 for discussion.
    c. Use defaults for remainder of settings.
6. Criteria, Diaphragms
    a. Assign rigid diaphragms to all levels (typical). See ASCE7-02, 9.5.2.3.1 for definition of diaphragm flexibility.
7. Criteria, Ground Level
    a. Ground level is unique to each building. Assign either building base or story level for ground level. This will determine at what level the horizontal seismic ground motions are considered to be imparted to the structure.
8. Criteria, Redundancy Factors
    a. Set appropriate code (IBC) and consider dual system if appropriate.
9. Loads, Mass
    a. Review the masses and assure that the values as defined in ASCE7-02, 9.5.3 are included.
10. Loads, Exposure
    a. Set parapet heights applicable
    b. Modify building exposure dimensions if necessary
11. Loads, Load Cases
    a. Wind Loads

i. Set applicable wind load factors and settings

b. Seismic Loads
   i. Use Equivalent Lateral Force option unless irregularities prohibit this.
   ii. Set applicable seismic load factors and settings
   iii. Apply 5% eccentricity to lateral forces
   iv. Set C_t per table 9.5.5.3.2
   v. Toggle between "Member Forces" and "Drift". See analysis sets below.

c. Dynamic
   i. Define a "Response Spectra" analysis if required due to vertical structural irregularities and ASCE7-02, section 9.5.2.5.1 and Table 9.5.2.5.1. Define one response spectra for drift called "MRS Drift" and one response spectra for strength called "MRS Strength".
   ii. Chose both x and y directions
   iii. Determine whether modal combinations shall be accomplished by SRSS or CQC. See ASCE7-02, 9.5.6.8.
   iv. Apply 5% eccentricity to lateral forces
   v. Determine the scale factor in both the x and y directions
      1. For drift calculations, the scale factor will equal I/R. This is the denominator in equation 9.5.6.5-3 of ASCE7-02.
      2. For strength design, compare the seismic base shear from the drift analysis (V_T) with the seismic base shear from the Equivalent Lateral Force (V) option. See ASCE7-02, 9.5.6.8. If V_T is less than 85% of V re-calculate the scale factor per ASCE7-02 equation 9.5.6.8 and the value in step 1 above.
   vi. Once the scale factor is properly set, analyze all the dynamic load cases for strength and determine the story lateral forces from the reports, building story shears.
   vii. Determine the centroid of masses and accidental eccentricities at each level from the reports, criteria, mass and exposure data.
   viii. Define the "User Defined Story Forces" of seismic loads for strength design
      1. Use User Defined Story Forces
      2. Assign these MRS Strength load cases: X+E, X-E, Y+E & Y-E
      3. Assign a load case for each of the dynamic load cases using the story lateral forces, direction of load and centroid of mass (considering accidental eccentricities).

RAM Frame – Analysis

1. Drift Design – Mode, Analysis, Load Case
   a. Determine wind lateral analysis drift limits (H/400)
   b. Determine seismic lateral analysis drift limits (See ASCE7-02, sections 9.5.2.8).
   c. Set "Provisions For:" under "Loads, Load Cases" to "Drift". (If applicable)
   d. Analyze wind and seismic load cases
   e. Check wind load case drifts against wind drift limits.
   f. Magnify elastic seismic drifts per ASCE 7-02, section 9.5.5.7.1. Check seismic load case drifts against seismic drift limits.
      i. Increase seismic drifts by a factor of 1.1 or decrease the seismic drift limits by a factor of 1.1 to account for "reduced beam sections", if applicable. This will satisfy AISC 358-05, section 5.8, step 1.

g. Increase beam sizes to satisfy strength requirements due to addition of lateral loads and reduced beam sections. Do not increase beam sizes further. See strength design below.
h. Increase column sizes until drift limits are satisfied.
i. Increase beam sizes further if necessary. (Check seismic provisions, joint code check to make sure that increasing the beam size will not require web doubler plates.)
j. Check "Redundancy Factor Summary" under "Reports". Redundancy Factor must satisfy ASCE7-02, section 9.5.2.4.
    i. If the Redundancy Factor is not satisfied, increase the number of lateral force carrying elements.
k. Check for any building "Plan Irregularities" per ASCE7-02, section 9.5.2.3.2. If there are any plan irregularities, check the corresponding requirements.
l. Check for any building "Vertical Irregularities" per ASCE 7-02, section 9.5.2.3.3. If there are any vertical irregularities, check the corresponding requirements.
m. Check "Overturning" per ASCE7-02, section 9.5.5.6.
n. Check "Stability Coefficient" per ASCE7-02, section 9.5.5.7.2. (Manual Calculation)
    i. When $\theta > 0.10$, P-Delta shall be considered
    ii. θ must be less than or equal to θ_{max}

2. Strength Design – Mode, Steel, Standard Provisions
    a. Before leaving Mode, Analysis, Load Case, set "Provisions For:" under "Loads, Load Cases" to "Member Forces". (If applicable)
    b. Before leaving Mode, Analysis, Load Case, analyze all load cases.
    c. Combinations, Generate
        i. Set code and S_{SD}
        ii. "Use Calculated" for Rho for SDC D or higher.
    d. Perform "Member Code Check".
        i. Shear check
        ii. Flexural check
        iii. Compression check
        iv. Combined forces check (interaction equation)
3. Strength Design – Mode, Steel, Seismic Provisions
    a. Combinations, Generate
        i. Set code, S_{DS} and Omega
    b. Criteria, Flange Bracing
    c. Criteria, Joints
        i. Design:
        ii. Optimization:
    d. Criteria, Reduced Beam Sections
        i. Define dimensions a, b, c for each beam. See AISC 358-05, section 5.8, step 1. (If applicable)
    e. Assign, Beams
        i. Assign Reduced Beams Sections (If applicable)
    f. Assign, Frames
        i. Assign Seismic Force-Resisting System frame type
    g. Perform "Member Code Check"
        i. Beam and column limitations check per AISC 341-05 table I-8-1.
        ii. Flexure check of reduced beam section
        iii. Lateral bracing of beams check
    h. Perform "Joint Code Check"

i. Shear strength check
ii. Panel zone strength check
iii. Panel zone thickness checked per AISC 341-05 equation 9-2
iv. Beam-Column moment ratio check per AISC 341-05 equation 9-3

9.5.2.2.4.2 Deformation Compatibility

9.5.2.6.4.1 Collector Elements

9.5.2.6.2.7 & 9.5.2.6.4.4 Diaphragms

9.5.2.6.4.3 Vertical Seismic Forces

9.5.2.7 Combination of Load Effects

Column Splices

Vibration Analysis Procedure

The are two separate analysis to perform. On the first and second floor, use the AISC Design Guide #11. For all other levels, use the Original method to determine the adequacy of vibration.

Using the AISC Design Guide #11

In the RAM model for a building, analyze the structure using the toggle switch for the AISC Design Guide. Members in the color Blue denote typical bay framing or "Perfect" framing. Members in the color Yellow denote an "Imperfect" bay of framing. All other beams are in the color Gray and are considered "Irregular". All irregular beams have been found through testing not to cause vibration problems. The rest of the beams can be analyzed with the aid of a program called "FloorVibe". Within the program, beams are evaluated based on given criteria such as beam sizes, floor widths, etc. Set the program the evaluate beams based on "Sensitive Equipment" and "Computer Systems". The program defines "Computer Systems" as operating rooms, surgery, and bench microscopes at up to 100x magnification. Using the walking speed of 50 steps/min and a velocity (μ-in/sec) of 8000, modify the beams as required to meet these standards.

Using the Original Method

In the RAM model, analyze the structure using the toggle switch for the Original Method. Click on a beam to check the analyzed results. Within the results, there is a Modified R-M Scale answer. Compare this to the attached chart and check to see if the beam in question falls below the "Distinctly Perceptible" range. Modify the beams as required to meet these standards.

Transfer Girder Design Procedure

Procedure to determine the forces applied to the transfer girder supporting Frame #11 at Level 95 in the Bed Tower

1) Check that all nodes are connected to their respective diaphragms except at Level 39.
2) Leave all mechanical unit braces in place.
3) Leave one diaphragm at Level 95
4) Upsize the transfer girder (beam #93) to balance the shear force from in the X-direction between braces 10 & 11 (Try using a W40x503)
5) Use these forces from the output to size the transfer girder.

7 Appendix B: Load Criteria

Design Criteria (Live Loads)

Hospitals

Operating rooms, labs	60 PSF *
Private rooms	40 PSF *
Wards	40 PSF *
Corridors (above 1st floor)	80 PSF *

* Design for uniform load indicated or 1000# concentrated load over 2.5 feet square, whichever produces the greater load effect.

Offices

Offices	50 PSF **
Lobbies & 1st floor corridors	100 PSF **
Corridors (above 1st floor)	80 PSF **

** Design for uniform load indicated or 2000# concentrated load over 2.5 feet square whichever produces the greater load effect.

Misc. Live Loads

Corridors, except as otherwise indicated	100 PSF
Stairs and Exits	100 PSF ***
Dining Rooms and Restaurants	100 PSF
Retail Stores (first floor)	100 PSF
Mechanical rooms	125 PSF (Includes allowance for equipment pads)
Storage – Light	125 PSF

*** Design for uniform load indicated or 300# concentrated load over 4 inches square whichever produces the greater load effect

Partition loads 20 PSF
(Offices & locations where partitions are subject to change)

Design Floor Live Loads (Typical unless noted otherwise in calculations)
Typical floors: 80 PSF (60 PSF + 20 PSF Partitions) or (80 PSF Corridors)
First floor (typical): 100 PSF (60 PSF + 20 PSF Partitions) or (100 PSF Corridors)
First floor (equip): 120 PSF (60 PSF + 20 PSF Partitions + 40 PSF Equipment)
Mechanical Rooms: 125 PSF
Elevator Machine Rooms: 500 PSF
Interstitial Level: 25 PSF
Roof Top Mechanical Unit Support: 50 PSF (Live Load + Snow Load)

Other Live Loads

Handrails and guards	50 PLF or 200# concentrated load @ top rail
Components	50# over 1 foot square
Grab bars, shower seats, dressing rm. seats	250# load in any direction at any point

Impact Loads

Elevator loads shall be increased by 100 percent for impact
Machinery weight shall be increased to allow for impact
Elevator machinery: 100 percent
Light machinery, shaft or motor driven: 20 percent
Reciprocating machinery or power driven units: 50 percent
Hangers for floors or balconies: 33 percent

Live Load Reduction
Live loads to columns will be reduced in accordance with IBC Section 1607.9.1. Live loads that exceed 100 PSF and roof live loads will not be reduced.

Distribution of Floor Loads
Uniform floor live loads shall be patterned to produce the greatest effect on continuous framing.

Roof Loads
Uniform roof live loads shall be patterned to produce the greatest effect on continuous framing.
Minimum roof load will be less than snow load
See section 1607.11 for other roof loads (roof gardens, landscaped roofs, canopies)

Interior Walls and Partitions
Interior Partitions 5 PSF horizontal pressure
Medical Equipment
MRI Equipment (four pt loads) 29000 lb/4 = 7250 lb
MRI Equip minus equip allowance 7250 lb – (40 PSF)*(25 ft2) = 6250 lb

Design Criteria (Dead Loads)

Hospital Floor (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
Ceiling/Mechanical/Misc	12 PSF
	60 PSF (Mass DL = 69 PSF + 10 PSF for Partition Mass)
Hospital Roof (Future Floor) (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
Ceiling/Mechanical/Misc	12 PSF
Roofing/Insulation/Ballast	18 PSF
	78 PSF (Mass DL = 87 PSF)
Hospital Roof (No future floors) (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume 9 PSF)
Ceiling/Mechanical/Misc	12 PSF
Roofing/Insulation/Ballast	18 PSF
	78 PSF (Mass DL = 87 PSF)
Power Plant Roof (No future floors) (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume 9 PSF)
Ceiling/Misc	7 PSF
Mechanical Piping	60 PSF
Roofing/Insulation/Ballast	18 PSF
	133 PSF (Mass DL = 142 PSF)
Penthouse Floor (Composite slab, 2 Hour)	
3" Deck + 3 ½" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
Mechanical/Misc	12 PSF
	60 PSF (Mass DL = 69 PSF + 10 PSF for Partition Mass)
Penthouse Roof (Steel Roof Deck)	
Steel Deck	3 PSF
Beams/Girders/Columns	Self Wt (Assume = 7 PSF)
Mechanical/Misc	7 PSF
Roofing/Insulation/Ballast	18 PSF
	28 PSF (Mass DL = 35 PSF)
Roof Top Mechanical Unit Support	
Beams/Girders/Columns	Self Wt (Assume = 7 PSF)
Mechanical Unit	60 PSF
Miscellaneous Pipes & Ducts 15 PSF	
	75 PSF (Mass DL = 82 PSF)
Hospital Floor – Piping Zone (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
Mechanical Piping	60 PSF
Ceiling/Misc	7 PSF
	115PSF (Mass DL = 94 PSF + 10 PSF for Partition Mass)
Hospital Floor/Power Plant (Composite slab, 2 Hour)	

3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
Mechanical Piping	60 PSF
Ceiling/Misc	7 PSF
	115PSF (Mass DL = 94 PSF + 10 PSF for Partition Mass)
Hospital Floor – MRI Zone (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
2" Concrete Topping	18 PSF
Mass for Permanent Equip	(15 PSF Mass DL)
Ceiling/Mechanical/Misc	12 PSF
	78 PSF (Mass DL = 102 PSF + 10 PSF for Partition Mass)
Hospital Floor – Piping Zone plus MRI Zone (Composite slab, 2 Hour)	
3" Deck + 3 1/2" LW Conc	48 PSF
Beams/Girders/Columns	Self Wt (Assume = 9 PSF)
2" Concrete Topping	18 PSF
Mass for Permanent Equip	(15 PSF Mass DL)
Mechanical	30 PSF
Ceiling/Misc	7 PSF
	103 PSF (Mass DL = 127 PSF + 10 PSF for Partition Mass)
MOB Floor (Non-Composite slab, 0 Hour)	
1 ½" Deck + 2" LW Conc	29 PSF
Beams/Girders/Columns	Self Wt (Assume 9 PSF)
Ceiling/Mechanical/Misc	7 PSF
	36 PSF (Mass DL = 45 PSF + 10 PSF for Partition M ass)

WIND LOAD TABLES FOR AREAS A,B,F & G

Zone (Note 1)	Area (sq ft) (Note 2)	Design Wind Loads (psf) 0' to 30' (Note 3)		Design Wind Loads (psf) 30' to 40' (Note 3)		Design Wind Loads (psf) 40' to 50' (Note 3)		Design Wind Loads (psf) 50' to 60' (Note 3)		Design Wind Loads (psf) 60' to 70' (Note 3)		Design Wind Loads (psf) 70' to 80' (Note 3)		Design Wind Loads (psf) 80' to 90' (Note 3)		Design Wind Loads (psf) 90' to 100' (Note 3)		Design Wind Loads (psf) 100' to 110' (Note 3)		Design Wind Loads (psf) 110' to 120' (Note 3)	
	10	10	-23.6	10	-25.3	10	-26.7	10	-27.8	10	-29.0	10.0	-30.1	10.0	-31.0	10.0	-31.8	10.0	-32.5	10.0	-33.2
1	20	10	-22.9	10	-24.5	10	-25.9	10	-27.0	10	-28.1	10.0	-29.2	10.0	-30.0	10.0	-30.8	10.0	-31.5	10.0	-32.2
ROOF	50	10	-20.7	10	-22.2	10	-23.4	10	-24.4	10	-25.4	10.0	-26.3	10.0	-27.1	10.0	-27.8	10.0	-28.4	10.0	-29.0
	100	10	-20.0	10	-21.4	10	-22.6	10	-23.5	10	-24.5	10.0	-25.4	10.0	-26.1	10.0	-26.8	10.0	-27.4	10.0	-28.0
	10	10	-36.4	10	-39.2	10	-41.5	10	-43.3	10	-45.2	10.0	-47.1	10.0	-48.5	10.0	-49.9	10.0	-51.0	10.0	-52.2
2	20	10	-34.9	10	-37.6	10	-39.8	10	-41.6	10	-43.4	10.0	-45.2	10.0	-46.5	10.0	-47.9	10.0	-49.0	10.0	-50.1
ROOF	50	10	-32.1	10	-34.5	10	-36.6	10	-38.2	10	-39.8	10.0	-41.4	10.0	-42.6	10.0	-43.9	10.0	-44.9	10.0	-45.9
	100	10	-30.7	10	-33.0	10	-34.9	10	-36.5	10	-38.0	10.0	-39.5	10.0	-40.7	10.0	-41.8	10.0	-42.8	10.0	-43.8
	10	10	-49.1	10	-53.0	10	-56.3	10	-58.9	10	-61.4	10.0	-64.0	10.0	-66.0	10.0	-67.9	10.0	-69.6	10.0	-71.2
3	20	10	-47.0	10	-50.7	10	-53.8	10	-56.3	10	-58.7	10.0	-61.2	10.0	-63.1	10.0	-64.9	10.0	-66.5	10.0	-68.0
ROOF	50	10	-44.2	10	-47.6	10	-50.5	10	-52.8	10	-55.1	10.0	-57.4	10.0	-59.2	10.0	-60.9	10.0	-62.4	10.0	-63.8
	100	10	-42.0	10	-45.3	10	-48.1	10	-50.2	10	-52.4	10.0	-54.6	10.0	-56.3	10.0	-57.9	10.0	-59.3	10.0	-60.6
	10	16.5	-22.3	17.6	-22.3	18.5	-22.3	19.2	-22.3	20.0	-22.3	20.7	-22.3	21.2	-22.3	21.8	-22.3	22.2	-22.3	22.7	-22.3
4	20	16.5	-22.3	17.6	-22.3	18.5	-22.3	19.2	-22.3	20.0	-22.3	20.7	-22.3	21.2	-22.3	21.8	-22.3	22.2	-22.3	22.7	-22.3
WALL	50	15.1	-21.3	16.0	-21.3	16.9	-21.3	17.5	-21.3	18.2	-21.3	18.8	-21.3	19.3	-21.3	19.8	-21.3	20.2	-21.3	20.6	-21.3
	100	14.4	-20.3	15.3	-20.3	16.0	-20.3	16.6	-20.3	17.3	-20.3	17.9	-20.3	18.3	-20.3	18.8	-20.3	19.2	-20.3	19.5	-20.3
	10	16.5	-40.9	17.6	-40.9	18.5	-40.9	19.2	-40.9	20.0	-40.9	20.7	-40.9	21.2	-40.9	21.8	-40.9	22.2	-40.9	22.7	-40.9
5	20	16.5	-40.9	17.6	-40.9	18.5	-40.9	19.2	-40.9	20.0	-40.9	20.7	-40.9	21.2	-40.9	21.8	-40.9	22.2	-40.9	22.7	-40.9
WALL	50	15.1	-36.8	16.0	-36.8	16.9	-36.8	17.5	-36.8	18.2	-36.8	18.8	-36.8	19.3	-36.8	19.8	-36.8	20.2	-36.8	20.6	-36.8
	100	14.4	-32.7	15.3	-32.7	16.0	-32.7	16.6	-32.7	17.3	-32.7	17.9	-32.7	18.3	-32.7	18.8	-32.7	19.2	-32.7	19.5	-32.7

WIND LOAD TABLES FOR AREAS A,B,F & G

Zone (Note 1)	Area (sq ft) (Note 2)	Design Wind Loads (psf) 0' to 30' (Note 3)	Design Wind Loads (psf) 30' to 40' (Note 3)	Design Wind Loads (psf) 40' to 50' (Note 3)	Design Wind Loads (psf) 50' to 60' (Note 3)	Design Wind Loads (psf) 60' to 70' (Note 3)	Design Wind Loads (psf) 70' to 80' (Note 3)	Design Wind Loads (psf) 80' to 90' (Note 3)	Design Wind Loads (psf) 90' to 100' (Note 3)	Design Wind Loads (psf) 100' to 110' (Note 3)	Design Wind Loads (psf) 110' to 120' (Note 3)
	10	-27.8	-29.9	-31.6	-33.0	-34.4	-35.8	-36.8	-37.8	-38.7	-39.6
2	20	-27.4	-29.4	-31.1	-32.5	-33.8	-35.2	-36.2	-37.2	-38.1	-38.9
ROOF OVERHANG	50	-26.8	-28.8	-30.5	-31.8	-33.1	-34.4	-35.4	-36.4	-37.3	-38.1
	100	-26.4	-28.4	-30.0	-31.3	-32.6	-33.9	-34.9	-35.8	-36.6	-37.4
	10	-43.4	-46.9	-49.7	-52.0	-54.2	-56.5	-58.2	-59.9	-61.3	-62.7
3	20	-34.9	-37.6	-39.8	-41.6	-43.4	-45.2	-46.5	-47.9	-49.0	-50.1
ROOF OVERHANG	50	-23.6	-25.3	-26.7	-27.8	-29.0	-30.1	-31.0	-31.8	-32.5	-33.2
	100	-15.1	-16.0	-16.9	-17.5	-18.2	-18.8	-19.3	-19.8	-20.2	-20.6

WIND LOAD TABLES FOR AREAS C & D

Zone (Note 1)	Area (sq ft) (Note 2)	Design Wind Loads (psf) 0' to 30' (Note 3)		Design Wind Loads (psf) 30' to 40' (Note 3)		Design Wind Loads (psf) 40' to 50' (Note 3)		Design Wind Loads (psf) 50' to 60' (Note 3)	
1 ROOF	10	10	-22.8	10	-24.5	10	-25.9	10	-27.1
	20	10	-22.1	10	-23.8	10	-25.1	10	-26.2
	50	10	-20.0	10	-21.4	10	-22.7	10	-23.6
	100	10	-19.3	10	-20.7	10	-21.8	10	-22.8
2 ROOF	10	10	-35.6	10	-38.4	10	-40.7	10	-42.6
	20	10	-34.2	10	-36.8	10	-39.1	10	-40.9
	50	10	-31.3	10	-33.8	10	-35.8	10	-37.4
	100	10	-29.9	10	-32.2	10	-34.1	10	-35.7
3 ROOF	10	10	-48.4	10	-52.3	10	-55.5	10	-58.1
	20	10	-46.2	10	-49.9	10	-53.0	10	-55.5
	50	10	-43.4	10	-46.9	10	-49.7	10	-52.1
	100	10	-41.3	10	-44.5	10	-47.3	10	-49.5
4 WALL	10	15.7	-17.7	16.8	-17.7	17.7	-17.7	18.5	-17.7
	20	15.7	-17.7	16.8	-17.7	17.7	-17.7	18.5	-17.7
	50	14.3	-16.9	15.3	-16.9	16.1	-16.9	16.7	-16.9
	100	13.6	-16.1	14.5	-16.1	15.3	-16.1	15.9	-16.1
5 WALL	10	15.7	-32.5	16.8	-32.5	17.7	-32.5	18.5	-32.5
	20	15.7	-32.5	16.8	-32.5	17.7	-32.5	18.5	-32.5
	50	14.3	-29.2	15.3	-29.2	16.1	-29.2	16.7	-29.2
	100	13.6	-25.9	14.5	-25.9	15.3	-25.9	15.9	-25.9

WIND LOAD TABLES FOR AREAS C & D

Zone (Note 1)	Area (sq ft) (Note 2)	Design Wind Loads (psf) 0' to 30' (Note 3)	Design Wind Loads (psf) 30' to 40' (Note 3)	Design Wind Loads (psf) 40' to 50' (Note 3)	Design Wind Loads (psf) 50' to 60' (Note 3)
2 ROOF OVERHANG	10	-35.6	-38.4	-40.7	-42.6
	20	-34.2	-36.8	-39.1	-40.9
	50	-31.3	-33.8	-35.8	-37.4
	100	-29.9	-32.2	-34.1	-35.7
3 ROOF OVERHANG	10	-48.4	-52.3	-55.5	-58.1
	20	-46.2	-49.9	-53.0	-55.5
	50	-43.4	-46.9	-49.7	-52.1
	100	-41.3	-44.5	-47.3	-49.5

NOTES:

1. ZONES ARE PORTIONS OF THE WALLS OR ROOFS WHERE WIND LOADS ARE APPLIED, AS SHOWN ON THE "COMPONENT AND CLADDING LOAD DIAGRAM". THE WIDTH OF THE EDGE STRIPS "a" SHALL BE 10 PERCENT OF THE LEAST HORIZONTAL DIMENSION OR 40 PERCENT OF THE EAVE HEIGHT "h", WHICHEVER IS LESS, BUT NOT LESS THAN EITHER 4 PERCENT OF THE LEAST HORIZONTAL DIMENSION OR 3 FEET.
2. AREA IS THE "EFFECTIVE WIND AREA" ON ELEMENTS OF THE COMPONENTS AND CLADDING, AND CLADDING FASTENERS, AS DEFINED IN IBC 1609.2.
3. BASIC WIND LOAD IS THE WIND LOAD ON COMPONENTS AND CLADDING FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B, AS SHOWN IN THE IBC TABLE 1609.6.2.1(2).
4. BASIC WIND LOAD IS THE WIND LOAD ON ROOF OVERHANG COMPONENTS AND CLADDING FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B, AS SHOWN IN IBC TABLE 1609.6.2.1(3).
5. DESIGN WIND LOADS ARE THE BASIC WIND LOADS, MULTIPLIED BY THE APPROPRIATE HEIGHT AND EXPOSURE COEFFICIENT FROM TABLE 1609.6.2.1(4) AND IMPORTANCE FACTOR FROM TABLE 1604.5.