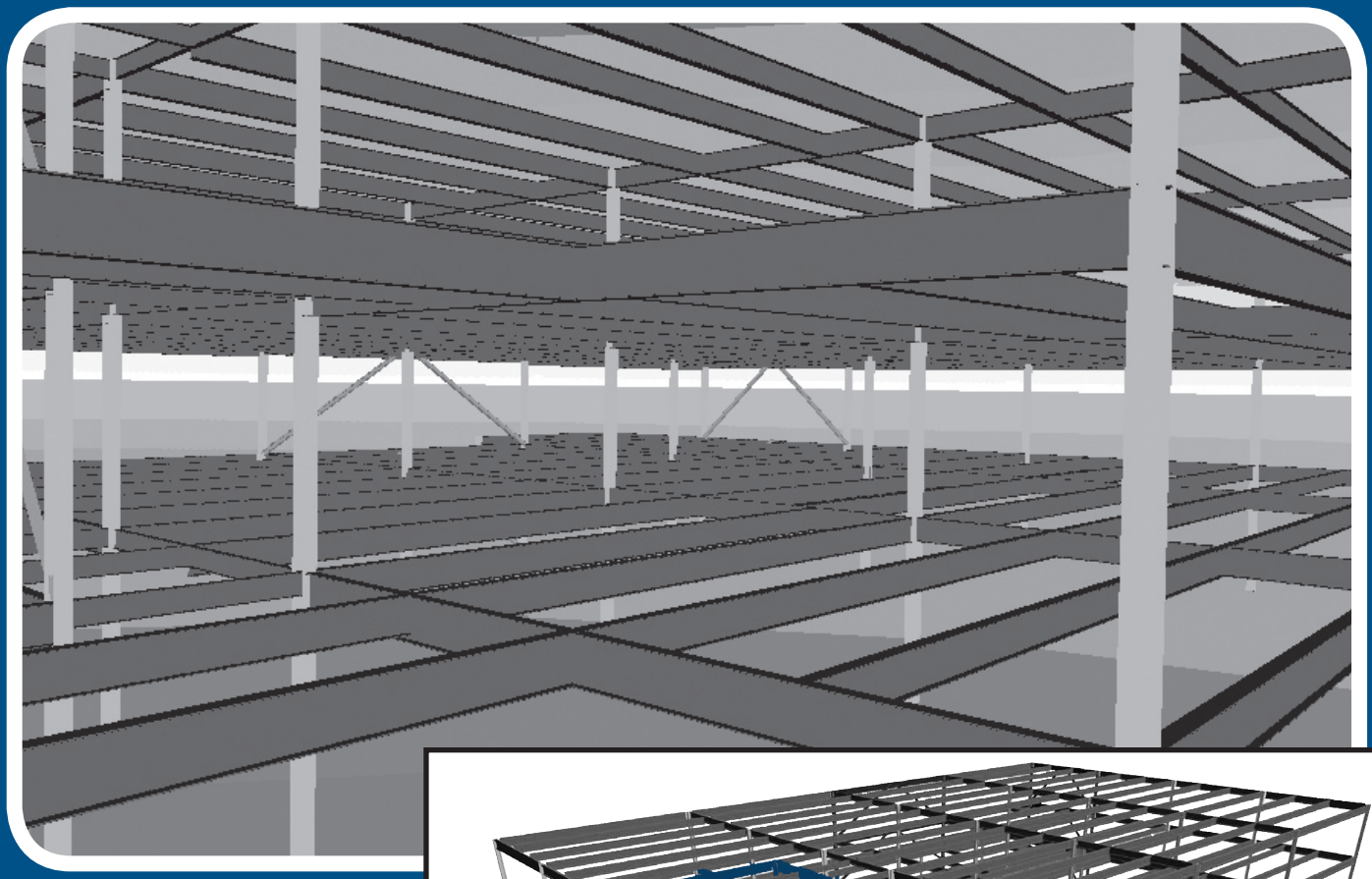
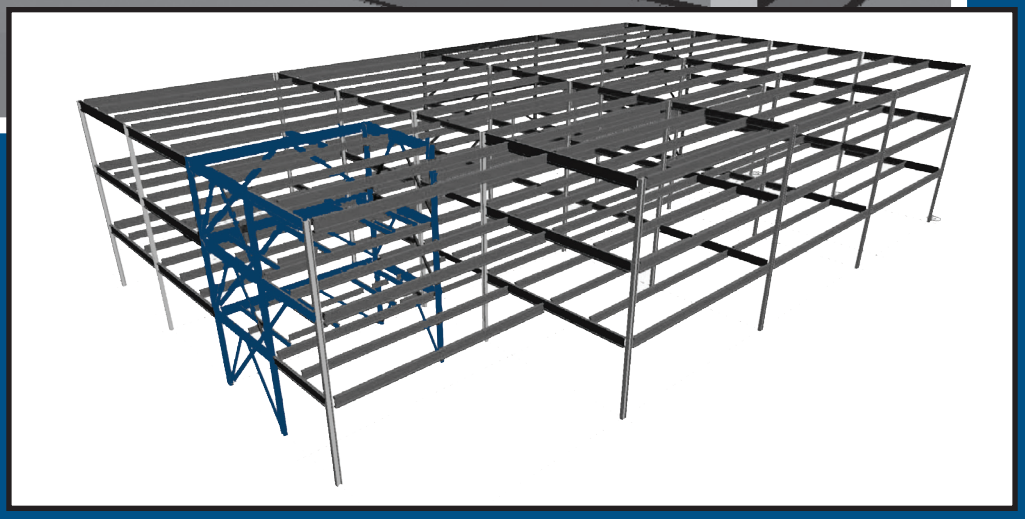
Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Office Building Prototype I

Prepared by: AISC Steel Solutions Center





What's this?

This package tells the story of a fictitious project with an imaginary client and illustrates the type of inquiry that the AISC Steel Solutions Center (SSC) often receives—again the project and all participants (besides AISC staff) are fictional. In this case, a Conceptual Solution is prepared for the client, which is then delivered with the continuing support of the SSC, the AISC Regional Engineer, and a local steel fabricator. As a team, AISC and its member fabricators commit to developing efficient, economical solutions in steel and providing continuous support for the life of the project. To best understand, let's look at an overview of the process and then experience the story of the Lawrence Office Building.

Project Inquiries

Projects find their way to the SSC in a number of ways. Common scenarios include:

- An owner or architect is developing the concepts for a new project and is interested in determining the advantages available by using a structural steel framing system and contacts the SSC.
- A project is over-budget in concrete, and a steel alternate is suggested. The architect, engineer, general contractor, or owner contacts a local steel fabricator for assistance who in turns contacts either the SSC or the AISC Regional Engineer for assistance.
- A fabricator or regional engineer hears of a new project in the early stages of development and contacts the owner or project architect to discuss similar steel projects and scenarios that could bring the advantages of steel to this project.

Developing a Solution

The AISC team and client work together, often through conference calls, to determine what can be done to provide a steel solution that meets all the needs of the client. We strive to demonstrate the cost, schedule, and other advantages of steel over other construction materials. Depending on the client's time frame, the SSC has the ability to provide a wide range of solutions. These might include, but are not limited to, a simple bay study, lateral system analysis, or full conceptual solution, which includes gravity framing plans, lateral frame elevations, and piece and weight takeoffs of the steel system. There is no fee associated with these services other than the commitment from the project decision maker to seriously evaluate the alternatives and to reach an objective conclusion.

What do I have here?

This prototype is one example of a Conceptual Solution the SSC can provide and is an example of the highest level of response and involvement. Because this prototype is representative of many steel low-rise office structures, SSC clients have found reviewing this document alone can convey the approach and benefits of utilizing a structural steel system, thus allowing them to move forward in the design process.

Since our beginnings in 2001, the SSC has been involved in a broad range of projects…multi-story residential structures, parking decks, office buildings. Whether high, medium, or low rise we will help you identify an economical and efficient solution for your project.

And now to the story of the Lawrence Office Building…

Steel SolutionsCenter
Your connection to ideas + answers
866.ASK.AISC • solutions@aisc.org

Office Building Prototype I

Prepared by: AISC Steel Solutions Center

The Lawrence Office Building

It is a Monday morning, and Kristin Armstrong, an architect with Downey & Mut, is working on a fast-tracked office project in Lawrence, Kansas. Time and money are of the essence, as always, and Kristin has to identify the most efficient and economical solution for this building, considering both the design and construction phases. While the project is a seemingly straightforward three-story office building in a moderate wind and seismic zone, Kristin knows that there are many possible ways to approach the design. Kristin recently attended an in-office presentation by Tabitha Stine, one of AISC's regional engineers, about innovations in steel framing systems. Kristin decides that contacting Tabitha might be a good place to start.

Engaging the Resources

Kristin gets a hold of Tabitha that afternoon, and Tabitha arranges a conference call the following morning with Kristin and Erika Winters Downey, an advisor in AISC's Steel Solutions Center (SSC). Erika informs Kristin that a steel solution will have many advantages:

- A steel frame is lighter than a traditional concrete frame, resulting in reduced foundation loads and costs.
- Steel can provide the architect with more flexibility in laying out space due to the large open spans that steel can provide.
- Building mechanical, electrical, plumbing, and fire protection systems can be run within the depth of the framing through the use of beam web penetrations, reducing floor-to-floor height. (See detail in solution.)
- Steel-framed buildings can easily be modified to account for new floor openings (vertical shafts, stairwells) or loadings (storage, equipment).

Through the conversation, Erika isolates Kristin's priorities in the design. Speed of construction, limited lay-down area, and ultimate cost are her priorities. In addition, she is concerned that the cost to provide fire protection of the steel might push the cost out of a competitive range. Kristin also mentions that the contractor her firm is working with has more experience with concrete and will probably need guidance on how to get the most benefits from a steel framing system.

Kristin e-mails Erika a typical floor plan for her to study. A few hours later, Erika calls Kristin back with her thoughts:

Erika suggests a conventional composite framing system to carry the gravity loads and braced frames located near the stairwells and elevators to carry the lateral loads. Because of the regular layout of the building, several bay framing configurations are possible. After discussing how Kristin is planning on laying out the space, they agree that Erika will do a detailed study with a 25 ft $\times$ 40 ft bay. Other bay sizes will be investigated in the form of simple bay studies to allow Kristin to see their effect on cost and architectural layout. Erika tells Kristin that she can get this information to her by the end of the week.

Further Support

As promised, Kristin has the conceptual solution in her hands on Friday. Tabitha contacts Kristin to answer any further questions she may have. In addition, Tabitha goes a step further and engages Sunflower Steel, a local AISC certified fabricator, to provide a quick cost estimate and erection schedule for the steel frame using the plans and quantity takeoffs provided in the solution. Kristin can use this information to further evaluate the steel system against other options.

At the same time, Kristin is able to discuss current steel supply issues with the fabricator and gain an understanding of the lead times he is experiencing in his shop as well as by other fabricators in the region. Kristin can also gain valuable insight from the fabricator on how best to manage her project in the current marketplace to optimize the project's cost and schedule. An example of the budget and schedule that was provided to Kristin follows the solution.

In the solution, Erika has followed up on Kristin's fire protection concerns. Erika explains that for a building of this size and type, no spray-applied fire protection is required as long as proper automatic sprinklers are provided throughout the building. The details concerning this evaluation are also included in the solution.

As an added bonus, an efficient floor-to-floor height is achieved by utilizing properly located, moderately sized beam web penetrations to run necessary mechanical system equipment. In this way, the entire mechanical system is run within the depth of the framing.

What about Kristin's limited lay-down area concerns? Sunflower Steel assures Kristin that trucks carrying the steel can have their delivery staged so they will be craned and erected directly from the truck; the steel never hits the ground. This system is used quite frequently on sites that have limited lay-down area and gives steel a real advantage over other systems that require more ground-based utilities.

Delivering the Message!

With the SSC's conceptual solution and Sunflower's initial estimate and schedule in hand, Kristin organizes a meeting with the developer, general contractor (GC), Tabitha Stine, and a representative from Sunflower Steel to present their findings, which include:

- erection schedule about a third less than competing systems
- cost advantage over competing systems
- spray-applied fire resistant material is not required if the building is fully sprinklered
- lower soft costs and earlier revenue generation due to decreased schedule
- small lay-down area on site can be accomodated
- increased design openness and flexibility for the office tenant layout

Tabitha also suggests that since the GC's firm hasn't had much experience with structural steel that she could come to their office and give them a presentation on structural steel erection, safety, and tolerances and how these integrate with other trades on a jobsite.

The developer and GC are extremely impressed with how steel stacks up to its competitors and are now convinced that it is the material of choice for their project. Sunflower Steel has shown they can be a valuable asset during project planning and may become part of the construction team. All parties involved are reassured knowing that AISC will provide a high level of service throughout the life of their project. They voice their agreement that—**"there is always a solution in steel!"**

Postscript

Yes, this is just a fictional account. But what happens in this story is being repeated in the SSC on a daily basis. Project decision makers are reaching out to AISC Regional Engineers and the SSC for new ideas to solve their project challenges. The SSC has resources to help you throughout the life of your project—we have worked with mills, service centers, fabrication shops, engineering and architecture offices, general contractors, and code officials, just to name a few. We can offer solutions that provide low floor-to-floor height, reduced foundation quantity and cost, and speed of erection. The SSC is providing tools that help prepare all parties involved to effectively communicate the benefits of steel to their clients and partners. The SSC provides a win-win outcome for everyone involved—and best of all, we are a free service!

What should you do next?

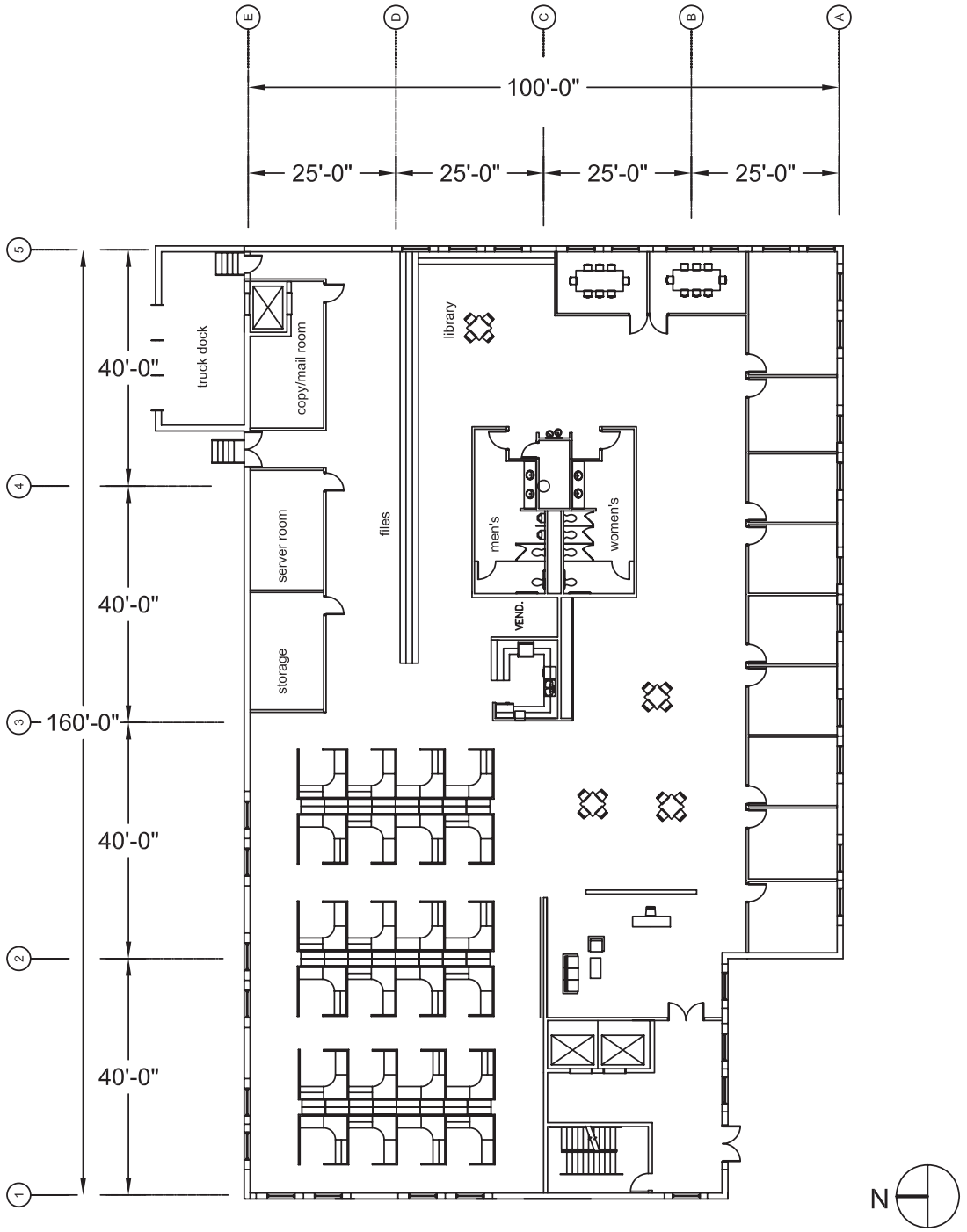
Take a few minutes and examine the attached prototype—the Conceptual Solution for the Lawrence Office Building. Ask yourself if this system might be beneficial for your next project. When you start to approach your next project, contact your local steel fabricator, AISC Regional Engineer, or call/e-mail the SSC directly to discuss what benefits a steel solution can provide to your project.

Steel SolutionsCenter
Your connection to ideas + answers
866.ASK.AISC • solutions@aisc.org

Office Building Prototype I

Prepared by: AISC Steel Solutions Center

Schematic Floor Plan



Downey & Mut	**Office Building** 2000 Winthrop Ave. Lawrence, KS	A1

Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Comments on Conceptual Solution

Project:	**Lawrence Office Building**	Date:	**6/9/2006**
Location:	**Lawrence, KS**	Engineer:	**Erika Winters Downey**
Company:	**Sunflower Steel**	Contact:	**Kristin Armstrong**

The structural system for the Lawrence Office Building, located in Lawrence, KS, is composed of the steel super-structure whose quantities and geometry are defined through the preliminary framing plans, column schedule, lateral elevations, and tonnage/piece takeoffs enclosed herein.

This project was based upon parameters defined through architectural drawings and project criteria received on June 6, 2006:

1. Reviewing your needs, we decided that a conventional composite framing system with braced frames would be best. This system will efficiently resist lateral loads while carrying gravity loads in a very light and economical way.
2. The floor slabs are assumed to consist of 2 in. composite metal deck with 3¼ in. lightweight concrete topping (5¼ in. total slab depth). Concrete strength $f'c$ = 4 ksi. Roof consists of 1½ in. roof deck, plus typical decking material.
3. Rolled shapes are A992, Gr. 50 material.
4. Lateral loads are resisted by Chevron-configured braced frames in each direction. Sizes for beams and columns in the braced frames are shown on the lateral elevations.
5. Floor-to-floor heights are 14 ft 0 in. for the first floor and 12 ft 3 in. for the remaining two floors. Floor-to-ceiling heights were assumed to be 11 ft 8 in. for the first floor and 10 ft 0 in. for the remaining floors.
6. For seismic loads, an *R* value of 3 was assumed for the braced frame system to avoid seismic detailing. In addition, soils Category D was assumed due to the absence of a soils report.
7. This design satisfies vibration checks according to the methods outlined in AISC Design Guide #11, *Vibration Due to Human Activity*.
8. **Results for this building are 161 tons at 6.7 psf for the 47,950 ft² structure with 389 pieces of steel.**

Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Loading Criteria

Project:	**Lawrence Office Building**	Date:	**6/9/2006**
Location:	**Lawrence, KS**	Engineer:	**Erika Winters Downey**
Company:	**Sunflower Steel**	Contact:	**Kristin Armstrong**

Loading Parameters per IBC 2003

Dead Load

Residential:	50 psf (slab + 6 psf SDL)
Roof:	50 psf (slab + 6 psf SDL)
Façade (all levels):	350 psf (precast panels)

Live Load

Office:	70 psf (50 psf + 20 psf partition)
Roof	20 psf

Basic Wind Speed: 90 mph

Seismic Parameters:

S_1	14.5% of *g*
S_s	5.8% of *g*
R	3 (non-seismic detailing)

Seismic Design Category B

Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Tonnage and Piece Takeoff Sheet

Project:	**Lawrence Office Building**	Date:	**6/9/2006**
Location:	**Lawrence, KS**	Engineer:	**Erika Winters Downey**
Company:	**Sunflower Steel**	Contact:	**Kristin Armstrong**

The following quantity estimate is based on a building area of 47,950 ft^2:

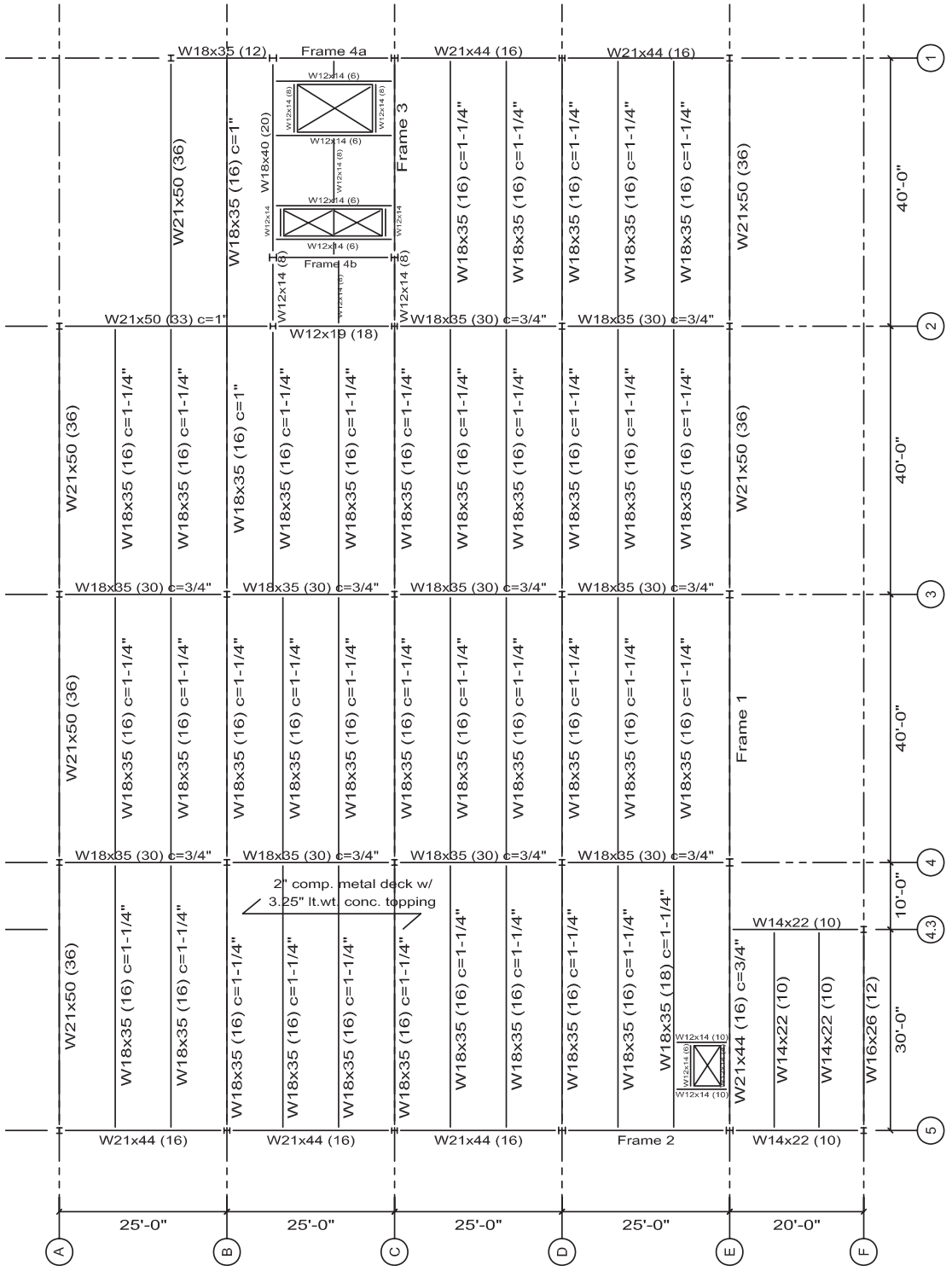
Columns (gravity)	13.1 tons	0.55 psf	59 pieces
Beams (gravity)	122.1 tons	5.09 psf	242 pieces
Columns (lateral)	5.5 tons	0.23 psf	24 pieces
Beams (lateral)	7.7 tons	0.32 psf	15 pieces
Braces (lateral)	4.8 tons	0.20 psf	30 pieces
Miscellaneous (10%)	7.7 tons	0.32 psf	19 pieces
TOTAL	**161 tons**	**6.7 psf**	**389 pieces**

Total quantity of headed studs = 3,133 studs

*The quantitites are based on centerline dimensions.

***Miscellaneous steel includes such items as: framing for openings, connection material, slab edge material, screen walls, base plates, and architectural elements (i.e., façade attachments, stairs, lintels, etc.).

Schematic Floor Plan

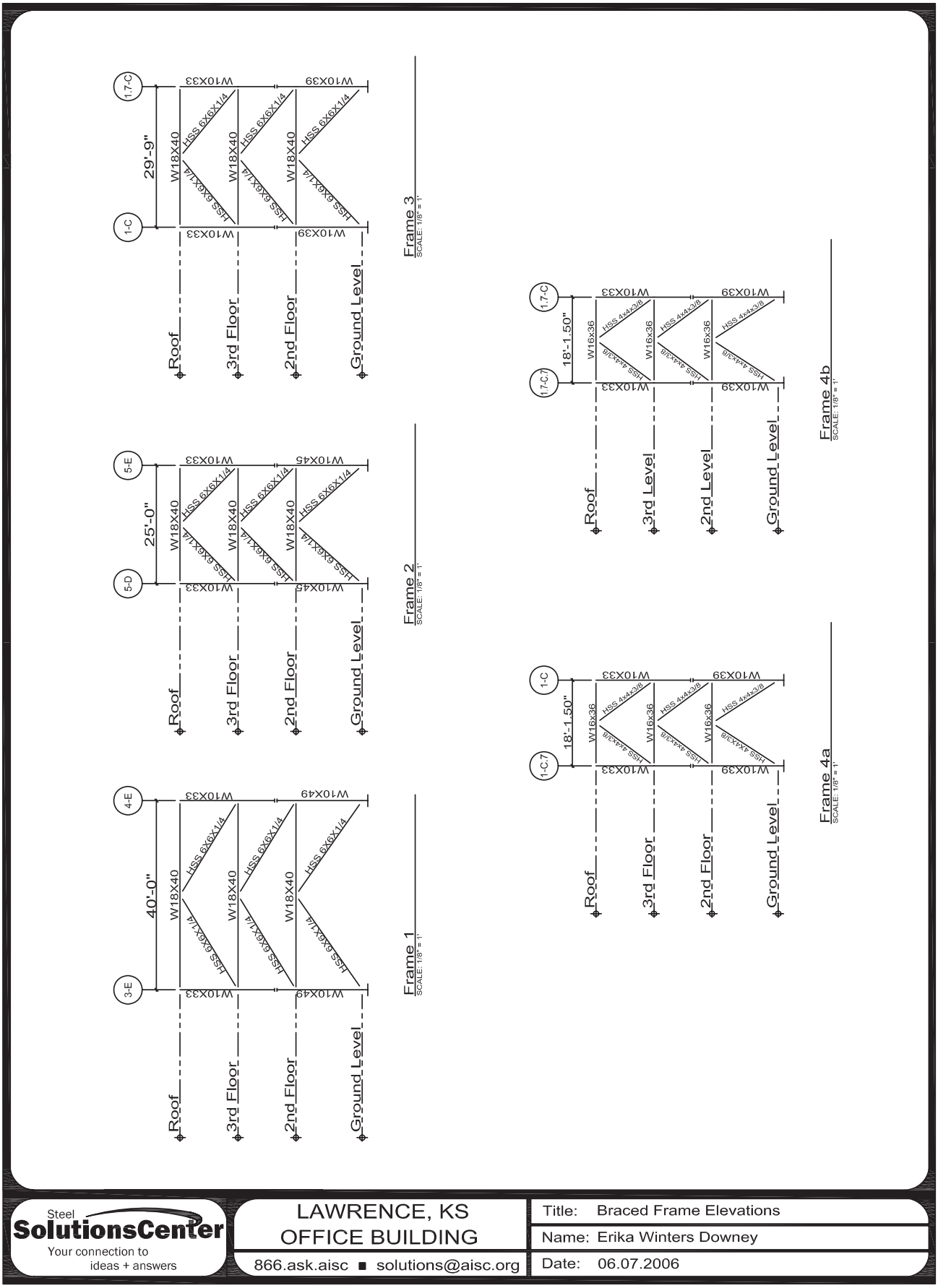


Steel SolutionsCenter
Your connection to ideas + answers

LAWRENCE, KS
OFFICE BUILDING
866.ask.aisc ■ solutions@aisc.org

Title: Second Floor Framing Plan
Name: Erika Winters Downey
Date: 06.07.2006

Braced Frame Elevations

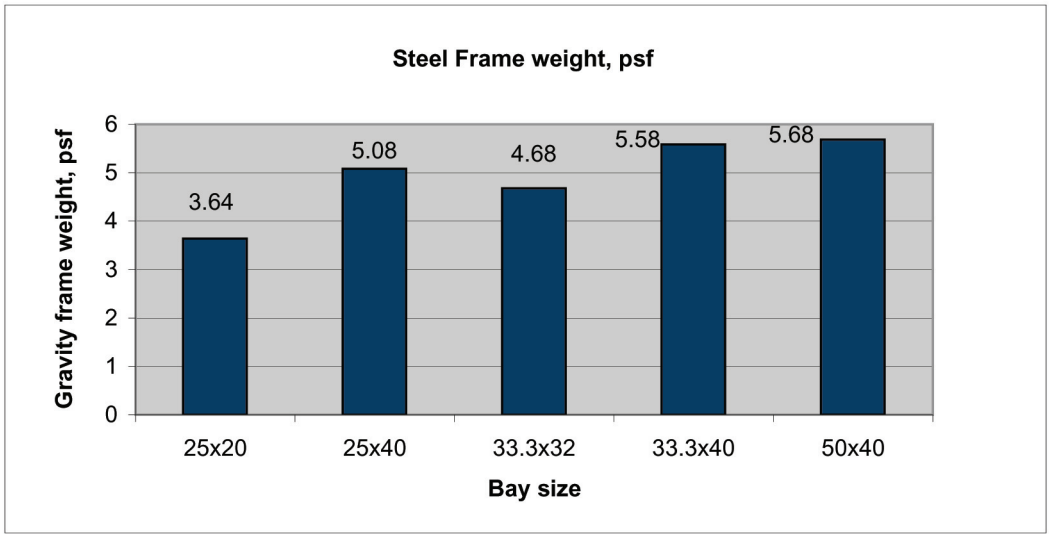


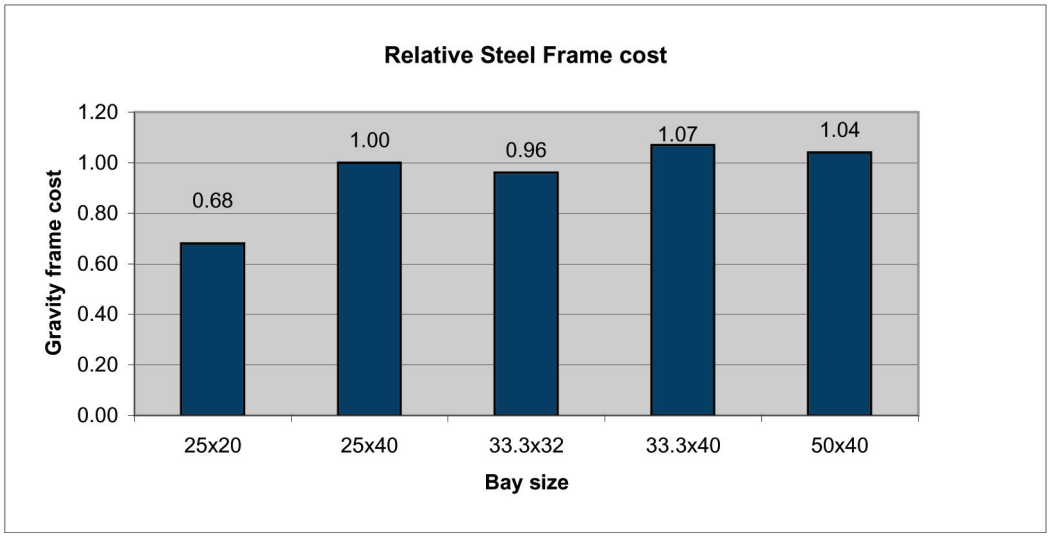
Steel SolutionsCenter
Your connection to ideas + answers

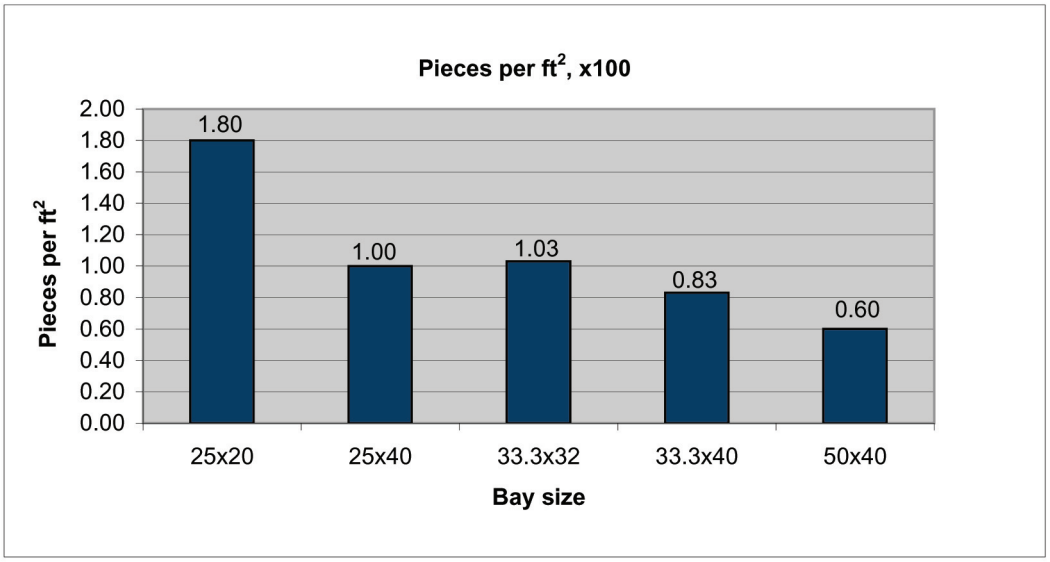
LAWRENCE, KS
OFFICE BUILDING
866.ask.aisc ■ solutions@aisc.org

Title: Braced Frame Elevations
Name: Erika Winters Downey
Date: 06.07.2006

Steel Weight and Cost Charts







Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Steel Weight and Cost Charts

Project:	**Lawrence Office Building**	Date:	**6/9/2006**
Location:	**Lawrence, KS**	Engineer:	**Erika Winters Downey**
Company:	**Sunflower Steel**	Contact:	**Kristin Armstrong**

The charts on page 11 present data for structural steel frame weight, cost, and piece count in relation to bay size. The chart for cost has been normalized as a ratio using the 25 ft × 40 ft bay cost as unity. The cost figures shown are for the structural steel frame only and do not include an allowance for fabrication and erection.

By comparing various bay sizes, one can evaluate the optimal configuration for their project. Some observations to be made from these charts are:

- The cheapest cost and lightest weight occur for a 20 ft × 25 ft bay. As a tradeoff for low weight and cost, the columns are spaced fairly closely. This scheme does not fit well with the current architectural layout.
- Steel cost and weight seem to optimize when bays are as square as possible. A 32 ft × 33.3 ft bay (1067 ft^2) is lighter and cheaper than a 25' × 40' bay (1,000 ft^2).
- Large, open spans are possible with structural steel and will result in a column-free, flexible space. This is represented by the two larger bay studies, (40 ft × 33.3 ft and 40 ft × 50 ft). In this case, the larger 40 ft × 50 ft bay only has a small weight disadvantage and, surprisingly, a small cost advantage.

Studies like this are easy to perform using AISC's Floor Framing Steel Tool, a free download on our website!

Steel SolutionsCenter
Your connection to ideas + answers

866.ASK.AISC • solutions@aisc.org

Fire Protection

Project:	**Lawrence Office Building**	Date:	**6/9/2006**
Location:	**Lawrence, KS**	Engineer:	**Erika Winters Downey**
Company:	**Sunflower Steel**	Contact:	**Kristin Armstrong**

Per IBC 2003 Table 601, construction type IIB requires no fire protection or spray-applied fire resistive material for any part of the building. Type IIB construction is that in which the major building components are of non-combustible material. The occupancy is Type B (Business) from IBC section 302.

- Per IBC Table 503, this type is allowed 4 stories at 23,000 ft^2 per story and a maximum height of 55 ft 0 in.
- If the building will be sprinklered, we can add 20 ft 0 in. to the ultimate height and increase the total number of stories by 1 according to IBC section 504.2.
- Allowable floor area can be increased by counting use of a sprinkler system and by taking full advantage of building frontage.
  - Per section 506.3, we can increase the allowable square footage per floor by 200% if the building will be sprinklered.
  - Section 506.2 governs frontage increases. Maximum for separation on all four sides of a building will give an area increase of 75%.

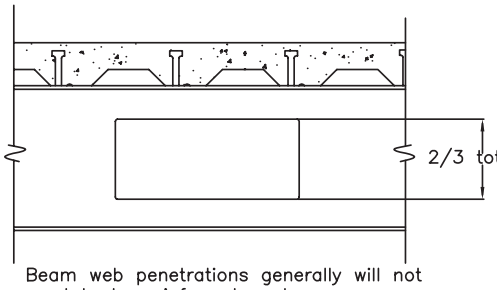
*In all, our building can be a maximum of 5 stories or 75 ft 0 in. tall. The maximum area of any one floor, taking into account sprinklers and frontage, is 86,250 ft^2. However, the total allowable building area is governed by IBC section 506.4. The maximum area is 3 times the floor area for 3 story or higher buildings. Therefore, for a 4- or 5-story building with equal floor sizes, the maximum area per floor would be ¾ or ⅗ of the maximum total building area, respectively.

Our building is 3 stories tall at 16,000 ft^2 per floor for a total of 48,000 ft^2. This easily falls into the applicable range of these requirements. The table below summarizes this data.

Type IIB Construction Limits Per IBC 2003

	Maximum Total Stories	Maximum Area of 1 Floor	Maximum Total Building Area*	Maximum Total Height
Base Value	4	23,000 ft^2	69,000 ft^2	55’-0”
Sprinklers + Full Separation	5	86,250 ft^2	258,750 ft^2	75’-0”

Details



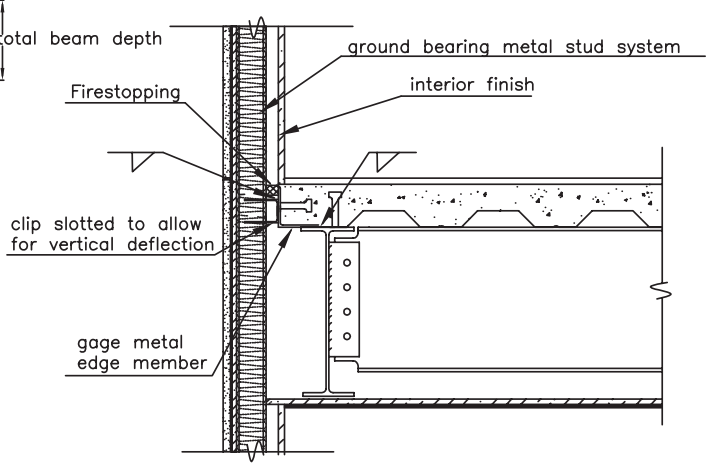
Beam web penetrations generally will not need to be reinforced as long as :

1) opening is in middle $\frac{2}{3}$ of beam span

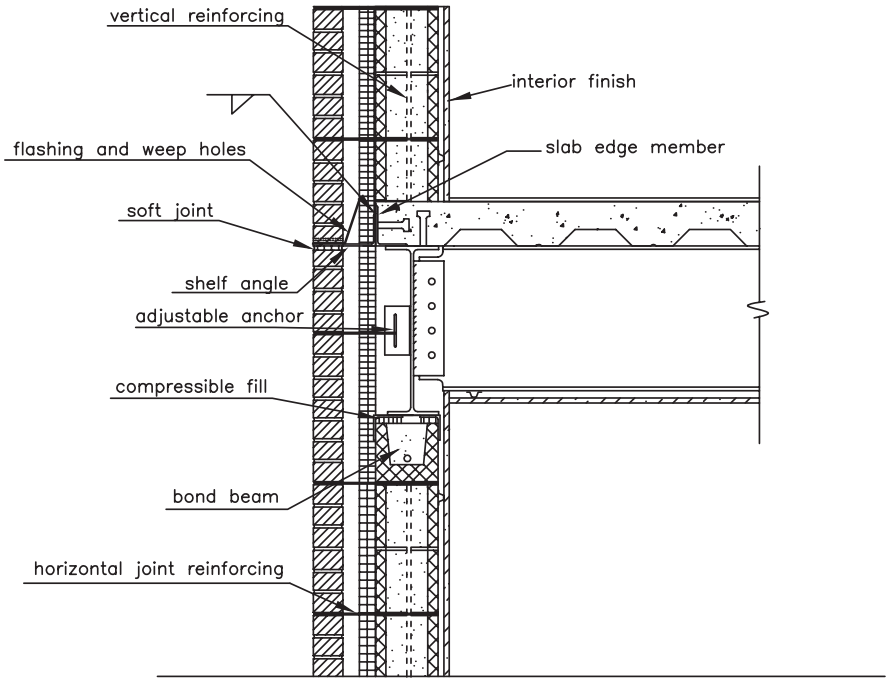
2) opening height to total beam depth is $\leq \frac{2}{3}$

Do not place penetration near a point load.
Engineer of Record to verify results using AISC's Design Guide 3.

1 beam web penetration detail

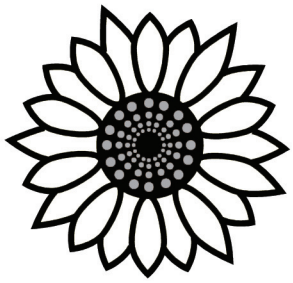


2 light gage curtain wall detail



3 masonry curtain wall detail

Steel SolutionsCenter Your connection to ideas + answers	FAIRWAY LODGE AT THE BILTMORE	Title: FIRST LEVEL FLOOR FRAMING
		Name: Jason R. Ericksen
	866.ask.aisc ■ solutions@aisc.org	Date: June 23, 2004



October 26, 2006

SUNFLOWER STEEL
SMALLTOWN, KS

Kristin Armstrong
Downey & Mut Architects

Ms. Armstrong:

Sunflower Steel is pleased to offer our budget and schedule for steel fabrication and erection for the Lawrence Office Building project.

Fabrication: $358,000.00*

Includes structural steel, detailing and shop drawings, metal deck, freight, standard shop primer, base plates, headed studs, and anchor bolts.

Erection: $170,000.00*

Includes labor, supervision, and equipment necessary to erect structural steel frame and metal deck.

Schedule:

Detailing and Advance Bill of Material: 2 weeks*
Completion and Submittal of Shop and Field Drawings: 2 weeks*
Fabrication after receipt of approved drawings: 5 weeks*
Steel and deck erection: 5 weeks*

We look forward to your response and working with you on this project.

Sincerely,

Sunflower Steel

**AISC Note: The reader should NOT take these figures as market guidelines, since pricing and schedule will vary by region, fabricator, present market conditions, etc. The reader should either contact their local fabricator or the Steel Solutions Center for any questions they may have.*

Steel SolutionsCenter

Your connection to
ideas + answers

In today's fast-paced, competitive construction industry, success is often a matter of access to the right information at the right time. AISC's **Steel Solutions Center** makes it easy for you to explore traditional and innovative solutions enabling you to find, compare, select, and specify the right system for your project by providing:

- Framing studies
- Total structural systems, with project costs and schedules
- Framing systems that will reduce the total project cost
- An outline of the positive impacts structural steel will have on your project, including faster schedules for reduced construction loans and earlier revenue generation.

Call or e-mail AISC's **Steel Solutions Center** today to explore a steel solution for your next project.

866.ASK.AISC
(866.275.2472)

solutions@aisc.org

There's always a solution in steel.

AISC Marketing, LLC.
One East Wacker Drive, Suite 700
Chicago, IL 60601

312.670.2400 www.aisc.org