

INTRODUCTORY GUIDE FOR INSTRUCTORS

Introduction

The primary purpose of this teaching aid is to provide a realistic and comprehensive experience in designing a steel building.

Core Educational Goal

This project was developed in conjunction with a structural design firm and experienced professors to ensure the building design and accompanying materials reflect industry-standard practice.

This teaching aid addresses the difficulty many academic programs face in securing and using drawings for real structures. It provides students with a design challenge that may only be accessible to those with contacts in practice who are willing and able to share project information. The materials offer the flexibility and opportunity to incorporate the experience of working with a complex, realistic building, making the learning experience highly valuable for a wide variety of capstone or advanced design courses.

Supporting Diverse Instruction

This resource is designed to be effective for professors across the spectrum of professional experience. The comprehensive nature of the instructor guides, the detailed solutions, and the structured modules offer a robust starting point for instructors who may not have extensive professional design experience but are tasked with teaching a design course.

Also, by providing verified project plans and solutions, the aid allows instructors to focus their time on pedagogy and conceptual understanding rather than spending significant time developing and verifying project data.

Modular Design

This teaching aid is built on a framework of multiple self-contained modules, that together, give a comprehensive look at the structural design process. This modular format provides instructors with the opportunity for a customizable scope. Instructors can select and sequence modules based on their course's specific learning objectives, disciplinary focus, and available time. It is not necessary to use all of the modules.

Content in each module focuses on the design of this project. It is assumed that the modules will be used alongside other instructional material that teaches the "how-to," which is beyond what these modules provide. For example, student are asked to design beams, but the material provided here does not outline the steps of beam design; it only provides information on the project that student would work with to perform this task.

While the modules naturally build upon each other (i.e. the output from one module is used as the input for the next), a single set of design criteria is available. The instructor can provide

some or all of these design criteria along with any module, ensuring students have the required starting data and do not have to have completed the previous modules.

Longevity and Future Development

The developers understand the need for fresh content for subsequent classes. Given the significant effort required to produce this teaching aid, a new set of plans is not anticipated annually. Instead, we support longevity through continuous adaptation and future releases:

- Keeping the Project Fresh: Instructors can adapt the project year-to-year by focusing on different areas of the building or by changing the project locations assigned for design (e.g., assigning different columns or beams).
- Anticipated Future Solutions: We anticipate releasing additional detailed solutions for other areas of the building over the course of the next year.
- Future Building Release: We envision releasing a new structure with the next major code cycle to provide an additional project and to ensure the teaching aid remains current and relevant.

Alignment with ABET Student Outcomes

A table (in a separate document) provides an advisory mapping of the modules to the seven ABET Student Outcomes (SOs). This resource is intended to guide faculty in strategically designing and assessing their use of this material to meet accreditation requirements.

Note: The ability of any module to fulfill a specific SO is determined by the instructor's use of that module and the implementation of an assessment process. The ultimate responsibility for demonstrating ABET compliance rests with the program faculty and the institution.

Teaching Aid Organization and Navigation

File Structure Overview

The teaching aid is organized into folders for each module. All files are located on the AISC Educator Forum. As a courtesy to other instructors, we ask that solutions to assignments not be given to students in full or posted on a learning management system. Although there is value in students understanding the solution, posting a full version opens the opportunity for online sharing and academic integrity issues.

Module 0 contains the architectural and structural drawings, as well as the design criteria. It is not an instructional module.

Modules 1 through 8 are instructional modules. They each contain an instructor guide, Powerpoint file, student assignment prompts, and answer keys. Some modules also contain instructional videos and example calculations.

Module Breakdown

The project is structured into eight modules, as summarized in the table below. The Dependencies column indicates the required starting information if the instructor chooses to skip previous modules.

Module #	Primary Focus	Key Deliverable	Dependencies
1	Design Loads	Design loads based on architectural layouts and project location	None
2	Gravity Framing System and Design Criteria	Conceptual floor framing layout, including column locations, bay sizes, beam spacings, etc.	None
3	Floor and Roof System Design	Sizing of representative floor and roof beams (composite or non-composite)	<ul style="list-style-type: none"> • Module 1 -OR- <i>Module 0 Design Criteria</i> AND • Module 2 -OR- <i>Structural Drawing Set #2</i>
4	Gravity Column Design	Sizing of representative gravity columns	<ul style="list-style-type: none"> • Module 1 -OR- <i>Module 0 Design Criteria</i> AND • Module 2 -OR- <i>Structural Drawing Set #2</i>
5	Lateral Framing Design <i>Note: This module is not part of the original release of this teaching aid. It will be released at a later date.</i>	Design of lateral force resisting system (i.e. braced frames)	<ul style="list-style-type: none"> • Module 1 -OR- <i>Module 0 Design Criteria</i> AND • Module 2 -OR- <i>Structural Drawing Set #2</i>
6	Connection Design	Design of representative connections (i.e. simple connections, moment connections, and base plate)	<ul style="list-style-type: none"> • Module 3 -OR- Connection Demands + <i>Structural Drawing Set #2</i>

7	Construction Documentation	Set of construction documents, including structural drawings and calculation documentation	Modules 1-6 as directed. Supplement with <i>Module 0 Design Criteria</i> and <i>Structural Drawing Set #2</i> as needed.
8	Construction Management <i>Note: This module is not part of the original release of this teaching aid. It will be released at a later date.</i>	Schedule and quantity take-offs for steel scope	Module 7 -OR- <i>Structural Drawing Set #1</i>

Drawings

The drawing package includes multiple variations of completeness, allowing the instructor to provide the set that best fits the scope of their class.

Architectural Drawings

- Set #1: Architectural plans (showing column grid) and building sections
- Set #2: Architectural plans (no grid or columns shown) and building sections

Structural Drawings

- Set #1: Full set of structural drawings with all sizes shown. Includes general notes, load maps, framing plans, column schedules, braced frame elevations, typical steel details, and typical slab on steel deck details.
- Set #2: Framing Plans with beam and column locations but no sizes. Column schedules showing the column splices but no member sizes. Braced frame elevations showing the brace configurations but no sizes.
- Set #3: Framing plans that show only the column grid (i.e. no beams). Elevations of braced frame locations without the actual braces (i.e. for students to determine the brace configuration).

Teaching Materials

To ensure effective use, instructors should understand the scope and intent of the supporting materials:

Powerpoint Files (Conceptual Focus)

The provided Powerpoint files assume students have prior knowledge of general design processes, mechanics, and core concepts taught in this course or as a prerequisite. The slides focus on big-picture concepts and highlight the specific features or challenges unique to this building (e.g., irregular geometry, specific load conditions). Instructors should not assume the Powerpoint files alone are sufficient to teach the design concepts, as they are not intended to teach structural concepts from scratch.

Solution Keys

The answer keys contain a few solutions for select locations in the building; they are not a full set of calculations for the entire structure. These solutions were selected to provide example calculations for typical locations for the instructor to review.

The solutions assume the given design criteria, but students may have chosen different deck types, beam arrangements, etc. Therefore, student answers may vary. The provided solution is one possible answer, not the only correct answer. In all cases, the provided solutions are consistent with what is shown on the final drawings.

Note that future solutions for future areas (e.g., beam design at the main roof, joist design at the upper penthouse roofs, alternative lateral force resisting systems, etc.) may be provided at a later date.

Project Introduction

This teaching aid centers on the design of a multi-story, steel-framed commercial structure. Understanding the building's context, location, and key features is essential before starting any module.

Building Overview and Scale

The project building is a seven-story mixed-use structure, using a steel framing system suitable for urban commercial and office space.

- Structure: Seven stories above grade, featuring an occupiable roof terrace and mechanical penthouse structure.
- Approximate Dimensions: The structure has an approximate footprint of 285 ft x 120 ft, with typical floor-to-floor heights of 16 feet.
- Design Focus: This teaching aid focuses specifically on the steel framing, including gravity system, lateral system, and connections.

Project Location and Site Data

The site location dictates the environmental loads (i.e. snow, wind, and seismic), which are determined in Module 1. The following geographic information was selected for this design.

- Geographic Location: The project is assumed to be located in Tulsa, Oklahoma. The instructor may opt to select a different location to change the loads, which can increase the longevity and reuse of the project framework
- Site Class: C (Very Dense Soil and Soft Rock)
- Risk Category: II

Key Architectural Features

Several architectural elements create unique loading demands and challenges:

- Irregular Geometry: The building features cantilever framing at one end and a slightly angled north face, introducing complexity beyond a simple rectangular box. (Note: For

some load calculations, students are encouraged to simplify the shape to a rectangular box.)

- **Amenity Space:** Level 2 features an amenity space with higher loading demands than the typical office space floors (Levels 3-7).
- **Mechanical Penthouse:** The penthouse introduces a significant concentration of heavy MEP live loads (e.g., 125 psf) and creates additional snow drift scenarios on the main roof.
- **Roof Terrace:** An occupiable main roof is designed for assembly loads (100 psf live load).

Advantages of Using Steel

Steel was selected as the primary structural system for this building due to its inherent advantages in efficiency, flexibility, and performance.

- *Speed of Erection:* Steel construction enables a faster erection schedule compared to conventional materials. Prefabricated steel components can be precisely fabricated off-site, reducing on-site labor and minimizing weather-related delays. The modular nature of steel framing allows for rapid assembly, often resulting in shorter construction timelines, earlier building enclosure, and accelerated overall project delivery. This efficiency can also reduce general conditions costs and facilitate faster occupancy or tenant fit-out.
- *Sustainability:* Steel is a highly sustainable building material. It is 100% recyclable, and the average new structural steel member from a domestic mill contains an average of 93% recycled material. Steel can be recycled over and over again with no loss of properties. In fact, the American steel industry is the least carbon-intensive of all major steel-producing countries. Additionally, steel construction generates less on-site waste due to precise prefabrication, and its adaptability allows for easier future modifications or deconstruction, supporting a circular building economy.
- *Long Spans and Architectural Flexibility:* Steel provides efficient and economical solutions for long spans often required in modern office and amenity spaces. By minimizing the number of interior columns, the system allows for greater architectural flexibility in floor plan layout, easy integration of modern MEP systems, and ease of future renovation or reconfiguration of tenant spaces.
- *Efficiency with Irregular Geometry:* Steel is exceptionally well-suited to handle the project's irregular framing demands. This is particularly true for the cantilever framing at the east (sloped) face of the building.
- *Weight Advantage:* Steel can offer a reduced dead load compared to equivalent systems in other materials. This weight advantage can be particularly advantageous for minimizing seismic forces and potentially reducing foundation costs due to lighter overall vertical loads.

Governing Codes and Design Criteria

The design and analysis for this project are governed by the following codes and standards:

- *Specification for Structural Steel Buildings* (ANSI/AISC 360-22)
- *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7-22)
- *International Building Code* (IBC 2024)

The complete design criteria are provided as a separate document in Microsoft Word format so that the instructor may easily adjust and select what content to share with the class. The document also summarizes the design loads (i.e. dead, live, snow, wind, and seismic). Supporting calculations for determining the design loads can be found in Module 1.

The drawings contain General Notes provided as an example from the consultant. Please note that these do not represent AISC's recommendations for best practices.

Instructor Flexibility and Customization Opportunities

Flexibility has intentionally been built into this teaching aid, allowing instructors to easily adapt the scope, complexity, and constraints of the projects to match their course objectives. A few specific customization options are provided here:

Load Case Complexity

Instructors are encouraged to use simplification options to ensure that students focus on steel member design, rather than getting bogged down in complex load calculations. All solutions provided assume these loads are handled in one specific way, but the following adjustments can be made:

- **Live Load Reduction:** The provided solutions incorporate live load reduction. Instructors may opt to instruct students to neglect live load reduction.
- **Snow Loads:** In modules where snow loads are required (e.g. for roof framing design and column selection), snow loads could be provided, rather than requiring the students to calculate them in Module 1. Additionally, they could be instructed to assume an approximate uniform snow drift for this preliminary design.
- **Wind and Seismic Loads:** Similar to the snow loads, the demands can be provided in lieu of the calculations in Module 1. For example, the design loads could specifically be provided at each level of each braced frame.

Adjusting Scope and Depth

The sheer size of the building offers inherent flexibility in the assignment scope. Instructors can easily adjust the number of components required for design. For example, instead of designing all typical columns, the assignment can be limited to one interior and one exterior column, or only to the most heavily loaded floor level.

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Development Team

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Disclaimer

While every effort has been made to ensure the accuracy and realism of the project, this teaching aid is intended purely for educational purposes and should not be used as the basis for actual construction.