Stepping Up

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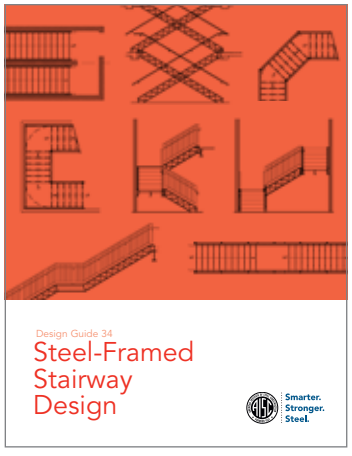
Timothy Hursley

Knowing how to frame your structural steel around stairs—and the stairs themselves—will help take your multi-story projects to the next level.



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STAIRWAY DESIGN HAS been, shall we say, up and down over the years.

At one point, stairways, handrails and guards were fully designed and detailed in the design documents. In the recent past, their presence on design documents became minimal or they were simply delegated to the fabricator. Little oversight or review was required or necessary.

However, with recent changes to the design code, ASCE/SEI 7-16 *Minimum Design Load and Associated Criteria for Buildings and Other Structures*, and more rigorous review requirements from the design team and authority having jurisdiction (AHJ), the design, layout, fabrication and erection of steel stairways have become a complex and involved process.

In an effort to set clear expectations and provide practical design information for the steel industry, AISC has developed a new publication: AISC Design Guide 34: *Steel-Framed Stairway Design* (available at **www.aisc.org/dg**). This new resource provides guidance for the design and layout of steel elements for steel-framed stairways, guards, handrails and re-

lated components. Background information regarding stairways, code requirements and design methods is presented, and complete design examples are also included. A handful of sample figures from the new guide are included in this article.

Design Criteria

The guide begins with a basic overview of stair and rail types, classes and nomenclature as defined by the National Association of Architectural Metal Manufacturers (NAAMM) based on AMP 510-92 *Metal Stair Manual* and AMP 521-01 (R2012) *Pipe Railing Systems Manual*. Layout recommendations depicting 2015 *International Building Code* (IBC) and Occupational Safety and Health Administration (OSHA) style stairs are included, along with recommendations to determine appropriate core opening dimensions, and the guide can be used as an aid in determining code requirements related to typical stair and rail layouts. One of the more common issues with stair design is the lack of support provided for the stairs in the structural design; another is insufficient opening sizes provided for the stairway. Several recommendations are included to provide layouts that allow for proper connection fit-up and help avoid these common design issues.

A key recommendation of the design guide is to use the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-16) and *Code of Standard Practice for Steel Buildings and Bridges* (ANSI/AISC 303-16) as reference documents for the design, detailing, fabrication and erection of steel-framed stairways (both are available at **www.aisc.org/specifications**). These criteria should be referenced as project requirements in the design documents, which will help ensure that all parties have the same set of criteria and expectations to meet.

Design loads are addressed per ASCE/SEI 7-16. Additional loading requirements, per current OSHA Standards 1910.25 *Stairways* and 1910.29 *Fall Protection Systems and Falling Object Protection-Criteria and Practices*, are also presented in the design guide.

Seismic Considerations

Specific guidance to determine seismic design forces and serviceability requirements per ASCE/SEI 7-16 is also included in the new design guide. In the 2016 edition of ASCE 7, major changes have been made related to seismic relative displacements, requiring that stair designs accommodate seismic movements within buildings without creating an undesirable load path or unacceptable performance. The

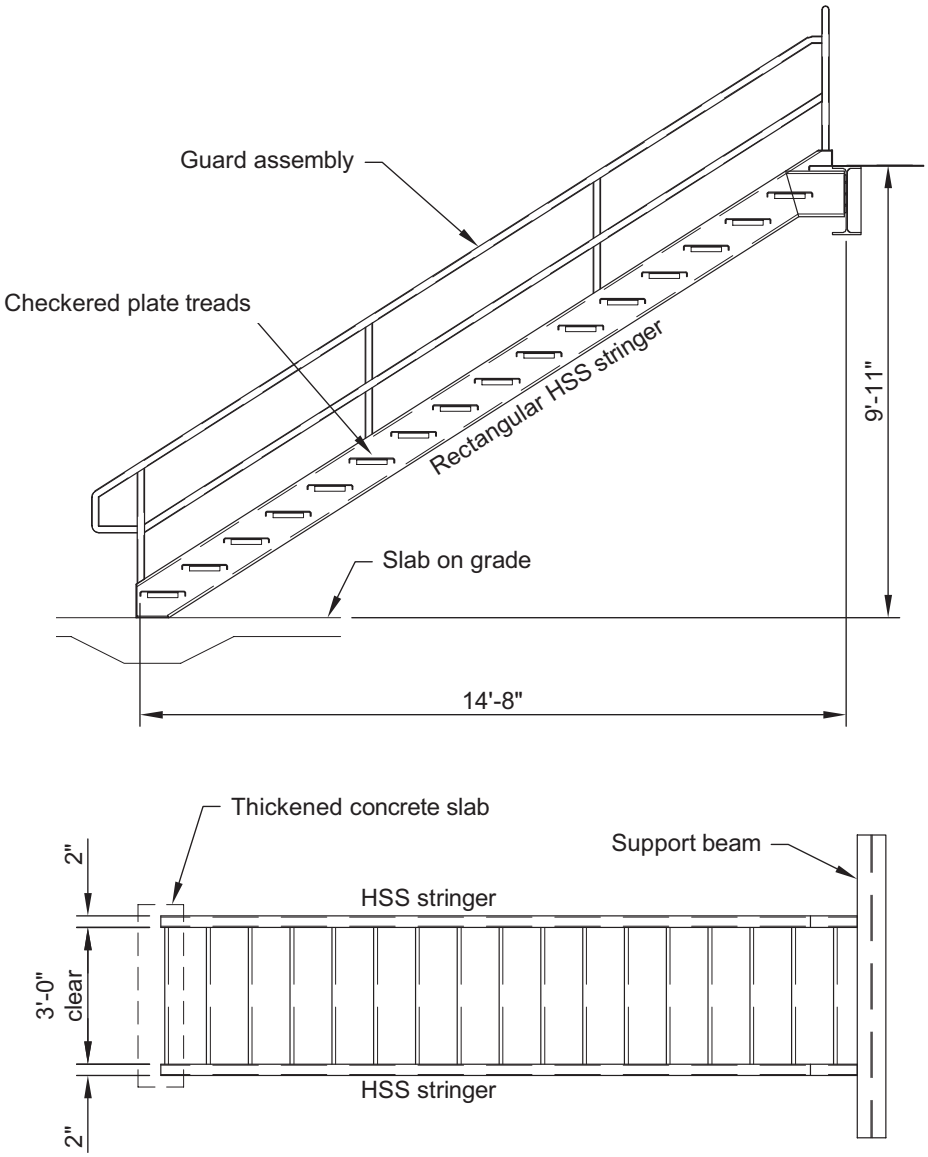

Fig. 10-9. Industrial stairway section and plan.

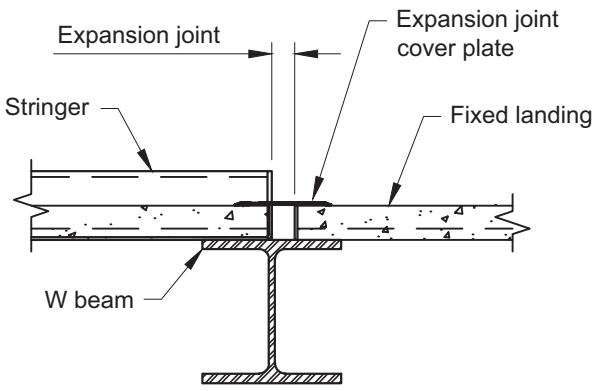

Fig. 6-20. Seismic displacement detail using expansion joint.

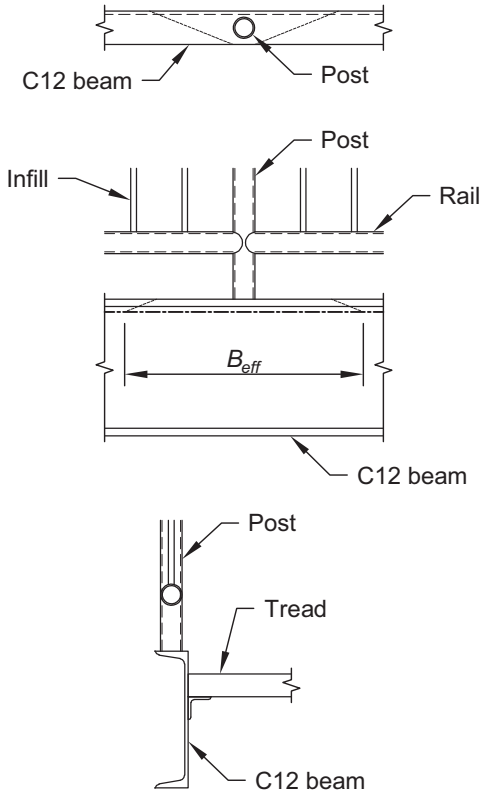

Fig. 10-8. Guard-post-to-channel-flange diagram.

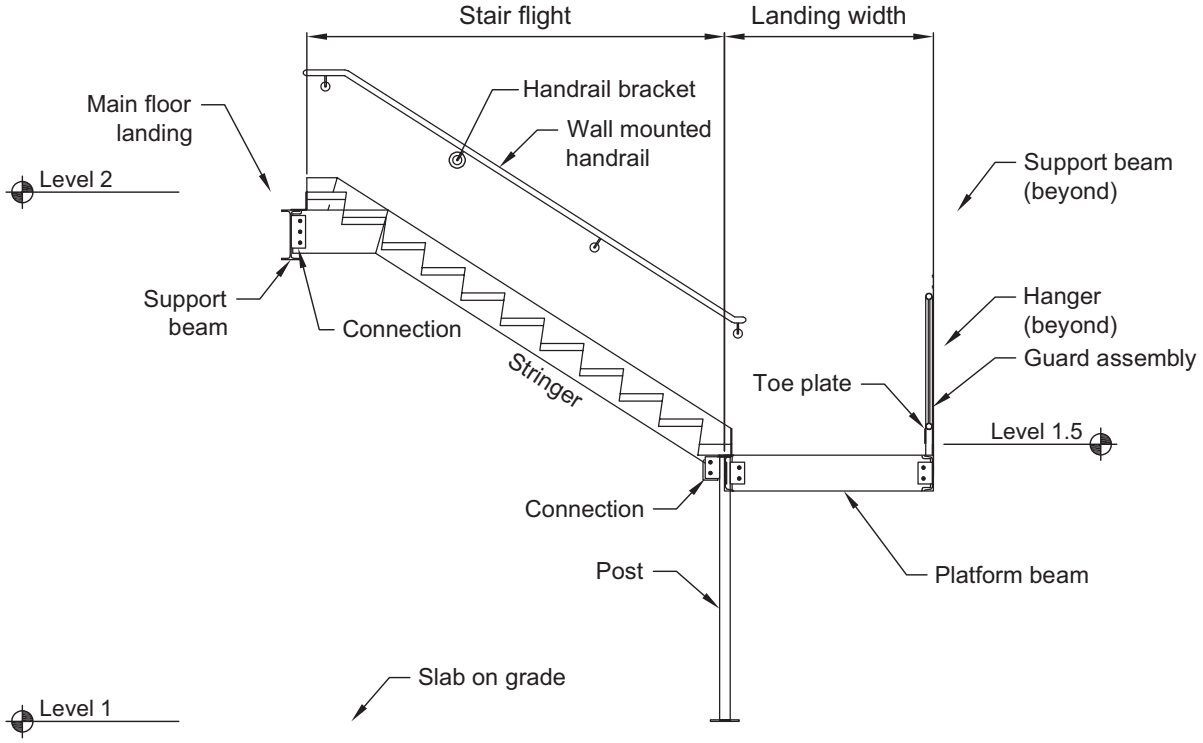

Fig. 2-12. Nomenclature—section views.

guide provides an overview of this criterion along with conceptual drift/sliding details. ASCE/SEI 7-16 also requires that stairs must be incorporated into the structural building model when the stair does not accommodate the seismic relative displacements using sliding or ductile connections. These code revisions will likely require changes to current stair design, layout, detailing and fabrication used in seismic regions.

Design Methodologies

Several recommendations and design methodologies are provided for typical stair elements. The application of loading on stringers and determination of forces can be solved using different methods. Various techniques and assumptions are explored to provide engineers with several options to verify design intent against real-world conditions. Determination of deflections at sloping beams (e.g., stair stringers) is covered as well to assist designers in accurately finding overall vertical deflection.

Recognizing that architectural requirements vary from project to project, the guide also discusses the aesthetic and engineering pros and cons of different member types. Figures and discussion are included for different aspects of the stair, guard and handrail elements, and each section provides conceptual details, recommendations and design resources.

Delegated Design

Because steel stairway design and layout is commonly delegated to others by the engineer of record, the design guide dedicates an entire chapter to this topic. The advantage with delegated design is that the team members with the expertise, experience and knowledge of steel stairways can provide the design and layout. Typically, delegated design will be completed by a specialty structural engineer to provide structural calculations and by the detailer/fabricator to provide the layout and fabricated stair. To accomplish this in an efficient and effective manner, the structural engineer of record and the architect of record need to provide critical information to the delegated design team. As such, the guide provides an overview of the critical information that should be provided within the design documents, as well as additional discussion regarding code compliance. The goal is to ensure that all project team members understand their scope of work and have clear expectations to meet project requirements.

Connections

Design and layout information regarding the members and connections of the guardrail and handrail elements are covered as well. Specific discussion is provided for the connection of a steel guard post to the top of an unstiffened channel flange. This detail is commonly used, and the guide provides recommendations to determine the capacity of the channel to resist the moment imposed by the guard post.

Using typical AISC connections can simplify the engineering process and make detailing and fabrication more straightforward and economical, and using similar connections for the main steel structure and on steel-framed stairways allows for greater repetition and efficiency. Considering this, the design guide provides figures of simple shear connections, hangers, moment connections, bracing and connections to non-steel members. References and guidance are also included to aid designers in finding the appropriate sections within the 15th edition AISC *Steel Construction Manual* (**www.aisc.org/manual**) as well as other available resources.

Additional guidance is provided related to lateral bracing and diaphragm design for stairs subjected to lateral loads. When considering seismic forces, it is critical that stair designers carefully determine the load path when implementing sliding or drift details.

Additional Considerations

Other topics covered in the design guide include construction tolerances, galvanizing, long spans, vibration and erectability. The intent is to make stair designers aware of these potential issues so that appropriate coordination is completed in advance of finalizing the design.

Several design examples are included, covering commercial and industrial stairs, with the industrial stair example stepping through the determination of seismic design forces. Various member design examples are included, following the design methodologies discussed throughout the guide, and specific connection checks for stair elements are also covered.

Overall, Design Guide 34 provides adequate information for structural engineers to design steel-framed stairways, as well as guidance on delegating this work to other engineers or stair designers. Combined with practical knowledge and sound engineering judgment, it can help optimize any steel stairway design. ■