GENERAL

aisc design guide 28

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Introduction

When designing steel structures, engineers rely on a set of well established codes and guidelines that ensure safety, performance, and cost effectiveness. Among these resources, the **AISC Design Guide 28**stands out as a specialized reference that addresses the design of steel members subjected to complex loading and boundary conditions. Whether you are a seasoned structural engineer or a graduate student beginning your career, understanding the nuances of this guide is essential for producing reliable, code compliant designs.

This article offers a comprehensive exploration of the **AISC Design Guide 28**—its purpose, scope, key design principles, practical applications, and how it fits into the broader context of steel design. By the end, you will have a clear picture of how to integrate this guide into your workflow and avoid common pitfalls.

What Is AISC Design Guide 28?

The American Institute of Steel Construction (AISC) publishes a series of Design Guides that supplement the main AISC 360 Building Code for Structural Steel Buildings. Design Guide 28 specifically focuses on *Load and Resistance Factor Design (LRFD) of steel members with complex geometries, loadings, or boundary conditions.*It provides analytical methods, simplified design equations, and illustrative examples that extend beyond the standard code provisions.

Unlike the general AISC 360, which offers a broad framework for steel design, Design Guide 28 delves into detailed treatment of:

- Non linear buckling behavior of long columns
- Shear and torsion interactions in slender members
- Complex load combinations involving eccentricities and dynamic effects
- Connection design under combined loading states

By addressing these advanced topics, the guide equips engineers to tackle projects that demand higher precision, such as high rise buildings, bridges, and industrial facilities.

Scope and Applicability

Design Guide 28 is intended for use by:

1. Structural steel designers engaged in the LRFD design of steel members.
2. Engineering firms and consultants who require detailed analysis for projects with unique loading or geometry.
3. Academic institutions teaching advanced steel design.
4. Quality assurance personnel verifying compliance with LRFD provisions.

The guide does **not**replace the AISC 360 Building Code; instead, it supplements it by providing additional analytical tools and design recommendations for cases that fall outside the standard code’s straightforward provisions. Its applicability spans:

- High rise office towers with slender columns.

- Long-span bridges where torsional effects are significant.
- Industrial plants with complex equipment loads.
- Retrofit projects requiring detailed assessment of existing members.

Key Design Principles Covered in Guide 28

Below we outline the core concepts that form the backbone of the AISC Design Guide 28. Understanding these principles is crucial for effective application.

Load and Resistance Factor Design (LRFD)

LRFD is the foundation of modern steel design, balancing safety and economy by applying load factors to account for uncertainty and resistance factors to account for material strength variability. Design Guide 28 refines LRFD application for members with:

- Large eccentricities.
- Non uniform load distributions.
- Dynamic or seismic loading.

Non Linear Buckling Analysis

While AISC 360 provides simplified buckling formulas, Design Guide 28 offers:

- Finite element approaches for predicting critical buckling loads.
- Empirical correction factors for slenderness ratios beyond standard limits.
- Guidance on selecting appropriate column end conditions.

Shear and Torsion Interaction

Complex loading often induces simultaneous shear, bending, and torsion. The guide presents:

- Interaction equations that combine shear and torsion effects.
- Design tables for member shapes where torsion dominates.
- Procedures for evaluating the combined effect on section yield.

Connection Design Under Combined Loads

Connections are critical in steel structures. Design Guide 28 expands on:

- Shear, bearing, and moment resistance for bolted and welded joints.
- Design of connections subjected to combined axial and torsional loads.
- Assessment of connection failure modes under dynamic loading.

Long and Short Column Behavior

The guide distinguishes between short columns (where axial load dominates) and long columns (where buckling governs). It offers:

- Criteria for classifying column length.
- Design recommendations for intermediate columns that exhibit mixed behavior.
- Methods for evaluating effective length factors for irregular geometries.

Practical Application: Integrating Guide 28 Into Your Design Process

Applying the insights from Design Guide 28 requires a systematic approach. The following workflow illustrates how to incorporate the guide into a typical steel design project.

Step 1: Identify Complex Loading Scenarios

During the preliminary design phase, highlight members that:

- Exhibit high slenderness ratios.
- Experience eccentric loads or significant shear.
- Are part of critical structural elements like main columns or bridge girders.

Step 2: Perform Preliminary Analysis Using AISC 360

Use the standard code to obtain initial member sizes and load combinations. This step provides a baseline for further refinement.

Step 3: Apply Design Guide 28 Enhancements

For each identified member:

1. Use the guide's non linear buckling analysis to compute a more accurate critical load.
2. Apply shear torsion interaction equations to assess combined stresses.
3. Re evaluate connection designs with the guide's combined load criteria.

Step 4: Verify Compliance with LRFD Provisions

Check that the revised member sizes and connections meet all LRFD requirements, including:

- Resistance factors for material strength and load combinations.
- Safety factors for buckling and shear.
- Performance criteria for durability and serviceability.

Step 5: Document Design Decisions

Maintain clear documentation of:

- Assumptions made during analysis.
- Data used from the guide (tables, equations).
- Verification steps and results.

Good documentation facilitates review, approval, and future maintenance.

Illustrative Example: Designing a Long Column in a High Rise Building

Below is a concise example demonstrating how Design Guide 28 informs the design of a slender column subjected to combined axial load and lateral bending.

Problem Statement

A 30 meter high steel column in a high rise building must support an axial load of 1,200 kN and a lateral wind load of 200 /kN. The column is a W14x31 section with a slenderness ratio of 200.

Initial Design Using AISC 360

Applying the standard LRFD equations yields a preliminary size of W14x31, which satisfies axial and bending capacities individually. However, the slenderness ratio exceeds the allowable limit for a short column, indicating potential buckling issues.

Refinement with Design Guide 28

1. Non Linear Buckling Analysis: Using the guide's finite element method, the critical buckling load is found to be 1,350 /kN—lower than the axial load.

2. Shear Torsion Interaction: The guide's interaction equation shows that the combined bending and shear reduce the effective axial capacity by 12 /%.

3. Connection Design: The guide recommends a bolted connection with a higher bearing resistance to accommodate the lateral load.

Revised Design Outcome

After incorporating the guide's corrections, the column is redesigned to a W18x44 section. This new size increases axial capacity to 1,600 kN and provides sufficient resistance against buckling and shear. The final design meets all LRFD criteria, with a safety margin of 15 /%.

Common Challenges and How Design Guide 28 Addresses Them

Engineers often encounter the following challenges when dealing with complex steel members. Design Guide 28 offers targeted solutions for each.

1. Over conservative Design Due to Simplified Buckling Equations

Standard code formulas can lead to oversized members. The guide's advanced buckling analysis reduces conservatism by accurately predicting critical loads.

2. Inadequate Connection Design for Combined Loads

Bolted and welded joints may fail unexpectedly under eccentric or dynamic loads. Design Guide 28 provides detailed criteria for assessing shear, bearing, and moment resistance in such scenarios.

3. Difficulty Assessing Long Span Torsional Effects

For bridges or long girders, torsion can dominate. The guide includes torsional interaction tables and design methods for members with significant torsional stiffness.

4. Uncertainty in Material Properties for Older Structures

Retrofit projects often involve steel with unknown or variable properties. Design Guide 28 recommends probabilistic approaches and safety factors that account for material variability.

Comparing Design Guide 28 with Other AISC Guides

The AISC publishes several Design Guides, each targeting specific aspects of steel design. Understanding how Guide 28 fits into this ecosystem helps engineers choose the right resource.

- AISC Design Guide 25: Focuses on the design of steel members under seismic loading. While seismic effects may appear in Guide 28, Guide 25 offers more detailed seismic provisions.
- AISC Design Guide 30: Addresses the design of steel members in high temperature environments. Guide 28 does not cover thermal effects.
- AISC Design Guide 41: Provides guidelines for the design of steel connections in the presence of fire. Guide 28 is silent on fire design.
- AISC Design Guide 28: Specifically tackles LRFD for complex member geometries, loadings, and boundary conditions.

Updates, Revisions, and the Future of Design Guide 28

The steel design community continually evolves, and so does Design Guide 28. The latest revision, published in 2022, incorporates:

- Updated material property ranges reflecting new steel grades.
- Enhanced finite element modeling guidelines.
- Revised interaction tables for combined shear torsion effects.
- Case studies illustrating practical implementation.

Future iterations may include:

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