

AISC Design Guides

Making Life a Little Easier

By Sergio Zoruba, Ph.D.

For many structural steel design challenges, AISC has a design guide to help you through.

The AISC Steel Solutions Center answers thousands of technical questions every year concerning structural steel design and construction. For the most part, the questions are based on AISC *Specification* provisions or design recommendations found in the AISC *Manual*. But then, there are a variety of questions with answers that can't be found in those two important publications.

Fortunately, AISC's *Design Guide* publications offer an abundance of design information on topics too broad for the *Specification* or *Manual*. Common design questions, such as how to account for shear in column anchorages, or when to use slip-critical bolted joints, are addressed in AISC design guides.

AISC design guides provide comprehensive guidance on specialized technical topics relevant to structural steel design, and they are authored by recognized industry experts. They can be ordered through the AISC web site at www.aisc.org/bookstore, or by calling 800.644.2400. All AISC members have free access to AISC's ePubs web site, www.aisc.org/epubs, where they can instantly download electronic copies of AISC design guides any time, anywhere. A brief summary of each design guide follows.

Design Guide 1: Column Base Plates

The AISC *LRFD Manual of Steel Construction* addresses the most common case for column anchorage design—axial compression. What to do if you also need to design for uplift, overturning moment, or shear? That's where *Design Guide 1* comes to the rescue. The guide discusses proper methods for column base shear resistance, suggestions for sizing plate

washers, and excellent recommendations from the experts.

A second edition of *Design Guide 1* is scheduled to be published later in 2005. It will address the new OSHA erection requirements that distinguish between posts and columns, as well as discuss base plate details pertaining to analysis assumptions of pin and fixed column anchorage, anchor rod pretension, contract documents, double-nutted anchorage configurations without grout and their design, regular and shear holes, fatigue, high-seismic design, applicable limit states, and base plate design examples.

Design Guide 2: Steel and Composite Beams with Web Openings

Design Guide 2 offers thorough guidance for the design of beams with circular or rectangular openings in their webs. Included in the design guide are LRFD and ASD design procedures for the effects of holes subjected to moment and/or shear. Most importantly, the guide covers design cases for both composite and non-composite steel beams, and includes a step-by-step procedure for checking, proportioning, and detailing beam web openings and reinforcement.

Design Guide 3: Serviceability Design Considerations for Steel Buildings, 2nd Edition

Did you know that the recommended maximum vertical deflection for an underhung crane runway beam is $L/450$? Recommended maximum serviceability values and considerations for a wide range of building applications are discussed in detail in *Design Guide 3*. This guide contains several tables with recommended maximum serviceability values for roofing, skylight supports, cladding,

ceilings, partitions, and equipment. The guide also presents the latest revision to existing vibration information due to human activity and machines as it relates to modal damping (a good supplement to *Design Guide 11: Floor Vibrations Due to Human Activity*). The guide contains information on cambering beams and how deflection issues relate to the construction of concrete slabs. Roof ponding cladding-structure interaction and membrane and metal roofs are also addressed.

Design Guide 4: Extended End-Plate Moment Connections, 2nd Edition

This second edition now addresses seismic and wind applications. It includes design procedures and examples for the four-bolt extended stiffened and unstiffened, as well as the eight-bolt extended stiffened, end-plate moment connections. Users will find that the guide contains a clarified design approach to seismic end-plate connection design compared to the recommendations found in FEMA 350. The basis for each design recommendation is outlined in detail and presented as a step-by-step procedure. Connection limit states are discussed in the guide to help designers understand the principles behind the behavior of extended end-plate moment connections.

Design Guide 5: Low- and Medium-Rise Steel Buildings

A great primer for designers involved in multi-story designs, *Design Guide 5* addresses many of the most common questions regarding the design of buildings. The guide includes design rules for economy, live load and bay size selection, composite floors, open web joist floors, wind load design, and other associated design topics.

It also discusses floor load capacity enhancement, shored vs. unshored construction, and underfloor duct systems.

Design Guide 6: Load and Resistance Factor Design of W-Shapes Encased in Concrete

Design Guide 6 contains more than 300 pages of LRFD composite beam-column design strength values. In addition, a thorough discussion of the use and design of composite columns is presented, covering practical design considerations, fire resistance, longitudinal reinforcing bar arrangement, ties, longitudinal reinforcing bar splices, connection of steel beams to encased wide-flange columns, shear connectors, base plates, erection, and temporary wind bracing during composite frame construction.

Design Guide 7: Industrial Buildings, Roofs to Column Anchorage

Design Guide 7 addresses all facets of industrial building design and includes a comprehensive section on crane runway design. Part I covers owner-established design criteria, roof systems, roof trusses, wall systems, framing schemes, bracing systems, column anchorage, and serviceability criteria. Part II concentrates on the complete design of industrial buildings with cranes and addresses fatigue, roof, wall, framing and bracing systems, crane runway girder design, crane runway fabrication/erection tolerances, and column design. Stepped column design is also discussed. A second edition of *Design Guide 7* will be published later in 2005.

Design Guide 8: Partially Restrained Composite Connections

Based on extensive research domestically and abroad, *Design Guide 8* introduces design criteria for designing with PR-CC connections. This approach affords the designer the ability to economize beam sizes for gravity loading or to resist lateral loads in unbraced frames. The guide contains several sections, including an introduction to PR-CC connections, covers analysis, moment-rotation curves, design procedures, and examples. As a bonus, the appendix contains a short but detailed discussion of story sway calculations.

Design Guide 9: Torsional Analysis of Structural Steel Members

An excellent introduction to the con-

cepts of torsion in open and closed cross-sections, this design guide facilitates calculations of torsional stresses and establishes a basis for design. For open-sections such as W-shapes, the normal and shear stresses due to both pure and warping torsion can be calculated using the guide. In addition, channel and Z-shaped open cross-sections are addressed, as well as closed cross-sections such as rectangular and round HSS and steel pipe. Several examples and design curves are included in the guide.

Design Guide 10: Erection Bracing of Low-Rise Structural Steel Buildings

Design Guide 10 addresses both permanent and temporary erection bracing, including an important chapter on construction phase loads. Topics addressed include column and column base (with extensive discussions of potential failure modes, including fracture of fillet welds between the two, bending failure of base plates, anchor rod rupture, buckling, pull, push-through, and push-out), discussions of tie members, beam to column connections, and diaphragms. In addition, wire rope diagonal bracing and connections are covered, as well as design of deadmen.

Design Guide 11: Floor Vibrations Due to Human Activity

Did you know that people in offices and residences do not like distinctly perceptible vibration, whereas people taking part in an activity will accept vibrations approximately 10 times greater? *Design Guide 11* has an entire chapter devoted to human response to floor motion, and addresses both walking and rhythmic excitations. There is also a chapter that addresses design for the effects of vibration on sensitive equipment. Special consideration for determining the natural frequency of open-web steel joists and joist girders is included. Several design examples are given, including interior office bays, footbridges, and mezzanines. Remedial measures are discussed in detail.

Design Guide 12: Modification of Existing Welded Steel Moment Frames Connections for Seismic Design

Where would you look to find information for upgrading existing seismic moment connections? Simple. FEMA 351/352 and *Design Guide 12*. This design guide discusses strategies and solutions for the upgrade of existing pre-Northridge

moment connections, including retrofit solutions with a welded haunch, bolted bracket, or reduced beam section (RBS). Based on experimental results, recommendations for modification of pre-Northridge moment connections are presented and discussed in detail. In addition, the guide discusses practical considerations for remedial work, such as removal and restoration of building finishes.

Design Guide 13: Stiffening of Wide-Flange Columns at Moment Connections: Wind and Seismic Applications

Do you need guidance in designing column stiffening for strong- and weak-axis moment connections? *Design Guide 13* contains this information and much more. The guide offers multiple examples for the proper design of transverse stiffeners, web doubler plates and diagonal stiffeners. Detailed discussions are included on topics such as unreinforced columns, stiffness considerations, force transfer and the economical selection of columns. Also covered are detailing recommendations for special cases, such as column stiffening for beams of differing depth and beam framing over columns. The appendix includes design recommendations for weak-axis moment connections, including research findings.

Design Guide 14: Staggered Truss Framing Systems

Originally developed in the 1960s, staggered truss framing continues to be a competitive framing configuration for mid-rise structures. Topics addressed in *Design Guide 14* include diaphragm action using hollow-core precast plank floor slabs and the design of truss members and connections in wind and low-seismic applications ($R = 3$). Special topics such as mechanical design considerations, plank leveling, erection, coordination with subcontractors, foundation overturning and sliding, and balcony design are also covered.

Design Guide 15: AISC Rehabilitation and Retrofit Guide

If you periodically work in retrofitting old structural steel buildings, then you definitely need *Design Guide 15* and its included CD companion, the *Shapes Database v3.1H*. *Design Guide 15* contains over 300 pages of historical information, including dimensional and geometrical properties of structural steel and wrought iron sections. The yield and tensile strengths of structural steels, includ-

ing ASTM A7 and A9, are tabulated over the past 100 years. Allowable stress information for bolts, rivets, and welds over the past several decades are tabulated. There are chapters dedicated to the evaluation and enhancement of existing structural systems and an appendix that outlines historical changes to the AISC specifications since their inception.

**Design Guide 16:
Flush and Extended Multiple-Row
Moment End-Plate Connections**

This design guide covers two- and four-bolted flush unstiffened, and four-bolt stiffened moment end-plate connections. This design guide includes design examples for multiple row $\frac{1}{2}$ and $\frac{1}{3}$ extended unstiffened moment end-plate connections, as well as the $\frac{1}{3}$ stiffened version. For pre-engineered metal buildings, there is a chapter dedicated to gable-frame panel-zone design. In addition, design procedures for using snug-tightened and pretensioned bolts are addressed.

**Design Guide 17:
High Strength Bolts – A Primer for
Structural Engineers**

A must-have design guide on structural bolting, this primer assists engineers in understanding the basis of the requirements in the *RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts*. The guide also includes a chapter dedicated to the static strength of rivets, which can be invaluable for retrofit work. The guide addresses bolt installation, inspection, behavior, and design. In addition, specialized topics are covered, including the proper use of washers, galvanized bolts, reuse of high-strength bolts, joints with combined bolts and weld, and surface coatings.

**Design Guide 18:
Steel-Framed Open-Deck Parking
Structures**

Design Guide 18 addresses the design of steel parking structures using five unique types of deck systems: cast-in-place reinforced concrete, cast-in-place post-tensioned slabs, precast double tees, filigree systems, and hollow-core plank. Deck system design parameters and framing systems are discussed in detail, including design examples in LRFD and ASD. In addition, there are several chapters that examine mixed-use structures, fire protection requirements, barriers and facades, stairs and elevators, and corrosion protection for exposed steel in open-deck parking structures.

**Design Guide 19:
Fire Resistance of Structural Steel
Framing**

Have you ever been confused by fire protection requirements and systems? This new design guide covers all facets of structural steel fire resistance, including building code requirements, thermal restraint, rated designs, the standard fire test and fire protection materials. There is ample fire design information for steel columns and associated fire protection systems and enclosures. In addition, steel roof and floor systems, including steel trusses, are discussed and examples given for determining the required thickness of protection coatings. There is also a chapter on spray-applied fire resistive material testing and inspection, as well as one on engineered fire protection. ★

Sergio Zoruba is a senior engineer in AISC's Steel Solutions Center in Chicago.