IF YOU'VE EVER ASKED YOURSELF "WHY?" about something related to structural steel design or construction, *Modern Steel Construction*'s monthly Steel Interchange column is for you! Send your questions or comments to solutions@aisc.org.

Historic Lattice Columns

We are examining an existing building constructed circa 1919. The columns in the building consist of double-angle flanges with lattice steel webs. We are trying to determine allowable loading for the column, but have been unable to find any documented information. Any help would be appreciated.

I am not sure what type of documented information you are looking for. You may be able to find discussions in old textbooks, but I don't think that you will find capacity tables. The design of such compression members usually started with the calculation of the basic section properties and determination of the unit compressive stress. The elements also had to be joined together to act as a unit. To act as a unit, the buckling resistance of the individual element has to be at least as great as that of the member as a whole.

Kurt Gustafson, S.E., P.E.

Evaluation of an Existing Structure

I am working on an addition to a 1922 steel-framed building. When I check the columns using ASD (unreinforced concrete encased, $F_a = 18000 - 70L/R$), many are overstressed. However, the results appear to be better using LRFD.

Is there anything in the AISC specification that would require that we use ASD and not LRFD to check the existing structure? Is it reasonable to apply today's load and resistance factors to historic steel?

There is nothing in the AISC specification that defines what load approach must be used in the analysis, design, or evaluation. Either method is acceptable as long as you stay consistent in the load and capacity sides of the design equations. Current requirements are often applied to existing structures. See Appendix 5 of the 2005 AISC specification for more information on evaluating existing structures.

Kurt Gustafson, S.E., P.E.

Shear Stud Requirements

Is there a minimum height requirement for studs used in the design of composite beams?

Section I1.3 of the AISC specification requires that studs shall not be less than four stud diameters in length after installation. Section I3.2c of the AISC specification requires that, when formed steel deck is used, after installation the studs shall extend not less than 1½ in. above the top of the steel deck. See Chapter I of the AISC specification for other stud requirements.

Amanuel Gebremeskel, P.E.

Crane Runway Forces

Where are "crane runway horizontal forces" addressed in the current AISC specification? This was formerly covered in Section A4.3 of the 1989 ASD specification. If it is not addressed in the new specification, where do I need to go to find these requirements?

The AISC specification no longer stipulates load requirements. Instead, loads and load combinations are now covered by the applicable building code or the ASCE 7 load standard. Crane loads are covered in Section 4.10 of ASCE 7-05.

Kurt Gustafson, S.E., P.E.

Expansion Joint Location

What is the maximum length permitted between expansion joints in a steel building?

There is no one specific requirement for permitted length between expansion joints in a steel building. The determination of when expansion joints should be introduced in a building structure is dependent on many factors, including the configuration of the structure, type of use, and climatic conditions, among others. You may want to look at Technical Report No. 65, *Expansion Joints in Buildings*, published by the Federal Construction Council (1974). Key points from this reference are summarized in the 13th Edition AISC *Steel Construction Manual* beginning on page 2-31. The full document can be read online and is also available for purchase at **www.nap.edu/catalog/9801.html**.

Kurt Gustafson, S.E., P.E.

Reduction for Splice Length

In the 3rd Edition AISC LRFD manual, footnote "e" in Table J3.2 requires that a 20% reduction is taken on bolt patterns in tension splices where the bolt pattern length measured parallel to the line of force is greater than 50 in.

Is any tension connection considered a splice? I am evaluating diagonal tension members in a truss that connect to the top and bottom chords as well as vertical members. Does this reduction apply?

The underlying requirement is to reduce the available shear strength by 20% of an end-loaded bolt group that exceeds 50 in. in length due to the uneven load distribution between such bolts. The connections you describe are likely such a case and, if the joint length exceeds 50 in., you do have to use the reduced capacity. The footnote was probably written with the term "splices" because it was rare to have connections other than splices of this length in an end-loaded configuration.

Amanuel Gebremeskel, P.E.

Seismic Retrofit of 1931 Building

I am doing a seismic retrofit for a structure designed and built in 1931. I guess it must be A7 steel. Could you let me know what values F_y, F_u, and R_y should be used?

In 1931, most structural steel for buildings was designated as ASTM A9 rather than ASTM A7, which was applicable to bridge steel at the time. The tensile strength of ASTM A9 was stipulated

as 55,000 psi to 65,000 psi and the minimum yield point as ½ T.S. or not less than 30,000 psi.

FEMA 356, which is a prestandard and commentary for the seismic rehabilitation of buildings, defines default lower-bound material strengths for ASTM A9 as a tensile strength of 55 ksi and yield strength of 30 ksi.

There would have been no R_y (nor R_t) defined for the material at the time, as these factors were only recently developed. FEMA 356 also provides factors to translate lower-bound steel properties to expected-strength steel properties. The factor given for steel produced prior to 1961 is 1.10 for both the tensile strength and the yield strength.

Kurt Gustafson, S.E., P.E.

Single Angle Design

Can you help me clarify the design of a single unequal leg angle in bending utilizing the new AISC specification? A very common situation for longer-span masonry brick openings is to use an L6×3½×5⁄16 LLV. Do you have an example or some clarification on the design?

Section F10 of the 2005 AISC specification addresses the design of unequal leg angles in bending. If the angle has lateral torsional restraint, the design can be carried out using equation F10-1. If there is no such restraint, the second paragraph of page 282 in the commentary to Section F10.2 provides some guidance for how to approach that problem. Equation F10-6 is applicable with that commentary.

Amanuel Gebremeskel, P.E.

Bolt Torque/Tension Equation?

I understand that the torque required for bolt installation in a slip-critical joint depends on the bolt class, the bolt diameter, and the faying surfaces properties. Can you tell me what equation to use to determine the torque required developing the required tension in the bolt?

No. Bolt installation is defined by the tension required in the bolt, not the applied torque. There is no defined torque/tension relationship, as this can vary considerably depending on the project conditions and must be calibrated if a torque-based method is to be used to provide pretension in bolts. The RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (a free download at **www.boltcouncil.org**) defines procedures for proper installation of high-strength bolts. Both the calibrated wrench method and the twist-off-type tension control bolt assembly method are torque-based methods. Note the special requirements for calibration that apply, particularly for the calibrated wrench method.

Kurt Gustafson, S.E., P.E.

Required Bolt Length

I am relocating a structure where there is not proper documentation of existing conditions, and I am unable to determine the required length of the structural bolts.

We have the connection drawings of the columns and beams, and the thickness of the splice plate. I want to know what the length of the bolt and of the threaded portion should be, taking into consideration the height of the nut and the thickness of the washer.

In addition to the information you summarized, you will also need to assess what loads the connections are required to transfer, that appropriate use of washers and nuts is followed, and whether the threads are required to be excluded from the shear plane. The length of bolt used must, at a minimum, allow for the end of the bolt to be flush with the outside face of the nut so as to have the threads adequately engaged. Furthermore, the washer requirements will depend on the bolt, hole, and base material types, as well as the method of installation.

The RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (a free download at **www.boltcouncil.org**) provides a good source of information on these subjects. The Commentary to Section 2.3 provides general guidance on proper selection of bolt length. An AISC *Engineering Journal* paper by Carter (second quarter, 1996) provides a more detailed treatment of the subject. This paper is available at **www.aisc.org/epubs**.

Amanuel Gebremeskel, P.E.

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Kurt Gustafson is the director of technical assistance and Amanuel Gebremeskel is a senior engineer in AISC's Steel Solutions Center. Charlie Carter is AISC's chief structural engineer, and Lou Geschwindner is AISC's vice president of engineering and research.

If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

Steel SolutionsCenter
One East Wacker Dr., Suite 700
Chicago, IL 60601
tel: 866.ASK.AISC • fax: 312.803.4709
solutions@aisc.org