Steel Interchange

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help you to solve, please forward it to *Modern Steel Construction*. At the same time, feel free to respond to any of the questions that you have read here. Please send them to:

Steel Interchange
Modern Steel Construction
One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001

Answers and/or questions should be typewritten and double-spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a Wordperfect file or in ASCII format).

The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principals to a particular structure.

Information on ordering AISC publications mentioned in this article can be obtained by calling AISC at 312/670-2400 ext. 433.

The following responses from previous Steel Interchange columns have been received:

Is there any testing or research to demonstrate that metal deck, parallel to the girder, does indeed provide adequate restraint or should the beam be checked for the temporary construction condition?

The AISC specification (for both ASD and LRFD) states, "Steel deck with adequate attachment to the compression flange...will usually provide the necessary lateral support." The key words are "adequate attachment".

Professor Larry Luttrell of West Virginia University performed hundreds of horizontally loaded tests with steel deck attached to perpendicular and parallel members. These tests were part of a program to determine the diaphragm strength and stiffness provided by steel deck. Bracing the frame (by diaphragm resistance) is somewhat different from bracing the compression flange of a girder. However, the diaphragm tests showed that the attachments to parallel members were used and were significant in developing the diaphragm, and, by the same reasoning, could be used to brace the compression flange. As an example, a 5/8" diameter weld through 20 gage deck into a structural steel member will provide a design shear strength of 760 pounds. The Steel Deck Institute (SDI) specifies, "Floor deck units shall be anchored to ... perimeter support steel ... Deck units with spans greater than five feet shall have side laps and perimeter edges (at perimeter support steel) fastened at midspan or 36 inch intervals - whichever distance is smaller." The Commentary points out, "This anchorage may be required to provide lateral stability to the top flange of the supporting members." Certainly if the deck is not attached to the girder then the unbraced length would be the spacing of the beams supported by the girder. If the deck, as it is installed, does not cover to the girder and a closure piece is needed, then the closure should be attached to the girder and the deck at the spacing given by the SDI specification.

Richard B. Heagler, P.E.
Steel Deck Institute
Canton, OH

Under what circumstances does the designer have to consider torsion in the design of a beam?

Torsion occurs in beams when the line of action of any transverse force applied to the beam does not pass through the shear center of the beam. The shear center location for various sections vary depending on the section.

The response to torsion in steel members can be divided into two groups. The first consists of beams of closed sections, such as pipes and tubes, which resist torsion by shear stresses. The other group consists of open sections, such as wide flanges and channels, which resist torsion by combined shear and warping. Usually, the primary stress of interest in typical open sections is the normal warping stress component. This stress adds to the bending stress in the beam, hence, reducing its "available" capacity for bending.

It is a usual practice to repair existing members by providing side plates that would "box" the wide flange beam, and then it would act as a tube and normal warping stresses would be eliminated. In new construction, the engineer should account for the torsion directly, and either use tubes for the design or provide adequate section in the wide flange beam to resist both bending and normal warping stresses.

As for references on the subject, Steel Structures, 2nd Edition, by Salmon and Johnson provide a basic background on theory and presents a simple method for accounting for torsion in chapter 8. AISC publishes Torsional Analysis of Steel Structures with extensive tables and charts for the solution of the torsion problem. For those more inclined to equations, Roark's Formulas for Stress and Strain 6th Edition presents comprehensive solutions in the form of equations for many boundary conditions and sections in chapter 9.

Hussain Shanaa, Ph.D., P.E.
AEC Engineering,
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Serviceability is a particular concern for crane systems in industrial buildings but is not covered in standard code literature. What are deflection limits for crane runway systems?

One is referred to the Guide for the Design and Construction of Mill Buildings: Association of Iron and Steel Engineers Technical Report No. 13. Section 5.8.8 of this report limits crane runway live load deflections without impact to l/1000.

AISE Technical Report No. 13 also offers very specific design information for crane runway systems.

AISE is located at Three Gateway Center, Suite 2350, Pittsburgh, PA 15222-1097 (412) 281-6323. FAX: 412/281-4657.

Dennis T. Pay
Geneva Steel
Provo, UT

The use of channel sections or other light weight narrow flange sections as girts supporting non-bearing exterior wall assemblies against wind load is common practice. How is lateral instability of the unsupported compression flange accounted for when the wall is subject to outward pressure due to suction at the leeward face of the building? These outward forces are equal to or greater than the inward forces.

Lateral stability of the compression flange of a girt subject to suction loading is an important design consideration. The lateral force needed to stabilize the compression flange is generally considered to be something less than two percent of the strong axis load, provided that the girt is properly aligned without sag or twist. Common sag rods can provide adequate lateral support for girts up to 8" deep even though they attach only to the girt webs. For deeper girts lateral support for the compression flange can be attained by means of a continuous vertical bar stock member (used in conjunction with sag rods), say 3x1/4, attached to the eaves beam, to the inside flanges of all the girts, and anchored to the sill or floor slab. If there is an inside wall finish such as plywood (check your local fire code) or corrugated steel, it too can support the inside flange of the girt (if adequately attached). As mentioned above, the proper girt alignment is necessary for predicted performance, The attachment of the girt to the column must be adequate to prevent the girt end from "rolling."

David T. Ricker, P.E.
Payson, AZ

New Questions

Listed below are questions that we would like the readers to answer or discuss.

If you have an answer or suggestion please send it to the Steel Interchange Editor, Modern Steel Construction, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

Questions and responses will be printed in future editions of Steel Interchange. Also, if you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.

I have searched for standards to use when designing hot-rolled or extruded stainless steel shapes made of AISI Type 304 or 316 (yield strength = 35 ksi; tensile strength = 80 ksi) without success. Cold-formed stainless steel design is covered by ASCE 8-90, but does not include the thicker walled extruded sections or hot rolled beam sections. The AISC Specifications do not include this material (Section A3) since the mechanical properties of stainless steel (an inelastic, anisotropic material) differ from those of structural carbon steels. Are there any design standards available? Or must the design engineer, with the help of available technical data and steel producer information, set the factors of safety and apply strength of materials and stability principles in designing these sections?

John M. Kropp, P.E.
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Cleveland, OH

What type of framing is considered bracing the compression flange? Does the member bracing the flange have to be attached to the flange? If a 4 inch deep member frames into mid-depth of a 10 inch deep beam is that considered bracing the compression flange (center lines of each member at same point)? My interpretation is that it would not because I would think the web/flange could still twist and buckle. I have not witnessed any fully loaded testing to see how the beam reacts and the AISC specification is not very descriptive of what they consider bracing of the compression flange.

Joseph Cook