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 Word 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 800/644-2400.

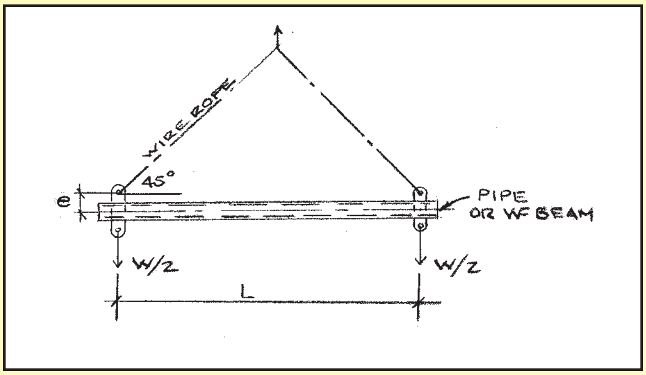
* * * * **Questions and answers can now be e-mailed to: newman@aiscmail.com** * * * *

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

A variation of the lifting beam question.

A typical lifting beam or strongback in the materials handling, crane and rigging industry take the form of either a horizontal pipe or wide flange beam, with padeyes top and bottom at both ends. The lifting wire rope bridle with 2 legs at about a 45 degree angel attaches to the top padeyes and the supported weight attaches to the bottom padeyes. (see sketch).

The wire rope bridle induces both compression and bending moment in the lifting beam. Again there is no lateral support.



What analysis would be used to solve for the safe lifting capacity of this form of lifting beam?

We use this type of spreader. The following text addresses this problem:

Steel Structures, Design and Behavior, Fourth Edition by C.G. Salmon and J.E. Johnson, example 6.19.2 page 353.

William J. Bees, PE
BWX Technologies
Barberton, OH

Another response:

The design of lifting beams for use with cranes is governed by ASME B30.20 "Below-the-Hook Lifting Devices." The only strength design criterion in this standard is a requirement that the device be designed with a safety factor of 3 with respect to yield. This is obviously an inadequate requirement in that it does not address buckling failure modes.

In practice, I typically use $F_y/3$ as an allowable bending stress for compact or non-compact sections and for tension. For beams that are slender enough to fail by lateral torsional buckling, I use the allowable bending stress given by AISC ASD equations F1-6, F1-7, and F1-8, as appropriate, divided by 1.80. This effectively gives an allowable stress that is about 1/3 of the stress that corresponds to buckling. For axial stress, I use modified versions of AISC ASD equations E2-1 and E2-2 that replace the AISC safety factors with an S.F. of 3. For both bending and axial stresses, the unsupported length is taken as the overall length of the member (dimension "L" in the drawing that accompanied the question). In the case of combined bending and compression, ASD equations H1-1, H1-2, and H1-3 can be applied directly using these defined allowable stresses. A similar philosophy is applied to connection design.

For the particular problem shown, which is correctly called a spreader bar and not a lifting beam, member forces are computed for the pipe or W shape. The horizontal components of the sling tensions produce axial compression and, due to the eccentricity of the end lugs, bending. The dead weight of the member adds to the bending. From these forces, the actual stresses are found. Using the above allowable stresses and the appropriate interaction equation, the member is evaluated.

David Duerr, P.E.
2DM Associates, Inc.
Houston, Texas

What is the in-plane effective length factor for each column of the frame shown the beam to be continuous but not rigidly connected to the center column? And b) the beam to be discontinuous at the center column with simple connections to it?

The interior column can be designed with an effective length factor (K) of 1.0 for both cases.

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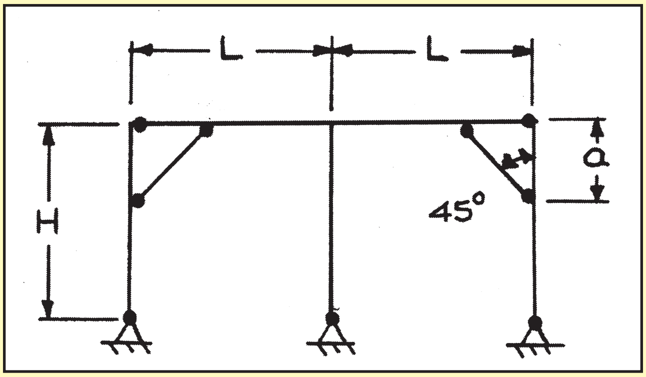
To derive K for the exterior columns, the beam and bracing can be treated as a non-prismatic beam with a straight segment and a haunched and open-webbed segment. The rotational stiffness and the corresponding moment of inertia of the non-prismatic beam can be calculated for both cases. A book titled "Moment Distribution"



by James Gere is one of the references giving detailed procedures for such calcualtions. The alignment chart can then be used to arrive at the K values.

Wing Ho, PE
CUH2A, Inc.
Princeton, NJ

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 can also be sent via e-mail to newman@aiscmail.com.

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.

In detailing rod x-bracing for the lateral stability of structures, we often call for turnbuckles and occasionally call for clevises without specifying a size. The problem with this practice is that the standar4d turnbuckle and clevis for a given steel rod is often not as strong as the rod (according to the tables in the AISC *Manual of Steel Construction—ASD*). For example, a 7/8" dia. A36 threaded rod has an allowable tension capacity of 11.5 kips, but the standard clevis (#2½) has a safe working load of only 7.5 kips and the standard turnbuckle has a safe working load of 7.2 kips. There is a note at the bottom of the clevis and turnbuckle tables which states that the safe working loads are based on a 5:1 safety factor because these devises are often used for dynamic and impact loading conditions. This seems to be conservative for detailing rod x-bracing in a small building. Are there any sources with more practical safe working load values, or is it reasonable to proportion the published numbers up to a smaller factor of safety (say 3:1)? The threaded rods are not designed with a 5:1 factor of safety.

Brandon M. Goodloe
Joew I. Guerra, Inc.
Austin, TX

In looking at using a pipe member for a spreader beam with the axial loads at the end resulting from a pinned connection at centerline of the pipe where the shackle attaches (i.e. completely axial loading without any bending on the ends of the spreader beam), would it not be true that the value for K would be 1.0 when determining the effective length for column loading from the AISC 9th Edition Manual page 5-135, Table C-C2.1 (d).

It appears that even though the ends of the spreader beam are not restrained physically, they are "counter-restrained" on the ends via the equal and opposite load from the lifting strap on the other end. Thus the use of the AISC reference as 1.0 where the ends are "Rotation free and translation fixed".

Michael T. Spires, PE
Fossil Engineering Department
via E-Mail