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).

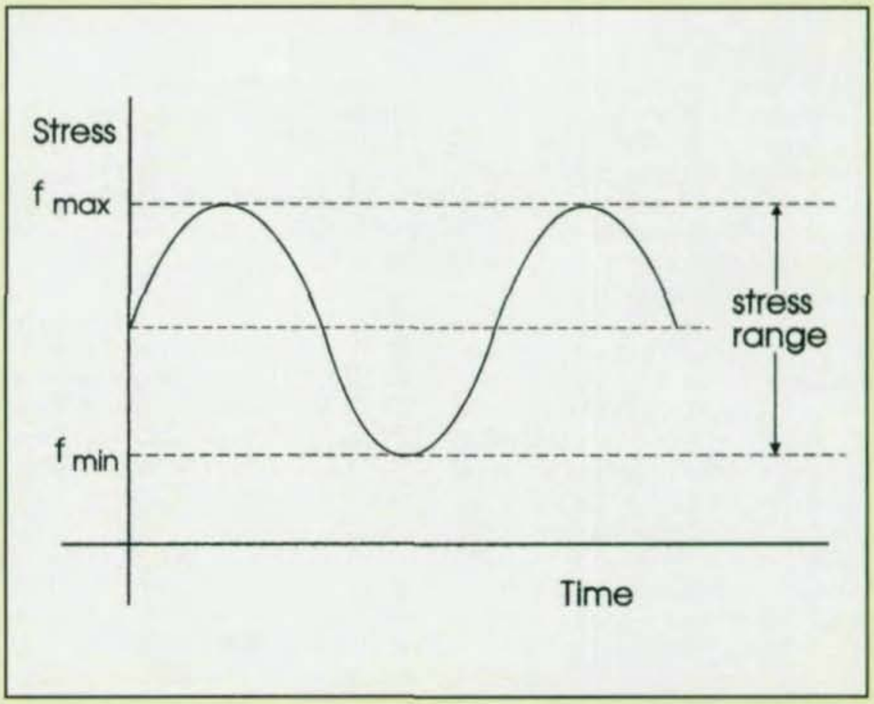
The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. and have not been reviewed. It is recognized that the design of structures is within the scope and expertiseof a competent licensed structural engineer, 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 the section in the Specification concerning fatigue appropriate for variable amplitude fatigue loading?

The allowable stress ranges used in the AISC Specifications Appendix A-K4.3 are for constant amplitude loading. For variable amplitude loading an effective stress range can be calculated using Miner's rule as used by Schilling, C. G. and K. H. Kleppstein, New Method for Fatigue Design of Bridges, Journal of the Structural Division, Vol. 104 No. ST3, ASCE, New York, March 1978.

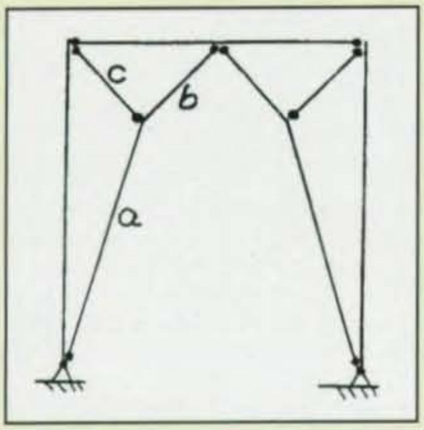


Due to a clearance requirement, a frame has the configuration shown. For out-of-plane buckling, what will be the unbraced lengths for members a, b, and c with the following conditions: (1) a and b are rigidly connected and (2) a and b are released at their ends.

Strictly from an engineering standpoint, the best solution to the problem of the kinked frame is to provide out-of-plane bracing at the intersection of Members a, b, and c, in effect creating a 3-D truss. Members a, b, and c could then all be designed with K equal to 1.

If out-of-plane bracing is not possible, members a and b must be continuous at their intersection point, and must be restrained torsionally at their bottom and top ends, respectively. If a and b are pinned at their intersection, and free to twist at their end points, the frame is unstable for out-of-plane buckling; i.e., its theoretical buckling capacity is nil. No information is given on member sizes, loads, or connections. A heavy gusset plate connection might provide enough torsional restraint, depending on the loads and geometry; a lighter gusset plate might not.

Determining the exact effective length of kinked member ab is not a simple problem. Member ab must resist out-of-plane buckling under its own axial load, and must also provide out-of-plane bracing for pin connected Member c, which increases the stiffness requirement. A hand analysis model could be developed; however I would suggest using structural analysis software to estimate the buckling load. If software capable of performing a buckling analysis (eigenvalue analysis) is not available, software which can perform a P-Delta analysis could be used. The frame should be



modeled as a 3-D frame, with only the top three and bottom two joints supported out-of-plane. The actual frame loads should be applied, along with a slight out-of-plane load, at the intersection of members a, b, and c. The ratio of the P-Delta displacement to the first order displacement (out-of-plane) at this joint can be taken as a (slightly unconservative) estimate of the amplification factor $1/(1-P/P_{cr})$. From this, P_{cr} can be estimated.

In either an eigenvalue or P-Delta analysis, the inelastic behavior of the members must be taken into account. This can be done by using the analysis only to determine an effective length factor (setting estimated $P_{cr} = \pi^2EI/(KL)^2$, and solving for K). Then using the usual AISC column formulas to calculate the strength of the member. Alternatively, the stiffness reduction factors on Page 3-8 of the 9th Edition of the AISC Manual of Steel Construction (Allowable Stress Design) can be used to reduce the moduli of elasticity of the members used in the analysis.

David O. Knuttunen, P.E.
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If a pin hole in a lifting lug is flame-cut, should the net section be reduced to compute the capacity of the lug?

I recommend throwing the lug away and making a new lug using a drilled hole with chamfered edges. My second choice would be to require that all the hardened material at the flame cut hole be removed by grinding.

Flame cutting produces a locally hard brittle zone with microscopic cracks—ideal for points of crack initiation. Lugs are usually made from thick plate material of unknown Charpy impact (low temperature) properties and used outside in all ranges of temperatures — often on a repetitive basis with some impact loading and non-redundant lifting devices. The cost of a good hole is very small compared to the potential loss of life and damages due to brittle fracture at a lug hole.

George D. Conlee, P.E.
St. Louis, MO

Where is the best place to get information on foreign specifications and requirements?

In 1991 the Structural Stability Research Council (SSRC) published Stability of Metal Structures - A World View (The World View) 2nd Edition. The World View is a 940 page comprehensive world-wide study of over 100 specifications and codes on stability design of metal structures. It is the only book in the world that evaluates specifications and codes, compares and contrasts them, and explores some of the major reasons for their differences. The geographical regions covered are: Australia, China, East Europe, Japan, North America, and West Europe. Divided into 14 topics, the World View condenses the specification provisions and then gives regional and international comparisons and comments. The topics are:

Compression Members
Built-Up Members
Beams
Plate and Box Girders
Beam-Columns
Frames
Arches
Triangulated Structures
Tubular Structures
Shells
Cold-Formed Members
Composite Members
Earthquakes
General Provisions & Design Requirements

The World View cost is $85 ($68 for SSRC members). It can be obtained from: Structural Stability Research Council, Fritz Engineering Laboratory, Lehigh University, 13 E. Packer Avenue, Bethlehem, PA 18015-3191, Phone: (215) 758-3522, Fax: (215) 758-4522.

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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.

When asked to design a temporary bracing system for steel beams and columns during the erection phase of construction, what loads are used and what factors of safety are employed for the bracing and its connections? California OSHA requires the bracing to be designed by an engineer but does not specify the loads.

Larry Borsclaire
Pace Engineering
Redding, CA

When is it appropriate to use clips instead of hook bolts to secure rails for top running crane runways? What are the service verses cost considerations?

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