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
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Chicago, IL 60601-2001

Answers and/or questions should be clearly presented. E-mail submittals and/or e-mail attachments are welcome.

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

How do you calculate the lower flange loading capacity of a steel beam to be used to support an underhung crane? Are there any published ASD or LRFD design procedures?

James F. Jendusa, P.E.
MSI General Corporation
Oconomowoc, WI

The bottom part of the crane beam must be checked for:

1. Tension in the web.
2. Bending of the bottom flange.

Most underslung cranes will have each end supported by 2 pairs of wheels. Each individual wheel load will include a portion of the lifted load (in its most critical position), the dead loads, and impact. Impact is usually about 25% of the lifted load but will depend on the speed and braking ability of the hoist. Allowable stresses must be reduced due to the cyclical nature of the applied load.

The wheels must be purchased to suit the profile of the supporting crane beam, either an S-shape or a W-shape. The web tension at each pair of wheels is checked at the intersection of the web and fillet (at the "k" distance).

Referring to Figure 1 below, the length of resistance is seen to be $3.5k$. The 30° angle is a consensus figure used for many years. Assuming 4 wheels (2 pair) at each end of the crane, each wheel will support $P/4$ delivered to the supporting crane beam. In Figure 1, two wheels cause the web tension, so the load is $P/2$.

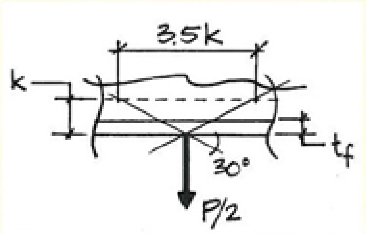

Figure 1

The tensile stress in the web becomes:

$$f_t = P/2A = P/(2t_w)(3.5k) = P/(7k)t_w$$

Flange bending depends on the location of the wheels with respect to the beam web. Referring to Figure 2, this is dimension *e*. As stated previously, each wheel load is $P/4$.

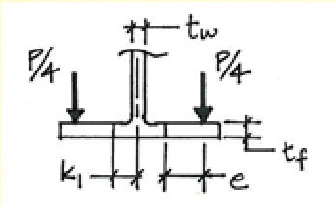

Figure 2

The longitudinal length of flange participating in the bending resistance can be taken as $2e$ per yield-line analysis. See Figure 3.

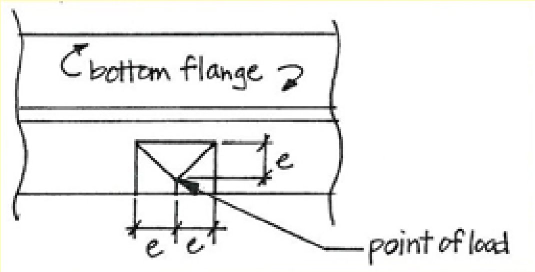

Figure 3

The section modulus at the plane of bending is $(bd^2)/6$ which translates to $e(t_f)^2/3$. From Figure 2 the bending moment is $eP/4$. The bending stress is:

$$f_b = M/S = 3eP/(4e)(t_f)^2 = 0.75P/(t_f)^2$$

Local loadings such as this often result in biaxial and triaxial stresses. These stress combinations are quite common, and designers must design accordingly. For more information on crane loading, refer to my paper in the *Engineering Journal*, 4th quarter 1982, called "Tips for Avoiding Crane Runway Problems."

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

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Question from October 1999:

Is the C_m value for a beam in a moment frame based on the sidesway behavior of the frame? Specifically, should the beam be considered subject to sidesway, resulting in C_m=0.85 per the 9th ed. ASD Manual, or does the sidesway only apply to the columns whose ends can translate relative to each other?

Raoul Karp
RAM International
Carlsbad, CA

In axially loaded members, C_m is a coefficient used to account for second order effects caused by bending. It is based on bending and/or relative translation of the ends of a compression member, not a frame. The frame drift does cause relative displacement of the column ends. However, the drift is in the plane of the beam. In order for the beam to be subject to sidesway, there would have to be relative axial deformation between the supporting columns (i.e. relative displacement of the beam ends transverse to its longitudinal axis). Therefore, in this situation, the beam is typically considered to be restrained from joint translation.

Heath Mitchell
American Institute of Steel Construction
Chicago, IL

Question from October 1999:

AISC's 1989 ASD Specification, Chapter F, states that C_b can (should) be taken as unity for cantilevers. Does this apply to columns of moment frames with pin supports? It appears as though the deformed shape, moment diagram, etc. are identical in the cantilever and the column (see figure). In one case the tip deflects, in the other case the support translates.

Raoul Karp
RAM International
Carlsbad, CA

The presence of lateral bracing at the free end of a cantilever affects the C_b value of the cantilever. If the free end is laterally braced, C_b shall be 1.75, based on an M_1 to M_2 ratio of zero. However, if the free end is not braced laterally, C_b is not 1.75 but may be taken conservatively as 1.0. The columns of the moment frame, which are assumed to be braced laterally, have a C_b of 1.75, based on an M_1 to M_2 ratio of zero.

It should also be noted that efficiently proportioned moment frames will undergo rotations at the joints. The deformed shape of the moment frame as shown indicated no joint rotation which is only possible with an infinitely stiff beam. It is not a realistic design.

Wing Ho, PE
CUH2A, Inc.
Princeton, NJ

Question from November 1999

Is there an AISC (or equivalent) steel design code for temporary structures which is less conservative than ASD or LRFD?

Mark A. Walters
Westinghouse Electric Company
Monroeville, PA

AISC specifications do not contain specific provisions for the design of temporary structures. ASCE 7 allows for lower nominal loads for certain types of structures where life safety is not an issue. This is accounted for in the "importance factors" that are used for wind and snow forces. No adjustments are made for live loads, however.

Bruce R. Ellingwood, Ph.D., P.E.
The Johns Hopkins University
Baltimore, MD

New Question

Are there any guidelines for flame-cut holes used for bolted connections?

via email