Bottom flange bending capacity

Question

12/01/1999

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?

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Answer(s)

12/01/1999

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

Tension in the web.
Bending of the bottom flange.

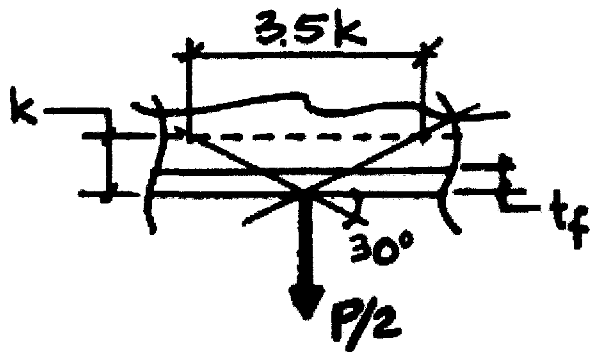
Most underslung cranes will have each end supported by 2 pairs of wheels. Each individual wheel load will include a portion of the lifted load (in its most critical position), the dead loads, and impact. Impact is usually about 25% of the lifted load but will depend on the speed and braking ability of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

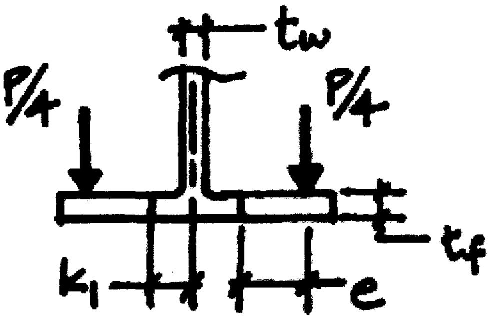
Referring to Figure 1 below, the length of resistance is seen to be *3.5k*. The 30° angle is a consensus figure used for many years. Assuming 4 wheels (2 pair) at each end of the crane, each wheel will support *P/4* delivered to the supporting crane beam. In Figure 1, two wheels cause the web tension,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

The tensile stress in the web becomes:

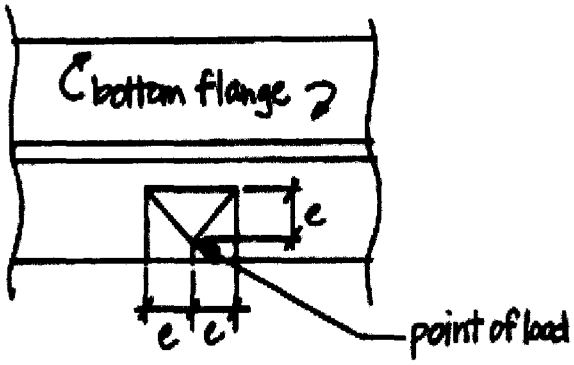
$$f_t = P/2A = P/(2t_w)(3.5k) = P/(7k)t_w$$



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*.



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

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Please feel free to submit a question/answer to solutions@aisc.org