steel quiz

This month's Steel Quiz takes a look at the design for torsion in W-shapes as addressed in AISC Design Guide 9: *Torsional Analysis of Structural Steel Members* and Chapter H of the AISC *Specification*.

Figures 1 and 2 illustrate normal stresses due to bending (σ_b) and warping (σ_w) and shear stresses due to bending (τ_b), torsion (τ_t) and warping (τ_w) in a wide-flange beam subject to shear, bending and torsional loading. The figures also indicate the location of the maximum stresses, which can be used to determine the locations on the cross section that need to be checked.

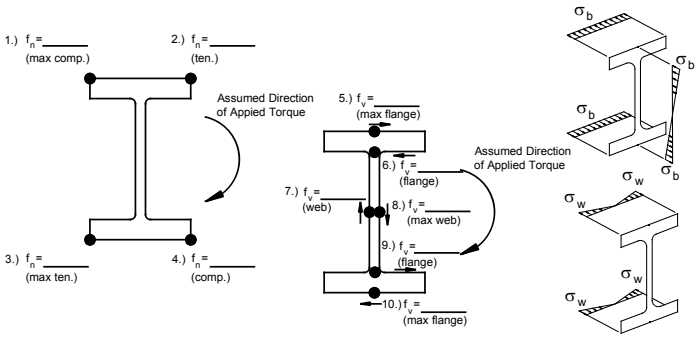
The calculated normal stresses due to bending and warping are:

σ_b = 18.7 ksi σ_w = 8.24 ksi

The calculated shear stresses due to bending, torsion and warping are:

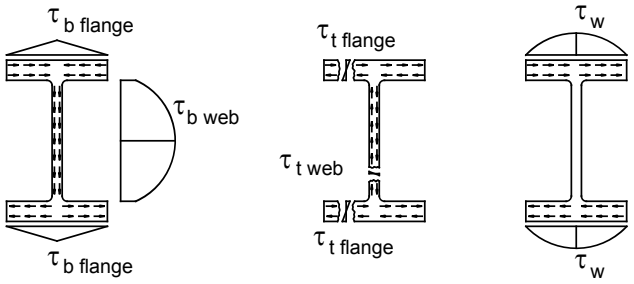
τ_b flange = 0.420 ksi τ_b web = 1.61 ksi
τ_w flange = 0.375 ksi τ_w web = 0 ksi
τ_t flange = 6.76 ksi τ_t web = 4.11 ksi

Using ASD, verify that the peak normal stress, f_n, and peak shear stress, f_v, satisfy the requirements in Chapter H of the AISC *Specification*. Assume that the limit state of buckling does not control. Note that the stresses at the 10 highlighted locations can be calculated to determine the location of maximum stress.



▲ Figure 1. Normal stresses due to bending and warping.

▼ Figure 2. Shear stresses due to bending, torsion and warping.



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Combining the shear stresses and normal stresses at the locations shown in Figure 3, the maximum normal stress and maximum shear stress are:

$F_{n\,max}$ = 26.9 ksi
$F_{v\,max}$ = 7.56 ksi

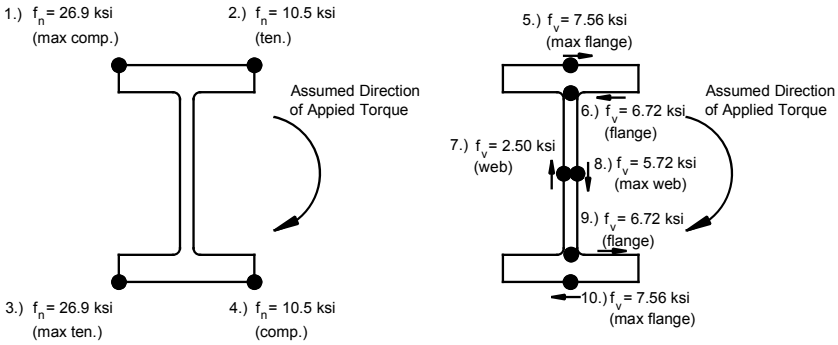
The allowable normal stress per equation (H3-7) is:

$$\frac{F_n}{\Omega} = \frac{F_y}{\Omega} = \frac{50\text{ ksi}}{1.67} = 29.9\text{ ksi} > 26.9\text{ ksi (OK)}$$

The allowable shear stress per equation (H3-8) is:

$$\frac{F_n}{\Omega} = \frac{0.6F_y}{\Omega} = \frac{30\text{ ksi}}{1.67} = 18\text{ ksi} > 7.56\text{ ksi (OK)}$$

Figure 3. Combined stresses where f_n = sum of σ_b and σ_w and f_v = sum of τ_b, τ_w and τ_t.



This information is taken from AISC Design Example H.6.
The complete design example can be viewed at **www.aisc.org/examples**.

Steel SolutionsCenter

Everyone is welcome to submit questions and answers for Steel Quiz. If you are interested in submitting one question or an entire quiz, contact AISC's Steel Solutions Center at 866.ASK.AISC or at **solutions@aisc.org**.