Simplified Design for Torsional Loading of Rolled Steel Members

Paper by PHILIP H. LIN
(3rd Quarter 1977)

Discussion by **Philip H. Lin**

There are two types of torsion, namely, uniform and non-uniform torsion. A straight round bar will rotate freely when subjected to two equal and opposite torques at the ends, and the twist per unit length or the angle of twist is constant throughout the bar; this is known as uniform torsion. When a member is under certain end boundary conditions, however, and torques somewhere along its length, it will be restrained to warp and the angle of twist will vary; this is known as non-uniform torsion. Because of the difference in the structural behavior of these two types of torsion, the treatment required is obviously not the same for both.

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Examples presented in the original paper are cases of non-uniform torsion, problems encountered frequently in the design office. In Example 1, the differential equation solution yields the results shown in Table 1. By investigation of the stresses in Table 1, one can comfortably design the beam based on normal stress. One can also see that the the summation of the shear stresses is very low, and thus not a governing factor in this structural steel design situation.

In his discussion of the subject paper (1st Quarter, 1978), Mr. Maitra used Eq. (7.17) in his quoted reference to check the shear stress of Example 1 and concluded that the beam is 60% overstressed. This, I believe, is not the case, because Eq. (7.17) is derived based on the concept of uniform torsion. It is not adequate to apply the equation for uniform torsion to Example 1, which deals with non-uniform torsion. Although it is left to the design engineer's discretion to use that equation to check torsional stress before going into design, it is not my recommendation, for one should always bear in mind that the structural member so designed will be extremely conservative. There are exceptions, however, e.g., the design of a highway sign post, where it is very likely the shear stress would govern the design. If that is the case, the torsional shear stress should be checked. (The closed shape structural section is recommended.)

As shown in Table 1, the total normal stress is the summation of torsional and ordinary bending stresses, and the total shear stress at flange or at web is the summation of St. Venant torsion, warping torsion, and vertical bending shear stresses as shown in Fig. 6 of the original paper.