Summary

Torsion in beams causes a beam to warp as a result of the shear stresses. If this warping is restrained, for example if the end of the bar is welded on a rigid structure, axial stresses will occur. For hollow sections this stresses can become significantly large.

Rotational stiffness of a beam greatly depends on the shape of the cross section. Beams of noncircular cross section are less stiff then circular cross sections, depending on their K-factor. Using approximations for K, reasonably accurate calculations can be performed for the twist and shear stresses in the beam.

Stresses in beam sections calculated using BEAM189 elements with ANSYS are well according to calculated stresses using the calculation methods of Roark & Young. For shear loads as well as for torsional loads the BEAM189 elements proof useful for calculating stresses in beams in free warping and restrained warping cases. When a beam is restrained for warping, extra axial stresses develop. These stresses become significant for thin-walled open sections like the channel section. The shear stresses however are lower since the twist is smaller. For the channel section the twist decreases with a factor 3.

The torsion of bars is described by its warping function, which has only one variable, the axial displacement. This warping function can be calculated by solving the differential equations for warping. Saint Venant found these equations by using the assumption that cross sections do rotate, but deform only in the beam's axial direction. These results in a Laplace's equation expressed in terms of the warping function ω. With the warping function known the torsion stiffness, twist and shear stress can be found.