Frequently Asked Questions

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How do I solve for stresses in the case of impact torque on an axis symmetric bar?

Why do we have to make the assumption that plane sections plane?

In order to make calculation of stresses due to torsion easy, we need to make certain simplifying assumptions on the deformation pattern which is realistic. It is has been found from the rigorous solution procedure (elasticity solution) and from the experiments that the circular cross section members subjected to pure torsion in the elastic range satisfy very closely this condition of plane sections remain plane and rigid. By making this assumption, the solution procedure becomes simple as shown in the 'basic concepts' section in the derivation for torsional stresses.

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How about bars with non-axis symmetric cross section?

For bars with non-axisymmetric cross section, the assumption of plane section remain plane is not satisfied. Regions of the cross-section undergo deformations in the axial direction leading to ‘warping’ of the section. There are again certain simplifying assumptions which are relaxation of the axisymmetric bar assumption that can be used to find stresses in a non-axisymmetric bar. (see Advanced Topics for details)

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The formulae derived look very similar to beam and axial deformation formulae?

Yes, that's true. In all the three derivations pertaining to axial, beam and torsional deformations, the assumption of plane section remains plane is used and it leads to very similar formulae for these three types of structural members.

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Is the derivation for composite axisymmetric bar subjected to torsion similar to the composite beam derivation?

Yes. Since plane sections remain plane assumption holds good for composite bar subjected to torsion, similar principle as derivation for composite beam can be used to solve for stresses in a composite bar subjected to torsion. (See 'Worked Examples" on "composite bars" for details)

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What if material is non-isotropic?

If the material is non-isotropic (i.e. anisotropic), then the elastic modulii will vary and thus the problem will be completely different with additional stresses appearing since there is a coupling between shear stresses and normal stresses for an anisotropic material.

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What if material goes to plastic range?

Even, if the material goes to plastic range, plane sections remain plane assumption is assumed to hold. Therefore, the strains can be found out from which distribution of stresses can be derived from equilibrium principles. (refer to 'Advanced Topics: Inelastic Torsional bars' for details of solving for stresses.)

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What about non-linear elastic materials?

For non-linear elastic materials again, the elastic modulii are different and are functions of the strains. Therefore, while solving for stresses, appropriate constitutive law should be used before applying the equilibrium conditions.

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Why is the variation of shear strain with radius linear?

This emanates from the fact that the cross-section rotates as a rigid body because of axis symmetry condition of the cross-sectional geometry and the anti-axis symmetry of the torque. Since the cross-section rotates as a rigid body, the amount of rotation is linear with respect to the variation in radius.

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What do we do for stepped shafts?

For stepped shafts, away from the abrupt change in the cross-section, the stresses can be computed using the same formulae derived taking appropriate diameter of the shaft portion in to consideration. (See: Worked out Examples: Stepped Shafts). At the region of change in geometry, stress concentrations can occur due to abrupt change radius. (refer to 'stress concentration' section of "Advanced Topics")

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