Introduction

Advanced Mechanics of Solids ME202

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Outline

Course Objectives

- To impart concepts of stress and strain analyses in a solid.
- To study the methodologies in theory of elasticity at a basic level.
- To acquaint with the solution of advanced bending problems.
- To get familiar with energy methods for solving structural mechanics problems.

Syllabus

Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.

Expected outcome

At the end of the course students will be able to

- Apply concepts of stress and strain analyses in solids.
- Use the procedures in theory of elasticity at a basic level.
- Solve general bending problems.
- Apply energy methods in structural mechanics problems.

Books

Text Books

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill, 2008
2. S.Anil Lal, Advanced Mechanics of Solids, Siva Publications & Distributors, 2017
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services, 2013

References Books

1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.

Review of Elementary Mechanics of Materials

Axially Loaded Members

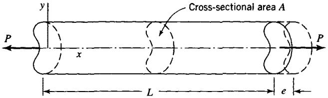


Figure: Axially loaded member

Axial stress away from the ends of the member, $\sigma = \dfrac{P}{A}$

Elongation of the member, $e = \dfrac{PL}{AE}$

Axial strain in the member, $\epsilon = \dfrac{e}{L} = \dfrac{P}{AE}$

Axially Loaded Members

Assumptions

1. The member must be prismatic (straight and of constant cross section).
2. The material of the member must be homogeneous (constant material properties at all points throughout the member).
3. The load P must be directed axially along the centroidal axis of the member.
4. The stress and strain are restricted to the linearly elastic range.

Torsionally Loaded Members

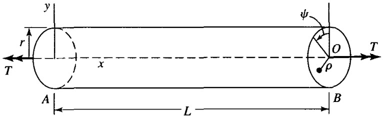


Figure: Circular torsion member

Shear stress in the member, $\tau = \dfrac{Tr}{J}$

Rotation (angle of twist) of the cross section B relative to cross section A,$\theta = \dfrac{TL}{GJ}$

Shear strain at a point in the cross section, $\gamma = \dfrac{r\theta}{L} = \dfrac{\tau}{G}$

Torsionally Loaded Members

Assumptions

1. The member must be prismatic and have a circular cross section.
2. The material of the member must be homogeneous and linearly elastic.
3. The torque T is applied at the ends of the member and no additional torque is applied between sections A and B. Also, sections A and B are remote from the member ends.
4. The angle of twist at any cross section of the member is small.

Bending of Beams

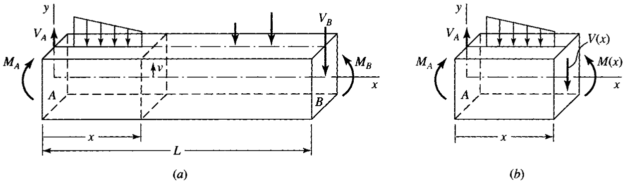


Figure: (a) Rectangular cross-section beam. (b) Section of length x

Bending of Beams

Stress acting normal to the cross section of the member at section x, $\sigma = \frac{-M(x)y}{I}$

The displacement ν in the y direction is found from the differential expression, $\frac{d^2\nu}{dx^2} = \frac{M(x)}{EI}$

Shear stress τ in the cross section at x for $y = y_1$,

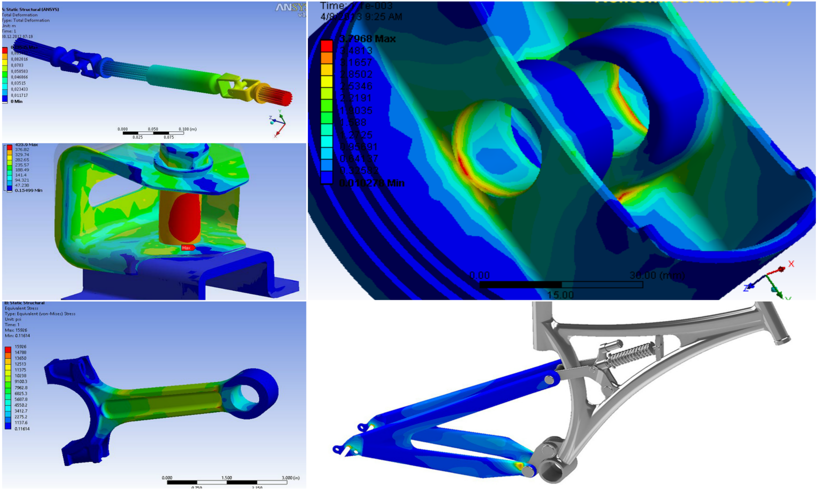
$\tau = \frac{VQ}{It}, whereQ = \int_{y_1}^{a/2} ydA$

Bending of Beams

Assumptions

1. Limited to bending relative to principal axes and to linear elastic material behaviour.
2. Applicable only to small deflections, since only then is $\frac{d^2\nu}{dx^2}$ a good approximation for the curvature of the beam.

Real world problems..



Thank You...