

Problem 5.4

Given a one-dimensional elasticity problem as shown in Figure 5.20. The bar is constrained at both ends (A and C). Its cross-sectional area is constant ($A = 0.1 \text{ m}^2$) on segment AB and varies linearly $A = 0.05(x - 1) \text{ m}^2$ on BC. The Young's modulus is $E = 2 \times 10^7 \text{ Pa}$. A distributed load $b = 10 \text{ N m}^{-1}$ is applied along the left portion of the bar AB and a point force $P = 150 \text{ N}$ acts at point B. The geometry, material properties, loads and boundary conditions are given in Figure 5.20a. Use a three-node element on AB ($n_{em}=3$) and a two-node element on BC ($n_{em}=2$) as shown in Figure 20b. The dimensions in Figure 5.20 are in meters.

- Construct the element body force matrices and assemble them to obtain the global force matrix.
- Construct the element stiffness matrices and assemble them to obtain the global stiffness matrix.
- Find and sketch the finite element displacements.
- Find and sketch the finite element stresses.

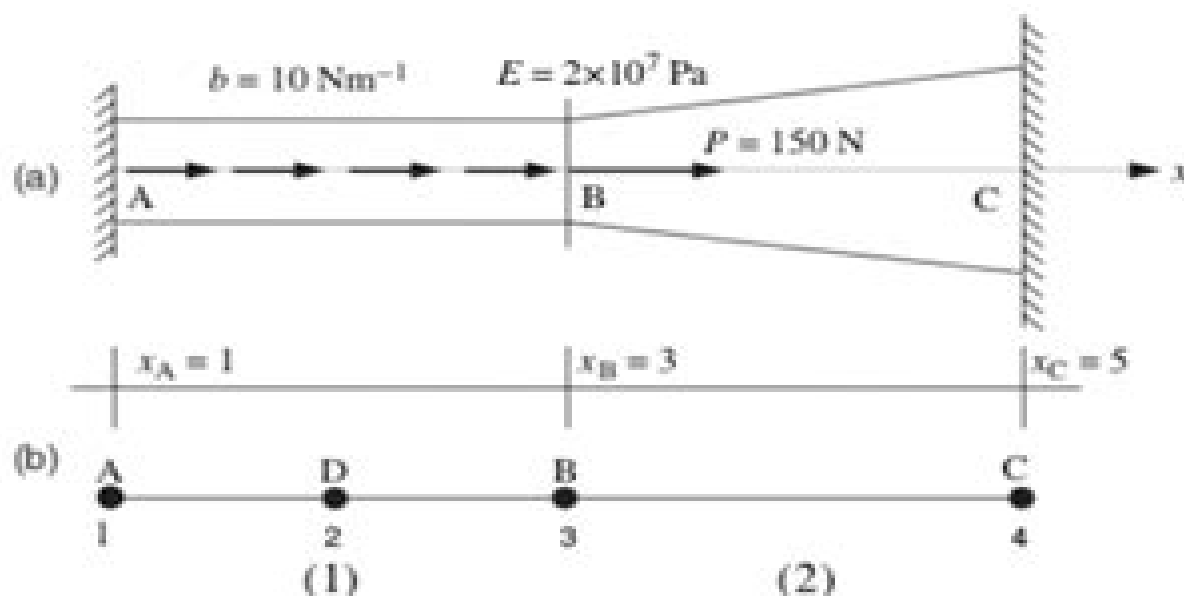


Figure 5.20 (a) Geometry, material properties, loads and boundary conditions for a bar with a variable cross-sectional area (b) the finite element model.

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Albert A Gayle



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Nonlinear Finite Elements for Continua and Structures Ted Belytschko, Wing Kam Liu, Brian Moran, Khalil Elkhodary, 2014-01-07 Nonlinear Finite Elements for Continua and Structures p Nonlinear Finite Elements for Continua and Structures This updated and expanded edition of the bestselling textbook provides a comprehensive introduction to the methods and theory of nonlinear finite element analysis New material provides a concise introduction to some of the cutting edge methods that have evolved in recent years in the field of nonlinear finite element modeling and includes the eXtended Finite Element Method XFEM multiresolution continuum theory for multiscale microstructures and dislocation density based crystalline plasticity Nonlinear Finite Elements for Continua and Structures Second Edition focuses on the formulation and solution of discrete equations for various classes of problems that are of principal interest in applications to solid and structural mechanics Topics covered include the discretization by finite elements of continua in one dimension and in multi dimensions the formulation of constitutive equations for nonlinear materials and large deformations procedures for the solution of the discrete equations including considerations of both numerical and multiscale physical instabilities and the treatment of structural and contact impact problems Key features Presents a detailed and rigorous treatment of nonlinear solid mechanics and how it can be implemented in finite element analysis Covers many of the material laws used in today's software and research Introduces advanced topics in nonlinear finite element modelling of continua Introduction of multiresolution continuum theory and XFEM Accompanied by a website hosting a solution manual and MATLAB and FORTRAN code Nonlinear Finite Elements for Continua and Structures Second Edition is a must have textbook for graduate students in mechanical engineering civil engineering applied mathematics engineering mechanics and materials science and is also an excellent source of information for researchers and practitioners **ACI Manual of Concrete Practice** American Concrete Institute, 2002 Introduction to the Numerical Modeling of Groundwater and Geothermal Systems Jochen Bundschuh, Mario César Suárez A., 2010-07-05 This book provides an introduction to the scientific fundamentals of groundwater and geothermal systems In a simple and didactic manner the different water and energy problems existing in deformable porous rocks are explained as well as the corresponding theories and the mathematical and numerical tools that lead to modeling and solving them This **Multiphysics Modeling: Numerical Methods and Engineering Applications** Qun Zhang, Song Cen, 2015-12-15 Multiphysics Modeling Numerical Methods and Engineering Applications Tsinghua University Press Computational Mechanics Series describes the basic principles and methods for multiphysics modeling covering related areas of physics such as structure mechanics fluid dynamics heat transfer electromagnetic field and noise The book provides the latest information on basic numerical methods also considering coupled problems spanning fluid solid interaction thermal stress coupling fluid solid thermal coupling electromagnetic solid thermal fluid coupling and structure noise coupling Users will find a comprehensive book that covers background theory algorithms key technologies and

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