Finite Element Method in Structural Engineering

Your Name

1 Introduction

This document covers the application of the finite element method in structural engineering.

2 Element Stiffness Matrix

2.1 Example Problem

Derive the stiffness matrix for a 2D truss element with nodes at $(0, 0)$ and $(L, 0)$.

Solution

For a 2D truss element, the stiffness matrix in local coordinates is given by:

$$k = \frac{EA}{L} \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix},$$

where E is the Young's modulus, A is the cross-sectional area, and L is the length of the element. Transforming to global coordinates, we use the transformation matrix T:

$$T = \begin{pmatrix} \cos\theta & \sin\theta & 0 & 0 \\ 0 & 0 & \cos\theta & \sin\theta \end{pmatrix},$$

where θ is the angle of the element. The global stiffness matrix K is then:

$$K = T^T k T.$$

For the given element with nodes at $(0, 0)$ and $(L, 0)$, $\theta = 0$, and the transformation matrix is the identity matrix. Therefore, the global stiffness matrix is the same as the local stiffness matrix:

$$K = \frac{EA}{L} \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}.$$