Let us suppose that the value of spring constant is k. Now, we'll evaluate the value of k in terms of the properties (length, area, etc.) of the bar: We know that: i

$F = kx$ i.e. $k = \frac{F}{x}$

Also: $Stress = \sigma = \frac{F}{A}$ i.e. $F = \sigma A$

And $Strain = \varepsilon = \frac{x}{L}$ i.e. $x = \varepsilon L$

$$k = \frac{\sigma A}{\varepsilon L}$$

But $Young's\ Modulus = E = \frac{\sigma}{\varepsilon}$

Hence, we may write:

$$k = \frac{AE}{L}$$

According to the diagram, the force at node x_1 can be written in the form:

$$F_1 = k(x_1 - x_2)$$

Where x_1 - x_2 is actually the nodal displacement between two nodes. Further:

$$F_1 = kx_1 - kx_2$$

Similarly:

$$F_2 = k(x_2 - x_1)$$

Now further simplification gives:

$$F_2 = kx_2 - kx_1$$

These two equations for F_1 and F_2 can also be written as, in Matrix form:

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} k & -k \\ -k & k \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Or:

$$[F] = [K^e][x]$$

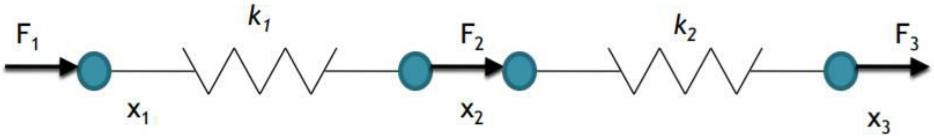
Questions

1.What is meant by finite element?
2. What is meant by node or joint?
3. What is the basic of finite element method?
4. What are the types of boundary conditions?
I. Primary boundary conditions
II. Secondary boundary conditions
5. State the methods of engineering analysis?
I. Experimental methods
II. Analytical methods
III. Numerical methods or approximate methods
6. What are the types of element?
I. 1D element
II. 2D element
III. 3D element

7. State the three phases of finite element method.
1. Preprocessing
2. Analysis
3. Post Processing
8. What is structural problem?
9. What is non structural problem?
10. What are the methods are generally associated with the finite element analysis?
1. Force method
2. Displacement or stiffness method.

Lecture No 40 Topic: Further Extension

- Here K e is known as the Stiffness Matrix. So a uniform material framework of bars, the value of the stiffness matrix would remain the same for all the elements of bars in the FEM structure.



Similarly for two different materials bars joined together, we may write:

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} k_1 & -k_1 \\ -k_1 & k_1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad ; \quad \begin{bmatrix} F_2 \\ F_3 \end{bmatrix} = \begin{bmatrix} k_2 & -k_2 \\ -k_2 & k_2 \end{bmatrix} \begin{bmatrix} x_2 \\ x_3 \end{bmatrix}$$

Problem

Three dissimilar materials are friction welded together and placed between rigid end supports. If forces of 50 kN and 100 kN are applied as indicated, calculate the movement of the interfaces between the materials and the forces exerted on the end support.

For aluminium	For brass	For steel
Area = 400 mm^2	Area = 200 mm^2	Area = 70 mm^2
Length = 280 mm	Length = 100 mm	Length = 100 mm
E = 70 GN/m^2	E = 100 GN/m^2	E = 200 GN/m^2