% Tapered bar example: 4 elements (Bhatti, Example 2.9, P159)

clear, clc

e = 70\*10^3; P = 20\*1000; % Modulus and the known applied load value

nodes = [0:150:600]; % Node coordinates (5 nodes)

A = [2175, 1725, 1275, 825]; % Average area of each element

lmm = [1,2; 2,3; 3,4; 4,5]; % Connectivity

%% Stiffness Matrix

K=zeros(5); % 5 nodes, 5x5 golal K matrix

% Generate stiffness matrix for each element and assemble it.

for i=1:4 % for every element

lm=lmm(i,:);

k=AxialDefElement(e, A(i), nodes(lm));

K(lm, lm) = K(lm, lm) + k;

end

K

%% Known Load Vector

% Define the load vector

R = zeros(5,1); % 5 nodes, 5x1 load vector

R(3)=P; % Known load

%% FEM Solution

% Nodal solution and reactions

[d, reactions] = NodalSoln(K, R, [1,5], zeros(2,1)) % d & R solutions

results=[];

for i=1:4 % for every element

results = [results; AxialDefResults(e, A(i), ...

nodes(lmm(i,:)), d(lmm(i,:)))];

end

format short g

results;

plot(nodes,d),title('Axial displacement'), xlabel('x'),ylabel('u')

%% Problem 2 - This code was created by modifying the code provided by Dr. Barakati for problem 1 example

clear all; clc; close all;

% Declare givens

a = 300/1000; % m;

b = 600/1000; % m;

A = 200/1000^2; % m2

P = 10E3; % N

e = 200E9; % Pa

nodes3 = [0,a,a+b]; % Node coordinates (2 elements -> 3 nodes)

nodes7 = [0:(a+b)/6:a+b]; % Node coordinates (6 elements -> 7 nodes)

A2 = A\*[1 1]; % Average area of each element for 2 element

A6 = A\*[1 1 1 1 1 1]; % Average area of each element for 6 element

lmm2 = [1,2; 2,3]; % Connectivity for 2 element

lmm6 = [1,2; 2,3; 3,4; 4,5; 5,6; 6,7]; % Connectivity for 6 element

%% Stiffness Matrix

K2=zeros(3); % 5 nodes, 5x5 golal K matrix

% Generate stiffness matrix for each element and assemble it.

for i=1:2 % for every element

lm=lmm2(i,:);

k=AxialDefElement(e, A2(i), nodes3(lm));

K2(lm, lm) = K2(lm, lm) + k;

end

K2

K6=zeros(7); % 5 nodes, 5x5 global K matrix

% Generate stiffness matrix for each element and assemble it.

for i=1:6 % for every element

lm=lmm6(i,:);

k=AxialDefElement(e, A6(i), nodes7(lm));

K6(lm, lm) = K6(lm, lm) + k;

end

K6

%% Known Load Vector

% Define the load vector

R3 = zeros(3,1); % 3 nodes, 3x1 load vector

R3(2)=P; % Known load

R7 = zeros(7,1); % 3 nodes, 3x1 load vector

R7(3)=P; % Known load

%% FEM Solution

% Nodal solution and reactions

[d3, reactions3] = NodalSoln(K2, R3, [1,3], [0;0]); % d & R solutions

results3=[];

for i=1:2 % for every element

results3 = [results3; AxialDefResults(e, A2(i), ...

nodes3(lmm2(i,:)), d3(lmm2(i,:)))];

end

format short g

% results3

fprintf('The nodal displacements in meters for the 2 element model are:')

d3

axialStrain3 = results3(:,1);

fprintf('The axial strains for the 2 element model are:')

display(axialStrain3)

axialStress3 = results3(:,2);

fprintf('The axial stresses for the 2 element model are:')

display(axialStress3)

axialForces3 = results3(:,3);

fprintf('The axial forces for the 2 element model are:')

display(axialForces3)

% Nodal solution and reactions for 6 element 7 node solution

[d7, reactions7] = NodalSoln(K6, R7, [1,7], [0;0]); % d & R solutions

results7=[];

for i=1:6 % for every element]

results7 = [results7; AxialDefResults(e, A6(i), ...

nodes7(lmm6(i,:)), d7(lmm6(i,:)))];

end

% results7

fprintf('The nodal displacements in meters for the 6 element model are:')

d7

axialStrain7 = results7(:,1);

fprintf('The axial strains for the 6 element model are:')

display(axialStrain7)

axialStress7 = results7(:,2);

fprintf('The axial stresses for the 6 element model are:')

display(axialStress7)

axialForces7 = results7(:,3);

fprintf('The axial forces for the 6 element model are:')

display(axialForces7)

figure(1)

plot(nodes3\*1000,d3\*1000,'^r',nodes7\*1000,d7\*1000,'.k','linewidth',2.25);

ylim([0,.055]);

title('Comparing Axial displacement of 2 Element and 6 Element Models');

xlabel('x [mm]'); ylabel('u [mm]')

legend('2 Element Model','6 Element Model');