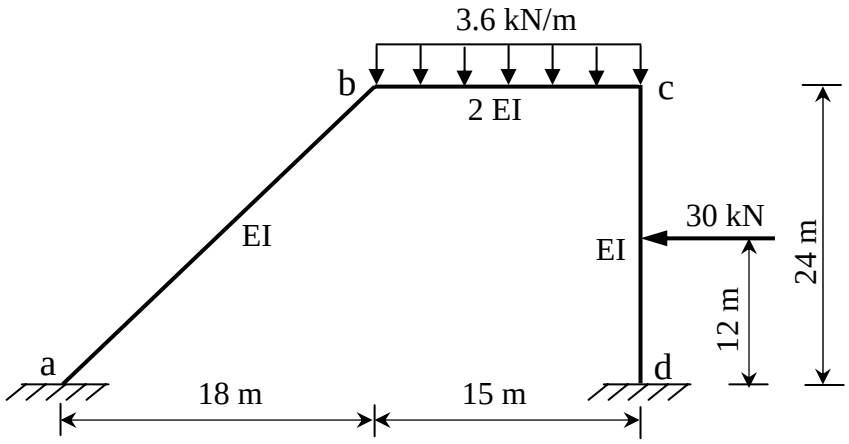
Department of Civil Engineering, IIT Bombay

CE317 Structural Mechanics –II Tutorial 6

Use stiffness method to find joint deflections, member end forces, and reactions. Compare with results obtained by slope deflection method and moment distribution method, which neglect axial deformations. Use $I/A=3000mm^2$



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%Tutorial 6 solution

%g=A/I in m^2 for respective member
g12=1/3000*1e6; g23=1/3000*1e6; g34=1/3000*1e6;

%matrix multiplications in matlab

a12=[-0.6 0.8 0; -0.8 -0.6 0; 0 0 1]; a21=[0.6 -0.8 0; 0.8 0.6 0; 0 0
1]; a23=[-1 0 0 ; 0 -1 0; 0 0 1]; a32=[1 0 0; 0 1 0; 0 0 1]; a34=[0 -1
0; 1 0 0; 0 0 1]; a43=[0 1 0; -1 0 0; 0 0 1];

L1=30; L2=15; L3=24;
k112=1/L1*[g12 0 0; 0 12/L1^2 -6/L1; 0 -6/L1 4]; k221=k112;
k12=1/L1*[g12 0 0; 0 12/L1^2 -6/L1; 0 -6/L1 2]; k21=k12;
k223=2/L2*[g23 0 0; 0 12/L2^2 -6/L2; 0 -6/L2 4]; k332=k223;
k23=2/L2*[g23 0 0; 0 12/L2^2 -6/L2; 0 -6/L2 2]; k32=k23;
k334=1/L3*[g34 0 0; 0 12/L3^2 -6/L3; 0 -6/L3 4]; k443=k334;
k34=1/L3*[g34 0 0; 0 12/L3^2 -6/L3; 0 -6/L3 2]; k43=k34;

K11=a12'*k112*a12; K12=a12'*k12*a21; K21=K12';
K22=a21'*k221*a21 + a23'*k223*a23;
K33=a32'*k332*a32 + a34'*k334*a34;
K23=a23'*k23*a32; K32=K23';
K34=a34'*k34*a43; K43=K34'; K44=a43'*k443*a43;
K13=zeros(3,3); K14= zeros(3,3); K24= zeros(3,3); K31=
zeros(3,3); K41= zeros(3,3); K42= zeros(3,3);

%remove rows/cols 1,2,3,10,11,12 from K_Total
KII=[K22 K23; K32 K33];

%remove rows 3,4,5,6,7,8 and cols 1,2,3,10,11,12 from K_Total
KII_I=[K12 K13; K42 K43];

F12f=[0 ; 0 ; 0]; F21f=[0 ; 0 ; 0];
F23f=[0 ; 3.6*L2/2 ; -3.6*L2^2/12];
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F32f=[0 ; -3.6*L2/2 ; 3.6*L2^2/12];
F34f=[0 ; 30/2 ; -30*L3/8];  F43f=[0 ; -30/2 ; 30*L3/8];

P1e= a12'*F12f; P2e= a21'*F21f + a23'*F23f;
P3e=a32'*F32f+ a34'*F34f; P4e=a43'*F43f;
Pa=[0 0 0 0 0 0]';

Pe=[P1e' P2e' P3e' P4e']'; Petilde=[ P2e' P3e']';
PI=Pa-Petilde; Pehat= [P1e' P4e']';
DeltaI=inv(KII)*PI

DeltaI =
  606.8382
  458.0569
   82.3718
  606.4830
    2.3979
  -24.9287

%reactions
P_II=KII_I*DeltaI+Pehat

P_II =
   15.7861
  -20.6961
    0.4228
   14.2139
  -33.3039
   81.6051

%member end forces
DeltaII=[0 0 0 0 0 0]';
Delta1= [DeltaII(1); DeltaII(2); DeltaII(3)];
Delta2= [DeltaI(1); DeltaI(2); DeltaI(3)];
Delta3= [DeltaI(4); DeltaI(5); DeltaI(6)];
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Delta4= [DeltaII(4); DeltaII(5); DeltaII(6)];
F12=k112*a12*Delta1 + k12*a21*Delta2+F12f
F21=k21*a12*Delta1 + k221*a21*Delta2+F21f
F23=k223*a23*Delta2 + k23*a32*Delta3+F23f
F32=k23*a23*Delta2 + k332*a32*Delta3+F32f
F34=k334*a34*Delta3 + k34*a43*Delta4+F34f
F43=k43*a34*Delta3 + k443*a43*Delta4+F43f

F12 =
  -26.0286
   -0.2112
    0.4228
F21 =
  -26.0286
   -0.2112
    5.9142
F23 =
  -15.7861
   20.6961
   -5.9142
F32 =
  -15.7861
  -33.3039
  100.4723
F34 =
  -33.3039
   15.7861
 -100.4723
F43 =
  -33.3039
  -14.2139
   81.6051
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