UNIVERSITY OF CALIFORNIA, BERKELEY
Spring Semester 2015

Dept. of Civil and Environmental Engineering
Structural Engineering, Mechanics and Materials

Name: .....

M.S Comprehensive Examination

Analysis

Note:

1. Dimensions, properties and loading are given in consistent units in all problems.
2. All figures are drawn to scale.
3. Calculations should be shown in detail with all intermediate steps; it is recommended to manipulate expressions symbolically as far as possible and substitute numbers only at or near the end.
4. Results involving multiplication or division with a matrix larger than 2 x 2 will not receive credit.

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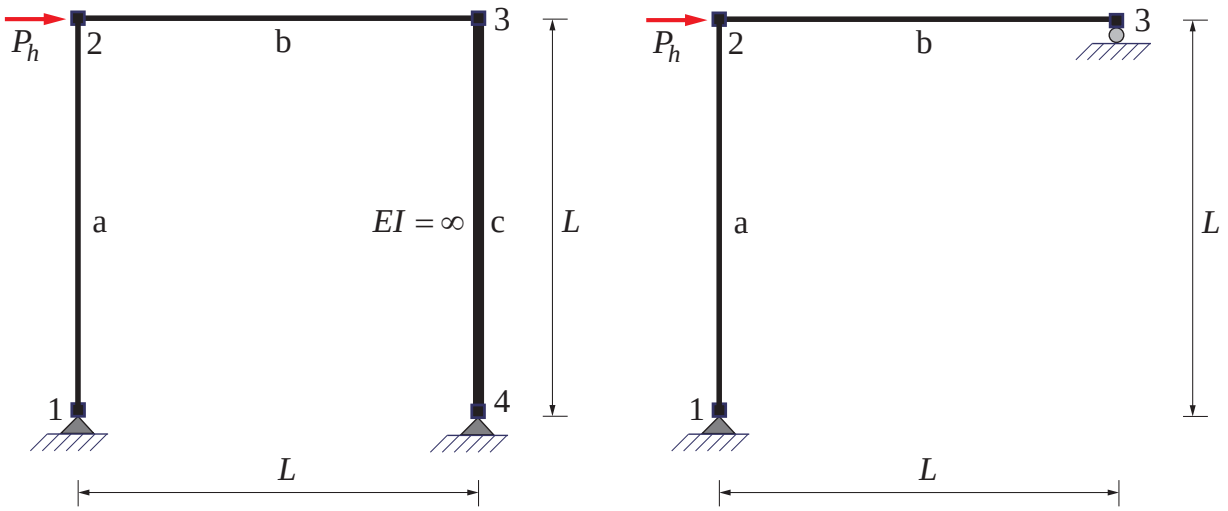
Problem

Fig. 1(a) and (b) show two structural models. Model A consists of two *inextensible* frame elements a and b and a frame element c, which is in addition *inflexible*. Model B consists of two *inextensible* frame elements a and b. All flexible frame elements have the same flexural stiffness EI. All elements have the same length L. Both structural models are subjected to a horizontal force P_h.

You are asked to answer the following questions *for both structural models*:

1. Determine the horizontal translation at the point of application of P_h in terms of P_h, L and EI.
2. Draw the bending moment distribution under P_h.



(a) Structural model A (b) Structural model B

Figure 1: Two structural models

Problem

The two girders in Fig. 1 are subjected to a uniformly distributed element load $w = 10$ over their entire length. The girders are inextensible with flexural stiffness $EI = 60,000$.

You are asked to answer the following questions:

1. Determine the bending moment distribution and draw it as precisely as possible supplying all necessary values *for both two-span girders.*
2. Determine the vertical translation at the intermediate hinge of the first span for any one of the two cases.
3. Determine the hinge deformation at the intermediate hinge of the first span for any one of the two cases.

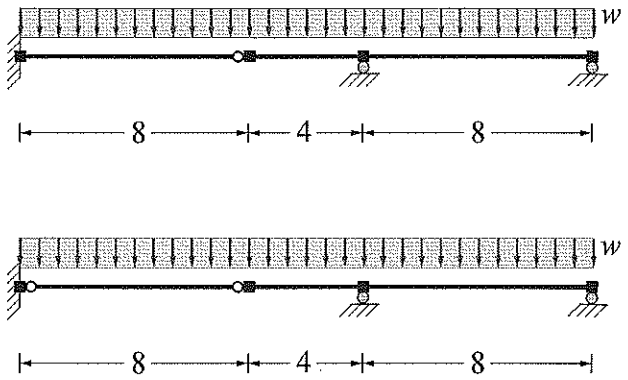


Figure 1: Two-span girders under uniformly distributed load w

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1. Problem (50% weight)

Elements a, b and c of the structural model in Fig. 1 are inextensible. The ratio of the flexural stiffness EI of these elements to the axial stiffness EA of brace element d is $EI/EA = 2$. The applied loading consists of a concentrated force of 50 units at node 2. The analysis of the structure with the force method of analysis uses the moment at end i of element a and the moment at end i of element b as redundant basic forces resulting in the values in Fig. 1.

You are asked to answer the following questions:

1. Draw the bending moment diagram.
2. Confirm that the values for the redundant basic forces satisfy the compatibility conditions.

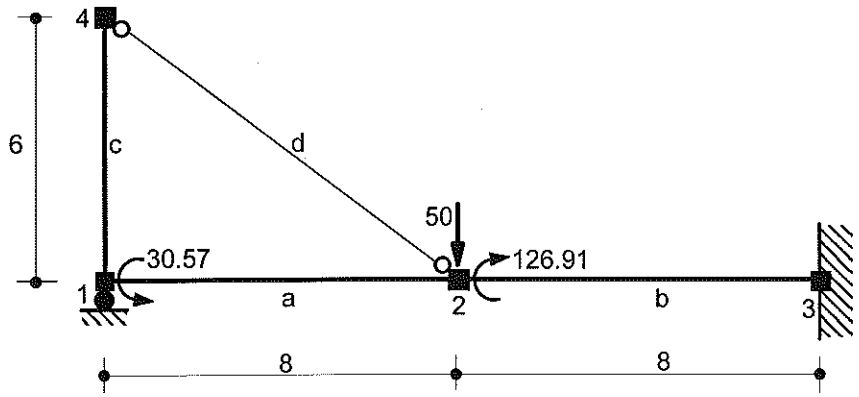

Figure 1

2. Problem (50% weight)

The truss elements of the model in Fig. 2 have axial stiffness EA=20,000 units. The loading consists of *a thermal strain* of element c equal to $\varepsilon_0 = -2 \cdot 10^{-3}$. Under this loading the values of the free dof translations are: $\boldsymbol{U}_1 = -7.4074 \cdot 10^{-3}$ and $\boldsymbol{U}_2 = 4.1667 \cdot 10^{-3}$.

You are asked to answer the following questions:

1. Determine the stiffness matrix at the free dofs of the structural model and confirm that the equilibrium equations for the displacement method of analysis are satisfied.
2. Determine the basic forces in elements a, b and c.

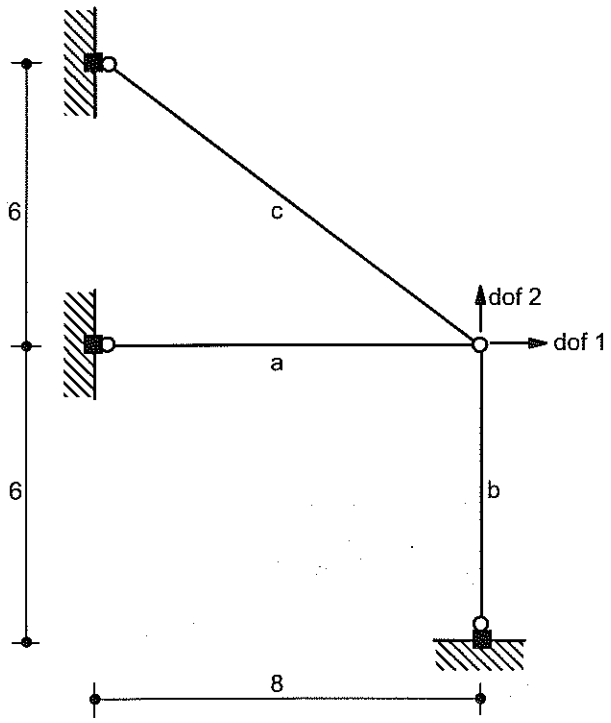

Figure 2