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Exercise #10 –Potential Energy Method of Equilibrium

Problem 1

The structural system shown in Figure 1 consists of a rigid vertical member that is subjected to a compressive force P and two horizontal beams of rigidities EI and $2EI$. The vertical member should not rotate by a certain amount in order to prevent any geometric instability.

Compute the following:

1. The total internal energy U of the system by considering no imperfections.
2. Compute the total external energy V_p of the system by considering no imperfections.
3. Investigate the stability (or instability) of the system based on the total potential energy theorem by using linear and nonlinear theory.

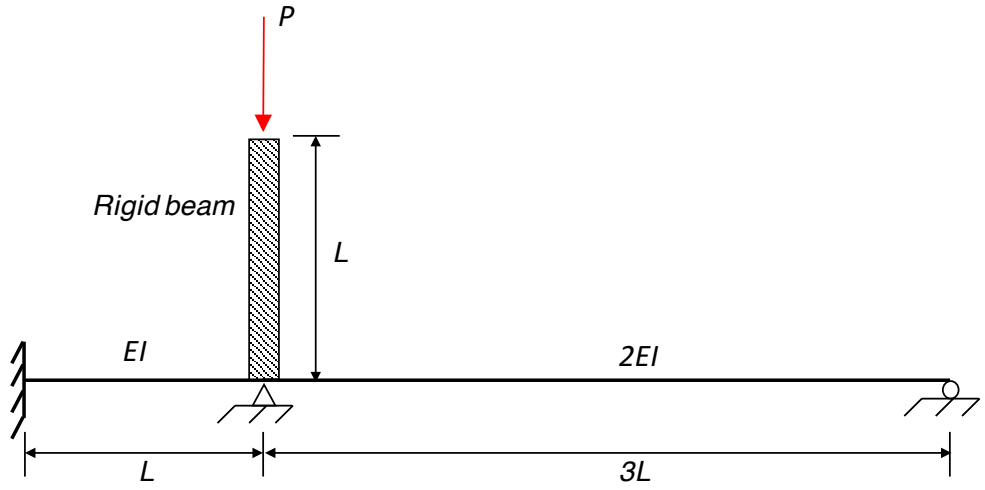

Figure 1. Planar structural system

Note that a beam with length L and end moments can be idealized as follows depending on its boundary conditions.

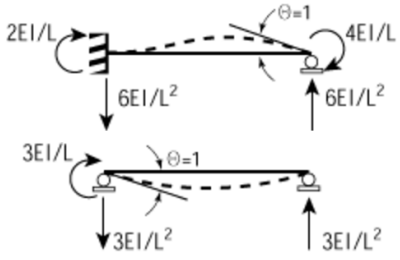

Figure 2. Stiffness coefficients

Problem 2

The steel bridge shown in Figure 3a can be represented by a set of two steel rods of infinite axial stiffness as shown in Figure 3b and a horizontal beam of rigidity *EI* that should not rotate by a certain amount in order to prevent any stability associated issues. Compute the following:

1. The total internal energy *U* of the system by considering no imperfections.
2. Compute the total external energy V_p of the system by considering no imperfections.
3. Investigate the stability (or instability) of the system based on the total potential energy theorem by using linear and nonlinear theory.

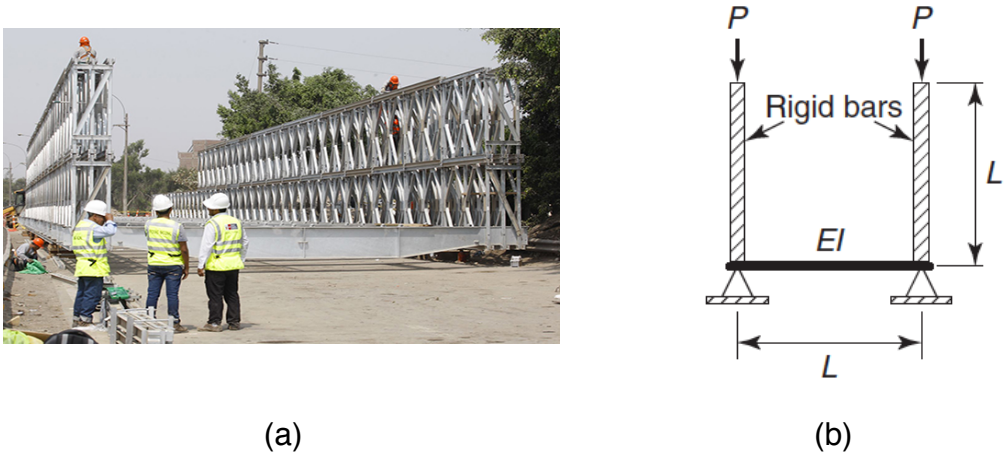

Figure 3. Steel bridge deck and mathematical model idealization

Note: a beam with end moments can be idealized as follows:

$$M = \frac{2EI}{L}\theta \qquad M = \frac{2EI}{L}\theta$$