Homework 07 – Plastic Analysis and Design

This problem set examines plastic analysis and design with emphasis on the kinematic or upper bound method. The first two problems make use of beam and joint basic mechanisms. The third problem focuses on sway (panel) and joint mechanisms. For each problem, verify that the collapse load calculated using the kinematic method is the true collapse load by showing that the plastic moment is not exceeded anywhere in the structure.

Problem 1: For the two-span beam shown below, calculate the maximum value of the load P for the following three cases: (a) a=b=c=0.5L; Q = 4P; (b) a=b=c=0.5L; Q = 2P; and (c) a=0.667L, b =0.333L, c=0.5L; Q=4P. The beam plastic moment in each span is $M_p$. Check each solution by drawing the corresponding moment diagram.

![Diagram of a two-span beam](image)

Problem 2: For the two span beam below, calculate the maximum load P. Check your solution by drawing the moment diagram corresponding to the load P.

![Diagram of a two-span beam with forces](image)

Problem 3: Calculate the collapse base shear force for the two-bay two-story steel moment-resisting frame below. Note the distribution of member strengths. Such a distribution could be representative of older construction where little attention was paid to the relative strengths of the beams and columns. The kinematic methods of analysis are a powerful tool for the evaluation of existing structures, and the method is widely used in earthquake engineering. For this example, gravity load effects on the beams and columns are ignored. Also, P-M interaction in the columns should be ignored. **Hints:** Consider three sway mechanisms. Add joint mechanisms to reduce the internal work and thus reduce the upper bound estimate of the collapse load.

![Diagram of a two-bay two-story frame](image)