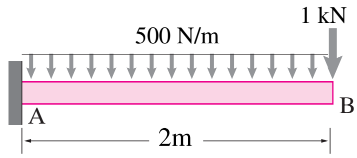
8.1 Shear force, bending moment and tension diagrams

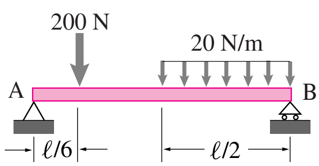
Preparatory Problems

8.1.1 A cantilever beam AB is loaded as shown in the figure. Find the support reactions on the beam at the left end A.



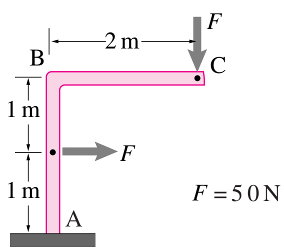
Problem 8.1.1

8.1.2 A simply supported beam AB of length $\ell = 6\,\text{m}$ is partly loaded with a uniformly distributed load as shown in the figure. In addition, there is a concentrated load acting at $\ell/6$ from the left end A. Find the support reactions on the beam.



Problem 8.1.2

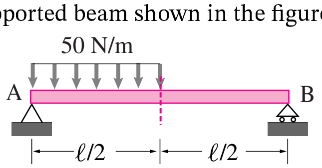
8.1.3 An (inverted) L-shaped frame is loaded with two equal concentrated forces of magnitude 50 N each as shown in the figure. Find the support reactions at A.



Problem 8.1.3

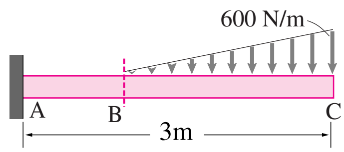
More-Involved Problems

8.1.4 Find the shear force and the bending moment at the mid section of the simply supported beam shown in the figure.



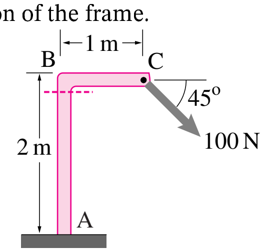
Problem 8.1.4

8.1.5 A cantilever beam ABC is loaded with a linearly variable distributed load along two thirds of its span. The intensity of the load at the right end is $600\,\text{N}/m$. Find the shear force and the bending moment at section B of the beam.



Problem 8.1.5

8.1.6 Analyze the frame shown in the figure and find the shear force and the bending moment at the end of the vertical section of the frame.

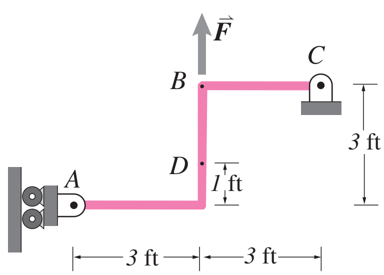


Problem 8.1.6

8.1.7 A force $F = 100\,\text{lbf}$ is applied to the bent rod shown. Before doing any calculations, try to figure out the tension at D in your head.

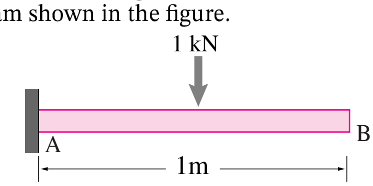
a) Find the reactions at A and C.

b) Find the tension, shear and bending moment at the section D. Check your answer against what you figured out in your head.



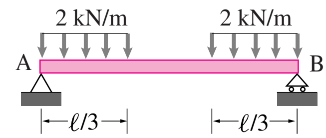
Problem 8.1.7

8.1.8 Draw the shear force and the bending moment diagram for the cantilever beam shown in the figure.



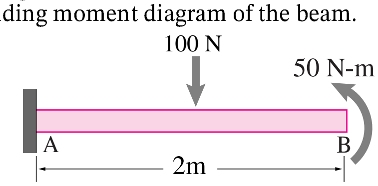
Problem 8.1.8

8.1.9 A simply supported beam AB is loaded along one thirds of its span from both ends by a uniformly distributed load of intensity $2\,\text{kN/m}$. Draw the shear force and the bending moment diagram of the beam.



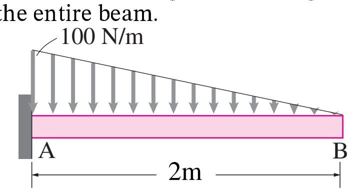
Problem 8.1.9

8.1.10 The cantilever beam shown in the figure is loaded with a concentrated load and a concentrated moment as shown in the figure. Draw the shear force and the bending moment diagram of the beam.



Problem 8.1.10

8.1.11 A cantilever beam AB is loaded with a triangular shaped distributed load as shown in the figure. Draw the shear force and the bending moment diagrams for the entire beam.

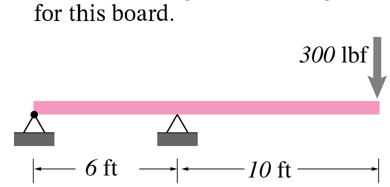


Problem 8.1.11

8.1.12 A regulation 16 ft diving board is supported as shown.

a) Where is the bending moment the greatest and how big is it there?

b) Draw a bending moment diagram for this board.



Problem 8.1.12

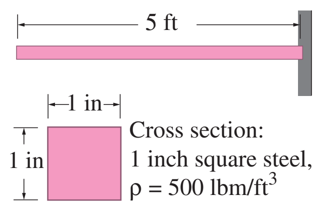
8.1.13 The cantilever steel beam is loaded by its own weight.

a) Find the bending moment and shear force at the free and at the clamped end.

b) Draw a shear force diagram

c) Draw a bending moment diagram

d) The tension stress σ in the beam at the top edge where it is biggest is given by $\sigma = 12M/h^3$ where $h = 1 \in$ for this beam. The strength (the maximum tension stress the material can bear) of soft steel is about $\sigma_{\max} = 30,000\,\mathrm{lbf}/\in^2$. What is the longest a beam with this cross section can be made and still not fail?

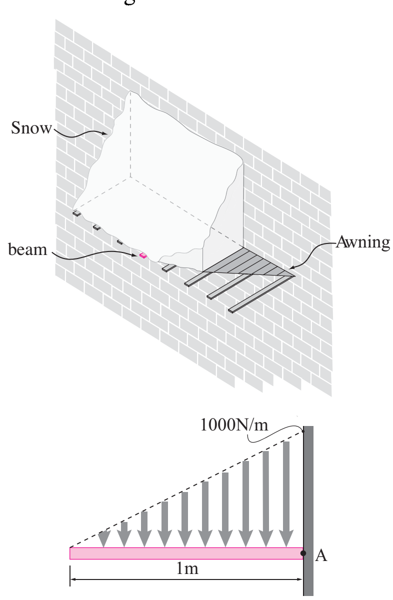


Problem 8.1.13

8.1.14 A snow loaded bus-stop awning (shown partially cut away) on the side of a building is supported by horizontal, cantilevered, beams. The loading that is carried by one beam is as shown below.

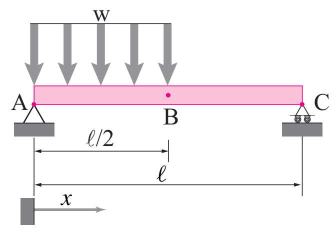
a) Find the reaction force and couple at the wall at A (the force and moment acting on one beam from the wall). *

b) Draw shear force and bending moment diagrams for the beam.



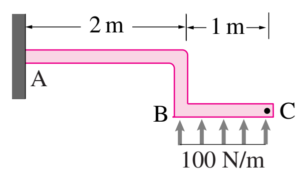
Problem 8.1.14

8.1.15 Draw shear and bending moment diagrams of the beam shown. Clearly label the values of the heights of the curves at jumps, kinks and local maxima (if and where they exist). *



Problem 8.1.15

8.1.16 A frame ABC is much like a cantilever beam with a short bent section of length 0.5 m. The frame is loaded as shown in the figure. Draw the shear force and the bending moment diagrams of the entire frame indicating how it differs from an ordinary cantilever beam.

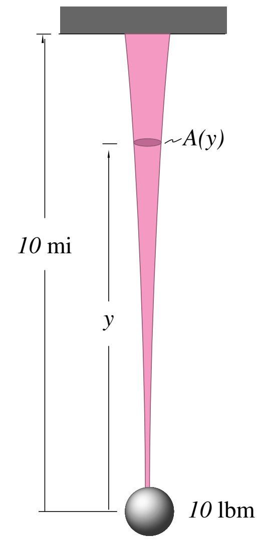


Problem 8.1.16

8.1.17 A 10 pound ball is suspended by a long steel wire. The wire has a density of about $500\,\mathrm{lbm}/\mathrm{ft}^3$. The strength of the wire (the maximum force per unit area it can carry) is about $\sigma_{\max} = 60,000\,\mathrm{lbf}/\in^2$.

a) First, neglecting the weight of the wire in the calculation of stress, what is the weight of wire needed to hold the weight?

b) Taking into account the weight of the wire in the load calculation, what is the weight of wire needed to hold the weight? *



Problem 8.1.17