

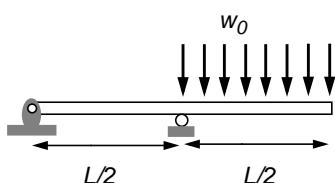
Class Exercise #24 1.050 Solid Mechanics

Fall 2004

Here are 6 problems of the same type, drawn from past years' final exams.

- i) What do they have in common? What's different?
- ii) What must you know in order to do the common part of the problem?
- iii) Which is the most difficult problem? Why? Which is the easiest?
- iv) Formulate a new problem - a variation on the common theme - that I might assign on this year's final.

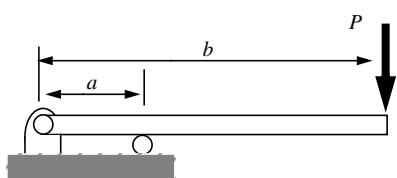
98 - Problem 3



A simply supported beam is subject to a uniformly distributed load, w_0 (force/length) over the out-board half of its length.

- Sketch the shear force and bending moment distributions. Make sure you show your sign convention.
- Where does the maximum bending moment occur?

99 - Problem 2



Sketch the Shear Force Diagram and the Bending Moment diagram for the simply supported beam shown at the left. Show the convention on positive shear force and bending moment.

Say you replace the roller at $x=a$ with a spring of stiffness, k . Assuming the board is rigid relative to the linear spring.

Show that the equivalent stiffness of the system at b , i.e., K in the expression

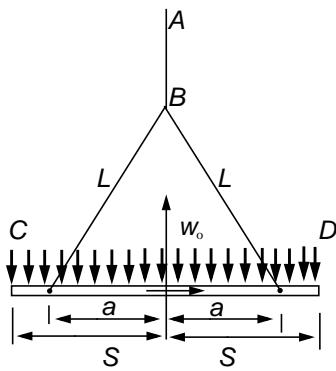
$$P = K\Delta$$

where Δ is the deflection under the load, is $K = k \cdot (a/b)^2$

where k is the stiffness of the linear spring at a .

Finally, what *non-dimensional* parameter must be small relative to 1.0 in order to justify the assumption that the board is rigid relative to the linear spring? An "order of magnitude" statement will suffice here.

00 - Problem 5



A beam, carrying a uniformly distributed load, is suspended by cables from the end of a crane (crane not shown). The cables are attached to the beam at a distance a from the center line as shown. Given that

$$a = (3/4)S \text{ and } L = (3/2)S$$

- 5a) Determine the tension in the cable AB . Express in non-dimensional form, i.e., with respect to $w_0 S$.
- 5b) Determine the tension in the cables of length L .
- 5b) Sketch the beam's shear force and bending moment diagram. Again, non-dimensionalize. What is the magnitude of the maximum bending moment and where does it occur?
- 5c) Where should the cables be attached - ($a/S = ?$) - to minimize the magnitude of the maximum bending moment? What is this minimum value?
- 5d) If a/S is chosen to minimize the magnitude of the maximum bending moment, what then is the tension in the cables of length L ? Compare with your answer to 5b.

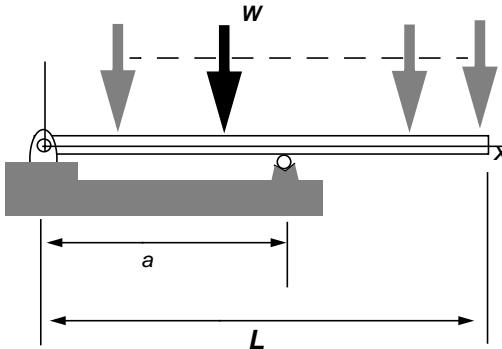
01 -Problem 2

A uniform beam is pinned at one end and supported by a roller at some distance a from this end.

The beam carries a moving load W , which can be positioned at any point along the beam from one end to the other.

Draw a shear force and bending moment diagram for each of the following cases:

- i) The load is positioned at the right end of the beam e.g., $x=L$.
- ii) The load is positioned outboard of the roller support at a . e.g., $a < x < L$
- iii) The load is positioned at $x=a$.
- iv) The load is positioned inboard of a . e.g., $0 < x < a$



In each case, note the magnitude of the maximum bending moment and where it occurs.

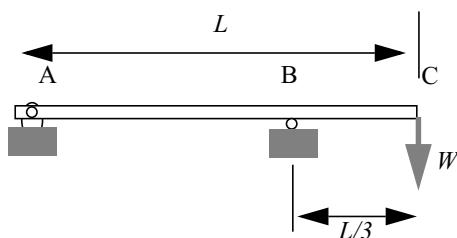
- v) Now, where should the roller support be located ($a/L = ?$) to minimize the maximum bending moment given that, as stated above, the load can be positioned at any point along the beam.

02 -Problem 1

A beam is pinned at one end, A , and supported at a third of its length from the other end by a roller - at B . A weight W is suspended from its free end, C . Neglect the weight of the beam.

Sketch the shear force and bending moment distribution.

Where is the bending moment maximum in magnitude and what is that magnitude?



03 -Problem 1

A beam is pinned at one end, *A*, and supported at a fourth of its length from the other end by a roller at *B*. The beam carries a uniformly distributed load *w*, force/length.

Sketch the shear force and bending moment distribution.

Where is the bending moment maximum in magnitude and what is that magnitude?

