MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF OCEAN ENGINEERING AND CIVIL AND ENVIRONMENTAL ENGINEERING
13.10J/1.573J Introduction to Structural Mechanics
Fall 1999
Problem Set 5

Assigned : October 7, 1999
Due : October 14, 1999

1. A steel mooring cable with the diameter $d = 20mm$ and length $L = 40m$ is deployed at a water depth $D = 30m$ so that it restricts the motion of a surface buoy. The maximum horizonal force on the buoy from the ocean currents is $10kN$. We are also given:

   - density of steel $\rho_s = 7040kg/m^3$
   - modulus of elasticity of steel $E = 200GPa$
   - Poisson's ratio of steel $\mu = 0.3$
   - yield stress of steel $\sigma_y = 250MPa$
   - density of sea water $\rho_w = 1025kg/m^3$
   - acceleration of gravity $g = 9.81m/s^2$

   (a) Determine the maximum vertical and horizontal forces from the anchor on the cable.

   (b) Plot $x(s)$, $z(s)$, $\phi(s)$, $T_e(s)$ where arc length s is measured from the anchor.

   (c) Qualitatively, if $x(L)$ is above a certain threshold, what changes to the mooring line could you do to reduce $x(L)$?

   (d) What is the tension in the material at $s = 0$, $s = L$?

   (e) Estimate the maximum axial strain, maximum axial stress and total elongation of cable under the above conditions (and justify any approximations in subproblems (a)-(d)).

(f) Estimate the maximum shrinkage of the cable diameter.

(g) Estimate the strain energy of the entire cable at the condition of maximum loading.

2. Beam problems from Chapter 10 and 11 of the course textbook.

   (a) Problem 10.2

   (b) Problem 10.8
   (And sketch shear and bending-moment diagrams labeling key points.)

   (c) Problem 10.31

   (d) Problem 11.8

Problem sets are also available in the course homepage.