MASSACHUSETTS INSTITUTE OF TECHNOLOGY
13.10J/1.573J Structural Mechanics
13.014 Materials and Structures
1.052 Mechanics of Structures
Problem Set 6

Assigned : October 11, 2000
Due : October 18, 2000
(Problem 4 is due : October 25, 2000)

1. For undergraduate students (1.052) : 10.7, 10.28

2. For undergraduate students (13.014) : 10.7, 10.28

3. For graduate students (13.10J/1.573J) : 10.7, 10.28

4. A problem for graduate students (13.10J/1.573J) [**Due October 25, 2000**] :

   An FPSO (Floating Production, Storage and Off-loading) system under operation at a water with the depth of $D = 1000m$ is moored by steel cables as shown in Figure 1. It has a riser for drilling and oil production so that the maximum excursion of the ship should be restricted to a certain range to prevent the riser from breaking. The fluid force (horizontal force) on the ship due to ocean currents, waves and wind is resisted by the steel cables. Here we are analyzing one cable AB which resists a horizontal force $H = 20kN$ (part of the total drag on the ship). The maximum allowed excursion of the ship is $X_M = 60m$. Fluid forces on the cable may be neglected. We are also given the following data.

   - diameter of steel cable : $d_s = 0.05m$
   - density of steel : $\rho_s = 7040kg/m^3$
   - modulus of elasticity of steel : $E_s = 200GPa$
   - Poisson's ratio of steel : $\nu_s = 0.3$
   - yield stress of steel : $\sigma_y = 250MPa$

- density of sea water : $\rho_w = 1025 kg/m^3$
- acceleration of gravity : $g = 9.81 m/s^2$

(a) Determine the vertical, horizontal forces from the anchor on the mooring cable and the length of the cable.

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

(c) What are the tension forces in the material at $s = 0$ and $s = L$?

(d) Estimate the maximum axial strain, maximum axial stress and total elongation of cable under the given conditions.

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

(f) Estimate the strain energy of the entire cable under the given condition.

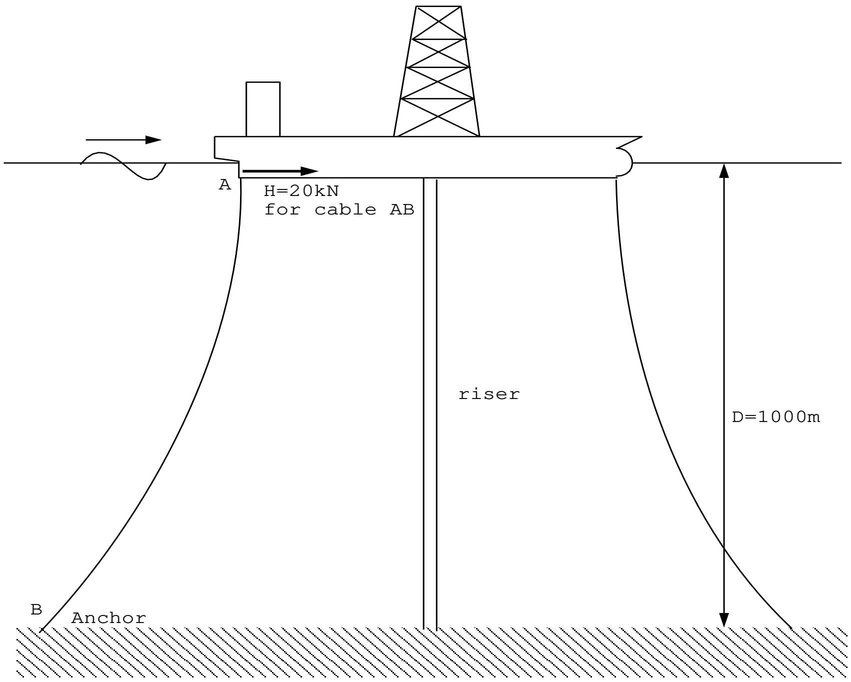

Figure 1: A diagram for problem 4

Problem sets are available also in the course homepage.