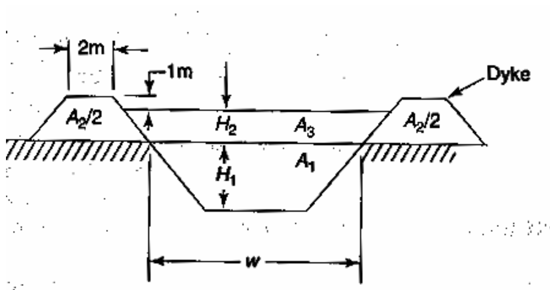
ME 748: Optimum Design of Mechanical Elements and Systems

Spring 2007; Assignment-1;

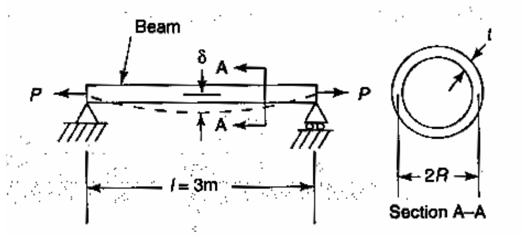
Due: 2nd Feb 2007; 5 pm in ECB 3108

NOTE: You are welcome to discuss/ clarify the theory discussed in class with your class-mates, but I expect you to work on the assignments by yourself.

Problem 1: (2.22 from textbook) Design a water canal having a cross-sectional area of $150m^2$. Least construction costs occur when the volume of the excavated material equals the amount of material required for the dykes, shown in Figure. Formulate the problem to minimize the dugout material A_1, in a standard form.



Problem 2: (2.24 from textbook) Design a hollow circular beam as shown to meet both of the following two conditions: when $P = 50kN$, the axial stress σ should be less than σ_a, and when $P = 0$, the deflection δ due to self-weight should satisfy $\delta \leq 0.001l$. The limits for dimensions are $0.1 \leq t \leq 1.0cm$, $2 \leq R \leq 20.0cm$ and $R / t \geq 20$. Formulate the minimum weight design in standard form. Use the following data: $\delta = 5wl^4 / (384EI)$, where w us the self weight/length, $\sigma_a = 250MPa, E = 210Gpa$, $\rho = 7800km / m^3$, $\sigma = P / A$, $g = 9.8m / s^2$ and $I = \pi R^3 t$.



Problem 3: Write a Matlab function to analyze (NOT TO OPTIMIZE) a generic three bar truss system of the type discussed in class. The Matlab code should be of the form:

`function [u,v] = solveThreeBarTruss_Suresh(E,d,nodeLocations,P)`, where

- You should substitute your last name instead of "Suresh"
- d is a 1x3 vector [d1 d2 d3] representing the three diameters
- nodeLocations is a 2x4 matrix of the form
  - [x1 x2 x3 xc; y1 y2 y3 yc]; the first bar joins (x1, y1) and (xc, yc), etc
- P is a 1x2 vector [Px Py]

Problem 4: Use the necessary and sufficient conditions to find the minimum of $f(x) = x^3 - 3x^2 + 6$