

Assignment 5: VBA Programming

Date Due: March 5, 2011

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Problem 1

A formula used in Coastal Engineering to estimate the transport rate of sediment for beaches exposed to waves is given below in equation (1).

$$Q = K \sqrt{\frac{g}{\gamma}} \frac{H_b^{2.5} \sin 2\alpha}{16^*(s-1)a^*} \quad (1)$$

where :

Q is the longshore transport formula (in cubic meters per second)

K = coastal coefficient

γ = is the ratio of the wave height to water depth at breaking

H_b = is the significant wave height (m)

s = sediment specific gravity (typically 2.65 for most sediments)

α = is the angle between the waves and the beach (degrees).

a^* = ratio of solid to total volume of sediment (dim)

g = gravity constant (m/s²)

Assume all units in Equation 1 are correct.

a) Write a **program in Visual Basic for Applications (VBA)** to calculate the value of Q given the values of all seven variables in the right hand side of Equation (1). The VBA program (either a function or a sub routine - your choice) should produce a single value (Q) as output. The values of the seven input variables are to be entered in the worksheet. Use the following parameters to test the program: $s = 2.6$; $H_b = 3.0$; $a^* = 0.6$, $g = 9.81$; $\gamma = 0.9$.

The value of K varies from 0.32 (for normal beach sands) to 0.03 for coarser shingle beaches. Your program should have a simple GUI interface that allows the user to change the values of K and α using a slider or combo-box control (your choice). The valid range of values for K have been stated above. For α possible values range from 0-90 degrees.

b) Implement a simple code with a warning message box to let the user know of possible out-of-range parameters (i.e., data validation).

Problem 2

A simple equation to predict the so-called basic resistance of a high-speed rail system (R_{basic}) moving at speed (v) is given by Davis' equation and shown below. This equation includes the resistance due to aerodynamic drag and axle load friction resistance (i.e., resistance between train steel tires and the rail track).

$$R_{basic} = A + Bv + Cv^2$$

where: A , B , and C are train-specific coefficients and v is the train speed in meters per second. The values of A , B , and C are determined using wind tunnel testing and actual testing of the trains in test tracks. The values of A , B , and C for a Japanese High-Speed Train of the series Shinkansen 300 (see <http://en.wikipedia.org/wiki/Shinkansen>) are provided below with their corresponding units.

$A = 8.20200$; % units are kN
 $B = 0.10656$; % units are kN s/m
 $C = 0.01193$; % units are kN s-s/m-m

Note that the units of A , B and C are consistent to produce a basic resistance of the train in kiloNewtons.

Task 1:

Create a VBA program (i.e., a subroutine) to estimate the basic resistance for the high-speed train for a range of velocities ranging from 1 to 85 m/s (range of speed where the train operates).

In your analysis create VBA code that includes a FOR-NEXT loop to estimate the resistance at various speeds (in meters/second). Create a run button to execute the code from within the Excel interface. The VBA code should write the header for velocity and resistance in the 10th row of the Excel spreadsheet. Make sure you place your name and the time of creation in the Excel spreadsheet. Declare all program variables using the Option Explicit statement.

Task 2:

Improve the code created in Task 1 by adding a separate worksheet to the problem. In this new worksheet include the description of the problem and add slider controls to set the values of A , B and C to simulate other versions of the High-Speed Train family of trains. The interface should let the user select the lower and upper bound of the speeds to be computed in the VBA code and also should let the user select the step size of speed to be used in the calculations.

Set limits for these sliders to be:

A - 6.0 (min) and 10 (max) in units of kN
 B - 0.10 (min) and 0.14 (max) in units of kN (s/m)
 C - 0.010 (min) and 0.013 (s²/m²) in units kN s²/m²

Task 3:

Test the behavior of the new interface for various Shinkansen train sets shown in the Table below.

Table 1. High-Speed Rail Systems in Japan.

Train Set	A	B	C
Shinkansen 200	9.21	0.121	0.012
Shinkansen 300	8.20	0.106	0.012
Shinkansen 500	8.10	0.105	0.011
Shinkansen 700	7.92	0.10	0.010

Comment on the basic resistance for the various Japanese Shinkansen series trains. Which of the Japanese train sets is the fastest based on the numbers on the table and the article in Wikipedia?

Problem 3

In hydraulics, one of the fundamental problems is to determine the reaction force (F) generated by a leaking tank is shown in the figure below. The following formulas apply to the problem using basic hydrostatic analysis: v is the velocity of the leaking water flow (m/s), d is the horizontal distance traveled by the leaking water (meters), Q is the volumetric flow rate (m³/s), and F is the reaction force acting on the tank (Newtons).

$$v = \phi \sqrt{2gh_1}$$

$$d = 2\sqrt{h_1h_2}$$

$$Q = \phi\mu A\sqrt{2gh_1}$$

$$F = 2\gamma gAh_1$$

where: g is the gravity constant (9.81 m/s²), h_1 is the water depth to the leaking point (meters), h_2 is the distance from the bottom of the tank to the leaking point (meters), A is the area of the leaking orifice (m²), μ is the contraction coefficient (0.62 for thin-walled tanks, 0.97 otherwise), ϕ is the equivalent friction (0.97 for water) and γ is the specific weight of the water (1000 kg/m³).

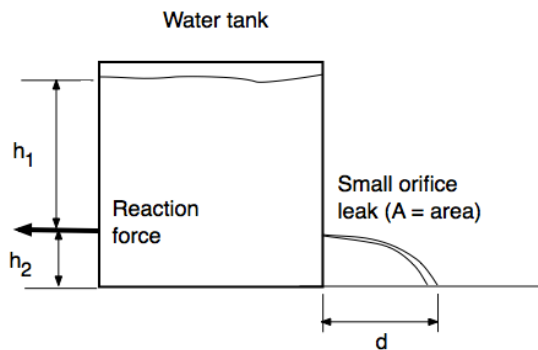


Figure 1. Leaking Water Tank Geometry.

Task 1:

Create a VBA program (i.e., a subroutine) to estimate the four parameters of the leaking water tank problem (v, d, Q, F). The inputs to the subroutine should be the values of h_1 , h_2 , A , ϕ , and γ . The value of μ should be determined internally by the subroutine based on the wall properties of the tank (i.e., thin or thick). Thus it is required that the key word “thin” or “thick” be an input to the subroutine to determine the appropriate value of μ . The subroutine should return 4 parameters: v, d, Q, F . All four parameters should be returned back to the spreadsheet in cells of your choice.

Task 2:

Create a simple interface using Excel controls for this program to select all possible input parameters and in the same interface display all output parameters.

Task 3:

Test your computer program with the following values: $h_1 = 18$, $h_2 = 1$, $A = 0.10$, $\phi = 0.97$, $\gamma = 1000$ for both thin and thick wall tanks. Comment on the results obtained.

Task 4:

Use the computer program created in Task 3 to examine the sensitivity of d with water tank depth. Create a table in Excel for values of d when h_1 varies from 5 meters to 18 meters at steps of 0.1 meters. As usual, create the headers for the table in VBA code and also generate the results for h_1 in the same VBA subroutine.