Addis Ababa Institute of Technology

Department of civil and Environmental Engineering

Hydraulics-II (CENG-2162)

Assignment 2 (Dimensional Analysis and Similitude)

1) Spillway model is, to be built to a geometrically similar scale of 1/ 40 across a flume of 50 cm width. The prototype is 20 m high and maximum head on it is expected to be 2m.

   (i) What height of model and what head on the model should be used

   (ii) If the flow over the model at a particular head is 10 liters/s, what flow per meter?

   Length of the prototype is expected?

   (iii) If the negative pressure in the model is 150 mm, what is the negative pressure in the prototype? Is it practicable?

2) The discharge Q through an orifice is a function of the diameter d, the pressure difference p, the density ρ, and the viscosity μ, where ϕ is some unknown function. Show that,
$$Q = \frac{d^2 p^{1/2}}{\rho^{1/2}} \phi\left(\frac{d\rho^{1/2} p^{1/2}}{\mu}\right)$$

3) A ship 250 m long moves in sea-water, whose density is 1030 kg/rn^3. A l: 125 model of this ship is to be tested in wind tunnel. The velocity of air in the wind tunnel around the model is 20 m/s and the resistance of the model is 50N. Determine the velocity of ship in sea-water and also the resistance of the ship in sea-water. The density of air is given as 1.24 kg/rn3. Take the kinematic viscosity of sea-water and air as 0.012 stokes and 0.018 stokes.

4) The variables controlling the motion of a floating vessel through water are the drag force F, the speed V, the length L, the density ρ and dynamic viscosity of water and acceleration due to gravity g. Derive an expression for F by dimensional analysis.

5) A 50 cm tall scale model of a proposed 50 m spillway is used to predict prototype flow conditions. If the design flood discharge over the spillway is 20,000 m^3/s, what water flow rate should be tested in the model?