Mid-Term Exam

Oct. 30, 2007
11:00~12:30

1. (35%) The height of freeboard is one of critical parameters in the design of offshore structures. The height of freeboard is related to manufacturing cost, and 1m difference of freeboard height can reduce or increase the cost of million dollars.

Let's consider a platform shown right, which its freeboard height is 15m. You installed a velocity and pressure sensors at 20m depth, and once you measured a regular oscillatory signal of horizontal velocity with the period of 4π-sec and amplitude 3m/sec.

Assuming linear waves in deep water, answer the following questions (put gravitational constant 10m/sec^2):

(1) How much is wave length?
(2) What is wave amplitude? Do the waves hit the deck of this platform?
(3) What are the phase and group velocities of the waves?
(4) What is the amplitude of vertical velocity?
(5) Estimate the maximum pressure.
(6) What is the mean wave energy density in a unit width if the wave is plane progressive?

15m

2. (30%) Let's consider a towing tank with two different depths as below:

T=10.93sec

3m

300m

500m
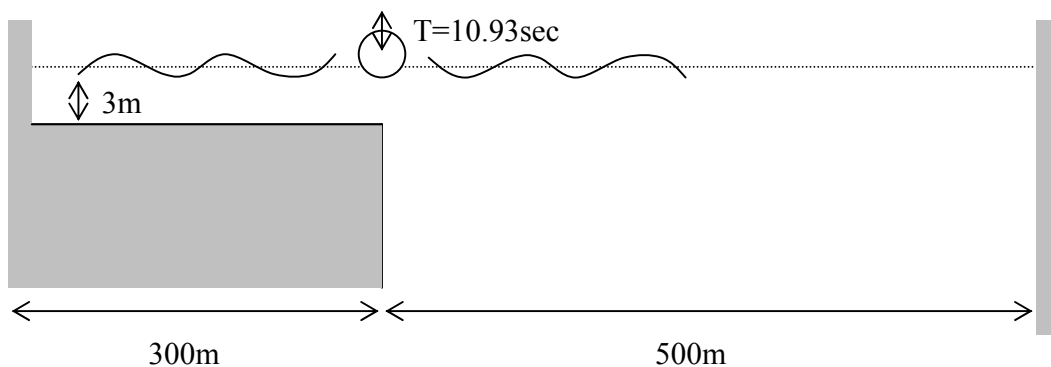
Tank depth in left domain is 3m and depth in right domain can be considered as deep water. The both sides are solid walls. There is a cylindrical wave maker just above the step of two domains, which oscillates with the period of 10.93sec.

(1) Find wave lengths in two domains.
(2) Compute times that the first waves return to the location of the wave maker in two
   domains.
(3) Let's assume that the waves reflect perfectly on the side walls. Sketch briefly the orbits
   of water particles in one wave length before and after (but before the first wave reach to
   the wave maker) the first reflections.

3. (35%)
(1) Write nonlinear free surface boundary conditions.
(2) Derive the linear kinematic and dynamic free surface boundary conditions.
(3) Describe shortly why dispersion relation is important in water wave problem.
(4) Buckingham's Pi Theorem and three similarities