INTRODUCTION TO COASTAL AND HARBOR ENGINEERING

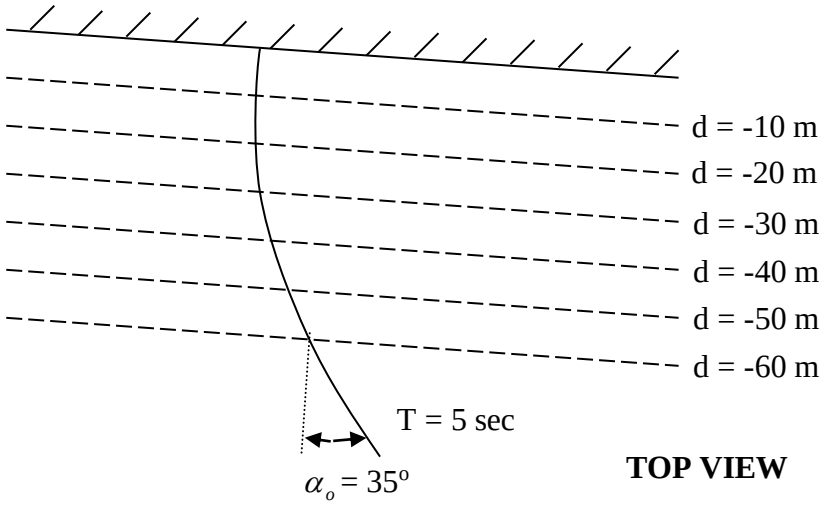
PROBLEM SET 3

1. A wave of period T = 8 sec. is approaching from deep water towards shore on straight and parallel bottom contours. The angle of incidence of the wave at d = 15 m water depth is α_{15} = 15°. If the wave height at d = 10 m. is H_{10} = 2 m. Calculate;

a) Wave height at d = 15 m.

b) The wave height at deep water.

2. Progressive waves of T = 5 sec. is approaching from deep water to shallow water on straight and parallel bottom contours. The deep water angle of incidence is α_o = 35°. This is schematically shown in the Figure below.

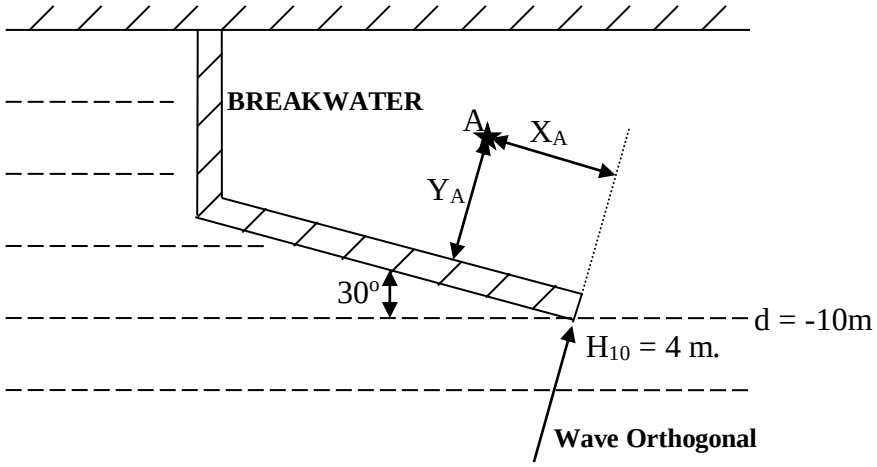


a) Extend the wave orthogonal given in the figure down to the shoreline qualitatively (schematically). (It is not necessary to calculate the angle of incidence at each water depth.

b) Calculate the water depth, d, which separates shallow water and intermediate water. Without Using Gravity Wave Table (GWT) calculate the angle of incidence of the wave at this water depth, α_d = ?

3. Waves of T = 9 sec., and H = 2.2 m. are measured at a depth of 25 m. with an approach angle α_{25} = 30° at this depth. Sea bottom has a uniform slope. Find deep water wave height H_o, and deep water approach angle α_o.

4. A progressive wave of T = 10 sec. is traveling from deep water towards shore on straight and parallel bottom contours. The incoming wave height at depth d = -10 m. at the tip of a breakwater is H_{10} = 4 m. This is shown on the Figure below;



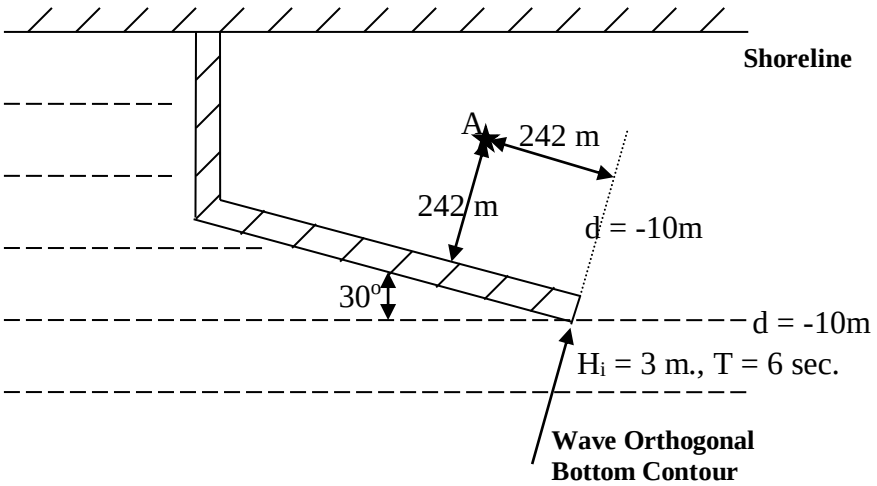
a) Calculate the distance X_A of point A inside the breakwater, such that Y_A = 450 m. and wave height at point A is H_A = 0.5 m.

b) Calculate the incoming wave height at a water depth of d = -25 m.

5. Figure (1) shows a harbor with a breakwater. Water depth in the harbor is d = -10 m. The incoming wave height at the head of the breakwater is H_i = 3 m., period T_i = 6 sec. and the angle of incidence is α_i = 30°. Calculate;

a) The deep water wave height H_o, deep water angle of incidence, α_{oi}

b) The wave height at Point A inside the harbor.



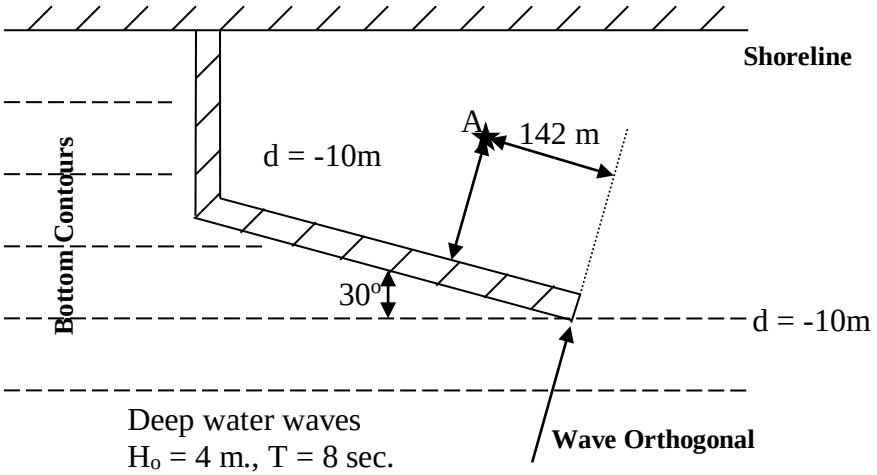
6. A harbor plan is schematically shown with a breakwater layout when a deep water wave with wave period of T = 8 sec. and a wave height of H_o = 4 m. comes to the breakwater. Its orthogonal makes an angle of 90° with the breakwater alignment. At point A inside the harbor area, diffraction coefficient is obtained as K_d = 0.2 Find;

a) Wave height at point A

b) Find the vertical distance y of point A from breakwater alignment

Given; - Breakwater head is constructed at -10 m.

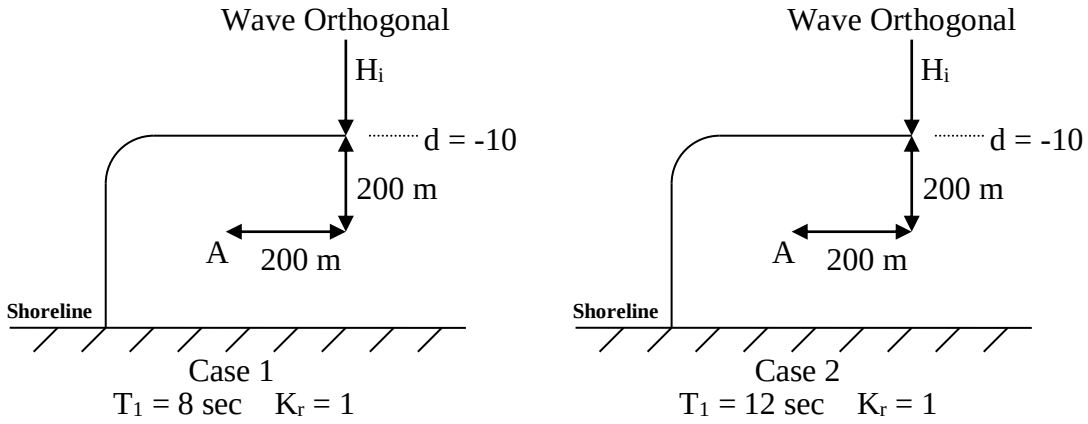
- The harbor basin is dredged to -10 m.
- Sea bottom slope is uniform.
- Wave crests are parallel to the breakwater alignment at breakwater location.



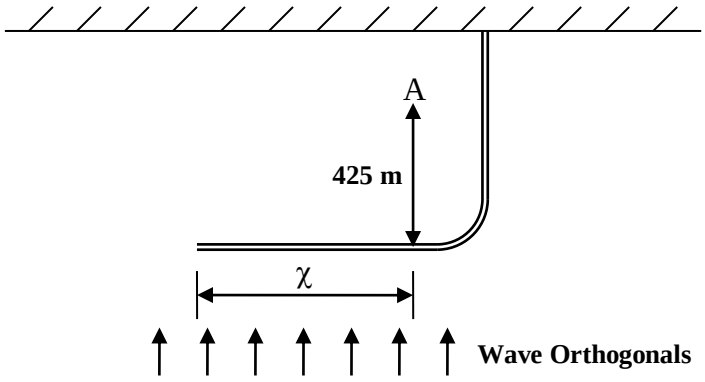
7. Wave of T = 8 sec and wave height of H_o = 4 m is propagating towards shore. If at a depth of d = 10 m. orthogonal spacing is reduced 50% due to refraction, find the wave height at this depth.

8. In case 1 and 2 the harbor is attacked by the same wave height H_i , but different periods (T_1 = 8 sec. and T_2 = 12 sec.) Diffracted wave heights (H_d) are measured for both cases at the same point A inside the harbor.

Compare and discuss the measured diffracted wave heights at point A for case 1 and 2.



9. A breakwater shall be constructed at a water depth of d = -17 m. as shown on Fig (1). The incoming wave height in front of the breakwater is H_i = 3 meters and period T = 8 seconds. Waves come perpendicular to the breakwater. Calculate the necessary length "X" of the breakwater such that, the incoming wave height at point A, inside the breakwater is H_A = 0.3 meters.

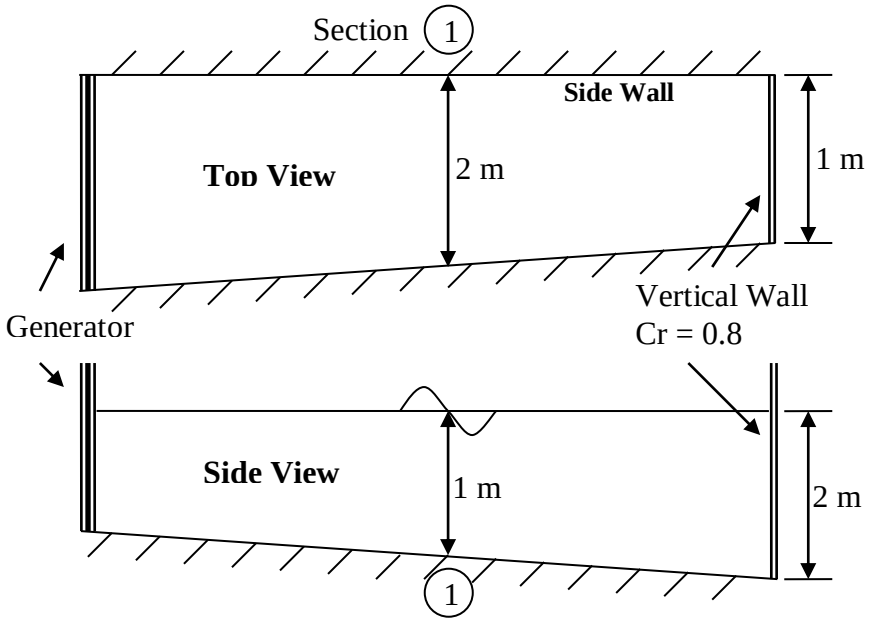


Layout of the Harbor

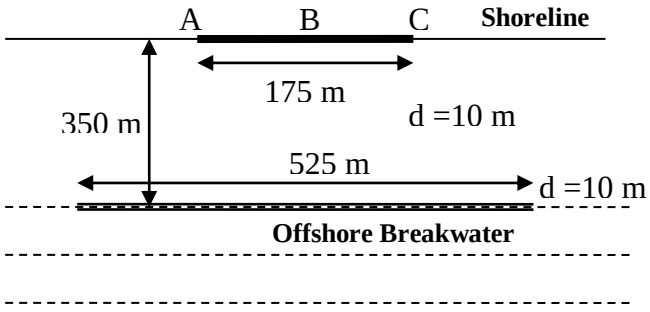
10. Figure shows the top view and the side view of a wave flume. At the end of the flume, there is a vertical wall where the width of the flume is 1 meter and the water depth is 2 meters. When the wave maker started it generates waves of T = 1 second. As these waves move towards the end of the flume, at section 1 the incoming wave height is measured as H = 10 cm. At section 1, the flume width is 2 meters and the water depth is

1 meter. When the waves reach the end of the flume, they are reflected back from the vertical wall. (Reflection coefficient of the wall is Cr = 0.8)

Compute maximum surface elevation (n) at the face of the wall and at the location L/4 meters away from the vertical wall after the reflection from the wall.

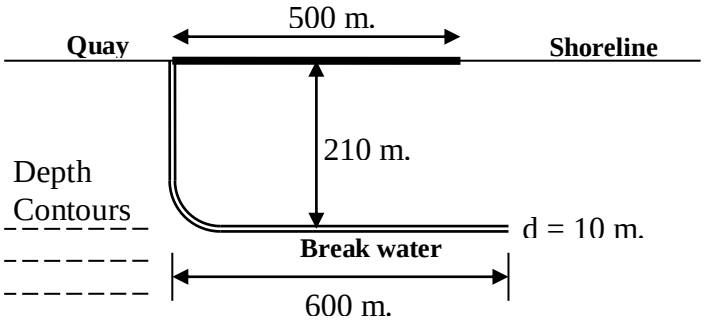


11. Wave of period T = 8 sec. and wave height of H_o = 5 m. are approaching towards the shore with crest lines being parallel to the bottom contours. Sea bottom has a uniform slope. An offshore breakwater at a depth of 10 m. and constructed parallel to the shoreline has a length of 525 m. The offshore breakwater is protecting the pier which is constructed parallel to shore as shown in figure. Find the wave height at points A, B and C along the pier. (harbor basin is dredged to -10 m. water depth.)



12. A harbor layout is shown in Figure. Breakwater is constructed parallel to shoreline and depth contours at depth d = 10 m. Along the shoreline inside the harbor a pile type quay (causing no reflection) is constructed for berthing of boats. Small boats are safely berthed if the wave height in front of the quay is equal or less than 50 cm.

If a deep water wave of height H_o = 4 m. and T = 8 sec. with crest lines parallel to depth contours, attack the harbor, find the length of the quay where the small boats can safely be moored.



13. Figure shows a harbor layout. Water depth at the entrance of the harbor and inside the harbor is d = -8 m. The incoming wave height at the entrance is H_i = 4 m. and wave height at point A inside the harbor is H_A = 0.56 m. Calculate the wave height at deep water for straight and parallel bottom contours. The angle of incidence of the incoming wave at the harbor entrance is 23.7°.