Exercise 12. Waves in Shallow Water and Beach Erosion

This exercise should follow Exercise 11 (Waves at Sea) and both may be completed in one two-hour lab session if students arrive having covered the basics of waves either in class or readings.

1. Longshore transport is toward the right-hand corner of the photo. Direction is shown by the accretion of sand on the up-drift side of the groins (built up to the left of each groin) in the groin field.

2. If the harbor is not dredged and sand moved down-drift, the tip shoal would eventually close off the harbor and the beaches down-drift would be deprived of their sand supply.

3. a. Breakwaters are artificial structures built to protect harbors and coastal areas by interrupting the progress of waves to shore. The area behind (shoreward of) the breakwater is quiet; materials (*e.g.*, sand) suspended by the wave action and carried by the longshore current settle out and build up here.

   b. See complete Figure 12–14 below.

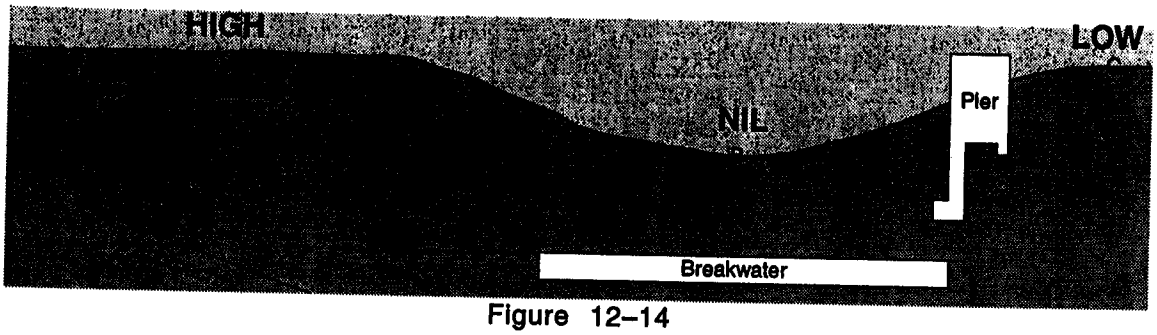

Figure 12–14

   c. Based on the presence of the breakwater and wave direction, one might predict slight deposition at point C. However, presence of the pier may prevent significant deposition on the right side of the pier, depending on its construction. At point C, neither deposition nor erosion prevail. One would predict increased erosion to the right of point C where wave approach is no longer affected by the breakwater.

4. The photo in Figure 12–4 shows curved patterns of wave refraction around both sides of the small island. The island forms a wave shadow which causes waves to converge, resulting in sand deposition behind the island.

5. a. Based on the visible wave patterns and refraction, as well as the beach growth direction, wave approach is generally from the east/southeast.

   b. Longshore currents are moving toward the north/northwest.

   c. Sandy Beach has grown ~7,312 feet between 1940 and 1957. This value is determined by measuring from the "X" marker to the northernmost tip of Sandy Beach in the photographs of Figure 12–13 (*i.e.*, 3.25 inches x 2,250 feet/inch = 7,312 feet).

   d. Sandy Beach has grown ~1,688 feet between 1957 and 1963 (*i.e.*, 4 inches x 2,250 feet/inch = 9,000 feet in 1963; 9,000 feet – 7,312 feet = 1,688 feet).

6. a. See completed Figure 12–15 below. Note that the labels for "Wave crests" as well as the 5-, 10-, 15-, and 20-m isobaths were omitted from the text. The instructor should have students add these to their text figure. Also, note that in the text figure, the orthogonal labels 1, 2, 3, and 4 are incorrectly positioned and orthogonal label 5 was omitted. The correct positions for this labels are shown in the revised figures below and coincide with the horizonal lines. Instruct students to make their orthogonals beginning from these straight lines.

The wave-crest diagram showing refraction shoreward is accomplished by simple "eyeballing" of the wave crest form, so expect reasonable variation from students. Convey to the student that the refracted waves are *subdued* (not exact) replicas of the bottom contours. Students should smooth the wave crests over minor irregularities in bottom topography, advance the wave fronts over the canyon, and retard crest advances over humps or ridges. The orthogonals were sketched in as near as one could estimate.

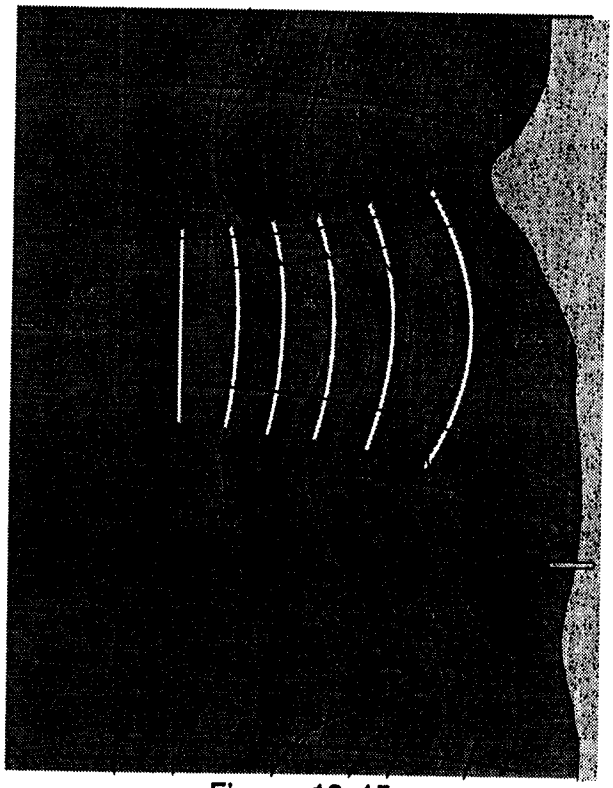

Figure 12–15

b. The beach would be narrow or non-existent off the point and in the vicinity of the proposed breakwater near point Y. The beach would be widest landward of the submarine canyon and south of the point where energy is dissipated most.

c. Breaker height would be 0.78 x 3 m = 2.34 m (7.8 ft).

d. The highest waves would occur off the point. The wave would break first at the point and break progressively north and south from the point.

e. The safest beaches would be where energy is most dissipated.

f. See Figure 12–15 above for the sketched refraction pattern over the submarine canyon. The longshore currents would move northward, driven by waves from the southwest.

g. The longshore current would eventually cause sedimentation in the harbor entrance.

7. Based on the maximum orthogonal distance from the 1963 shoreline to the 1871 shoreline, the southern coast of Hog Island retreated ~1.5 miles (~2.33 km) at a rate of 0.016 miles/year.