

October 31, 2008

Additional Information Regarding Salient Formation in the lee of Offshore Submerged Breakwaters

The shoreline response to either submerged or emergent offshore structures is well known and well documented in the scientific literature. In general this response is in the form of a widened beach directly shoreward of the structure. The widened coastline is termed a 'salient'. If the salient grows too wide and connects to the offshore structure it is called a 'tombolo'. The basic mechanism behind this effect is the reduction and redirection of incident wave energy caused to the structure, which in turn reduces the alongshore current velocities, promoting sediment deposition.

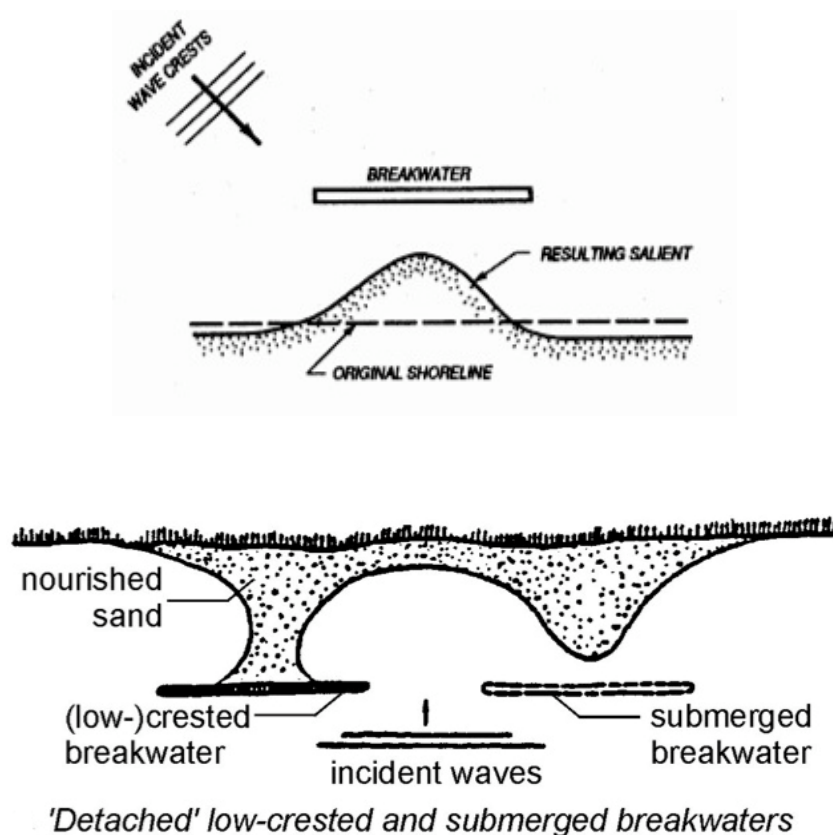


Figure 1. Basic shoreline response from emerged or submerged offshore structures.

The notion of the effectiveness of a detached submerged structure is supported in textbooks on coastal engineering. From Dean and Dalrymple “Coastal Processes with Engineering Applications”,

Offshore breakwaters need not be emergent to be effective. Submerged, or reef breakwaters are designed on the concept that the shallow depth over the structure will induce wave reflection, breaking and turbulent energy dissipation within the structure, leading to a reduction in wave height shoreward of it.

One advantage of the submerged breakwater is that the structure is not visible and thus does not disturb the view of the sea.

*The higher the structure, the greater the reduction wave height behind the structure. This leads to a disadvantage of these structures: they become less effective during a storm when a storm surge increases the mean depth. However, recall that the sediment transport depends on the wave energy, and thus a reduction in wave height of 10 percent means a reduction in wave energy by 20 percent. **Furthermore, sediment deposition occurring during times of low wave height provides a reservoir of sand to be eroded during a storm.***

Dean, R.G. and Dalrymple, R.A., (2002) “Coastal Processes with Engineering Applications”, Cambridge University Press.

The shoreline response behind an offshore breakwater has been shown in at least one Florida example. This was for the case of an emerged breakwater in Redington Beach on Florida’s Gulf Coast. While the break water was effective in retaining sand and building a wider beach, it was ultimately too effective, and formed a tombolo which caused sand starvation and continued erosion downstream. One of the recommendations of the project engineers (the US Army Corps of Engineers) was to **‘increase the transmissibility of the structure by lowering the crest height’** i.e. by making it a submerged, or partially submerged structure.

Chu,Y. and Martin,T., 1992. Beach Response to the Redington Shores Florida Breakwater, US Army Corps of Engineers, CERC-92-B.

Over eight years of monitoring the shoreline response to the Narrowneck Reef, performed by the Water Research Laboratory (WRL) at the University of New South Wales in Australia, has shown the clear formation of a salient in the lee of the structure. This is shown in Figure 2 below which was modified from Figure 7.1 of the WRL report (WRL, 2008/06).

M.J. Blacka, D.J. Anderson and Lopez 2008. "Analysis of Shoreline Variability, Seasonality and Erosion/Accretion Trends: August 2007-January 2008." Report 17: Northern Gold Coast Coastal Imaging System. WRL Technical Report 2008/06, Water Research Laboratory, University of New South Wales.

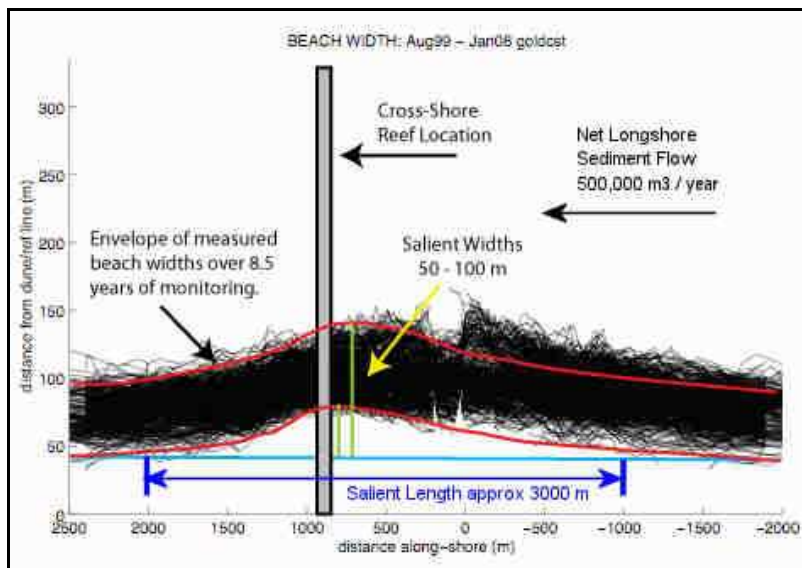


Figure 2. Salient Formation in lee of the Narrowneck Reef

Figure 2 clearly shows that an asymmetric salient with a varying cross shore width of 50m to 100m and an alongshore length of approximately 3000m has formed behind the Narrowneck Reef. These results compare favorably to the initial design predictions (78m cross shore, asymmetric to south) from Black, 1998c.

Black K.P., 1998c. "Narrowneck Reef Report 3: Sediment Transport." Prepared for Gold Coast City Council. 162 p.

The as built parameters for the Narrowneck Reef are a alongshore width of 150m, a cross shore width of 300m, and an offshore position of 225m. (WRL, 2008/06, Figure 3.6). Using the empirical methods developed by Black and Andrews (2001a), a salient with dimensions of 98m cross shore and 675m-933m alongshore is predicted. The actual salient, shown in Figure 2 above, is wider alongshore and roughly equivalent cross shore to the empirical predictions.

Black, K.P. and C. Andrews, 2001a. Sandy Shoreline Response to Offshore Obstacles Part 1: Salient and Tombolo Geometry and Shape. *Journal of Coastal Research*, Special Issue 29: 82-93.