OBLIQUE BREAKWATERS FOR MULTI-PURPOSE BEACH RECREATION AND SHORE PROTECTION

William Dally, University of North Florida, w.dally@unf.edu

INTRODUCTION

Breakwaters, jetties, and groins have long been used in the littoral environment as port, navigation, shoreline stabilization and beach protection structures. Customarily however, the recreational benefits of structures such as these have been realized only incidentally. For example, jetties built solely to stabilize an inlet almost immediately attract surfers who exploit the break created by waves reflecting from the structure. This is the case at Sebastian Inlet, Florida, where the world renowned 'First Peak' was created when the north jetty was lengthened in the early 1970's. Often when the waves elsewhere are too small to surf, one can rely on First Peak to be surfable. Also, under conditions of large, long-period swell, although the normally incident surfbreak elsewhere tends to 'close-out', not only is First Peak an excellent break, but sometimes a second and third surfable peak appear.

PHYSICAL MODELING

A physical model study of the north jetty at Sebastian Inlet revealed that the source of the exceptional surfbreak is the fact that waves partially reflected from the obliquely oriented jetty are actually trapped to the beach by refraction, and it is the interaction of the incident and refracted-reflected waves that creates the surfable break – see Figure 1.

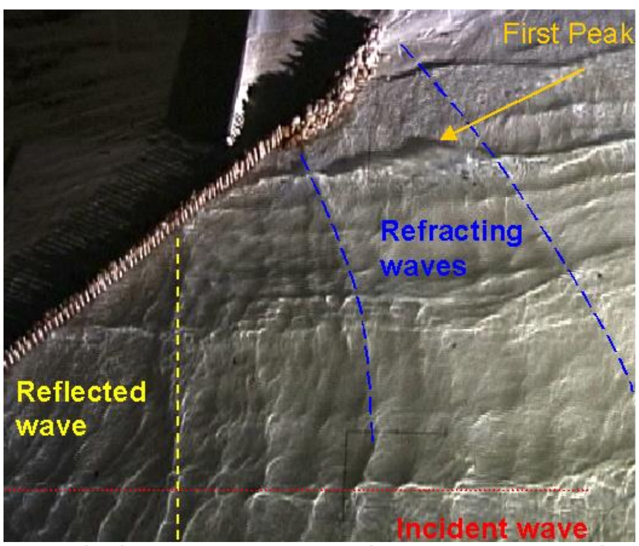

Figure 1 - Overhead photograph of the physical model of 'First Peak' adjacent to the north jetty at Sebastian Inlet, Florida showing the interaction of incident and refracted-reflected waves that enhances the surfbreak.

NUMERICAL MODELING

The First Peak phenomenon has been subsequently replicated and investigated using the 2D Boussinesq wave model COULWAVE (Lynett and Liu, 2008). In fact, it has been discovered that if the structure is assumed to be perfectly reflective, that multiple surfbreaks are indeed created – see Figure 2.

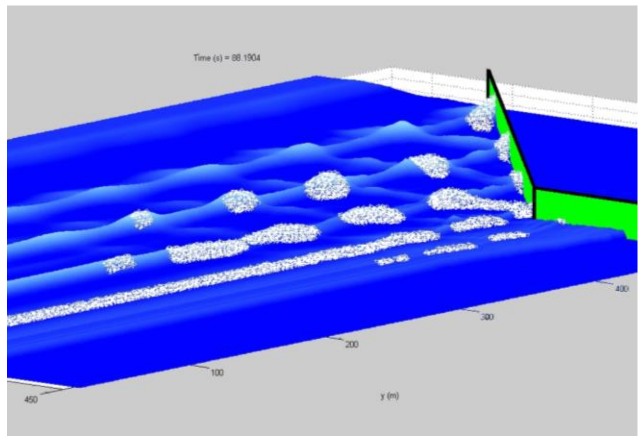

Figure 2 – Frame-grab from animation of COULWAVE results of normally incident waves on a planar beach interacting with an oblique structure, assuming complete reflection.

MULTI-PURPOSE OBLIQUE BREAKWATERS

Other incidental recreational uses are often created by coastal structures due to the wide variety of marine life that colonize them, thereby offering snorkeling/diving opportunities that might otherwise be unavailable on a predominantly open sandy coast. Finally, the wave shadow zone created in the lee of a coastal structure, particularly an offshore breakwater, affords a protected wading & swimming environment for young or less-hardy beachgoers. With this understanding, a new type of coastal 'infrastructure' is proposed that is essentially a breakwater, but it is sharply oriented to the shoreline & incoming waves, as opposed to parallel to the beach as is typical. It is envisioned that the structure would be detached from the beach, so as not to act as a groin and to minimize detrimental impacts to the downdrift shoreline. Such an 'Oblique Detached Breakwater' (ODB) is still expected to create an impounded salient in the shoreline, perhaps purposely providing localized protection to a pre-existing erosion hot-spot.

DESIGN CONSIDERATIONS

Key design considerations of an ODB include:

- Structure length, orientation, and shape (is linear best?).
- Offshore distance.
- Gap width of multiple ODBs.
- Crest elevation.
- Reflectivity of the structure face.
- The portion of the local nearshore wave climate that is targeted for surfbreak enhancement.
- Sediment pathways around (or under) the structure.
- Shoreline response and management of the salient and adjacent impacts.
- Unintended consequences (e.g. rip currents).

A hypothetical cross-section of an ODB is presented in Figure 3. As indicated, artificially placed stone and concrete habitat units could be installed on the landward side of the ODB to enhance biodiversity, and consequently its value for snorkeling.

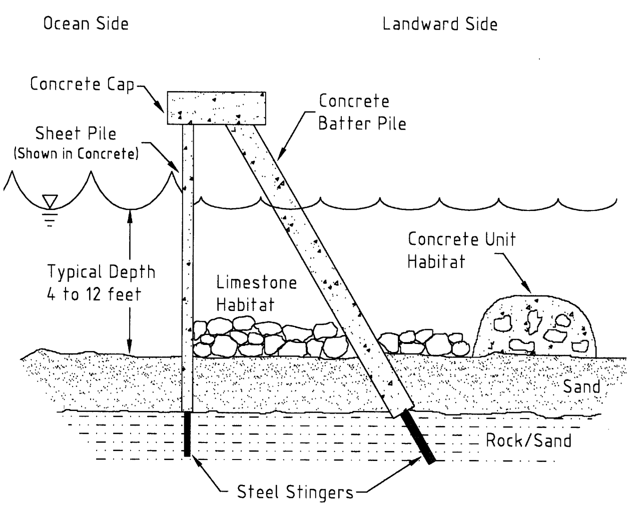

Figure 3 – Conceptual structural cross-section for Oblique Detached Breakwater and associated surfing and snorkeling habitat.

Structural design of an ODB would most likely follow conventional practice for e.g. piers, seawalls, and rubble mound construction, utilizing estimates of the extremes of the local wave climate. User safety concerns will also be discussed.

REFERENCES

Lynett and Liu (2008): Modeling Wave Generation, Evolution, and Interaction with Depth-Integrated, Dispersive Wave Equations; COULWAVE Code Manual, Cornell University Long and Intermediate Wave Modeling Package v. 2.0, 90 p.