Abstract

Kaumalapau Harbor is a small barge harbor located in a natural embayment on the southwest coast of the island of Lanai, Hawaii. The existing breakwater was constructed in 1925 of quarried rock and field stone cleared from the pineapple fields. The original structure has suffered extensive damage over the years, and has been repaired numerous times. Maintenance of the breakwater has been done using just about anything that would sink. Hurricane Iwa in 1982 and Iniki in 1992 severely damaged the structure. It is now a very large subsurface rubble mound, with only a small portion of the crest still above water.

Design of repairs to the breakwater has involved a number of interesting considerations.

- Wave Climate – The breakwater requirements for typically prevailing conditions are moderate. The southwest coast of Lanai is, however, exposed to possible hurricane storm waves. Direct hurricane storm wave attack could result in deepwater wave heights of 35 feet plus at the site, and are controlling for the design stability of the structure.
- Water Depth – The water depth at the toe of the rubble mound is 70 feet, and the bottom slopes about 1V:10H seaward of the mound before dropping rapidly to deep water. Thus there is little deepwater wave energy dissipation or refraction prior to waves reaching the site, and waves are not depth limited.
- Structure Size – The new breakwater has been positioned to utilize the existing rubble mound as the core, in order to reduce the volume of material required and to provide a stable foundation. In order to limit the size of the structure, and due to the nature of the operational criteria, the new breakwater has been designed for severe overtopping during hurricane wave conditions. A special detail has been developed at the crest using mass concrete to stabilize the armor layer during overtopping.
- Selection of Armor Layer – Core-Loc concrete armor units have been selected for the armor layer as the most cost effective design solution. Model testing has shown a requirement for 35-ton units for stability. The project will utilize the largest Core-Loc armor units constructed to-date, and the deepest toe (~58 feet) and longest overall slope length (130 feet) of any Core-Loc armored structure. Achieving the design armor unit packing density is critical for stability of the single layer Core-Loc armor.