US Army Corps of Engineers®
Engineer Research and Development Center

Monitoring Completed Navigation Projects (MCNP)

Kaumalapau Harbor Breakwater Core-Loc

Problem

The Kaumalapau Harbor breakwater was being steadily damaged by westerly storms with a loss of about half of the breakwater's original 400-ft length. Waves removed armor stone over the outer 200 ft of the structure to the point where the structure crest elevation was below the mean lower-low water level elevation. As a direct result of the breakwater deterioration, more wave energy entered the harbor making loading and unloading operations at the barge landing problematic during some conditions. The Corps of Engineers' Honolulu District developed a plan to repair the breakwater using 35-ton Core-Loc concrete armor units, and the new breakwater construction is nearly complete.

Kauamalapau Harbor and breakwater,

Little is known about the settlement of concrete armor layers and subsequent movement of individual armor units as a newly constructed or rehabilitated structure adjusts to the pounding of ocean waves. Less is known about the capability of large Core-Locs to tolerate movement without breaking. Construction of the Kaumalapau Harbor breakwater is a unique opportunity to gather data about Core-Loc armor layer response and concrete armor unit strength. The goal of the monitoring is to improve Core-Loc breakwater design guidance.

Research Approach

Immediately after initial construction of the new Core-Loc armor layer, an extensive survey of the structure will be conducted to establish a baseline for measuring settlement during the first two years. The survey accuracy will be sufficient to monitor movement of individual armor units. Visual inspections will identify cracked and broken Core-Locs, and this information will be related to movement and settlement information. Integrity of the cast-in-place concrete breakwater cap will be monitored for any damage related to settlement. Wave data seaward of the breakwater will be related to armor layer response, and a wave gauge inside the harbor will document the breakwater effectiveness in reducing wave action.

An important aspect of armor unit breakage is the strength of the concrete and the distribution of strength within the armor unit. During casting, one Core-Loc unit was fractured to provide vital calibration data for use with ultrasonic nondestructive testing methods that allow mapping of concrete strength throughout the armor unit. After breakwater construction, selected in-situ armor units will be field-tested using the same nondestructive technique to judge strength increase with age. These data will be correlated with fracture strength results obtained from breaking test cylinders from the same concrete batch that have been aged in the water at the site.

Labs/others involved

ERDC: Coastal and Hydraulics Laboratory and Geotechnical and Structures Laboratory.
POD: Honolulu District

Final Products

Research and monitoring results will be published in an ERDC technical report that will present new findings related to Core-Loc armor layer settlement, armor movement, breakage during settlement, and strength of Core-Loc armor units. These findings will be the basis for improved design guidance for rehabilitation of damaged structures using Core-Loc concrete armor units, or for construction of new breakwaters and jetties. Interim results and descriptions of new monitoring techniques used during this project will be presented in one or more technical notes.

Point of Contact

Dr. Steven A. Hughes
ERDC Coastal and Hydraulics Laboratory, Vicksburg, MS
email: Steven.A.Hughes@erdc.usace.army.mil
phone: 601-634-2026, fax 601-634-3433

Ms. Jessica Hays
U.S. Army Engineer District, Honolulu, Honolulu, HI
email: Jessica.R.Hays@poh01.usace.army.mil
phone: 808-438-1680