



US Army Corps
of Engineers®
Engineer Research and
Development Center

Evaluation of Armor Stone Protection in Great Lakes Coastal Navigation Projects

Problem

Degradation of armor stone protection used in Great Lakes coastal navigation projects may occur because of a number of interacting and interrelated factors, rather than a single major cause. The need exists for a better understanding of the relationship between the standard tests used in stone specifications and the performance of stone in the structures. Research to meet this need calls for careful comparisons of stone of similar, if not identical, properties, conducted both in the laboratory and in the structures.

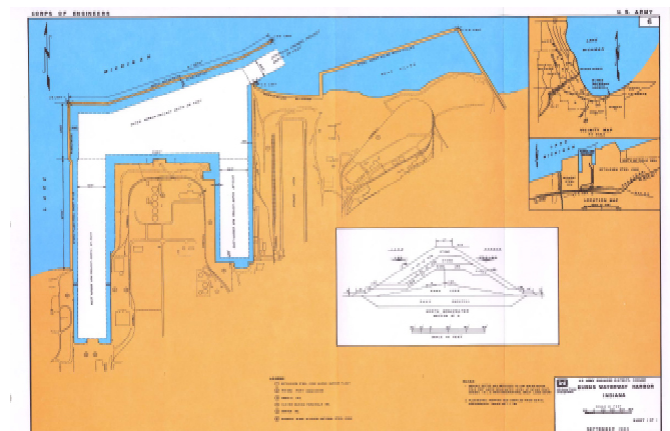


Burns International Harbor, Porter County, Indiana

Previous investigations have been directed at considering the causes, based on comparison of different types of stone used in different structures. Much of the testing performed on stone submitted as material for erosion protection is based on the protocols used to evaluate concrete aggregate and subgrade stone materials—that is, tests designed for use on material orders of magnitude smaller than armor stone of several tons. Acceptance of sources is then based on a combination of test results, performance records, and quarry inspections.

Description of Research

This research comprises a portion of the U.S. Army Corps of Engineers' [Monitoring Completed Navigation Projects \(MCNP\) research program](#). The Corps engineers and scientists who participate in the MCNP program are working to learn definitively if elements used in design of these structures are appropriate for the conditions under which they were applied.



Burns International Harbor, Plan Sheet

The initial phase of this research will be to collect and review the data from previous studies of the issues of armor stone durability, particularly related to the projects identified. The research team members will visit each of the quarries and each of the sites to become familiar with the projects, the stone sources, and their surrounding environments. Another portion of the study will focus on evaluating testing methods and protocols used in typical armor stone specifications. Test methods will be reviewed, and samples will be collected from participating quarries for testing at larger than the ASTM standard sizes, to consider the effects of scaling on test results.

Long-term performance or deterioration of armor stones will be quantitatively monitored and characterized by the changes in dimensions measured. Qualitative observations will be documented and samples photographed with each inspection. By using stones cut to the same dimensions and subjected to the same testing in the lab and onsite at projects, stones from different quarries and different rock types (and different excavation methods) can be compared objectively. Observations and data comparisons between stones at the quarry versus in-place in shoreline projects will provide further information for use in considering the potential differences between in situ performance and stockpile or nonfield conditions beyond the standard wet-dry and freeze-thaw testing.

Expected Products

Research results will be published in an ERDC technical report that will include combined review of the collected data and that of previous studies regarding the importance and control of factors related to armor stone durability. This report will also summarize the investigation of laboratory test methods used—both ASTM and modifications to those procedures—and possible recommendations with respect to more applicable testing for armor stone. A guide specification (in Specsintact format) will be included as an appendix.

Potential Users

The MCNP Program findings apply to completed projects operated and/or maintained by the U.S. Army Corps of Engineers nationwide.

Projected Benefits

The MCNP program is designed to determine how well projects are accomplishing their purposes and how they are resisting attacks by their physical environment. Information collected and analyzed on a national basis documents successful designs, disseminates lessons learned on projects with problems, and provides upgraded field guidance that will reduce life-cycle cost on a national scale.

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