

CHAPTER 103

DURABILITY AND TESTING OF STONE FOR USE IN RUBBLEMOUND STRUCTURES

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Rubblemound structures protected from wave action by a layer of quarried rock (stones) are the most common form of breakwaters. While extensive guidelines and procedures exist to select the size of stone there is very little information available on procedures to be followed to assure the quality of the in-place stone. This subject is not covered in depth in the principal breakwater design manuals such as the U.S. Army Corps of Engineers Shore Protection Manual (1984).

However, review of existing breakwaters show that deterioration of the stone is a common problem and some projects have experienced very serious difficulties in assuring the placement of durable stone.

Review of construction specifications used throughout the world shows considerable variability in testing procedures required to define properties of the stone and different criteria to measure acceptability of a stone.

In response to these issues a two-day seminar was held in Cleveland, Ohio on 22 and 23 May 1991, sponsored by the Rubblemound Structures Committee of the Waterways, Port, Coastal, and Ocean Division of the American Society of Civil Engineers. Cleveland was an important location because of the serious deterioration of some of the stones placed on the Cleveland breakwater.

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Contractors, researchers, geologists, and design engineers were invited to discuss their common concerns associated with the durability of quarried rock on a breakwater. The results of this seminar are presented in the conference proceedings by Magoon, et.al.(1)

Some initial observations by the participants were as follows:

- Problems associated with stone durability are relatively widespread, based on the number of problem breakwaters described.
- Problems of stone durability may be as much a result of blasting and handling practices as they are the result of weaknesses in the properties of the rock.
- There are no reliable, systematic procedures for assuring rock of acceptable durability exists on the completed structure (other than to involve a geologist or engineer with considerable experience both with the type of rock and its use in the marine environment, and with construction procedures).
- In general, specifications addressing stone quality, as well as the handling and placement of stones on the breakwater, vary considerably from project to project and, in some instances, are unsatisfactory. It appears that inspection and quality assurance has on many breakwater projects been unsatisfactory.

The experience of all the participants, as discussed at the seminar, represent an extremely valuable source of information.

Some of the principal conclusions and overall observations for this seminar are as follows:

- There are considerable differences between North American and European procedures for defining the quality of rock.
- For any given procedure, there is not demonstrated criteria that will assure acceptable quality of stones on a breakwater.
- The stone type is not necessarily a useful guide. There is considerable variability in the quality of a particular type of stone.

- Previous successful use at a quarry does not assure acceptable stone. Stone quality may vary within a quarry and different production practices may limit stone durability.
- There must be coordination between laboratory investigations, production procedures and the design effort, field inspections, in order to achieve acceptable quality for breakwater stone.
- Stone quality may be, in some instances, achieved by re-designing production procedures which may, in turn, require different designs. For example, cut stones can be produced in some locations relatively inexpensively and with minimum damage to the stone. However, a rubblemound structure design using cut stones in a regular pattern requires considerable attention and more information than exists in current literature.
- The subject of stone durability is receiving considerable attention for researchers at Queen Mary College, London, the U.S. Army Corps of Engineers, Ohio River Division Laboratory, Cincinnati, and the Waterways Experiment Station, Vicksburg, Mississippi. However, it will take time before field data will substantiate recommended procedures.

In summary, there needs to be as much care expended in determining the in-place quality/durability of stone as there is in designing the structure. Considerable guidance is provided by the various authors in the seminar proceedings on methods of selecting and producing durable stone for coastal structures. However, there is no completely reliable testing method to assure that the stone's performance will be satisfactory.

References

- (1) Magoon, Orville T., et.al. "Durability of Stone for Rubble Mound Structures"; published by the American Society of Civil Engineers, 345 East 47th Street, New York, NY; 264 pages; February 1992.