HYDRAULIC PERFORMANCE OF CHANNEL LOCK II - ENERGY DISSIPATION SYSTEM

CONCRETE BLOCKS IN VARIABLE-SLOPE INDOOR
and
STEEP SLOPE OUTDOOR TESTS

No Drainage Layer

Prepared for:

Erosion Prevention Products
P.O. Box 891586
Houston, TX 77289-1586

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1. INTRODUCTION

1.1 General

This report documents a series of full-scale tests to determine the hydraulic properties and resulting stability of an articulating concrete block (ACB) revetment system developed by Erosion Prevention Products. Ayres Associates was contracted by Erosion Prevention Products to conduct the study program involving the installation and testing of an articulating concrete block revetment system known as the Channel Lock II Energy Dissipation System.

The testing program described in this report was conducted during July 2009 at Colorado State University's (CSU) Engineering Research Center in Fort Collins, Colorado. The testing program was conducted in CSU's Indoor Variable Slope Flume and outdoor Steep Slope Flume.

Multiple tests were conducted at five different slopes an indoor facility using a 4-foot wide, 23-foot long test section with the blocks installed directly onto the flume's steel floor. One test was conducted in CSU's outdoor flume in a 4-foot wide, 23-foot long test section of compacted soil, 12 inches thick, at a slope of 1V:2H (50%) in the direction of flow. This test was performed at the direction of EPP to see if the system could withstand the hydraulic forces when the ACB armor is placed directly on a soil subgrade with an appropriate geotextile, without the use of a drainage layer beneath the blocks.

The Channel Lock II Energy Dissipation System consists of precast open cell concrete blocks with two different thicknesses arranged in a staggered pattern. Each block in the system has 5 open cells that can be filled with rock, or with topsoil for vegetation. Physical characteristics of the blocks are discussed in detail in Chapter 2.

The system as tested in the outdoor steep flume included a nonwoven needle-punched geotextile (Mirafi® 180N) installed directly on the soil. The revetment system was placed by hand on top of the geotextile according to procedures outlined by Erosion Prevention Products. No drainage layer was used beneath the block system. No cables were used in the installation.

In the indoor flume tests, the blocks were installed directly onto the steel floor of the flume. No drainage layer or geotextile were used in these tests.

Personnel from the CSU hydraulics laboratory constructed the test sections, installed the block system, conducted the test runs, and performed all data collection. Ayres Associates personnel observed installation of the testing system, all phases of the testing program, conducted the hydraulic analysis and interpretation of test data, and developed this report.

The preparation and construction of the test sections and installation of the revetment product followed the techniques outlined in ASTM standard D7277, *"Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow."* The hydraulic tests, including data collection techniques and reporting, followed the protocols established by ASTM D7277.

Hydraulic analysis included regression techniques and direct-step computation as recommended in ASTM standard D7276, *"Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow"*. These procedures were used to determine the Manning's n value and associated hydraulic conditions using measured water surface elevations and total discharge for each test.

Key personnel involved in the study included:

Erosion Prevention Products:	Ayres Associates:	Colorado State University:
Mr. Lee Smith	Mr. Paul E. Clopper, P.E. Ms. Laura Girard	Dr. Chris Thornton, P.E. Ms. Amanda Cox Mr. Michael D. Turner

1.2 Study Objectives

The objectives of this hydraulic testing program included full-scale physical laboratory testing, measurement, and documentation of the hydraulic performance of the Channel Lock II Energy Dissipation System manufactured by Erosion Prevention Products. Tests were conducted with unidirectional flow conditions on 23-foot long test sections at variable slopes and velocities in the direction of flow. The specific tasks that were performed to achieve these goals are described below:

1. Install the energy dissipation system on the indoor test flume steel floor with no crest section and a downstream slope that can be set at any desired slope ranging from 0 to 50 percent in the direction of flow. The total vertical drop over the 23-foot long test section ranged from 0 to 11.5 feet, depending on the slope of the flume.
2. Install the energy dissipation system in the outdoor flume on a test section of compacted soil having a horizontal crest length of approximately 10 feet and a downstream slope of 50 percent (1V:2H). The total vertical drop from the crest to the toe of the revetment system was approximately 11.5 feet. System installation included a nonwoven needle-punched geotextile (Mirafi® 180-N) placed directly on the soil.
3. Subject the system to increasingly severe overtopping discharges until system failure occurs, or the maximum flow capacity of the test facility is reached.
4. Measure and record flow depths and velocities at predetermined locations along the centerline of the flume. For the outdoor test, a total test duration of 4 hours was specified, with data collection at hourly intervals.
5. Examine the system at the conclusion of each test, noting areas where the revetment blocks may have shifted, or any loss of soil beneath the system.
6. Perform an analysis of flow conditions and hydraulic stresses imposed on the system using measured flow depths to determine representative values of bed shear stress, flow velocity, energy slope, and Manning's "n" resistance coefficient for each test.

The hydraulic stability of the system, as tested in this program, relates only to the system unit weight, the characteristic block-to-block interlock properties, and the specific details relating to system installation and test methodology as described in this report. The criterion for determining the performance threshold, as used in this study program, is defined as the local loss of intimate contact between the revetment system and the underlying soil. This criterion follows the definition established in ASTM standards D7276 and D7277.

1.3 Disclaimer

The firm of Ayres Associates neither endorses nor promotes the application of any particular product investigated under its direction and supervision. The sole purpose of the investigation was to examine and document the hydraulic characteristics and stability of the concrete block revetment system under controlled laboratory conditions. The selection and installation of a particular product at any project site will necessarily incorporate site-specific conditions, and are therefore the responsibility of the engineer of record on a project-by-project basis.

5. REFERENCES

ASTM D6684. "Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems," ASTM International, West Conshohocken, Pennsylvania.

ASTM D6884. "Standard Practice for the Installation of Articulating Concrete Block (ACB) Revetment Systems," ASTM International, West Conshohocken, Pennsylvania.

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