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EROSION PROTECTION AT HYDRAULIC STRUCTURES: A REPORT FROM THE TASK COMMITTEE

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R. J. Wittler
F.J. Watts
J.E. Hite, Jr.
G. E. Urroz

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A Report From the Task Committee

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R.J. Wittler[1], A.M. ASCE, Dr. F.J. Watts[2], M. ASCE, Dr. J.E. Hite Jr.[3], M. ASCE,
Dr. G.E. Urroz[4], A.M. ASCE

INTRODUCTION

In 1991 the ASCE Hydraulics Structures Committee formed a task committee on Erosion Protection at Hydraulic Structures. The purpose of the committee is to determine current practices in erosion protection, collect, organize, and disseminate information that will improve engineering practice, and identify research needs. This paper is a report on the activities of the committee to date.

SCOPE OF STUDY

The committee is limiting the scope of the study to problems created by typical rainfall-runoff events, rough to smooth open channel transitions, and discharges from urban drainage, small hydro, diversions, over sills and under gates. The types of structures include culverts, plunge pools, detention ponds, drop structures, check structures, and stilling basins. The committee will attempt to classify the environmental aspects that often motivate erosion mitigation.

GOALS AND OBJECTIVES

The committee has four goals. The first goal is to document sources of information related to erosion and erosion protection methods, and design guidelines. The second goal is to compile and publish this information in a concise and simplified form so that

[1]Research Hydraulic Engineer, US Bureau of Reclamation, D-3751, P.O. Box 25007, Denver, CO 80225
[2]Professor and Head, Dept. of Civil Engineering, University of Idaho, Moscow, ID 83843
[3]Research Hydraulic Engineer, U.S. Army Corps of Engineers, Waterways Experiment Station, 3903 Halls Ferry Rd., Vicksburg, MS 39180
[4]Assistant Professor, Utah Water Research Laboratory, UMC 8200, Utah State University, Engineering Research Center, Logan, UT 84322

it is usable by practitioners. The third goal is to identify areas of research for measures that lead to better and more economical control of erosion. The fourth goal is to provide a basis for evaluating the economics of protecting against erosion.

METHODS AND MATERIALS

The overall goal of erosion protection is to convey water along or through a hydraulic structure with the same amount of erosion as if the structure did not exist. Zero net transport should be the goal of erosion protection strategy. Erosion protection can be a simple part of the design process. The type of protection strategy employed and the type of material utilized is the most difficult aspect of erosion protection.

Material science and the market place have produced a vast selection of erosion protection materials. Examples include geotextiles, erosion mats, articulated blocks, riprap, pavement, walls, soil cement, gabions, sand bags, and grout bags. There are several varieties of each type available at varying cost and effectiveness. Methods include bioengineering, controlled erosion, energy dissipation, and protective schemes. Bioengineering usually means vegetation or revegetation of an area after installation of a hydraulic structure.

STATE OF THE ART - WHAT'S IN PRACTICE NOW?

The committee's charge is to develop economical procedures for protecting hydraulic structures. These structures are usually a stock design of small or medium sized culverts, plunge pools, canal turnouts, stilling basins, and detention ponds. The engineering cost of a typical structure is usually only adequate to design the new structure, survey the site, and construct the new structure. The up front cost of these types of structures typically excludes O&M costs associated with erosion resulting from operation of the new structure.

The committee solicits information from practitioners on current practices. Is erosion protection a high, medium or low priority in the design and construction of small and medium sized hydraulic structures? What are the preferred materials? What is the availability of erosion protection materials? Where do designers and contractors get information about the latest and most effective technology? What practices are common, what damage is acceptable or tolerable, and how do you integrate protection into a project? Lastly, we need case studies of successful projects and examples of protective measures that failed with explanations and remediation plans.

CONSTRUCTION TECHNIQUES

Integrating erosion protection into structural design is the first step in successfully preventing erosion at hydraulic structures. The final step is quality control and quality assurance during construction and installation. Lack of quality control coupled with shoddy construction has led to many failures of erosion control installations. For example, research has shown that bedding and filter design is critical to the long term stability of geofabrics and riprap. The quality controls related to size distribution and mean size of riprap is also very important. The integrity of geofabrics and the incidents of tears, rips or punctures during placement is important to long term performance. Properly designed and placed seams and joints of geofabrics are more reliable and desirable than the alternative. All of these factors weigh heavily upon the success of post construction remediation and long term O&M costs.

The practicing engineer should be familiar with quality control practices for each material utilized in a project. The owner should budget sufficient money and provide adequate specifications for materials to insure that specified materials are being placed properly and with minimal damage.

Since there are economies of scale associated with the various materials offered to engineers for erosion control, it makes sense that those who market the material will recommend it for as many different applications as possible. In practice it is common for a material manufacturer to produce a product and then test it under controlled and limited circumstances. Often a manufacturer or supplier will contract with a university or private laboratory to conduct physical tests. Then with the results in hand, advertisements in the trade magazines trumpet the performance of the new and highly dependable product. The designer should be very careful to specify materials that have been specifically tested for the application intended.

RESEARCH

Small projects do not enjoy the luxury of research budgets. Therefore material manufacturers and governments underwrite most of the research in the area of erosion. As such there exists a large body of literature on erosion. Listed below are sources of literature for research on erosion.

Nuclear Regulatory Commission	Corps of Engineers
CAL-TRANS	U.S. Bureau of Reclamation
U.S. Bureau of Land Management	Soil Conservation Service
National Park Service	AASHTO
U.S. Bureau of Indian Affairs	Agriculture Research Service
USGS	Manufacturers of materials

The purpose of research is to translate design philosophy tempered with practical knowledge and application into construction practice. The committee has several recommendations for research directions.

First, dissemination of information gained from research is very important. Manufacturers and suppliers should publish the results of independent investigations and tests of erosion protection materials so that the practitioner does not have to depend solely upon a material supplier for information regarding a product. Researchers should seriously consider how to present, and therefore how to represent, their information and how that information can best serve the engineering profession.

Second, there is a need to study the magnitude and time scales of erosion problems. Erosion should be keyed to interpretation of site conditions. If a channel is already eroding it may not be the function of a new structure to halt all erosion. If there are no environmental or economic considerations then erosion protection is purely a case of structure protection. If there are environmental considerations proper criteria need to be identified and met.

Third, the characteristics of the receiving channel should govern the type of protection employed. A rocky stream naturally invites riprap as protection while a geofabric seems more appropriate for grassed or soil banks. Concrete paving may be appropriate in an urban setting. The overall goal of a protection scheme is to reduce velocities to that which would exist if the structure were not there. The protection scheme should protect or enhance the environment near the structure.

Research should quantify aspects of erosion protection in units and measures that are easily obtained and specified. For example, rock size for riprap is often specified in size units such as inches, or by weight. Uniformity of riprap is often expressed as a ratio of representative size fractions. Unless those fractions are measured in the field just before placement, and in an economical fashion, the quality control may be sacrificed for the sake of expediency. Researchers should give consideration to material testing and quality control issues. Cooperation with manufacturers and suppliers is required and will greatly enhance the reliability and repeatability of material qualities.

CONCLUSIONS

The task committee on Erosion Protection at Hydraulic Structures continues to gather information for dissemination to designers and contractors. There is a vast array of erosion protection materials. Most information on these materials is marketing related, not research or performance related. The primary goal of erosion protection is zero net transport. Put another way, the velocity or erosion capacity downstream of a hydraulic structure should be managed in such a way to reflect the velocity present if the structure did not exist. Environmental considerations must be part of the design criteria of any erosion protection scheme.