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Evaluation of River-spanning Rock Weir Performance

Design guidelines will improve performance and reduce repairs and replacement costs

What Is The Problem?

River-spanning rock structures are constructed for water delivery, bank stabilization, grade control, fish passage, and to improve aquatic habitat for endangered fish species. Current design methods are based upon anecdotal information applicable to a narrow range of channel conditions. The complex flow patterns and performance of rock weirs is not well understood. As a result of minimal design guidance, many rock weirs do not function as intended and need frequent repairs or replacement.

Field investigations of 127 rock weirs found that failures were most commonly caused by development of downstream scour holes and the subsequent slumping of the rock components. Guidance is needed to define the analysis required for structure design and construction to better predict scour patterns and to minimize the likelihood of structure failure.

What Is The Solution?

Reclamation is combining field investigations, physical modeling, and computer simulations to develop design guidelines and countermeasures for avoiding failure of river-spanning rock weirs. Using the design guidelines and countermeasures will result in more robust structure design or retrofits based upon predictable engineering and hydraulic performance criteria.

Rock weir structure

Physical and numerical models were applied to better understand scour processes and expand the range of application beyond the sites visited in the field. Physical-scale models were tested in the hydraulics laboratory at Colorado State University using various channel and weir configurations, bed material sizes, and flow conditions. Two- and three-dimensional numerical models developed by Reclamation (SRH-2D and U^2RANS) were applied across wide ranges of design parameters and conditions to identify how variations in structure geometry affect the local hydraulics and resulting scour development.

Results of laboratory tests and numerical modeling show that scour depths below rock weirs are significantly deeper than typical foundations designed for rock weirs. Empirical methods for scour prediction were analyzed with respect to rock weirs. Also, design techniques to reduce the likelihood for failure were investigated through physical models, field studies, and numerical models. These techniques may include deep foundations to protect against scour, grouted weir crests, using multiple structures in series, and using interlocking and block-shaped rocks.

Who Can Benefit?

Natural resource managers with a need for aesthetic river structures composed of natural materials for diversion, fish passage, channel stabilization, etc., will benefit from the results of this research. The design guidelines will be used by project engineers to determine the suitability of using rock weirs to meet their objectives and to construct rock weir structures that perform as intended.

Where Have We Applied This Solution?

The findings of this research thus far have been applied to develop plans for repairs and retrofits of rock weir diversion structures on the Lemhi River in Salmon, Idaho; Beaver Creek near Twisp, Washington; and Entiat River near Entiat, Washington. Repairs and retrofits of these structures incorporated design guidelines and countermeasures to protect the structure against common failure mechanisms.

Future Development Plans

The rock weir research is part of a larger effort to evaluate the use of natural materials in many types of water engineering projects. Results from the rock weir research will be incorporated into a river spanning rock structure design guidance document.

More Information

Additional information on river-spanning structure research and associated numerical modeling, physical modeling, and field performance reports and theses are available at: http://www.usbr.gov/pmts/sediment/kb/SpanStructs/index.html

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