RECLAMATION *Managing Water in the West*

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The Knowledge Stream

Research Update

Electro-Osmotic Pulse (EOP) Technology

Adapting EOP technology to handle water seepage problems at Reclamation's unique facilities

Bottom Line

EOP prevents water from leaking through concrete, thus preventing structural damage, corrosion, and other issues—including potential dam safety concerns.

Better, Faster, Cheaper

EOP can be installed without interruptions in water or power delivery, reducing operations and maintenance costs. Also, EOP has a lower life-cycle cost than grouting or concrete repair alone.

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Collaborators

- **Reclamation's Northern California Area Office**
- **U.S. Army Corps of Engineers**
- **Electro Tech**

Problem

Reclamation has many older dams and associated structures with massive amounts of concrete. These structures play a critical role in the United States' water and power infrastructure, and any type of failure could be severe and costly. Water seepage through concrete can cause extensive damage, including corrosion of the reinforcing steel, cracks and potential structural failure, and corrosion of nearby equipment (e.g., gate operating motors, pipelines). Extensive maintenance is required to mitigate the corrosion damage to equipment, remove calcite deposits, and mitigate safety issues due to inoperable equipment and poor air quality. Grouting cracks and leaks may be only a temporary fix and often takes a significant amount of time. Also, grouting does not prevent seepage through the concrete pores.

Solution

Electro-Osmotic Pulse (EOP) technology can mitigate many water-related problems from the interior of affected areas without the cost of excavation. EOP prevents corrosion and water/moisture-related damage to equipment and reduces humidity. Thus, EOP technology can address issues that could affect dam safety or operations.

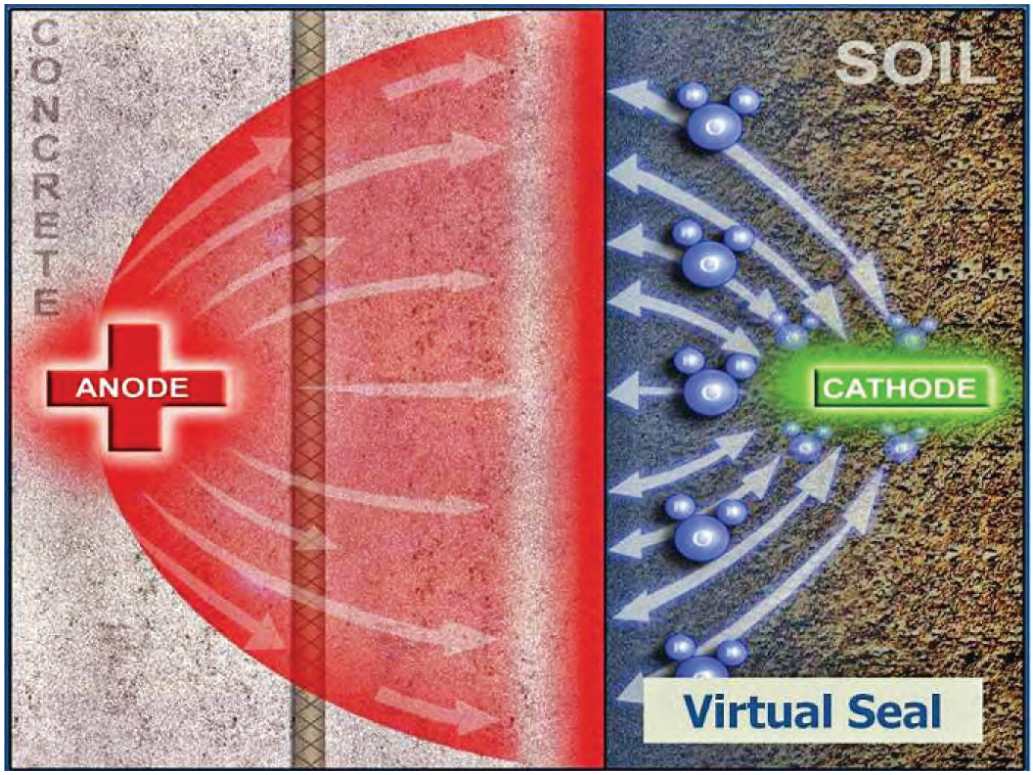

Illustration of the effects of the application of EOP technology to create a virtual seal or barrier to prevent water from entering the concrete on a macro scale (image from Electro Tech).

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Reclamation tested the EOP technology at Trinity Dam near Redding, California. Trinity Dam has water leaks through the bonnet chamber shaft, which leads to several maintenance problems in the shaft and bonnet chamber. The walls of the shaft and bonnet chamber are covered with calcite from seepage over time. The extent of the calcite deposits prevents the door from sealing. If there is a failure in the chamber, this door is the only thing that would stop water from the reservoir flowing through the door, down into the penstock tunnel, and then out into the powerplant yard.

An EOP system involves inserting anodes (positive electrodes) into the concrete wall or floor on the inside of the structure and placing cathodes (negative electrodes) in the water or soil directly outside the structure. A commercial system was developed to apply EOP technology using a pulsating direct electric field to reverse the flow of water seepage and create a barrier to prevent further water coming in. The pulse sequence consists of a pulse of positive voltage (as seen from the dry side of the concrete wall), a period of rest when no voltage is applied, another positive pulse, and then a pulse of negative voltage. The negative voltage pulse prevents the alteration of the chemical composition of the pore solution due to the application of the current. This prevents the system from losing efficiency and prevents damage to the concrete.

Reclamation installed an EOP system in a 12-foot-wide by 6-foot-high wall in the bonnet chamber shaft. Measurements determined that this first phase worked to dry out the concrete. The next phase test section will include concrete that contains leaking cracks.

Benefits

This is a common problem throughout Reclamation, and savings from an EOP system will allow more money to be used for other structure maintenance and issues to improve operations.

An analysis can be used to determine the cost/benefit of installing an EOP system compared to continual repairs. Installing an EOP system to dry out a concrete structure can provide the highest return on investment if, as expected, it:

- Prevents new cracks that could compromise the system, which can lead to dam safety or other issues.
- Costs less than other options over time. Extensive excavation is not required to install an EOP system, and an EOP system needs minimal maintenance.
- Avoids costs of service disruption and lost productivity.
- Prevents structural degradation of the facility from water penetrations.

Future Development Plans

This successful test section was small, and a larger installation should be tested. For the larger test section, an EOP system should be installed in the bottom 10 feet of the shaft around its entire circumference. For this test, leaking cracks would be included in the test section. If the technology works for this larger test, then it would likely work for the entire area of the gate shaft.

However, the success of the pilot test at Trinity Dam strongly suggests that an EOP system could work to address the problems Reclamation faces in its other facilities. Mount Elbert Powerplant, for example, faces similar water seepage problems. Reclamation managers are looking at applying an EOP system to other structures.

"EOP technology can mitigate many water-related problems from the interior of affected areas without the cost of excavation. This can mitigated corrosion damage to equipment and reinforcement and reduce O&M costs."

Daryl Little,
Principal Investigator

More Information

Reclamation, 2012.
Technical Memorandum
No. MERL-2012-10
Electro-Osmotic Pulse Leak Repair Method: Evaluation in Trinity Dam Bonnet Chamber

U.S. Army Corps of Engineers
Construction Engineering Research Laboratory
www.cecer.army.mil