



**US Army Corps
of Engineers®**
Engineer Research and
Development Center

Electro-Osmotic Pulse (EOP) Technology

Technology

EOP technology mitigates water-related (“wet basement”) problems from the interior of affected areas without the cost of excavation. An EOP system consists of three essential parts: (1) anodes (positive electrodes), inserted into the concrete wall or floor, (2) cathodes (negative electrodes), staked into the soil outside the structure, and (3) an electronic control unit that delivers electric pulses to the anodes. The pulses of electricity draw water away from the anode, toward the cathode, reversing the direction of water seepage. The system causes water to actually flow out of the basement walls, away from the building.

Problem

In older buildings, severe damp-basement problems can increase maintenance requirements and make affected areas uninhabitable or even unusable. Below-ground masonry and concrete structures, such as basements, can sustain structural damage from chronic water seepage through floors and walls. Water corrodes steel reinforcement bars, cracks concrete walls, and erodes mortar. Intruding water raises the interior relative humidity, accelerating the corrosion rate of mechanical equipment in the area and creating unacceptable air quality due to the rapid growth of bacteria and mold. The usual approach to solve such groundwater intrusion problems in problem areas is the labor intensive and costly “trench and drain” method, which involves excavating the exterior to expose the wall area and the base of the foundation, replacing damp-proofing on the wall surface, and installing a drain tile system around the building or affected area.

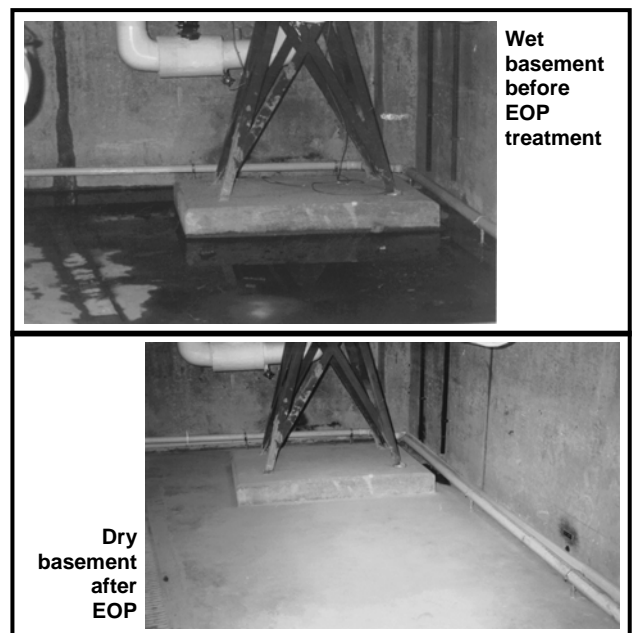
Expected Cost To Implement

Field experience at two Army sites showed the average cost to install an EOP system to be \$188.49/sq ft, 40 percent lower than the cost of the alternative conventional trench and drain approach. The operating or energy cost of the EOP system is negligible—on average, about the same as burning a 60W light bulb (i.e., a 1200 sq ft area would require up to a maximum of 60W; a 2000 sq foot area up to 105 watts; in all cases, when the concrete is dry, zero watts).

Benefits/Savings

For concrete applications, EOP technology significantly outperforms conventional technology. EOP offers a long-term, cost-effective alternative to the trench-and-drain approach to mitigate water-related problems. System installation is quick (typically about 1 week). The EOP system is installed from the interior (negative side) of affected areas, avoiding the cost of excavation and interruptions to normal operations.

The use of EOP technology offers several additional benefits. It can eliminate corrosion damage to mechanical equipment and improve



indoor air quality by maintaining the relative humidity on the interior wall and floor surface at a level below 55 percent, which prevents mold and bacteria growth. This technology can also prevent mineral deposits (efflorescence), and eliminate rising damp in walls.

Status

EOP technology is a commercially available product. (See the Distribution Sources below.) CERL has partnered with Drytronic, Inc. (a subsidiary of Osmotech) to further develop and monitor innovative EOP designs that met specialized needs of government users. In 2003, Drytronic installed an EOP system in 100 feet of a Washington, DC, Metropolitan Area Transit Authority (WMTA) tunnel. Because the tunnel was constructed in bedrock and the concrete walls were greater than 2 feet thick at that point, the cathodes were placed deep in the tunnel walls. A year's monitoring of the WMTA application showed the average relative moisture content at a 2-in depth in the wall had decreased by 70%.

CERL and Drytronic are currently monitoring the performance of EOP technology in two lock and dam structures on the Mississippi River (with concrete walls about 8 feet and 17 feet thick, respectively) and in a buried military command/control bunker. For these applications, CERL contributed innovative designs of probe electrodes for submerged applications to adapt EOP to control water flow in large, deeply-buried underground concrete structures, or submerged structures such as lock walls.

CERL and Drytronic also successfully installed EOP systems in a total of 382 basements of family housing units at Fort Sill, OK, Fort McPherson, GA, Fort Gillem, GA, and Bolling AFB. EOP was selected for its low cost, and its superior ability to control water and indoor humidity problems (to prevent mold growth and improve air quality).

ERDC POC(s)

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Distribution Sources

Electro Pulse Technologies, of Greenwich, CT, administers the licensing of the patented EOP technology in North America. System components and necessary parts are available through other sources. The CERL demonstration projects used the following suppliers:

- OsmoTech, Inc., 17295 Chesterfield Airport Road, Suite 200, Chesterfield, MO 63005, tel. 636-733-7570
- Drytronic, Inc., 709 Gillette Street, La Crosse, WI 54603-2286, tel. 800/497-0579
- APS Materials, APS Materials, Inc., 4011 Riverside Drive, Dayton, OH 45405.

Available Documentation

A more detailed description of EOP technology, and links to technical literature (white papers) that describe its history and applications are available through OsmoTech web site, through URL:

<http://www.goosmo.com/>

Available Support

Direct general questions and requests for support to OsmoTech, Inc., 17295 Chesterfield Airport Road, Suite 200, Chesterfield, MO 63005, toll-free: 866-GO-4-OSMO; voice: 636-733-7570; fax: 636-733-7571; e-mail:

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US Army Corps
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Service

Groundwater Intrusion Control Using Electro-Osmotic Pulse (EOP) Technology

Description

The Construction Engineering Research Laboratory (CERL) offers engineering services on a reimbursable basis to adapt [EOP technology](#) for application in locations and activities that are unique to the public sector. In its basic form, EOP technology helps mitigate water-related (“wet basement”) problems from the interior (negative side) of affected areas without the cost of excavation. The EOP system uses pulses of electricity to reverse the natural flow of water, actually forcing moisture to flow away from treated structures. The CERL team, with industry partner OsmoTech, has extended the application of EOP technology to treat military installation housing communities, lock and dam structures, subway tunnels, and roadway pavement.

Capabilities

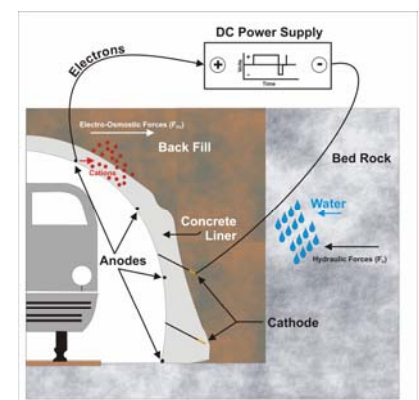
In standard, reimbursable projects that treat typical “wet basement” problems, CERL’s EOP installations involve seven standard steps:

1. Repair cracks or voids where water penetration is obvious using mortar, grout, foams, or epoxies, depending on conditions.
2. Perform resistivity and conductivity tests of the concrete, soil, and water to determine both the type (cable or probe) and locations of the anodes (positive electrodes) and the type, number and locations of the cathodes (negative electrodes).
3. Drill holes or cut grooves in the structure in the anode locations that are specified in the design, then place anodes in these holes or grooves.
4. Install the cathodes either into the exterior soil or into the exterior of the structure itself. Generally, holes are drilled either completely through or deeply into the structure at the locations specified in the design. The cathodes are then installed either into the exterior soil or deep into the structure.
5. Run wiring from the EOP power supply to both the anodes and the cathodes.
6. Pack the anode holes and grooves with mortar to within 1 centimeter of the surface.
7. Turn on the EOP control unit, adjust, and calibrate.

Once installed, EOP uses a DC electric pulse applied between a ceramic coated anode mortared into the concrete and an external cathode. CERL engineers are working to extend the capabilities of the EOP technology beyond the scale and scope of “wet basement” problems, to meet broader needs of military and government agencies.

Benefits

Systems using EOP technology within concrete structures offer an attractive alternative to traditional methods to mitigate water-related problems from the interior of affected areas without the cost of excavation. In fact, EOP is the most efficient technology available for interior application (cf., use of paints or coatings, or installation of interior drains). Correctly installed EOP technology results in a long-lasting, low maintenance system with a low cost of ownership per year. The operating or energy cost of the installed EOP system is negligible—in a standard



Cutaway profile of the EOP installation in the Washington DC Metro tunnel.

application, about the same as burning a 60W light bulb. Moreover, EOP is permanent; it does not need to be periodically redone. EOP technology can eliminate corrosion damage to mechanical equipment, improve indoor air quality by controlling the relative humidity (RH) on the interior wall and floor surface at a level below 55 percent, preventing mold and bacteria growth. EOP can also prevent mineral deposits (efflorescence), and eliminate rising damp in walls, tunnels, bunkers, retaining walls, and pavement. For applications in concrete, EOP has significantly outperformed conventional technology.

Success Stories

EOP technology has been installed in numerous Department of Defense (DoD) facilities where this cost-effective, non-intrusive waterproofing technology prevents moisture intrusion in below-grade structures. In 2003, an EOP system was installed in 100 feet of a Washington, DC, Metropolitan Area Transit Authority (WMATA) tunnel. Because the tunnel was constructed in bedrock and the concrete walls were greater than 2 ft thick at that point, the cathodes were placed deep in the tunnel walls. Monitoring of the EOP system in a Washington Metropolitan Area Transit for a year showed the average relative moisture content decreasing with respect to the EOP system commissioning time, approaching the typical moisture content of 70% at 2-in depth in the wall. The EOP system forces the water toward the exterior so that the interior concrete surface remains dry while the exterior stays wet. EOP's ability to reduce interior surface moisture below 55% makes the technology ideal for mold and mildew remediation and prevention.

The ability to control water flow in large, deeply-buried underground concrete structures or submerged structures such as lock walls led to innovative designs being implemented in two lock and dam structures on the Mississippi River (with concrete walls about 8 ft and 17 ft thick) and in a buried military command/control bunker. CERL and OsmoTech are currently monitoring the performance of EOP technology in these applications, which resulted in some special, innovative probe electrode designs: special plate cathodes were designed for submersion applications and are being monitored for performance in the locks of the two structures.

In 2003 and 2004, the Directorates of Public Works at Fort Sill, OK, Fort McPherson, GA, Fort Gillem, GA, and Bolling AFB implemented EOP technology in family housing to take advantage of its low cost (about 40% less to install than traditional exterior "trench and drain" waterproofing methods), and its ability to control water migration in below-grade structures, to reduce indoor humidity (thereby eliminating mold growth can occur and improving air quality in the family housing units). ERDC-CERL, in partnership with OsmoTech, successfully installed EOP systems in the basements of family housing units at these three bases: 276 at Fort Sill, 76 at Fort McPherson, 10 at Fort Gillem, and 20 at Bolling AFB.

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