Electro Osmotic Pulse Technology For Prevention of Water Intrusion In Concrete Basements

Innovative Technique

ElectroOsmotic Pulse (EOP) technology uses sets of electrodes placed inside a concrete structure and in the surrounding soil. These electrodes are used to create a pulsating electric field that causes the movement of water molecules which results in the drying of the concrete and prevention of water intrusion.

Benefits

The ElectroOsmotic Pulse (EOP) system provides three main benefits:

1. The prevention of structural damage by reducing rebar corrosion and concrete cracking.
2. The prevention of corrosion damage to interior mechanical and electrical equipment by reducing relative humidity.
3. The improvement of interior air quality for the safety for occupants and workers.

Other benefits of EOP technology include the ease of EOP installation which therefore causes less disruption to operations. For example, a typical EOP installation takes about 1 week. Unlike other methods, EOP is a permanent solution and does not have to be redone every five years or so. These benefits have been recognized in the numerous EOP installations by the U.S. Army Construction Engineering Research Laboratories (CERL). CERL has performed two technology demonstrations and has installed and monitored systems in several wet basements with great success and cost savings.

Background

Below-ground masonry and concrete structures, such as basements, can sustain structural damage from chronic water seepage through floors and walls - water causes corrosion of steel reinforcement bars, cracks concrete walls, and erodes mortar. Furthermore, the intruding water raises the interior relative humidity thereby accelerating the corrosion rate of mechanical equipment in the area and creating unacceptable air quality due to the rapid growth of bacteria and mold.

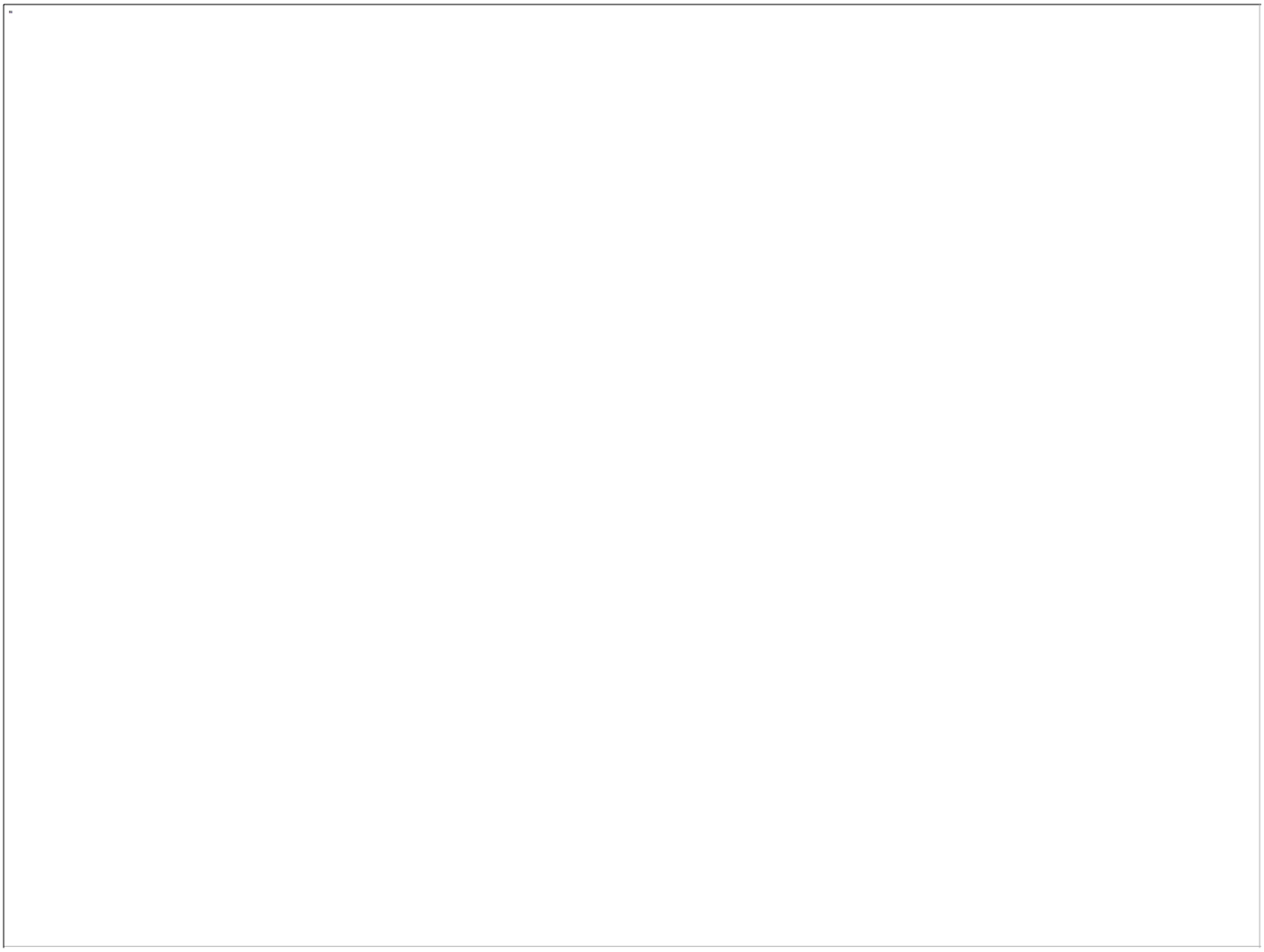
Humid conditions in a workplace or home environment are known to promote growth of mold and microbes that have an adverse effect on human health. As the molds and microorganisms proliferate, air quality decreases and health problems increase. To improve air quality it is therefore necessary to decrease relative humidity and lower the moisture level of the surfaces on which the molds and microorganisms grow.

Traditional methods for correcting water seepage involve the application of sealants or costly excavation to place drainage tiles around the facility exterior. ElectroOsmotic Pulse (EOP) technology represents a promising alternative. EOP technology is based on the concept of electroosmosis, the movement of water through porous media due to an external electric field. To apply electroosmotic pulse technology commercially within concrete structures a system has been developed which applies a pulsating direct electric field in combination with an off-period. The pulsating electroosmotic system consists of a pulse of positive voltage (as seen from the dry side of the concrete wall), a pulse of negative voltage, and a period of rest when

no voltage is applied. The pulse of positive voltage has the greatest duration and amplitude. The amplitude of the signal is typically on the order of 30 volts. The electrical pulses cause cations (e.g. Ca^{++}) and associated water molecules to move from the dry side towards the wet side, against direction of water flow induced by the hydraulic gradient, thus preventing water penetration through buried concrete structures.

The system consists of an electronic control unit which delivers electric pulses to positive electrodes (anodes) that are inserted into the concrete wall or floor. The anode is either cylinder-shaped or in the form of a cable. The anode coating is either rubber-graphite or a conductive ceramic material. The negative electrode (cathode) is typically a copper-clad steel rod staked into the exterior structure soil, or inserted into the soil through a hole drilled into the concrete structure.

Technology demonstration and validation was conducted under the Facilities Engineering Applications Program (FEAP) which was administered by the Corps of Engineers Center for Public Works (CECPW-EB). At the Fort Jackson demonstration site, the EOP power supply output current varied from 0.75 amps for a high exterior water level to less than 0.2 amps for a low water level; the concrete surface humidity dropped from an initial 95% to 50% in 5 months, and; the EOP installation saved more than 40% over the cost of the conventional "trench and drain" method.



Technology Demonstration

The utility room of the Fort Jackson, South Carolina, barracks, which is situated on land with a high water table (4 feet above floor level) and subject to runoff from higher land, collected between 1 and 4 feet of water and had to be pumped out on a weekly basis. ElectroOsmotic Pulse (EOP) technology was used in 1994 to mitigate the problem: a set of electrodes was mortared directly into the concrete walls; another set was installed in the adjacent soil; a pulsed electrical current was applied between the electrodes to create an electric field in the walls. The electrical pulses caused the water to move from the inside surface toward the outside surface, against the direction of flow induced by the hydraulic gradient, which prevented water penetration through the concrete.

Within one week after the installation, the basement was noticeably drier, the humidity dropped from an initial range of 92 to 98 percent to a range of 43 to 68 percent, and the room has remained dry. The cost of installing the EOP system was 40% lower than installing drain tiles.

The electrical energy cost of operating this EOP system is less than $4 per year.

PUBLICATIONS

Demonstration of Electro-Osmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures, by V.F. Hock, M.K. McInerney, and E. Kirstein, presented at the U.S. Army Corps of Engineers Electrical/Mechanical Technology Transfer Conference held 21-24 April, 1998 in Kansas City, Missouri.

Electroosmotic Pulse Technology for Groundwater Intrusion Control in Concrete Structures, by M.K. McInerney and V.F. Hock, presented at the 21st Army Science Conference held 15-17 June, 1998 in Norfolk, Virginia.

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