PCL

Engineering Solutions

## Innovation and Engineering

# AOP

# Advanced Osmotic Pulse

***The Permanent Solution to Water Ingress***

## *What is the Advanced Osmotic Pulse system?*

AOP is an evolutionary technology based on accepted scientific theory. It gives new life to existing structures avoiding expensive reconstruction and has a broad field of application in new concrete structures. The "state of the art" methods in use in the building industry today can be characterised as temporary solutions to a problem for which there is no apparent permanent solution. The AOP system **PROVIDES A PERMANENT SOLUTION.**

The Advanced Osmotic Pulse system can waterproof existing and new concrete, brick and masonry structures / basement walls through a complex electrical low voltage positive / negative pulsating charge.

Concrete, brick and masonry structures consist of a mass containing capillary formations. Water may penetrate structures in a multitude of ways, the simplest form of which is as a result of gravity. Water can also penetrate structures through capillary synthesis, very much in the same manner as plants and trees receive and distribute water to smaller branches.

The AOP System is utilised for transporting water encapsulated within the capillaries out of structures, as well as permanently preventing the penetration of water into structures. A control unit produces a low voltage electrical charge, which is passed through electrodes in the form of probes or wires strategically placed within portions of the walls and/or floors which are wet or are required to remain dry.

## *How does it work?*

By placing a low voltage pulsating charge between negative and positive electrodes within a structure, the water becomes ionised. Ionising the water molecules within the capillaries causes the water to travel towards the negative electrodes to be evacuated at an optimum site, and at the same time preventing the water from intruding back into the structure. The wet area is eradicated and remains dry for the life of the structure.

## *The Science.....*

The movement of the ionised water in the capillaries is both stronger than gravity and capillary syntheses. The AOP System has proven successful in preventing the penetration of water in a turbine chamber with a pressure of 600 metres head (60 bars). Thus, an impenetrable virtual membrane shield is created and will prevent the entry of water and moisture into the structure for as long as the power is on.

## *Where can AOP be installed?*

No other available method provides permanent protection from the ingress of water, using the same mechanism as the AOP System. Until now, a "wet" structure required costly maintenance or disruptive and expensive permanent renewal over its prematurely shortened useful life

The AOP system is extremely effective in the following types of construction:

- Basement walls with a high water table
- Tunnels with concrete or masonry lining
- Underground Structures and car parks
- Dams, Marine structures and foundations
- Bridge abutments and arches

### *What is the installation / project process?*

The typical project process / installation can be completed in as little as 3 weeks depending on the type of structure. A typical contract delivery includes the following:

- Identification of an osmotic humidity problem or water seepage problem

- Undertaking of a survey, quantifying, analysing and measuring the relative humidity over the area where the AOP system will be applied (Feasibility Study)

- Obtaining drawings of the area to be treated from architects and engineers

- Providing options and potential arrangements, amounts, types and sketches of the layout arrangement of the AOP equipment.

- Providing a price quotation for the installation. Contract award

- Taking of concrete/structure samples to determine its composition if unknown

- Taking soil samples to determine pH levels

- Producing design and construction documentation

- Installing of Anodes and sealing with a special conductive cement based grout

- Drilling on site and placing of the cathodes at required locations

- Wiring of the electrodes and cathodes according to the engineering patterns

- The curing period for the special conductive cement should be a minimum of 14 - 28 days

- Applying power to the installation, measuring all electrodes with respect to conductivity to ensure they all are contributing to the drying out process of 1-3months.

- Regular monthly monitoring controls and follow up until the agreed completion of the process

- Ongoing management and monitoring services (remote or on site) can be provided at the request of a client.

### *Why choose the AOP system?*

Conventional waterproofing techniques only address specific problems for a specific period of time. The existing techniques generally have significant deficiencies compared to the AOP System. AOP is safe, reliable and cost effective

Furthermore:

- The System provides permanent solutions to waterproofing, which are simple to install

- Dry-wall construction with drained cavities is not required, representing improved space utilization and reduced construction costs

- Pumping out of water from basements is not necessary

- If there is water ingress after installation, mechanical crack remedial measures are extremely effective and easy to implement

- The elimination of an internal wall when a diaphragm wall type of construction has been used, at its structural minimum, provides a significant cost saving for new project installations

- The System is flexible and can be installed from the exposed side of a structure, negating the need for expensive exterior excavation work to existing basements

- The System prevents peeling paint, mould and mildew and foul smells

- The System stops efflorescence

- The System is a low voltage system, with minimal running costs. (About 10 Watts for a 1,000m² basement area.)

- The System is touch safe

- The System has no damaging side effects, and will not alter the material composition of a structure

- The System reduces the corrosive environment for steel reinforcement within a structure

- The System may reduce cracking of the structure

- The System reduces relative humidity in basement areas, reducing the corrosive environment for mechanical equipment and other fixtures

- The System improves a structure's insulation, reducing cooling and heating loads

- The System enhances the bonding properties between old and new concrete, an important consideration in the renovation of deteriorated (cracked) concrete

- The System prevents penetration of dangerous gases and waterborne bacteria

### *What are the alternative water-ingress solutions?*

In all water-ingress treatments the AOP System is a preferred more cost effective PERMANENT solution

**Penetrates**

**Penetrates require frequent applications, which limits their use to above grade exterior surfaces, or below grade interior surfaces.**

Penetrates, such as grout applications, are implemented either by injection via high-pressure pump, or by trowel. Other penetrates, such as chemicals, are applied as a sealant to the surface of the area requiring protection.

Surface applications of grout and epoxy can either be applied with a trowel, or sprayed or rolled on like paint. These materials, such as chemically cured urethane and resin, as well as chemical paints, such as methyl methacrylate, provide a surface coating which acts to protect against water penetration.

While protective surface penetrates can act to prevent water intrusion, they do not address the problem of existing water; nor can they address the problem of water intruding from unexposed below grade surfaces. Furthermore, protective penetrates do not penetrate surfaces deeply and subsequent adhesion and penetration to wet surfaces is poor. They wear off in heavily trafficked areas. There is also a health hazard associated with protective penetrates due to their high flammability and toxicity.

The grout injection process is inherently weak in that the grout must cover the entire area requiring protection, this whole application is rendered practically useless.

The cost of the injection process is difficult to predict in advance as there is no sure way by which to predetermine the quantity of grout needed. Many of the penetrates fulfil the limited purposes they are meant for. Depending on the particular kind of penetrates used, they can serve as a good supplement to the AOP System.

**Membranes**

**Membranes are large uninterrupted surfaces covering the area requiring moisture protection. They rely on continuous integrity for the barrier to repel the water. Most membranes are made of polyurethane.**

Membranes require great care in installation to avoid failure but regardless, degrade within 7 to 10 years. One tear during construction can be enough to compromise the essential continuous integrity of the membrane. This will render the system useless.

The use of membranes will be costly in a retrofit because to be effective, they should be applied to the outside of a basement wall. Excavation to provide this is often not feasible and cannot solve seepage through the slab.

**Additives**

**Additives, such as a mixture of bitumen and crushed brick, cause an inert crystalline to grow and block the capillary system in the Structure.**

Additives block the capillaries causing the Structure to become significantly less elastic. Additives are predominantly used in new construction by an injection application. A feature of concrete is that it expands and contracts. The application of additives may render the concrete less elastic, causing the concrete to become brittle and dry, and to develop cracks.

However certain additives in particular circumstances may serve as a good supplement to the AOP System.

**Dehumidification**

**An electro-mechanical device that draws moisture from the air.**

Dehumidification draws more moisture through the surrounding

structure into the dehumidifier, resulting in a continuously wet structure. The evaporation rate of the saturated wall increases, resulting in increased water flow through the capillary structure. Larger and larger capacity dehumidifying units are required. The increased water flow in turn increases efflorescence.

Dehumidifiers rely on continuous electricity supply, rendering the running costs of dehumidification very high.

**Pumping Equipment**

**A pump installed inside or outside of a structure for the purpose of regulating the water level.**

Although pumps remove water they do not remove humidity existing in the surrounding structure. A wet wall promotes the growth of organisms, such as moulds and mildew.

**External Drainage (Tanking)**

**External drainage systems alone are not sufficient in most cases to protect against water intrusion, and will, over time, deteriorate (usually in 25 years or less).** A series of water drainpipes can be installed outside a structure to lead water away from the structure. This system is installed to all new constructions, wherever this is possible.

***Where is the evidence?***

**THE AOP SYSTEM has been successfully installed for the following clients: *references supplied on request.***

**Location: London, Walthamstow Central**
**Client: Metronet / London Underground**

Problem: The chosen design solution was a Benternite matt. This failed to be effective and the contractor spent a considerable sum chasing leaks around the subway. The situation turned contractual and work was stopped

**SUCCESS STORY**

- Current condition: the system was installed, seepage has been arrested and the structure has met the LUL cat 1 level 4 standard of “totally dry”.

**Location: Hong Kong, Cityplaza 4, Taikoo Shing**
**Client: Swire Properties Ltd.**

- Problem: An existing basement was deteriorating rapidly with excess water seepage penetrating the perimeter wall. Numerous

attempts to repair this by different methods and contractors had all failed.

**SUCCESS STORY**

- Current condition: the system was installed, seepage has been arrested and the wall is now in dry condition.

**Location: Hong Kong, Central Station Airport Express Concourse.**
**Client: MTRC**

- Problem: Water seepage through a diaphragm wall was causing severe damage to an artwork panel, donated by one of the MTRC's principal tenants.

**SUCCESS STORY**

- Current condition: The System was installed and the treated area is now dry.

**Location: Hong Kong, basement of Hang Seng Bank Headquarters.**
**Client: Hang Seng Bank**

- Problem: Since the building was new, the Bank had experienced water ingress throughout the basement areas. Since these are all occupied by the banking operations, this has become a severe problem over the years. As a pilot project, the system was installed to a fire services tank that leaked severely into the surrounding areas.

**SUCCESS STORY**

- Current condition: The affected area is now in a dry condition.

**Location: Hong Kong, basement of International Finance Centre 1.**
**Client: International Finance Centre,**

- Problem: Although a relatively new building, less than 3 years old, severe water

ingress through perimeter walls and into lift shafts was casing deterioration of finishes and fittings.

**SUCCESS STORY**

- Current condition: After the installation of the System, the treated areas are now dry.

**Location: Norway.**
**Client: Oslo Central Railway Station. (Norwegian State Railways)**

- Problem: Water ingress to blockwork wall located 100 meters from the sea and below

ground water level, constructed with external membrane and back-filled.

- Solution: Installation of anode lines to inside wall with external ground spear.

**SUCCESS STORY**

- Current condition: Dry construction.

**Location: Norway.**
**Client: Drammen Central Railway Station. (Norwegian State Railways)**

- Problem: Water ingress to brick wall located 150 meters from the sea and below ground water level, constructed with external membrane and back-filled.
- Solution: Installation of anode lines to inside wall with external ground spear.

**SUCCESS STORY**

- Current condition: Dry construction.

**Location: Norway.**
**Client: Norway. Skien Central Railway Station. (Norwegian State Railways)**
Year of installation of the System: 1992.

- Problem: Water ingress to concrete underpass to railway lines, below ground water level, constructed with external membrane and back-filled.
- Solution: Installation of anodes throughout to inside wall with external ground spear.

**SUCCESS STORY**

- Current condition: Dry construction.

**Location: Norway.**
**Client: Fet County Local Authority**

- Problem: Water egress to 60 nos. concrete pre-cast elements (31 elements total) water holding tanks. Vertical joints seeping water.
- Solution: Installation of line anodes to vertical joints between elements on the outside of the tank, with cathode suspended inside tank.

**SUCCESS STORY**

- Current condition: Dry joints to a distance of 500mm either side. Capillary migration of water observed to parts of elements not protected by the system.

**Location: Norway.**
**Client: Oslo Housing Society. (OBOS) A development in 4 blocks, 900 apartments**

- Problem: Water ingress to underground basement in all buildings.
- Solution: Install point anodes throughout the affected area. Insert cathode to ground outside.

**SUCCESS STORY**
- Current condition: Dry construction.

**Location: Norway.**
**Client: Tonstad Power Station. Sira Kvina Works. (The largest hydroelectric power station in Norway.)**

- Problem 1: Water ingress to 10 meters thick concrete water shaft 598.5 meters below ground water level, (turbine No. 5) constructed without external membrane. The shaft was pressure injected 5 times over the years without lasting effect.
- Solution: Installation of anodes throughout to inside surfaces with external cathode in the reservoir some miles away.

**SUCCESS STORY**
- Current condition: Dry construction.

- Problem 2: Water ingress through thick concrete soffit, walls and floors in turbine hall.
- Solution: Installation of anodes throughout to inside surfaces with external cathode into the rock wall.
- Solution: Installation of anodes throughout to inside wall with external cathode in the reservoir some miles away.

**SUCCESS STORY**
- Current condition, both installations: Dry construction.

**Location: Norway.**

**Client: The Norwegian Building Research Station Oslo.**

- Problem: Water ingress to underground lift pits.
- Solution: Install point anodes throughout the affected area. Insert cathode to ground outside.

**SUCCESS STORY**
- Current condition: Dry construction.

**Location: Norway.**

**Client: The Norwegian National Hospital, Oslo. (Rikshospitalet)**

- Problem: Water ingress to underground lift pits.
- Solution: Install point anodes throughout the affected area. Insert cathode to ground outside.

**SUCCESS STORY**
- Current condition: Dry construction.

**Location: Norway.**

**Client: Ullevall Hospital, Oslo.**

- Problem: Water ingress to underground lift pits.
- Solution: Install point anodes throughout the affected area. Insert cathode to ground outside.

**SUCCESS STORY**
- Current condition: Dry construction.

**Location: Norway.**

**Client: The Norwegian National Museum.**
- Problem: Water ingress to underground basement book and manuscript archive. The basement was useless for this purpose until the installation of the System. The criteria for allowing these National treasures to be stored underground were that the environment had to be controlled to a level of 54% relative humidity. This could only be achieved with a combination of the EPS System and sophisticated environmental controls.
- Solution: Install line anodes throughout the affected area. Insert cathode to ground
  outside.

**SUCCESS STORY**

- Current condition: Dry construction.

Note: In selecting the project references listed above, we have endeavoured to put together a broad selection of projects. In addition to these, there are over 1650 successful installations in the United States and Scandinavia, consisting of public and private buildings such as schools, hospitals, sports centres, libraries, public and private housing.

***What the experts say?***

*"I believe the key to the success of the AOP system is in the short duration of the pulses that are used and the ability of the system to accommodate different ground and structural conditions" This is indeed*

*an outstanding product*
Australian Centre For Geomechanics

*"It is the control system and its implementation that makes the AOP system Unique.....energy consumption rates are extremely low, with the amount of energy required to treat a 5,000 square meter section of a basement being about the same as that required by a house hold light bulb"*
Australian Centre For Geomechanics

*"AOP System (prototype), build state as at 21 September 2006, not only meets the protection requirements Article 4 of the EMC Directive 89/336/EEC when used in a railway environment but exceeds it due to its permanency"*
York EMC