Training manual AOP system installation

Content:

1. Introduction

AOP is a proprietary system which utilises advanced electro-osmotic technology specifically designed to dry out subterranean capillary structures, such as concrete and, masonry structures and maintain them in a permanently dry state. AOP can either be retro fitted or specifically incorporated into new buildings and structures to prevent the ingress of water and moisture. AOP is ideally suited to drying out basements and tunnels that already suffer from a chronic water seepage problem.

AOP is evolutionary technology based on long established principles of electro-osmosis and works through administering a series of low voltage pulsating charges. Other methods of addressing water seepage in use in the building industry today can be characterised as temporary solutions to a problem for which there has previously been no convenient, economic and permanent solution.

Concrete and brick 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 way as plants and trees receive and distribute water to smaller

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branches. AOP is utilised for transporting water encapsulated within the capillaries out of structures, as well as permanently preventing the penetration of water into structures.

Electro Osmosis

By placing a low voltage charge between negative and positive electrodes within a porous structure, the water becomes ionized. Ionizing the water molecules within the capillaries causes the water to travel towards the negative electrodes. As the system is on continuously it will prevent the water from intruding back into the structure. The wet area will quickly dry and remain dry. In capillary structures the normal osmotic effect will cause water ingress. The AOP system will not only stop this process but will reverse it and become a reverse osmotic system.

This is all possible by embedding the positive electrodes (anodes) on the interior side of the affected structure and placing the negative electrode (Cathode) at the water source in which causes the water ingress.

Rapid dehumidification.

Once the system is powered on, the dehumidification process starts immediately. After two weeks there will be a decrease in the relative humidity close to the surface of the structure. The process will continue until it reaches the desired humidity level and will keep it there for as long as it is powered on.

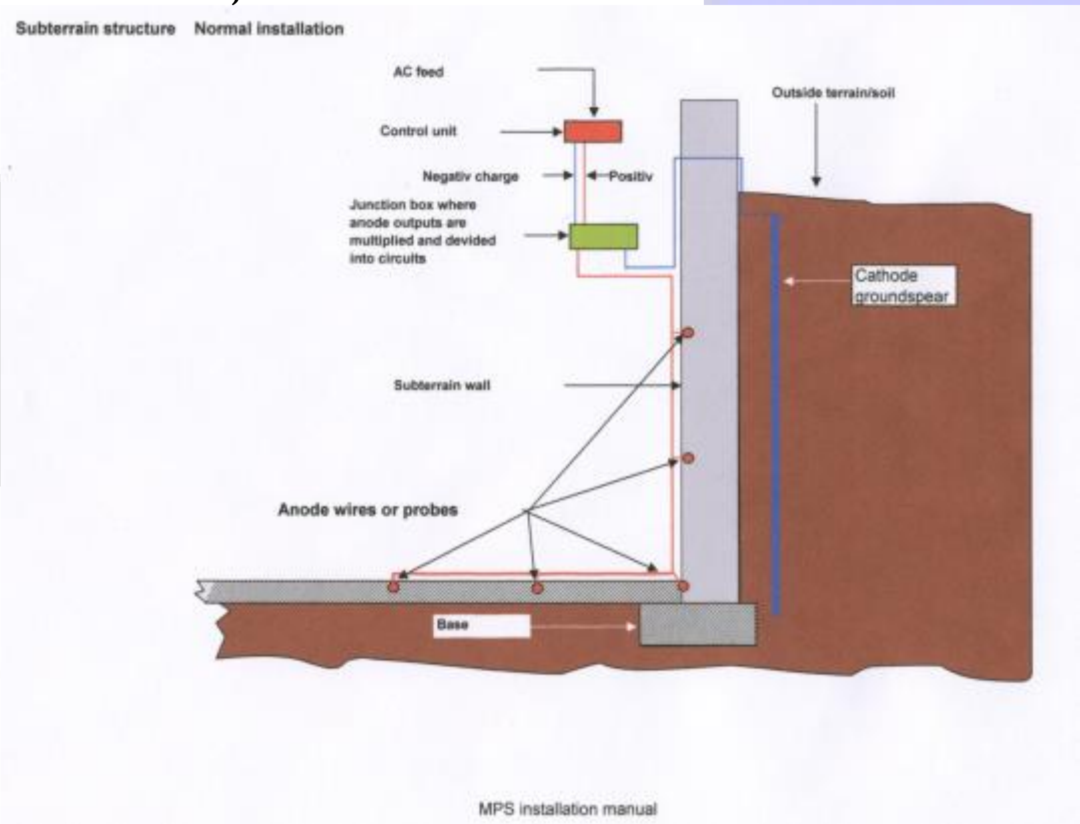
Even in places where the water table is above the structure, the AOP system will withstand the high water pressure and prevent water ingress through the capillaries in the structure.

2. AOP system benefits:

There are numerous benefits to be derived from AOP compared with the more traditional barrier and penetrative coatings.

- **AOP provides a permanent solution to waterproofing suitable structures.**
- **AOP can be retro-fitted to existing buildings and structures.**
- **AOP is both cost effective and comparatively simple to install.**
- **AOP is flexible and can be installed from the exposed inside of a structure, negating the need for expensive exterior excavation work.**
- **AOP is a safe, extra low voltage system with minimal running costs requiring, on average, approximately 10 Watts of power for a 1,000m2 treated area.**
- **AOP is environmentally friendly with no harmful emissions or waste.**
- **All electrodes used in the system are isolated from the regular AC source and is only subject to 20 volts. This means that these electrodes are touch safe even when the system is on.**
- **The AOP system is designed to be powered on continuously and will have the same life expectancy as other electro installations.**
- **The system prevents peeling paint, mould, mildew and foul smells.**

- **The system reduces corrosion of steel reinforcement within the structure.**
- **It reduces the relative humidity in basement areas, reducing corrosion to mechanical equipment and other fixtures.**
- **Mechanical cracks are easy to detect after the initial drying period.**
- **Dry-wall construction with drained cavities is not required, resulting in improved space utilisation and reduced construction cost.**
- **The system stops efflorescence.**
- **AOP is safe to use and has no damaging side effects on a structure and will not alter its material composition.**
- **AOP enhances the bonding properties between old and new concrete, an important consideration in the renovation of deteriorated (cracked) concrete.**
- **By dehumidifying, AOP improves a structure's insulation, thereby reducing cooling and heating loads.**
- **AOP enhances mechanical crack remedial measures.**
- **AOP has potential to reduce the required thickness of diaphragm walls to a structural minimum providing cost savings for new projects. (Ref: Normal install cross-section)**



3. Site survey

The survey of an installation site is a very important part of the overall project. It is here where we create the foundation for the technical solutions specifically designed for the particular client site. We will also use the survey for economical reasoning, and determine the actual size and complexity of the project.

The client specifications:

The survey must substantiate solutions that will meet the client's requirements. If we encounter client specifications that can not be met with a high degree of certainty, we will inform the client of this at an early stage. For some projects the AOP system may only be a part of a larger multitask solution.

Control

The supervisor must check that the site is according to contract. He must make sure that no extra work is needed that is not specified in the contract. This being removal of equipment or other time consuming labour. If this is the case, a variation cost may be needed. The supervisor must check that all needed equipment is in order and in place before commencement of the installation.

Drawing reference:
The client shall provide Hydrotech with overview and cutaway drawings of the structure. This will be used as reference drawings when Hydrotech create AOP installation drawings. The client must also provide information about the ground conditions around the structure and all other information considered relevant to the survey.

Water ingress mapping:
Localization of different moisture levels throughout the structure by the use of surface probes connected to a moisture measurement instrument.
Visual inspection for mechanical cracks and water seepage:
Salt and chloride deposits are good indicators of high moisture level in the structure. In places of no visual indication, use the measurement equipment.
Water ingress due to capillary suction can quickly vaporize into the air without leaving any trace of chlorides.
Create measurements points in strategic places where there is a high moisture level. These measurement points will be used as reference throughout the dehumidification period.
Once the water ingress problem has been mapped out, the next step is to locate the most feasible place for the cathode placement.

Hose down:
Before commencement of any installation, the entire target area must be hosed down with a pressure water hose. It will further need to clear any sign of chlorides and salt deposits on the target areas.

Components.
The installation consists of several components.
A: AOP control unit and slave units.

B: Junction box.
C: Anode (positive electrode).
D: Cathode (negative electrode).
E: Feeder wires in conduits and trunking.
F: Cement grout.
G: Graphite powder.

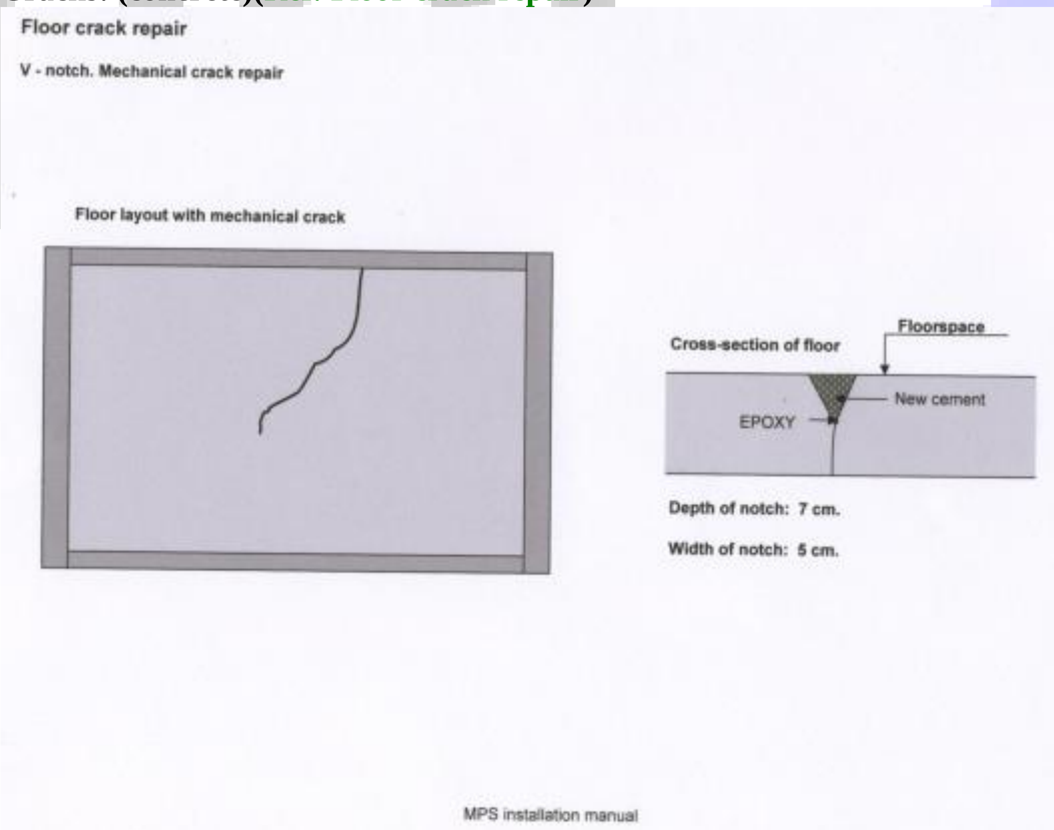
4. Repair

Structural damage.

General :

All visible damages to the structure must be repaired before commencement of an installation.
A damage survey should be carried in collaboration with the client.
Once the AOP system has dried out the structure, it is time to make another survey to look for patches of moisture. These are usually small mechanical cracks that are very hard to spot when the entire structure is moist. Once the AOP system has dried up structure, it is easier to identify the remaining mechanical cracks. In these instances we need to repair the cracks. If it is not a mechanical crack, we need to install an anode in that particular spot.

Cracks: (concrete)(Ref: Floor crack repair)



During a survey we usually find cracks where there are deposits of chlorides on the concrete. There might be cracks elsewhere as well.
Some cracks are very thin and they might not be through the concrete.
These cracks will most likely not have a build up of chlorides.
In order to establish the status of the crack, we drill a measurement hole next to it and perform a moisture reading.
If the reading indicate that it does not have higher moisture content than other non crack areas, the crack is not all the way through the structure.

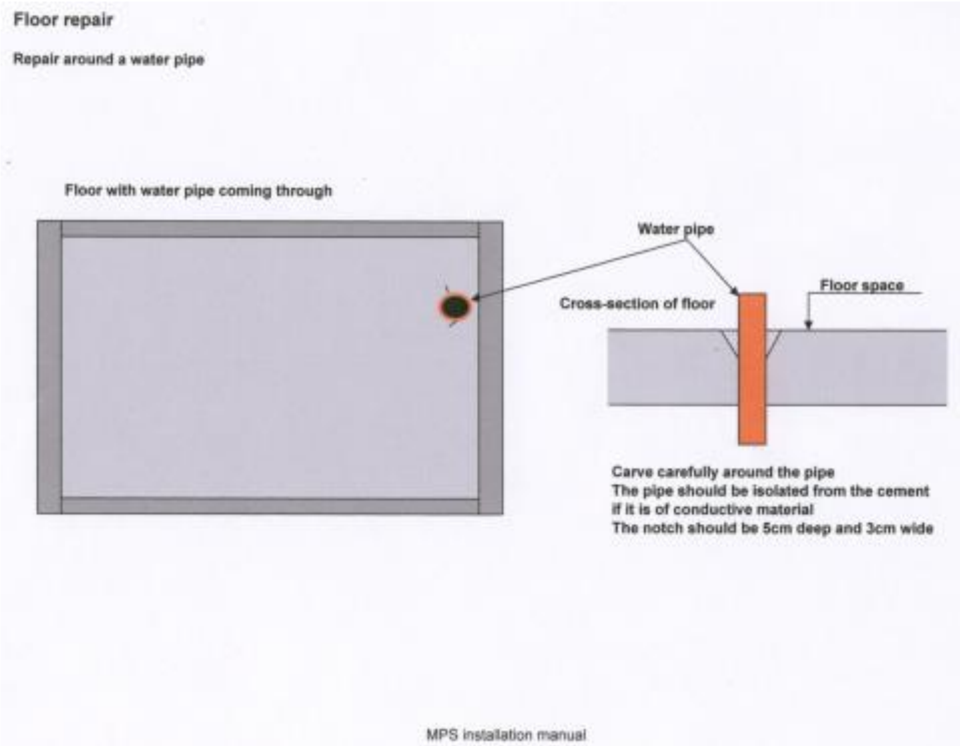
There can be cracks next to , straight through trunking or pipes or other installations and precaution is needed in these areas during chasing.
Pipes can be corroded and contain dangerous fluids or be under high pressure. Precaution is also taken close to electrical wiring.

The principal procedure for repair of cracks is the same on all part of the structure. Walls, floors, and ceiling have the same procedure.
Start by applying a strong colour along the crack. This will help in accurately following the crack during chasing.
The depth of the chase should be at least 7cm. Make the notch at least 5cm at the surface.
Chisel a slot down to 7cm depth. Then clean the slot with a vacuum cleaner. It is important that a cavity is not forming in the notch when it is filled up.
Apply a 5mm thick layer of liquid epoxy at the bottom of the notch.
Let this epoxy cure before continuing.
The cement mix being used should be as close to the original as possible.
Moist the notch and then apply the cement mix into the notch.
Make sure that the cement is of proper consistency to evenly fill the notch.
Once the cement mix has cured it is time to polish the surface.
See drawing: repair of cracks.

Column:
When we need to make repairs on columns, it is only where column meets floor or ceiling we need to do this. If we can stop the capillary migration at these points, the rest of the column will remain dry.
Any repair on the column other than this is purely cosmetically.

Concrete beam:
The same approach applies to the concrete beams.
By stopping the capillary suction at the ends, the rest will remain dry.

Steel beam: (Ref: Floor pipe repair)



Corrosion is often found where steel beams are in contact with the concrete structure. There might be several reasons for this.

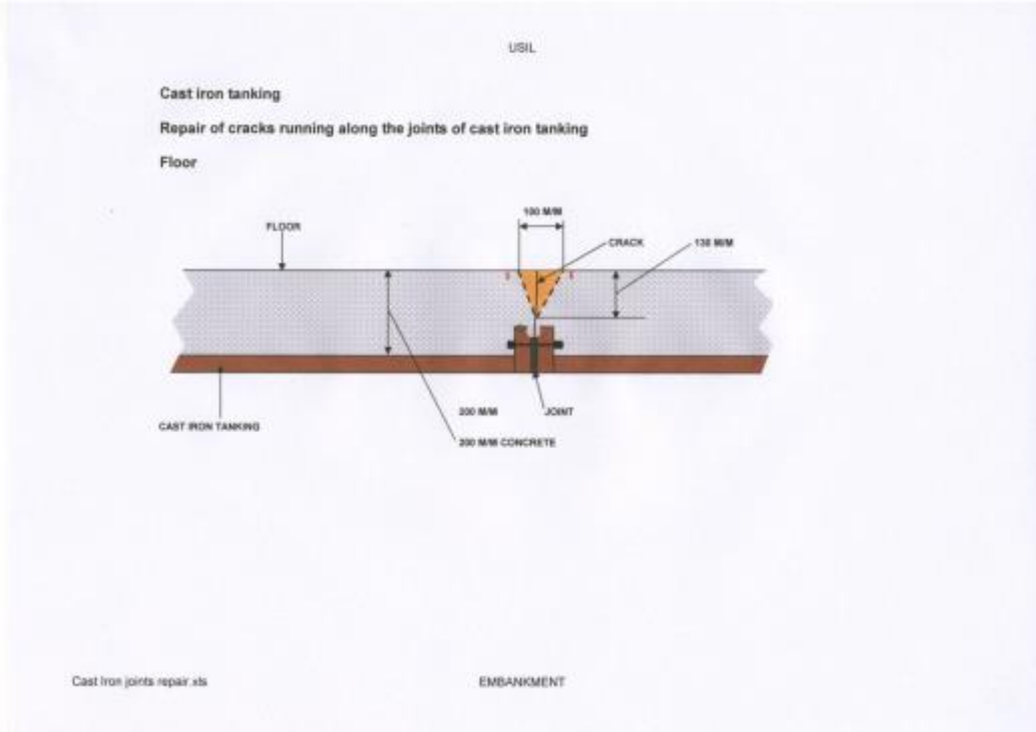
1. Insufficient ventilation and high humidity levels in the air.

2. Capillary pressure of water against the steel. This water might vaporize very slowly due to poor ventilation.
This can create a build up of chlorides that will damage the concrete.
In this case the steel need to be sandblasted and the concrete repaired.

3. Moisture may find its way to the steel through cracks and the chlorides will crystallize against the steel.

These are the most significant factors creating damages.
Other factors may apply and must be dealt with individually.
Our objective is to make sure that the structure is intact where our system is installed to keep the integrity of the system satisfactory.

Iron cast tanking: (cast iron joint repair)



Some structures have an cast iron tanking surrounding the structure.
This is quite common practise in old underground rail tunnels.
The movement of the trains will make the cast iron sections move and create cracks in the structure running along the joints between the sections. In these cases we need to repair the cracks and install anodes on each side of the repaired area.

Bricks:
Repair of brick structures are a lot more demanding than concrete in order to maintain the integrity of our system at the highest level.
Old brick structures may have up to 5 layers of brick.
If no drawings are available, we need to drill a hole into the structure to find out the depth and number of brick layers.
The drilling is always carried out in the joints.
A survey drilling will also determine if there is a void or cavity between the brick layers.
The system will not be able to push the water pass a void inside the structure, hence only the first layer might be applied to the system.
The Cathode placement must then be considered to create a connection through the moisture between the Cathode and the anodes.

Cracks in brick structures usually follow the joints, but displacements may crack the bricks. Cracked bricks should be replaced with a minimum of 2 layers.
cracks in joints should be chiselled and new cement mix applied.

Old brick structures may contain almost pure sand like joints.
The cementing agent has been washed away over the years.
In these instances, we need to replace with new grouting.

This can only be done in the first brick layer, which means that the next layers will not have the capillary properties to make a good dehumidification possible. Hence only the first layer will be dried out.
In most cases this is sufficient since the client looking for a dry inner surface. A survey drilling will also disclose the sand issue.

Conclusion:

If a dehumidification process is to be successful in a brick structure it needs to be compact. It needs a capillary connection between the Cathode and thee anodes.
Cracks must be repaired, broken bricks replaced and sand like cement in the joints replaced with new grouting.
If this is in place we are able to dry out the first layer of bricks and create a dry surface.

Mechanical cracks

There is a great possibility of mechanical cracks in the structure.
These cracks have to be repaired before the installation can take place.

Cracks in floor and wall:
Start by cutting a V shaped notch where the crack is identified. Make it 7cm deep and 5 cm wide. The notch must then be cleaned and vacuumed. At the bottom of the notch (on the floor)(ref.Rep.1) we start by applying a 3mm layer of liquid epoxy. We then apply a more solid epoxy on the wall. The purpose of this method is to make the crack especially watertight at the bottom of the crack. Minimize the use of epoxy, since its properties prohibits a full movement of moisture where used. Once the epoxy has cured, seal the notch with expanding Portland cement with water as the only additive. Moisten the notch before applying the cement grout. Cracks found higher on the wall is repaired using the same method.

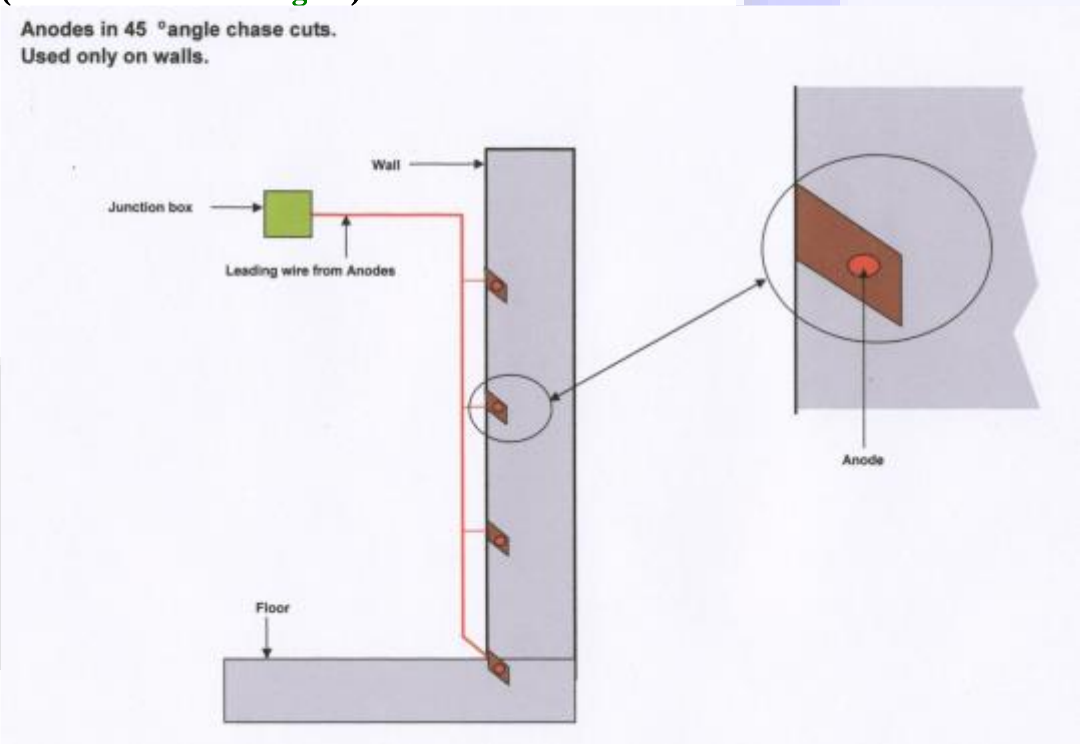
All cutting must be completed before applying any epoxy or cement grout. The cement grout must be cured for at least 24 hours before any further chiselling or cement is to be applied. Halfway cured cement will fall off if tampered with. The same rules apply for the graphite/cement grout used in the anode cuttings.

Water pipes and other similar installations coming through the floor or walls need special attention, especially if they are made of conductive material. We start by carving a 5cm deep notch around the pipe and then isolate the pipe from the cement (ref.Rep.2). We then plaster the notch with cement grout. Use caution when carving around plastic tubes or electrical trunking.

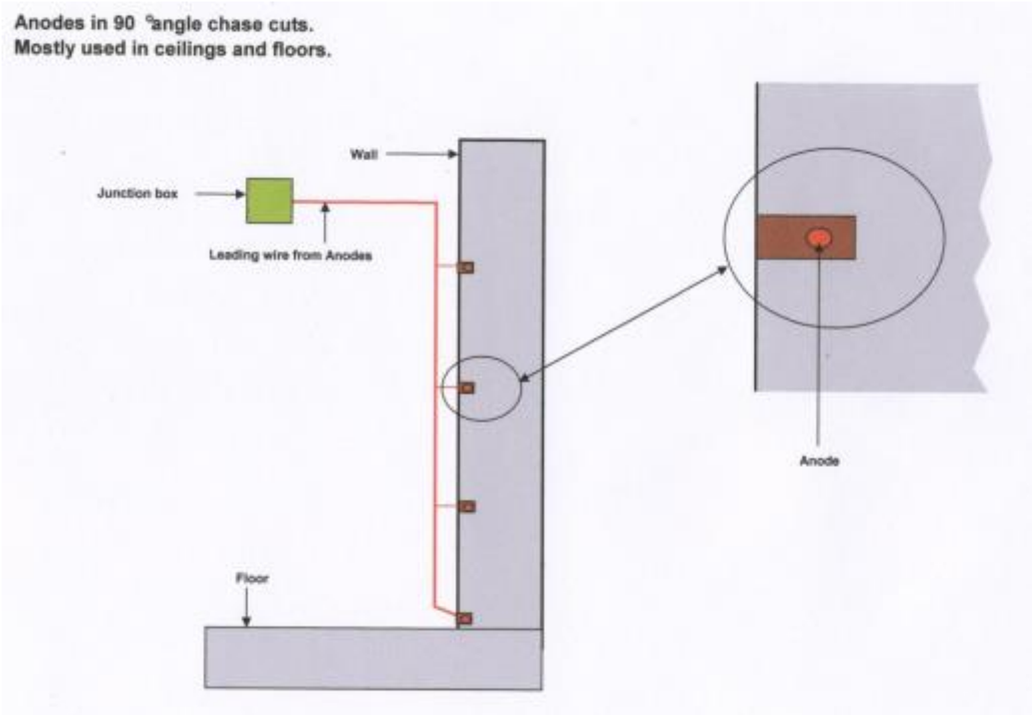
Repair of large patches of damaged cement.
When carving out large patches of cement it is important to make sure that all loose cement is removed and that all cavities are accessible by the new cement. The idea is to get a good merger of the cement. This is done to create a good capillary connection between the new and old cement. The new cement must be expanding Portland cement.

5. Chase cuts

**The cutting should be at least 28mm deep and 5 to 8mm wide.
When the cut is completed, it needs to be cleaned and vacuumed.
It must be completely free from dust and debris.
Chase cuts on walls are done at a 45 degree angle downward.
This is done for easier handling and placement of anodes and mortar grout.
(Ref: Chase cut 45 degree)**



**Chase cuts on the floor and ceiling are done at a 90 degree angle.
(Ref: Chase cut 90 degree)**

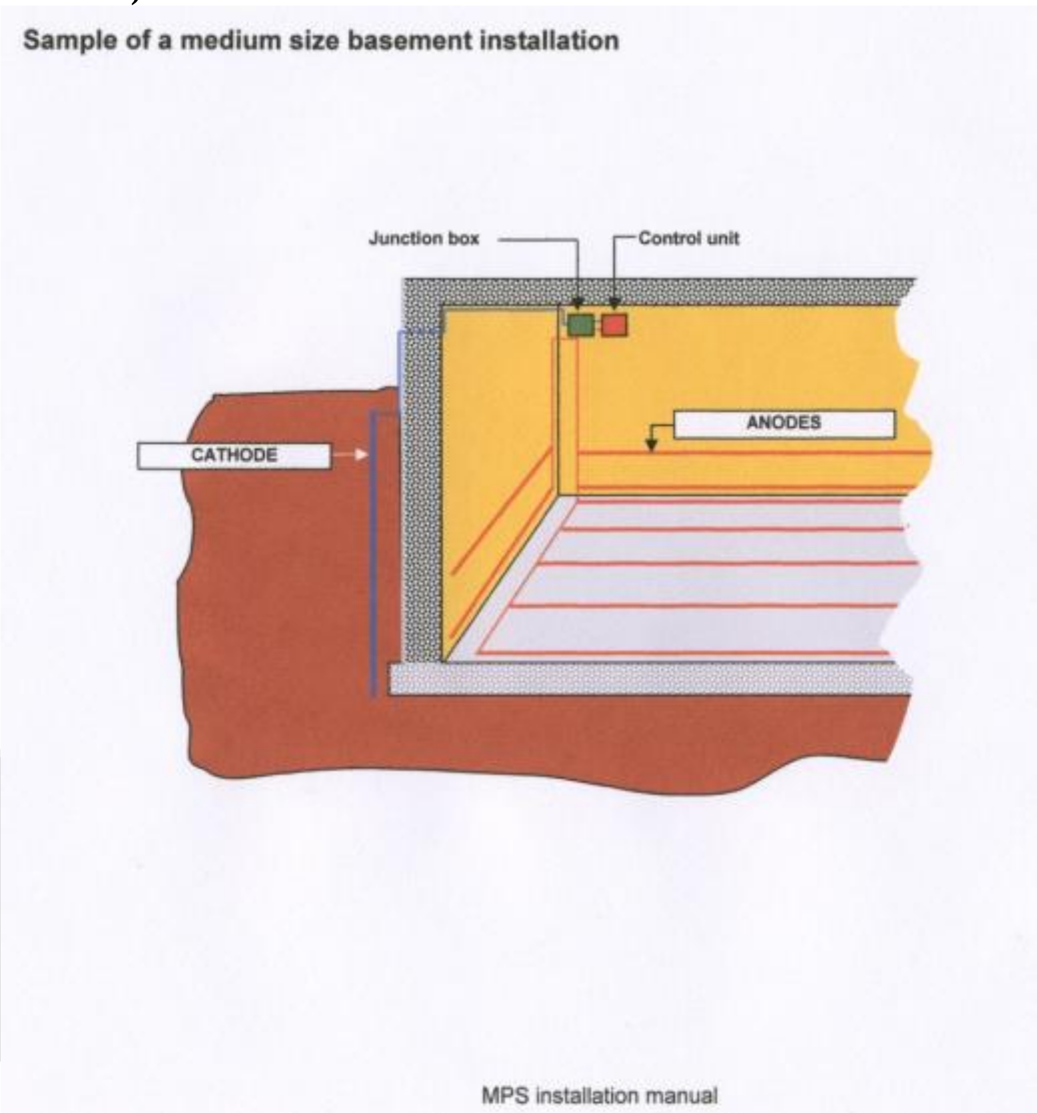


The chase cuts are mostly for the anodes to become embedded into the dry side of structure. In some instances the feeder wire will also be placed in a chase cut, but then it will consist of a sheathed anode wire rather than an insulated feeder wire.

6. Anodes

The effective electro osmotic field radiating from the anodes will vary depending on the quality and properties of the specific concrete in the structure.
As a default measure, 100cm between the anodes is sufficient for a good quality concrete structure.
Once the placement of the anodes have been decided, and checked for feasibility, the drawings can be completed.(Ref: AutoCad sample)
The placement of the trunking and conduits for the feeder wires should also be done before any cutting takes place.

The positions of all anode lines will be marked up with a red marker. (Ref: Medium basement)



When an anode line is marked, it should be scanned for rebars or other metal fixings inside the structure. The interior side of the structure should normally have 30mm of concrete outside the rebars.UK standard being 50mm; the minimum between anode and rebar is 5mm, with the minimum depth of anode should be 20mm.
The results of the scanning must be commented on the drawing.
If the rebars are to close to the anode trail, the anode must be redirected around it. This deviation must be implemented into the final drawings i.e. the ' as built' drawings.

Cut the anode to fit the length of the cut.
In each end of the anode, we now connect a feeder wire.
Try to keep the feeder wire in one length all the way to the junction box.
The wire from the junction box to the anode shall be connected to the anode with an inline crimp type splice connector. The connector shall be protected with thermal heat shrink insulated tubing containing a sealant to provide an a water tight seal for the

connection. Wires in the junction boxes shall have markers designating the circuit letter and anode number permanently attached to facilitate testing and repair.
Make sure that the connection is 100% moisture proof.
All feeder wires must be numbered when they are connected to an anode.
If an anode has a feeder wire at each end, both feeder wires will have the same number.
In some instances, an anode will only have one feeder wire due to practical reasons.
If a feeder wire is too short to reach the junction box, make sure the connection will end up in the trunking.

An anode is now ready to be installed

Make a grout mix from the basis of expanding C25 or C40 Portland cement.
The grout must have non shrinking properties.
Add 15 % graphite powder to the mix.
Then add water until the grout has the right consistency.

The cut is now sprayed with water. Make it moist but do not let it pour out.
Put a layer of grout at the bottom of the cut, about 15mm thick.
Place the anode in the cut until the grout covers it.
Use clips to keep the anode wire in the cutting.
Cover up the rest of the cut with the grout mix.
Make a nice cosmetic surface over the cut.
Leave it and let <u>it cure for one day.</u>
Remove the clips very carefully the next day to make sure the grout mix does not loosen up. Moisten the gap from the clips and fill with grout mix.
The anode is now installed and only the feeder wires are visible from each end.

The installation procedure for concrete structures is the same whether is it on walls, floors or ceilings. This rule is for concrete structures that have a thickness of 25cm to 60cm.

Anode loops
In structures thicker than 60cm, the need for anode loops may become apparent. The loops will give the anodes a better depth into the structure and make it more effective in thick structures.

In order to maintain a good monitoring of the system and the dehumidification process of the structure, it is recommended to only have 10 loops per anode circuit.
Mark up where the loops are to be inserted.
Scan the loop area with a metal scanner to make sure the loops will avoid the rebars and other fixings inside the structure.
If necessary, move the loop to the side of any risk area.
It is very important that the anodes do not become in physical contact with rebars or other metal fixings inside the wall.
The depth of the anode loops should not exceed 20% of the thickness of the structure.
When the drilling is done, the hole must be cleaned.
Cut the anode wire to correct lengths.

Connect the feeder wire by standard method.
Make the grout mix ready.
Moisten the hole and fill it half way with grout mix.
Make a loop on the anode wire and insert it into the hole.
Leave 1 cm between the loop and the floor of the hole.
Fill up the hole with grout mix, and make a nice surface.

The grout mix must now cure for at least one day before continuing the work on the feeder wires. The feeder wires must not be in motion while the grout mix cures to assure that the grout mix do not crack up.

The concrete structure:
This may lead to variations in cut depth, but it should never be less than 22mm deep. The cut must always stay at least 5mm away from the rebars. If the distance to the rebars or other metal is less than 5mm, we need to make the cut around it or move the entire cut.

New concrete vs Old concrete:
In new concrete the distance between the anode lines can vary from 0.7m to 1.2m.
In older concrete the distance between the anode lines should be reduced to 0.5m.
It all depends on the conditions of the structure and there are many variables.

Old Structures:
In old structures the capillaries may be filled with humus.
This is dirt brought into the capillaries by the water over the years.
This reduces the effective osmotic field and to counteract this effect, we need to place the anode lines closer together. The general rule is that the older the structure, the closer we place the anode lines.
Another rule is that the thicker the structure, the closer we place the anode lines. This will all be independently assessed for each project.

Brickworks:
An installation in brickworks will represent a more advanced task, and a lot more attention must be paid to the design of the installation.
The cathode placement will be with the same procedure as in concrete.
The anodes however, will be a lot more difficult to place. The capillary in the bricks can vary in size. A harder baking of the bricks will produce smaller capillary, in which will result in a slower dehumidification rate. In old structures we might encounter grout cement with less bond strength than desired. In these instances, we need to decrease the distance between the anode lines to 0.3m.
If the bond strength of the cement grout is completely gone, it is not recommended to continue the installation without the following work.
The old grout between the bricks must be removed at least 5cm deep, and replaced with new grout. A second alternative is to render the entire wall with a 5cm thick new cement grout on top of the bricks. A visual inspection and brick samples will determine the various conditions of the brick structure.

If the brick structure is in good condition, there will be no reason not to install the AOP system. The structure needs to be washed down with pressure water, before accessing mechanical cracks and before installation commence.

The anodes should be placed in the grout joints where this is possible.
That is where they will be most effective.
In places where capillary suction is proven, we need to add a loop in addition to the regular cut by drilling a hole in the cut. The depth of the hole will vary depending on the thickness of the structure.
Start by making a cut in the joints between the bricks that are closest to the floor and ceiling. Then continue with equally spaced intervals.
The cut should be at least 4cm deep in the joints.
Clean the cut properly. Cut the anode to proper length.
Connect the feeder wire according to proper procedure.
Make a grout mix with expanding cement containing 15% graphite powder.
Fill the bottom of the cut with 1cm thick grout mix.

Insert the anode into the cut.
Fill up the cut with grout mix until there is 1 cm left to the surface.
Let the grout mix cure for a while.
Then top off the cut by using a regular grout without the graphite power mixed in it. This is done to leave the cut with a regular colour grout and not the dark colour made by the graphite power.
This procedure is not applicable in places where the joints will not be visible.

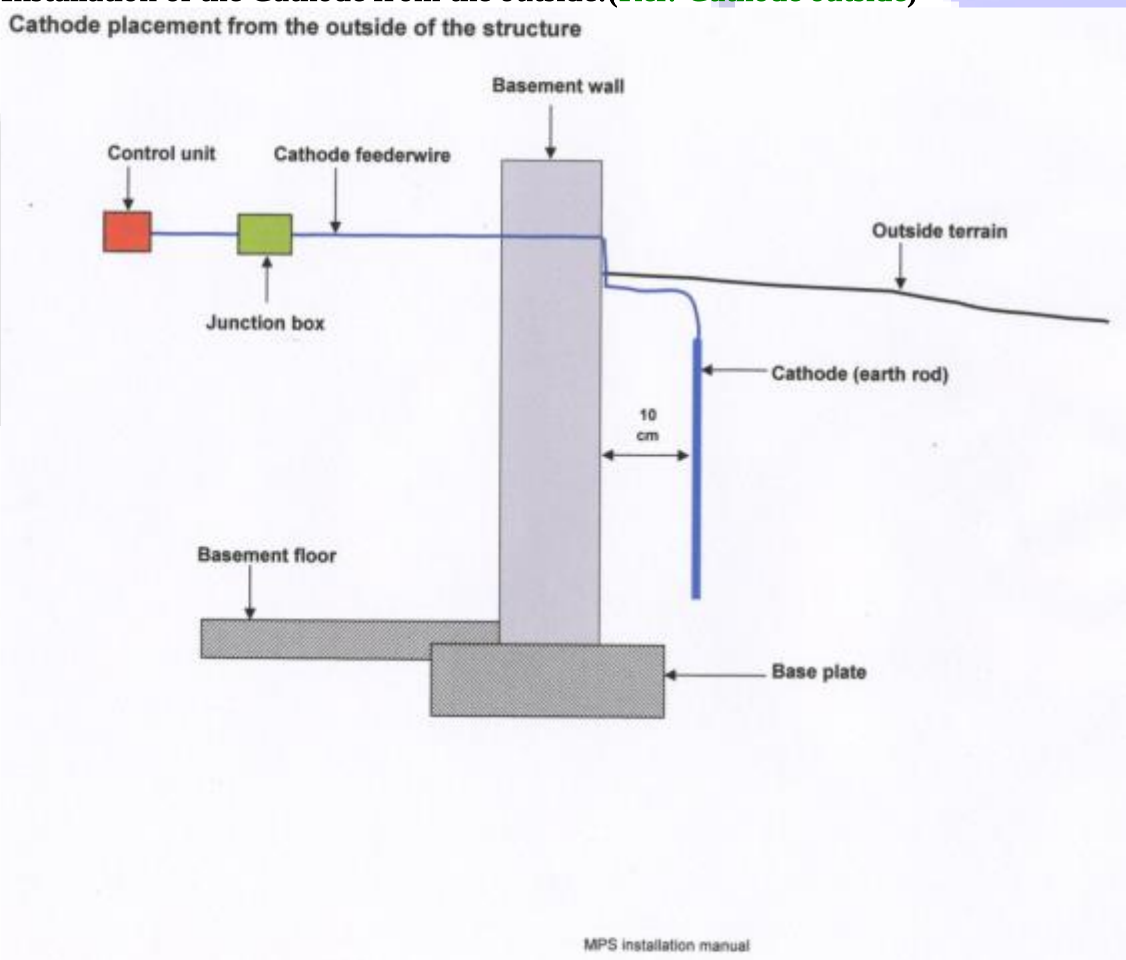
7. Cathodes

Obtain the cutaway drawings for the area of placement. Make sure there is no obstacle inside the wall before drilling. The area need to be scanned if an acceptable drawing is not obtainable. If the scanning indicates the embedded metal, it will need to be further investigated. It may be something other than
Reinforcement rebars.
To localize the perfect placement of the cathode is not always easy.
Where the water pressure is equal all around the structure, it is easier to place the cathode. In other instances, where the moisture is only detectable randomly, it is harder to determine where to place the cathode. And it is also in these instances where the placement is most crucial. When there is doubt, we always install several cathodes for good practice.
We always install at least two cathodes as a default measure.
This is done in case of insufficient connection to the water source on one of them. Once the installation is complete, we can measure the current draw and determine if we need to connect both cathodes. If the current draw is low, we connect both cathodes to get a better connection to the water source.

Placement of Cathodes:
When looking at the moisture readings done during the survey, we can now determine where to place the Cathodes.
It is important that the soil condition on the outside of the structure is known and a part of the consideration.
A decision is to be made if the Cathode is to be installed from the outside or the inside of the structure. Sometimes it is impossible or impractical to install the Cathode from the outside.
It is of outmost importance that the Cathode never becomes in physical contact with the rebars or any other metal installations.

When the locations of the Cathodes are decided, it is important to mark them accurately on the drawings.
The Cathode placement drawings must be approved by the client prior to installation.

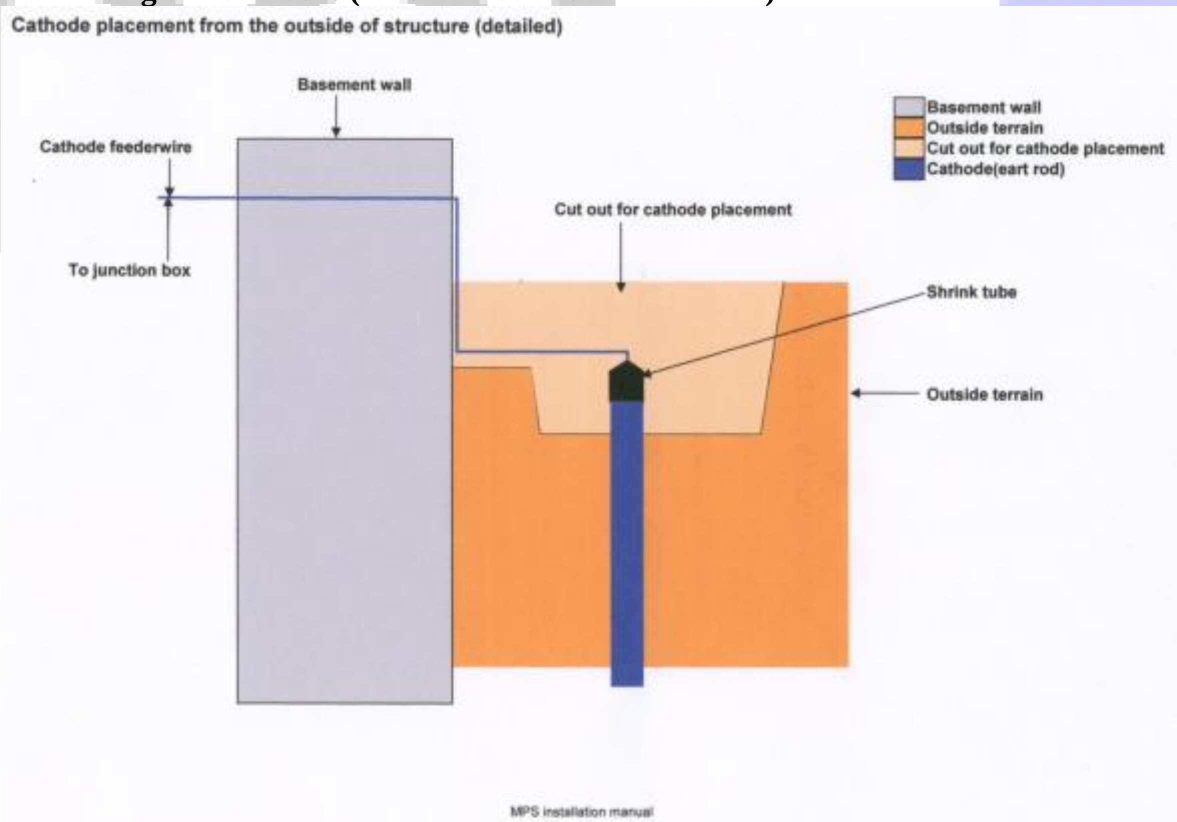
Installation of the Cathode from the outside:(Ref: Cathode outside)



Before we place the cathode in the ground on the outside of the structure, we need to access where the water source is located.
It is important to be sure that the location has a high degree of moisture and has a good connection to the water source.
How many Cathodes and how deep we place them are determined individually for every installation, depending on the water table level.
Keep the Cathode at least 10cm away from the structure when fully inserted into the ground.
Do not place the Cathode parallel to the structure, but at an angle towards it.
Be aware of any conditions that may give the Cathode direct contact with the rebars or other metal installations in the ground. (Ref: Cathode
The size of the installation and the quantity of anodes will determine how many cathodes are needed. An important parameter is how much water is present in the ground around the structure.
1 cathode placement can be sufficient if the water table surrounds the structure, while other locations may need several cathodes.

At the desired location:
Dig a hole in the ground on the outside of the structure. Keep it 30cm away from the outside walls. Make it 30cm in diameter and 30cm deep.
At the bottom of this cut out, ram the earth rod into the ground until only 10cm is left protruding

Connecting the Cathode: (Ref: Cathode outside detailed)



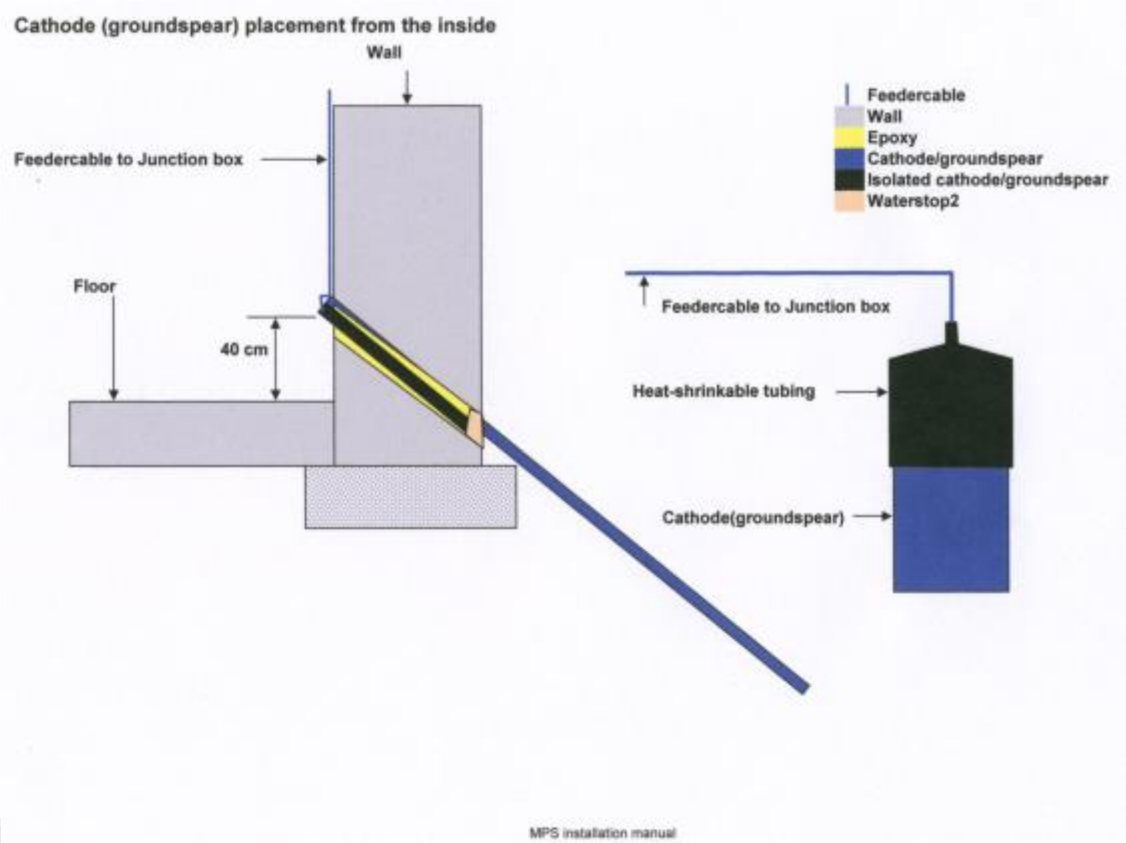
At the visible end of the earth rod, we now connect a 2.5kv size feeder wire.

At the upper end of the Cathode we drill a hole of 6mm diameter.
Then we use a tap drill to make a thread in the hole.
A screw in the threaded hole will be used to fasten the feeder wire.
The end of the feeder wire is connected to a cable eye.
Insert a 12cm long shrink tube over the cable eye and part of the feeder wire.
This shrink tube shall have a diameter of 18mm.
All connector and shrink tubes must have integrated glue.

Then we place a second shrink tube over the cable eye.
This smaller shrink tube shall have a diameter of 7mm and 5cm long.
The smaller shrink tube must cover the entire cable eye and connector when cured.
The larger 18mm shrink tube is to be placed over the entire end of the Cathode in such away that it covers the entire connection point including the smaller shrink tube and screw.
This procedure is important to do accurately in order to make sure the connection is 100% waterproof.
If any water finds its way to the connector and screws it will become coated with Verdi Gris and may compromise the connection to the Cathode.

The feeder wire is placed 20cm under the ground to the structure for a suitable place to enter the structure and continue to the junction box.
The cut out is then refilled to cover the earth rod and the feeder wire.

Installation of the Cathode from the inside: (Ref: Cathode inside)



All needed materials and equipment must be close at hand before commencement of core drilling through the structure.
It is very important to make sure the crew has waterstop equipment before drilling holes through the walls for cathode placement. This is a precaution since the water pressure may be very high and a jet of water may come out from the hole.
Insulate the part of the Cathode to be stationary inside the structure by use of 2 layers of electrical insulating tape or by a shrink tube.
The core drilling diameter is 30mm. Stand by with a wooden plug that are 15cm long. One end must be 27mm in diameter and the other 34mm in diameter. This is kept as a precaution measure in case of emergency plugging of the hole.

The core drilled hole is to be drilled at an angle of 45 degrees downwards starting at 50cm above the floor. If there is high water pressure on the outside of the structure, the water will flow through the hole.
If that is the case, we need to stand by with the materials needed.
If we can not insert the Cathode quickly, we need to plug the hole with the wooden plug until we are ready to try again.

Place a dedicated plastic tube in the hole. This is used to keep the Cathode centred in the hole.
Insert the Cathode through the tube and hammer it through the hole. So as to have an average of 1 metre into soil.
Leave 10cm remaining of the upper end of the Cathode.

**Pull the tube off the Cathode and the Cathode should remain centred now.
Push some hemp into the hole around the Cathode to prevent water from coming up through the hole. This needs to be pushed far into the hole as far as possible
Then we do the same with Waterstop. Push it all the way down to the hemp.
This will make the core hole waterproof.**

**When the Waterstop has cured, fill up the hole with epoxy.
The Cathode will now be completely isolated from the concrete.
Once the epoxy has cured, we can cut the Cathode end to leave only 1cm.
(See drawing)
Connect the feeder wire to the Cathode. This is done by the same procedure as explained for an outside cathode.
On the inside Cathode we replace the 18mm shrink tube with a thick layer of silicon to protect it from moisture. Give the silicon time to cure.
This is an important procedure to prevent Verde Gris and possible loss of connection to the Cathode.
Remember that when a cold ground spear meets a warm room it will create condensation**

Installation of Cathode in brick wall.

**This type of installation is very similar to concrete installations, but there are a few differences.
The core drilling must be done in a joint between the bricks to avoid cracking the bricks.**

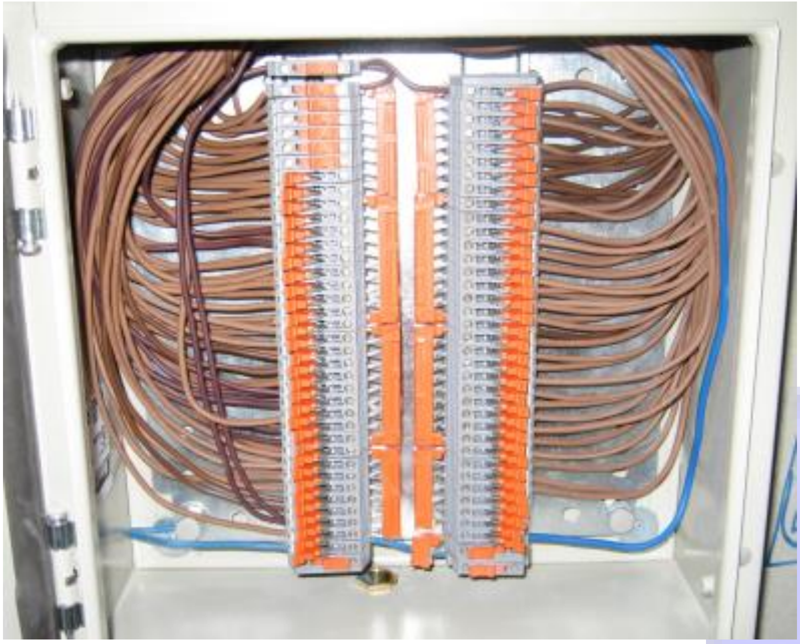
**In some instances we might be denied to drill into a joint due to visual architectural restrictions. Then we need to remove one brick before we do the Cathode installation.
Make sure that the hole is placed in the joint. Put in the removed brick.**

**The feeder wire will be placed in the joints to the nearest trunking.
This way the installation of the Cathode will remain invisible.**

8. Junction box

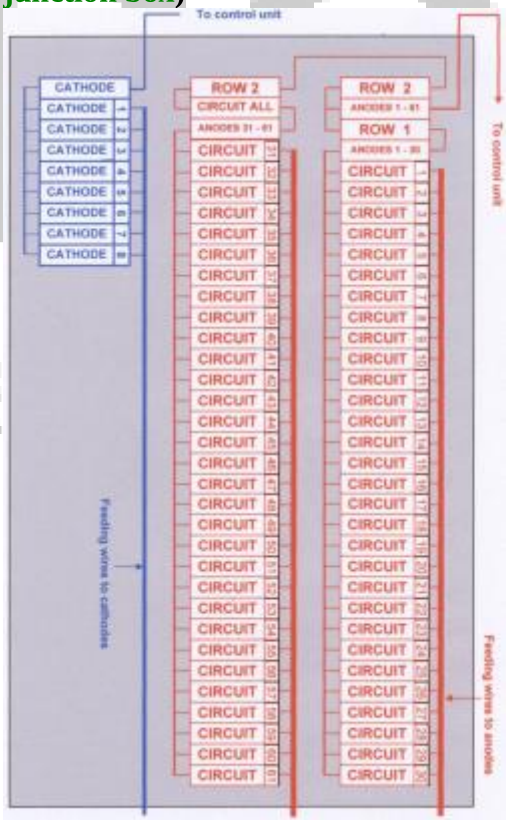
The Junction box is where all anode lines are connected. There may be several hundred anode lines and this makes the need for a junction box.

Each anode line has its own knife switch inside the junction box. (Ref: inside junction box)



This makes it possible to read off the current draw on each anode line separately as well as the entire installation.
The anode wire is made of 2.03mm titanium.

Feeder wire is to be placed between the AOP control unit and the Junction box.
From the Junction box the feeder wires go to the anodes and cathode. (Ref: Large junction box)



Anode feeder wire is 1.5mm2 and Cathode wire is 2.5mm2 or 4mm2 depending on the size of the installation.

The design of the trunking must be completed before any commencement of feeder wire cable pulling.
This is a measure to avoid unnecessary splices on the feeder wires.

All cables from the Anodes and Cathodes are to be congregated in the junction box.
In the junction box, each cable from the Anodes and Cathodes are connected to its own numbered knife switch. (Ref: small junction box)
Feeder wire nr 1 from Anode nr 1 is connected to knife switch nr 1 and so on.
This procedure allows us to read the current draw of all Anode lines exclusively and create a picture of how the dehumidification is progressing.

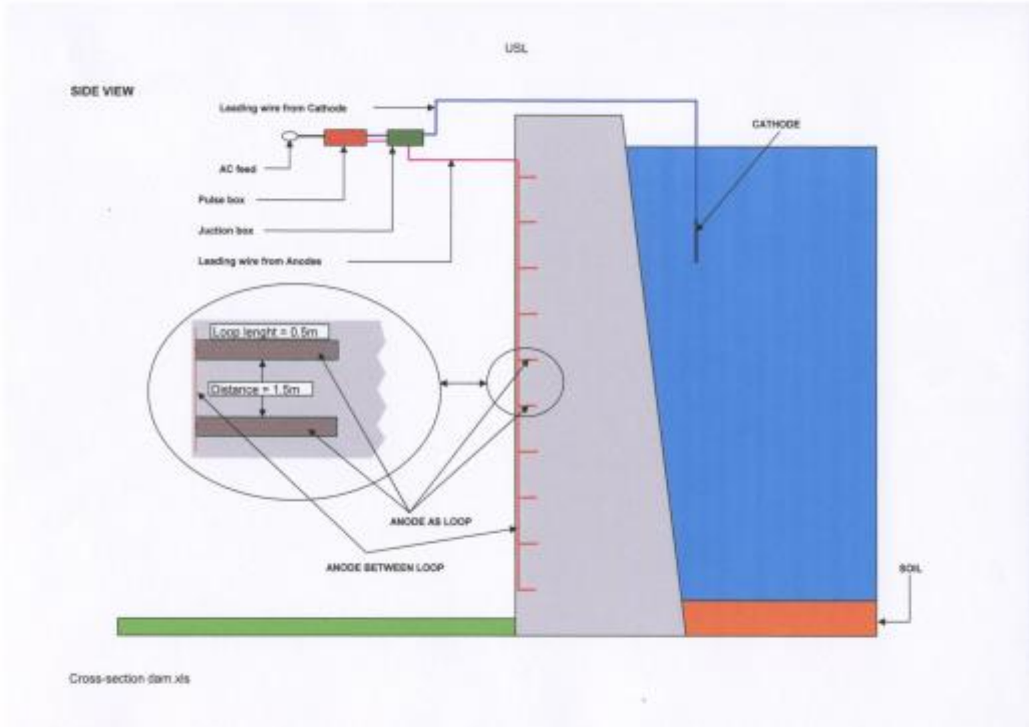
Operation

Continuity control.
When the installation is done and all anodes are connected to the junction box, the supervisor measures the current draw for all the anode lines to make sure that there is continuity on all lines and no breakage of wires in the installation. All current draw values are logged in the logbook.
The AOP system will then be powered off for 21 days.
This is the time the cement grout needs to cure, and during that time the installation can not be powered on. When the cure period is over, the installation may be powered on and the humidity monitoring begin.

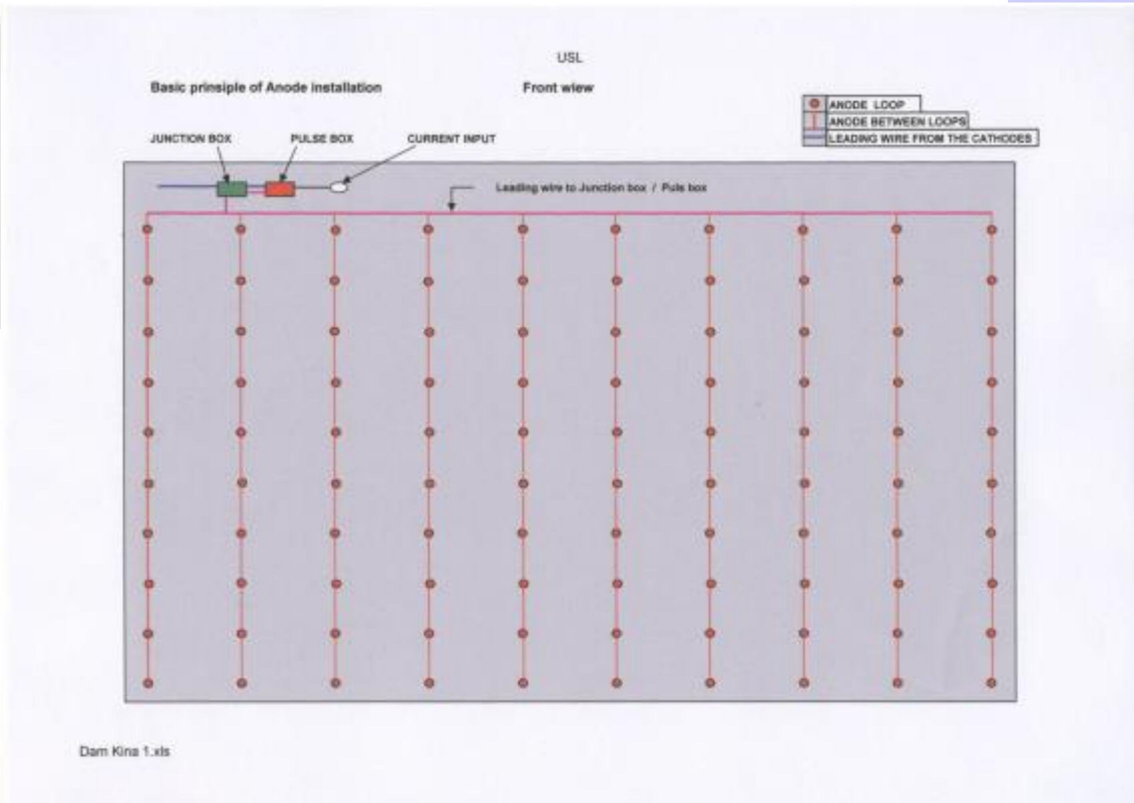
Humidity Monitoring during normal operation:
The AOP Control Unit output current depends upon the moisture level of the structure. Moisture readings may be taken at the structure surface and presented as the percent relative humidity of the material. To be an effective aid in monitoring AOP system performance, humidity readings should be performed at several locations along the structure perimeter. Also, these readings should be taken at various time intervals to check for trends.
The pre power measurement will be used as the reference for pre installation conditions and all other measurements will be compared against it.
In addition to the humidity monitoring by use of protimiter or moisture probes, the AOP current draw history graph will reveal humidity trends as well.

9. Other Applications

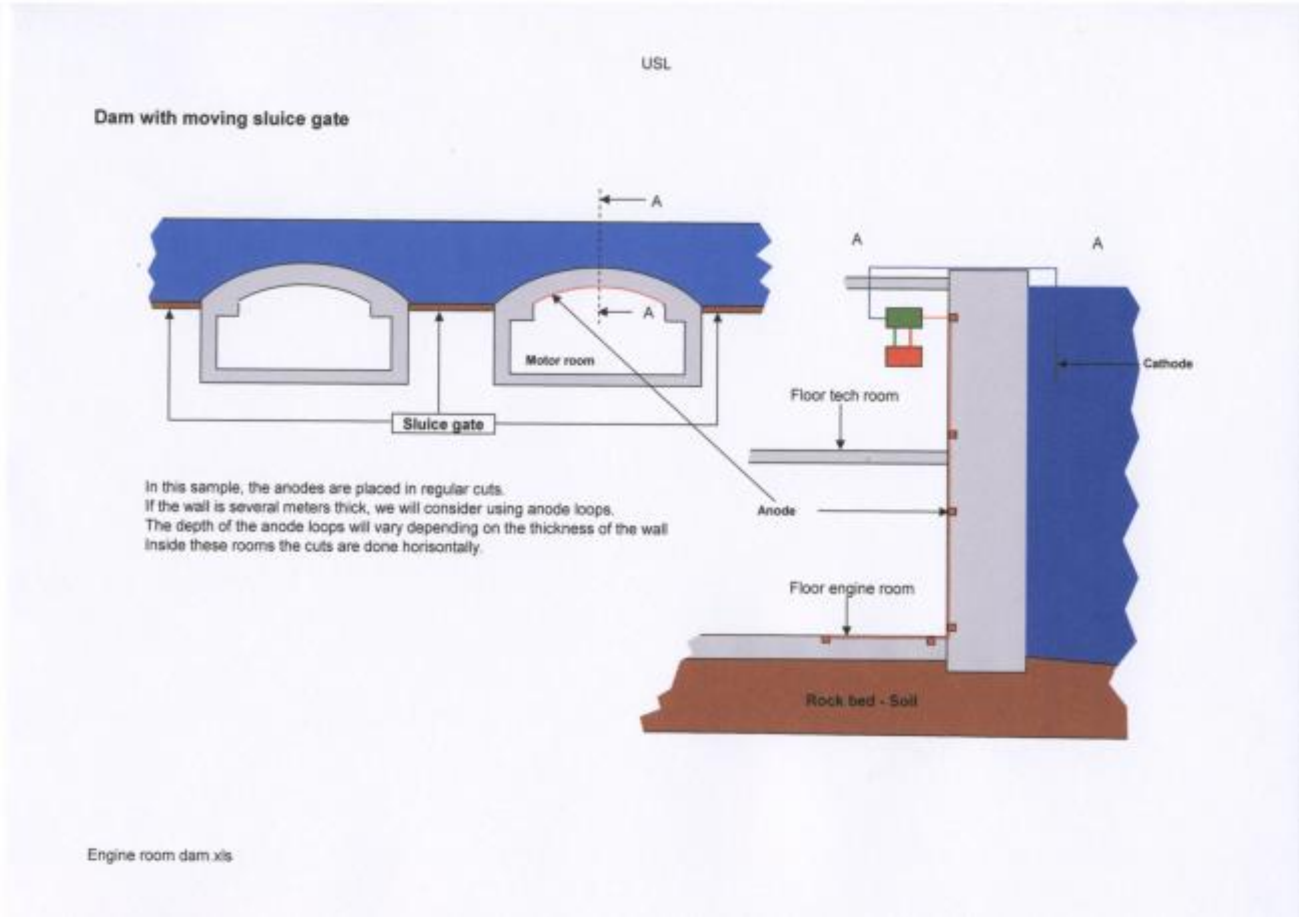
Samples of other applications other than sub terrain structures
Ref: Dam cross section:



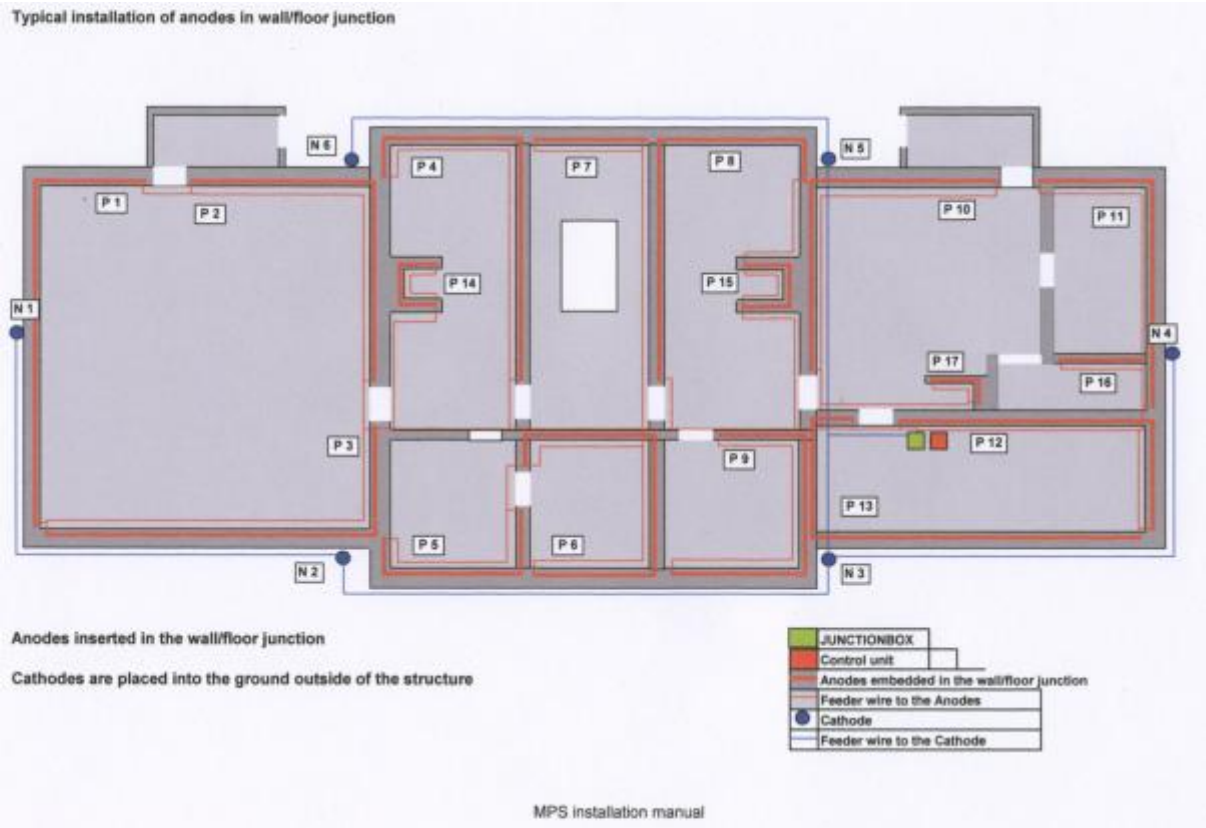
Ref: Dam front view:



Ref Dam with gate:

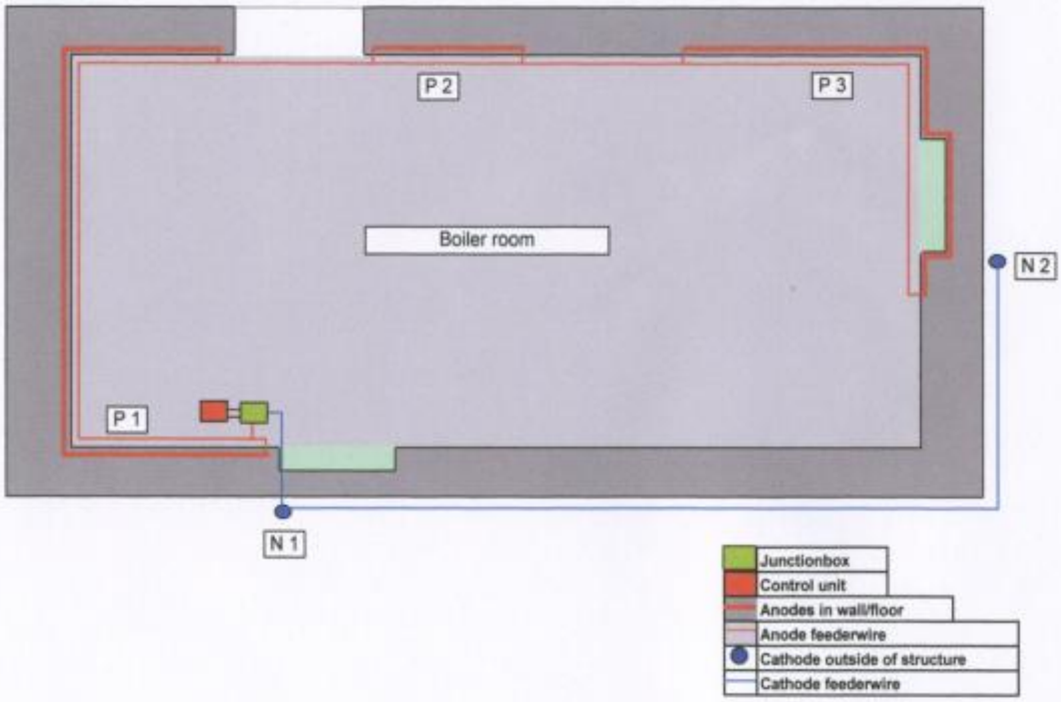


Sample illustrations of installation methodology


Typical installation of anodes in wall/floor junction
N 1
N 2
N 3
N 4
N 5
N 6
P 1
P 2
P 3
P 4
P 5
P 6
P 7
P 8
P 9
P 10
P 11
P 12
P 13
P 14
P 15
P 16
P 17
Anodes inserted in the wall/floor junction
Cathodes are placed into the ground outside of the structure
JUNCTIONBOX
Control unit
Anodes embedded in the wall/floor junction
Feeder wire to the Anodes
Cathode
Feeder wire to the Cathode
MPS installation manual

Typical installation in small boiler room

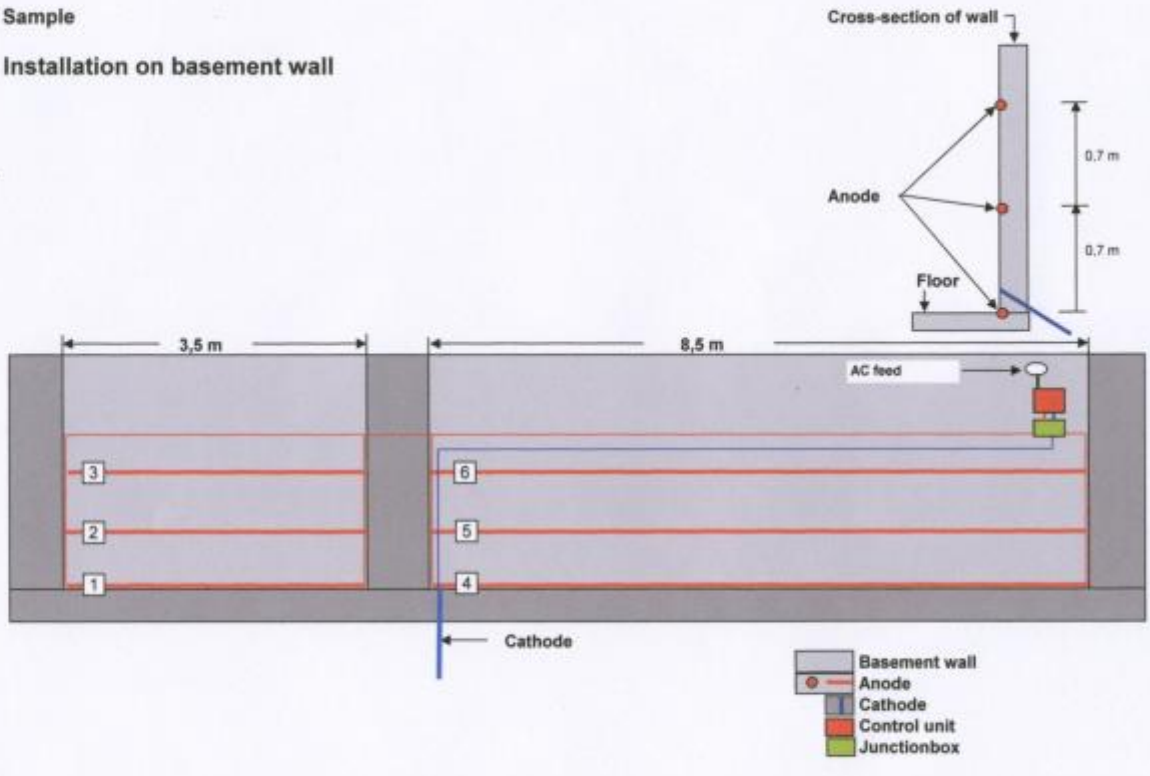
View of anode placement in wall to floor junction



MPS installation manual

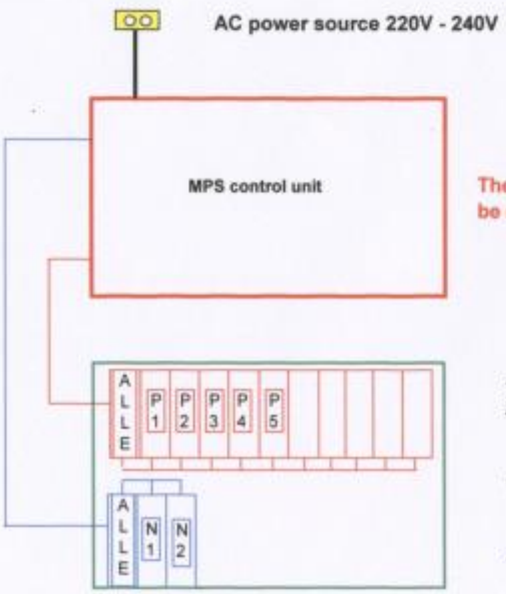
Sample

Installation on basement wall



MPS installation manual

Technical description 2.



The control unit and all components on the positive side is to be marked with red color

All anode lines and cathode lines are to be connected in the junction box by knifeswitches

Junction box is to be marked with green color

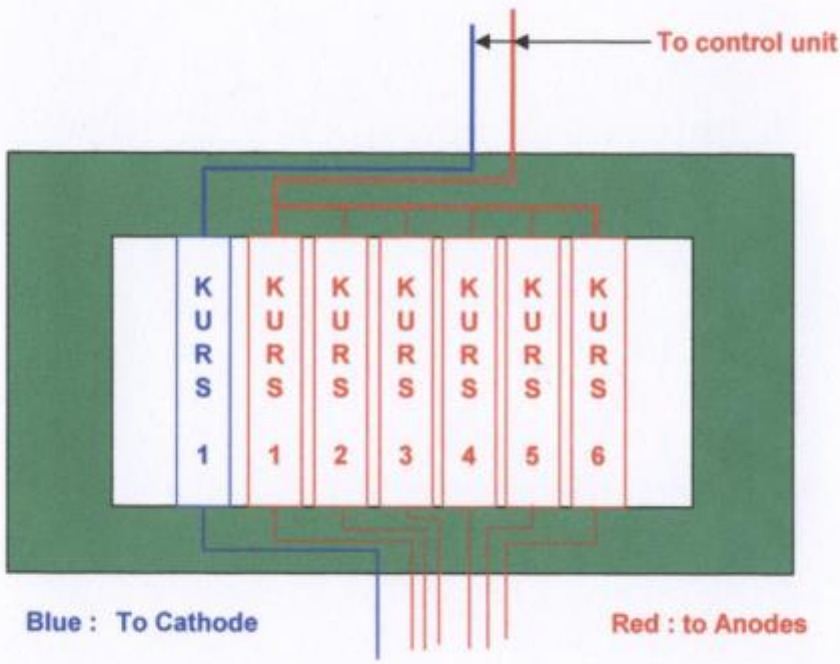
All components on the negative side is to be marked with blue color

MPS installation manual

Pacific Coast Limited
19/2 Road to the Lines, Gibraltar GX11 1AA
Telephone +350 200 65950, Email info @pclgib.com, Web www.pclgib.com

Typical small scale installation

Sample of Junctionbox



MPS installation manual

10. Operating manual for AOP V1 control unit

1. General
2. Equipment ratings
3. Equipment installation
4. Equipment operation
5. Equipment maintenance

1. General

1.1 System Overview.

The AOP system is an electro-osmotic pulse system that uses an alternating pulse of DC through anodes embedded in a concrete structure, to ionise water molecules which becomes attracted to the cathode when placed external to the structure thus removing water from the concrete structure. The system is defined as an extra low voltage system and is touch safe.

1.2 Working Principle

The AOP system can be described as a system to waterproof underground concrete structures by the application of an electro-osmotic technique.

The AOP system is based on Multi Pulse Sequencing (MPS) technology; the movement of an electrically charged ion in a liquid under the influence of an external electric field. The system uses two sets of electrodes; one set is embedded into the interior concrete walls and the other set is embedded in the surrounding backfill/soil. A pulsing DC voltage is applied between the electrodes to produce an electric field across the walls/floors, which move water from the dry side (interior) toward the AOP side (exterior), preventing moisture from reaching the interior surface of the concrete.

1.3 Components.
The AOP V1 Control unit is one component among several that comprises an electro osmotic installation. This operating manual refers to the AOP V1 control unit only and is not intended as an instruction for an entire installation.(Please refer to the Installation manual).

A complete installation comprises of the following components:

A: AOP V1 control unit.
B: Junction box.
C: Anode wires.

D: Cathode earth rod.
E: Feeder wires in conduits and trunking.

A).The AOP control unit creates the signal pattern that makes the movement of fluid possible. The movement of moisture will be from the positive anodes to the negative cathode.

B).**The Junction box is where all anode lines are connected. There may be several hundred anode lines and this makes the need for a junction box.**
C).The anode wires are embedded into the structure from the inside.
D).The cathode is placed in the ground outside the structure.
It can be inserted into the ground either from the inside or outside of the structure.
E).**Feeder wire is to be placed between the AOP control unit and the Junction box.**
From the Junction box the feeder wires go to the anodes and cathode.
Anode feeder wire is PN 1.5mm3 and Cathode wire is PN 2.5mm3 or PN 4mm3 depending on the size of the installation.

1.4 Manufacturing

The AOP V1 control unit is produced for PCL by Norteam Electronics AS of Norway.
Norteam Electronics AS is an ISO 9001-2000 certified electronics manufacturer.

2. Equipment ratings

2.1 Power ratings

Maximum rated input current, or rated power or volt amperes.

Supply Vrms	Frequency Hz	Input Current Arms
220	50	1.338
240	50	1.448

2.2 Category ratings

Safety category of product: **Class 1.** Protection against electric shock is achieved by the use of basic insulation in conjunction with protective earthing of accessible conductive parts.

The equipment is permanently connected equipment.

The equipment is stationary whilst in use.

The equipment will operate only under **Pollution Degree 2** conditions.

The mains supply falls into **Installation (Overvoltage) Category II** (As normally found at a final circuit socket-outlet)

The Category for protection against ingress of dust and water is **IP20.**

The equipment is intended for e.g. **Continuous Operation** (Operation under normal load for an unlimited period).

The maximum room ambient temperature for this apparatus is 40°C.

2.3 EMC

The AOP V1 control unit is in conformance with the EMC Directive 89/336/EEC.

The EMC Directive 89/336/EEC applies to all electrical and electronic equipment and systems. The UK implementation is Statutory Instrument No. 2005:281. Conformance is achieved by:

By considering the electromagnetic hazard scenario for the AOP product, the use of the railway EMC standards BS EN50121-4:2000 has been identified. The Control unit has passed the railway EMC standards BS EN50121-4:2000.

Manufacturers and suppliers of all equipment and systems for the AOP System will be required to comply with the protection requirement of the EMC Directive, where appropriate be provided with documentary evidence of compliance and their equipment/systems will carry the CE marking as evidence of compliance to the EMC Directive 89/336/ECC.

3. Equipment installation

3.1 Safety information

The mains AC supply for the AOP control unit shall be from a 13 Amp fused circuit.

The mains must be hardwired to the AOP control unit by way of the mains input connector inside the unit.

The mains supply circuit must be isolated and the control unit power switch must be in the off position before any hardwiring may take place.

Do not remove the extrusion cover inside the unit unless the power switch is in the off position.

All installation, operation and maintenance must be in accordance to the User manual.

Caution: The surface of the control unit may be hot during operation.

3.2 Wall mounting

The control unit chassis have two reinforced mounting holes on the rear.

These mounting holes are to be used with stainless screws and washers.

All cables running into the control unit must be by way of conduits that are properly fastened to the chassis conduit inputs. This will not apply to the AC mains cable if such a cable meets the standards of external use.

Do not place the control unit close to any heat source or sensitive devices.

3.3 Mains connection

Installation of AC supply wiring shall be in accordance with the UK Regulations and according to BS 7671:2001 - Requirements for Electrical Installations.

The Apparatus is to be hardwired from a standard 13Amp fused circuit.

The wire in the mains lead are coloured with the following code: Blue = neutral (N). Brown = Live (L).

Connect the Blue wire to the terminal marked N or where it have a Blue wire connected to it.

Connect the Brown wire to the terminal marked L or have a Brown wire connected to it.

Connect the Earth wire (green and yellow) to the terminal marked E or have a green and yellow wire connected to it.

3.4 Output connections

This apparatus is fitted with two low voltage output terminals. The first terminal is marked A and is the Anode output and the second terminal is marked C and is the Cathode output.

Connect the RED wire from the junction box to the terminal marked A.

Connect the BLUE wire from the junction box to the terminal marked C.

3.5 Installation Requirements

All AOP system components must be isolated from other electronic systems or earthed devices. This also includes AOP trunking and conduit installations in which must not be in physical contact with other systems trunking or earthed devices.

4. Equipment operation

4.1 Activate unit

The AOP control unit is fitted with a main power switch placed inside the unit.
The switch is clearly marked ON and OFF. The unit is activated by selecting the ON position.
Before switching ON, make sure that all connections are securely fastened and that the unit has been installed according to the manual.
When the unit is switched ON, check that the fan is running and that the Red power LED and green normal operating LED is illuminated. The yellow LED is disconnected on trial models.

4.2 Performance Monitoring

The AOP Control Unit output voltage and current may be monitored. Normal operating output voltage is ± 30 to 40 volts DC. Because each installation is different and load current depends on the length of wire (for wire anodes), or the number of anodes (for probe anodes), and moisture content of the structure material, only qualitative performance criteria can be given; current will be greater for high moisture conditions than for low moisture conditions. A significant drop in current will be observed during the first few months of operation as the moisture is slowly driven out of the structure material
When the moisture level reaches its nominal AOP operating level, the load current will become nearly constant.

5. Equipment maintenance

5.1 Maintenance requirements

There are no specific maintenance actions to maintain the AOP control unit apart from ensuring that the earth terminal at the Control Unit is free from corrosion. To ensure EMC any line replaceable units required should always be sourced from the manufacturer of the AOP system.
When the periodic current measurement of the system is performed, the operating status of the unit is revealed. A check of the LED`s indicating proper operation and that the fan is working is to be carried out during the periodic current measurement.
No other maintenance action is required.

5.2 Periodic current measurement

The maintenance plan for the AOP control unit consists of monitoring of the relative humidity. This monitoring is divided into 3 phases.

Phase 1

There will be performed a measurement of the Relative Humidity at designated measurements points once a week.
The measurements will start at the beginning of the commissioning and go to phase 2 when the Relative Humidity is decreased to 92%.

Phase 2

Measurements will be performed every 4 weeks at the designated measurements points until the Relative Humidity have decreased to 90%. We will then go to phase 3 for long term monitoring.

Phase 3

Measurements will be performed quarterly.

5.3 Power consumption

The AOP output current depends on the moisture level of the structure. Increased moisture content will exhibit a higher current draw.
The current drawn by each circuit will differ, and is dependent on the following factors

(a) Length of anode
(b) Moisture content of concrete
(c) Conductivity of concrete

For max power consumption see section 2.1 Power ratings.

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