KÖSTER

Waterproofing Systems

Horizontal barriers against rising damp in masonry

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Why is rising damp a concern for building owners?

Rising damp is among the most frequently encountered causes of damage to masonry walls. The results are usually clearly identifiable through spalling of plaster, damaged joints and bricks, but also through salt efflorescence and algae growth.

Change of color, reduction of the thermal insulation

Damaged plaster

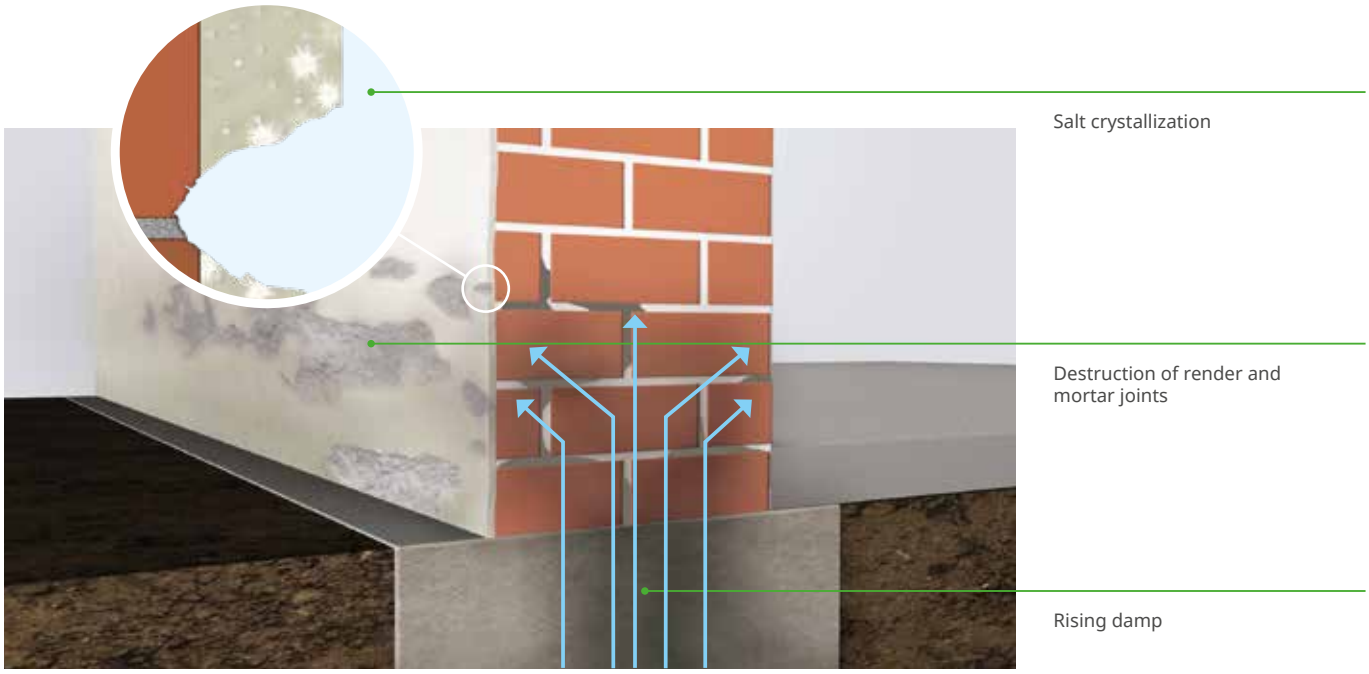
Destruction of render and mortar joints

Development of mold and damage to the fabric of the structure

Over time rising damp in combination with salt contamination and / or frost can destroy masonry structurally. Taking into account the decrease of the remaining lifespans of such buildings, rising damp causes high financial damage every year.

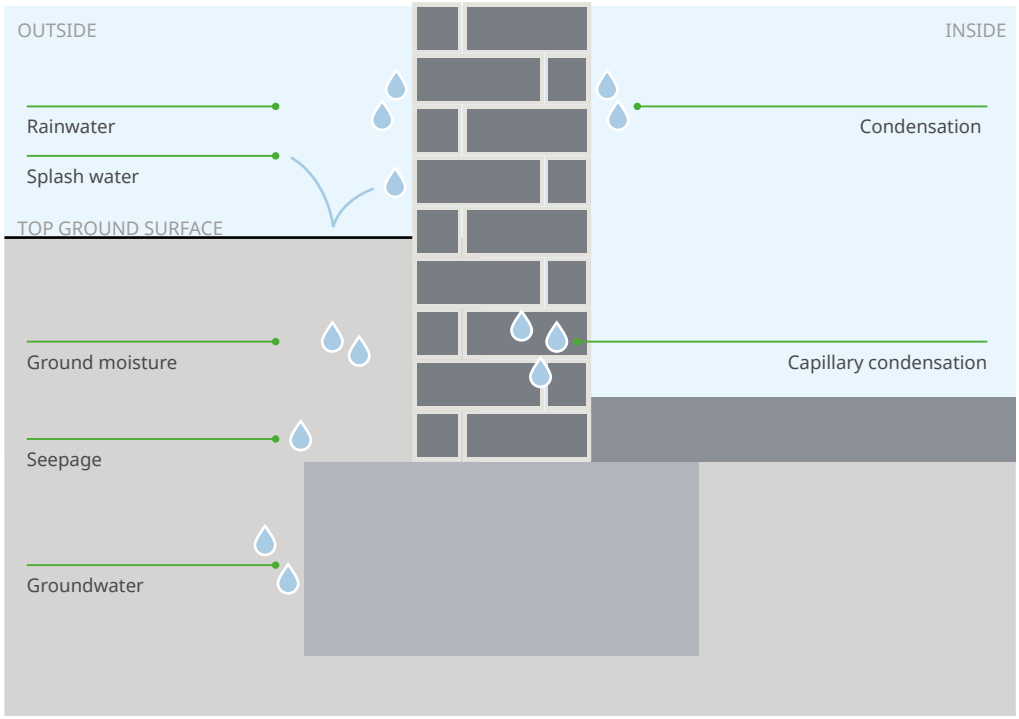
How does rising damp damage masonry?

In masonry that is affected by rising damp, moisture is continuously transported upward through the capillaries. The water evaporates on the surface and more moisture follows. This process will usually lead to an increase in the concentration of salts on the surface. Most evaporation takes place in the area between the dry (top) and the damp part of the wall (bottom). In these areas, there are often the first signs of damage.



Where does the water come from?

There are many sources from which water can get into a wall such as rainwater, groundwater, and condensate (see graphic below). Leaking gutters or drainage pipes can be sources of water. If the water which is entering a wall is constantly replenished then a continuous transport of water through the capillaries of the building material will take place. The water rises upwards against gravity due to the physical process of capillary action, and is known as „rising damp“.



Is it rising damp?

A wall with damage apparently attributable to rising damp should always be analyzed by a specialist before any renovation measures are undertaken.

Determining the cause of the damage is always important. Information such as the type of damage, the characteristics of the building, as well as the salt and moisture contents of the building materials all have to be taken into consideration when determining how to repair the damage and remove its cause. The source of damage may not always be rising damp. Other possibilites are: splash water above a functioning horizontal barrier, hygroscopic action, or just leaking pipes.

If it is rising damp, the restoration has to take into account the salt and moisture content of the building material. Therefore, a salt and moisture analysis is recommended.

Why does moisture rise in masonry?

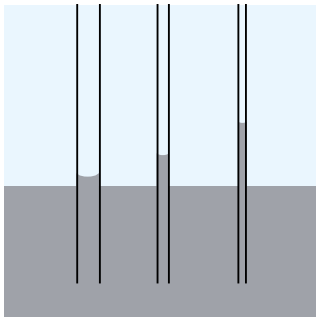
Rising damp is an effect created by the surface tension of a liquid (cohesion) and the interfacial tension (adhesion) between the liquid and the solid surface. Generally a liquid has the tendency to spread when it comes in contact with a surface. On the other hand liquids like water have a surface tension. These two forces together cause water to rise in a narrow pipe (see graphic).

Interfacial tension of liquids (adhesion)

Surface tension of water (cohesion)

Building materials like bricks absorb water in a similar way to a sponge (see photo). This occurs because masonry as well as concrete contain small pores. Depending on the diameter of the pores, they can tranport water upwards against gravity (rising damp). Pores with a radius between 0.0001 mm and 0.1 mm show the most distinctive water transport and are referred to as capillaries. Between 20 % and 50 % of the pores in the building materials concrete, brick, and mortar fall into that category. Pores with a radius of below 0.0001 mm are called „micro pores“ and are too small for capillary water transport, where as pores with a radius of above 0.1 mm are too large.

The smaller the diameter of the capillary, the larger the capillary pressure and the higher the capillary elevation. A capillary with a diameter of 1 µm (0.001 mm) can theoretically create a suction pressure of 1.5 bar which corresponds to a capillary elevation of water of approximately 15 m.



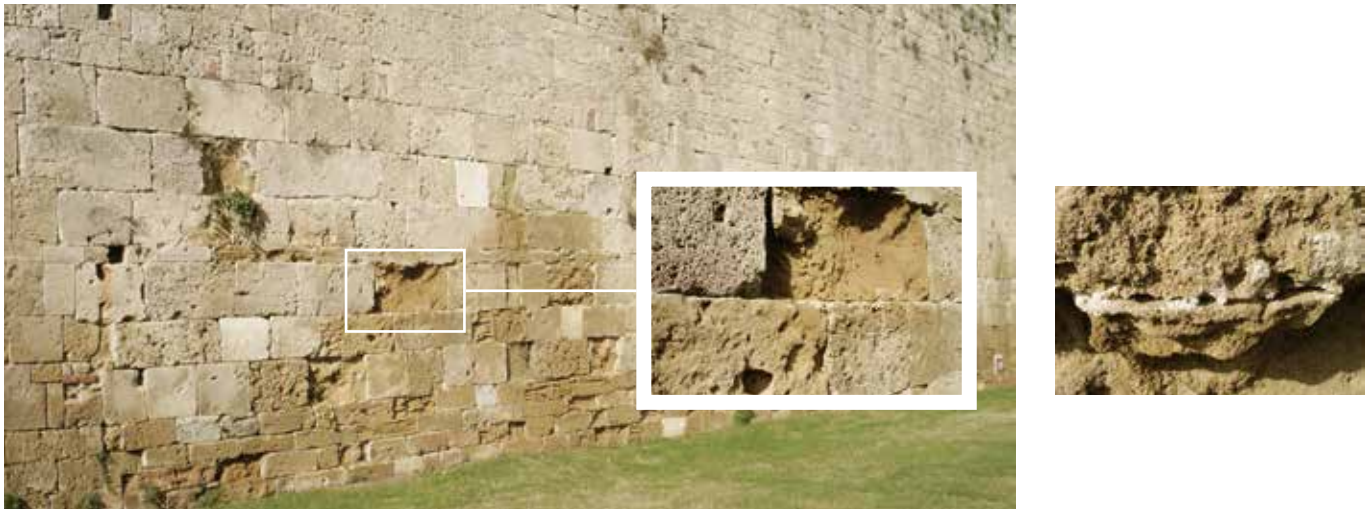
Rising of liquids in capillaries. The thinner the capillaries, the higher the capillary rise, but also slower

Example of rising damp

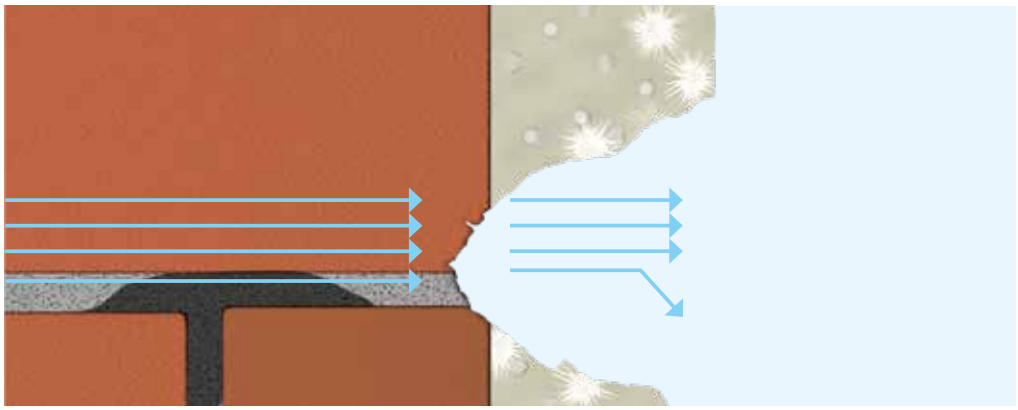
What have salts got to do with rising damp?

Usually, the water which is transported into and through a wall contains salts. These salts can have different sources, such as salts that are present in the ground. They dissolve in groundwater or ground moisture and can then be transported with the groundwater into the wall. Salts that are present in the brick itself can be dissolved by the rising damp in the masonry, or other sources such as deicing salt, fertilizer, or feces which are transported by rainwater, splash water or groundwater into the wall.

When the salt containing water evaporates in the surface area of the wall, the salt remains in the wall or on its surface, leading to an increase of the salt concentration. The salt then crystallizes on the surface or in the pores of the building material. This process is characterized by directed growth, an increase in volume and high strength of the crystals. When salt crystals form in the pores of a building material over a longer period of time, a high crystallization pressure builds up. This eventually leads to destruction of the pores. Once this process has proceeded far enough, the surface of the construction material becomes brittle and starts to fall off.



Rising damp > Damaged surface > Salt crystalization on the surface



Destructive crystallization process

Frost has a very similar effect. The ice crystals that form when liquid water freezes have a much larger volume than before the water freezes in the pores, the expanding ice crystals build up a high pressure that can lead to the destruction of the building material.

How can rising damp be stopped?

There are two fundamental ways to stop rising damp: Blocking capillary active pores or hydrophobing their structure. Hydrophobizing the surface of a pore means to modify the surface tension so that it becomes water repellent (hydrophobic). Thus, the capillary action of that pore is stopped. Blocking a pore means to partially or totally fill the pore in order to stop the transport of water. It is crucial to bring enough material into the pore so that the diameter of the pore is narrowed far enough that no more capillary action can take place.

Hydrophobizing: Making the building material water repellent

Narrowing/blocking the capillary, forming an elastic film in the capillary

KÖSTER Crisin 76 stops rising damp with the following effects: It first lines the capillary with a water repellent film. In the next step it narrows the pore diameters to the extent that the capillary action cannot take place anymore. The combination of these effects together ensure that KÖSTER Crisin 76 works every time, regardless of the pore structure, salt or moisture content. It penetrates deeply into the smallest capillaries in building materials and permanently stops capillary action.

Due to the hydrophobic effect of KÖSTER Crisin 76, the drying process in the wall begins immediately, creating an active horizontal barrier as soon as the system has been installed.

The patened KÖSTER Suction Angle System is the result of decades of experience and development work by the KÖSTER BAUCHEMIE AG. The horizontall barrier is distributed through the capillary transport itself, stopping the rising damp with its own physical cause.

The KÖSTER Capillary Rod acts like a wick, one end is inserted into the wall and the other end into the KÖSTER Suction Angle. From there, it draws the injection liquid into the wall. The KÖSTER Capillary Rod is available in lengths of 45 or 90 cm.

The patented KÖSTER Suction Angle System:

The system consists of the KÖSTER Crisin 76 cartridge, the KÖSTER Capillary Rod, and the KÖSTER Suction Angle.

Schematic representation. Actual circumstances may differ in reality.

This is a crucial advantage not only when installing horizontal barriers into hollow bricks, vertically perforated bricks or old and cracked masonry, but also for all other conditions. The method is transparent and allows easy control of the distribution of the injection material into the wall. It also gives security in the cost calculation for the installation of a horizontal barrier since the amount of material needed can be easily and accurately determined (the flow of the material is achieved through the rods and therefore there is no possibility of material run off).

Advantages
of KÖSTER Crisin 76

- suitable even in cases of high moisture contents upto 95 %
- suitable regardless of salt content
- suitable for a variety of salts such as sulfates, nitrates, and chlorides
- solvent free
- the treated substrate does not have to be alkaline for the material to react
- no prior mechanical drying of the wall is necessary, even in case of high moisture contents
- No subsequent drying is needed
- resistant against most ordinary aggressive substances that are encountered in masonry such as acids, alkalis, and salts
- fast reaction, immediately effective
- not bio-degradable
- does not cause or promote corrosion of steel reinforcement
- Density (0.91 g/cm³); penetrates deeply even into the smallest capillaries of the construction material
- the cured material and as a result the horizontal barrier itself is elastic
- can be applied to perforated brick and cracked or hollow masonry without the necessity of filling the voids
- no subsequent injection necessary, one time installation, guaranteed success
- patented system
- easy installation, horizontal drilling
- the material´s action principle is proven to be effective for more than 30 yearst
- does not mix with water
- 10 years warranty*

KÖSTER Crisin 76 ist chemically neutral and does not cause efflorescence. It is furthermore resistant against most ordinary aggressive substances that are encountered in masonry such as diluted acids and alkalis.

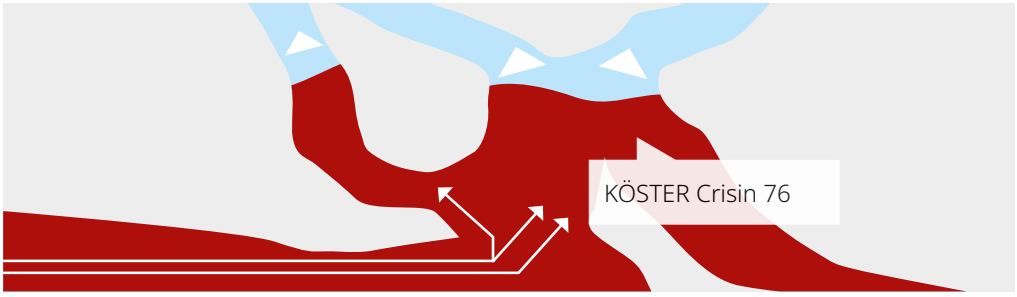
* Under the condition that the material is applied by a certified applicator.

How can KÖSTER Crisin 76 be injected into a wall that is already saturated with water?

A pore filled with water is not like a bottle but more like a pipe. Therefore even a highly saturated wall can be treated with KÖSTER Crisin 76. The water flows continuously through the capillary system from bottom to top. When KÖSTER Crisin 76 is installed, the active substances use this same transport mechanism to enter the finest capillaries. With its hydrophobic effect, it stops the flow of water from the bottom and penetrates deeply into the pore structure.

KÖSTER Crisin 76 is an injection material that is not in danger of being diluted with the water that is already present in the masonry. If an injected material can be diluted, the material can fail to function properly. KÖSTER Crisin 76 cures and develops its full functionality even if the wall is completely saturated with water. KÖSTER Crisin 76 does not require a prior or subsequent mechanical drying of the wall to become effective.

KÖSTER Crisin 76 penetrates into the capillaries and displaces out the fluids.



Why is the chemical composition of KÖSTER Crisin 76 so important with regard to salts?

Salts operate physically. The stream of water that is transported as rising damp through a porous building material often contains dissolved salts that will dry and crystilize, creating pressure in the structure that eventually leads to is distruction. Therefore it is very important, especially at high concentrations, that the reaction of the injection material is not influenced by salts. Due to its unique combination of active ingredients, KÖSTER Crisin 76 remains completely unaffected by high salt contents in the substrate. Given the fact that KÖSTER Crisin 76 is not an emulsion, the ingredients do not flocculate when they come into contact with salts but remain fully effective.

How does KÖSTER Crisin 76 penetrate so deeply into the structure?

A liquid installed horizontal barrier must penetrate deeply into the capillary system of a masonry in order to function properly. For this purpose, a very low viscosity liquid is required.

In order to achieve a widespread wetting of the capillary walls, the injected material has to possess a low surface tension. KÖSTER Crisin 76 is a resin based liquid with a very low viscosity. Due to its low surface tension it is able to penetrate deeply into the pore structure of a building material. Additionally, KÖSTER Crisin 76 contains special additives that promote its penetration into the building material.

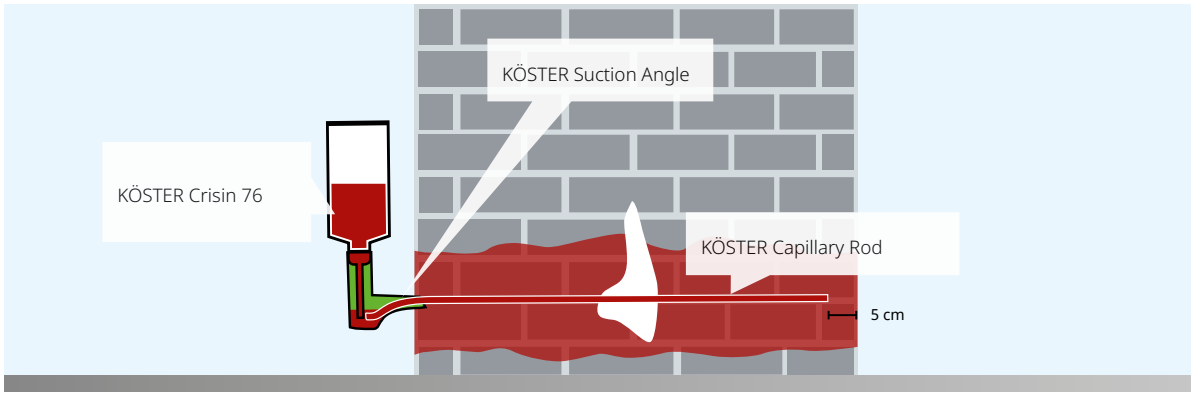
How to apply KÖSTER Crisin 76

Remove the plaster and any loose materials completely from the wall.

Drill the boreholes at the required distance (see table). The length of the borehole is the thickness of the wall minus 5 cm. Clean the boreholes with pressurized air or a brush, e.g. a steel wire cylinder brush to remove the drilling dust. If there is a high level of moisture, rinsing may also be necessary.

After that, the KÖSTER Capillary Rod is cut to the required length (depth of the borehole + 7 cm) and inserted into the borehole. Then the KÖSTER Suction Angle is installed. Then, the cartridge filled with KÖSTER Crisin 76 is set into the KÖSTER Suction Angle. The KÖSTER Crisin 76 flows into the supply chamber of the KÖSTER Suction Angle where the liquid is absorbed by the KÖSTER Capillary Rod. The injection liquid is transported through the KÖSTER Capillary Rod. It is only released into the wall where the KÖSTER Capillary Rod has contact with the wall of the borehole. In those places where the KÖSTER Capillary Rod does not have contact with the wall of the borehole (like cracks and voids in the masonry), no injection liquid is released and thus no injection liquid is lost into cracks or voids.

Once the cartridge is empty, the cartridge and the suction angle can be removed. Both can be re-used. The cartridges can be removed after 7 days but are usually empty before that. Once the cartriges are removed, the capillary rods are pulled out, cut off approx. 2–3 cm, and then pushed back into the boreholes. The boreholes are then closed using KÖSTER KB-Fix 5. The KÖSTER Capillary Rods stay inside the borehole. As an ideal combination the wall or substrate can be renovated with KÖSTER Restoration Plasters after deep priming and salt treatment with KÖSTER Polysil TG 500.



The consumption depends on the thickness of the wall. With the following table the consumption can easily be calculated.

Thickness of the wall in cm up to	Borehole distance in cm *	Cartridges per m	Cartridges per borehole	Capillary rods (90 cm) per m **	Consumption of material per m
20	12.5	8	1	2	1.6 l
30	12.5	8	1	3	1.6 l
40	11.0	9	1	5	1.8 l
50	10.0	10	1	6	2.0 l
60	8.5	12	1	9	2.4 l
70	7.0	14	1	12	2.8 l
80	6.5	16	1	15	3.2 l
90	11.0	9	2	10	3.6 l
100	10.0	10	2	12	4.0 l

* Borehole diameter: 14 mm, distance: from hole center to hole center

** Measurements calculated; length can vary according to conditions on site

Installation

The following pictures show the installation of a new horizontal barrier with KÖSTER Crisin 76 in a historic building.

1 The masonry is from 1750 (wall thickness: 80 cm), the existing plaster is damaged. The salt and moisture contents are high.

2 Boreholes are drilled into the inner wall with a distance of 10 cm from one another and depth of 40 cm
(Wall thickness: 45 cm and 30 cm above grade).

3 The boreholes are cleaned from dust by blowing the dust out of the borehole with pressurised air.

4 KÖSTER Capillary Rods are installed so that they protrude 7 cm from the borehole.

5 The KÖSTER Suction Angles are installed so that the KÖSTER Capillary Rods reach into the supply chamber of the KÖSTER Suction Angles.

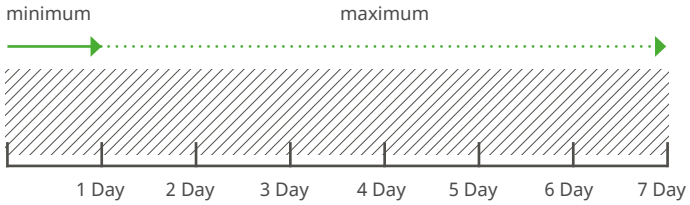
6 The KÖSTER Crisin 76 cartridges are then installed into the KÖSTER Suction Angle.

7 The nozzles of the catridges sit directly on top of the capillary rod and allow the material to be soaked up.

8 The pressureless injection of KÖSTER Crisin 76 into the masonry starts immediately after the installation of the cartridges.

How fast does KÖSTER Crisin 76 become active?

The KÖSTER Crisin 76 cartridges empty between 24 hours and a maximum of 7 days after they have been installed. Now the horizontal barrier has been successfully installed. Due to the hydrophobic characteristics of the KÖSTER Crisin 76, the reduction of rising damp starts immediately after the installation. The horizontal barrier becomes fully effective within the curing time of the resin which can take up to 10 days. During this period, the masonry already begins to dry. The drying time depends mainly on the moisture content and the thickness of the walls. The moisture content can be determined by taking core samples which are then weighed and dried according to the kiln-dry method.



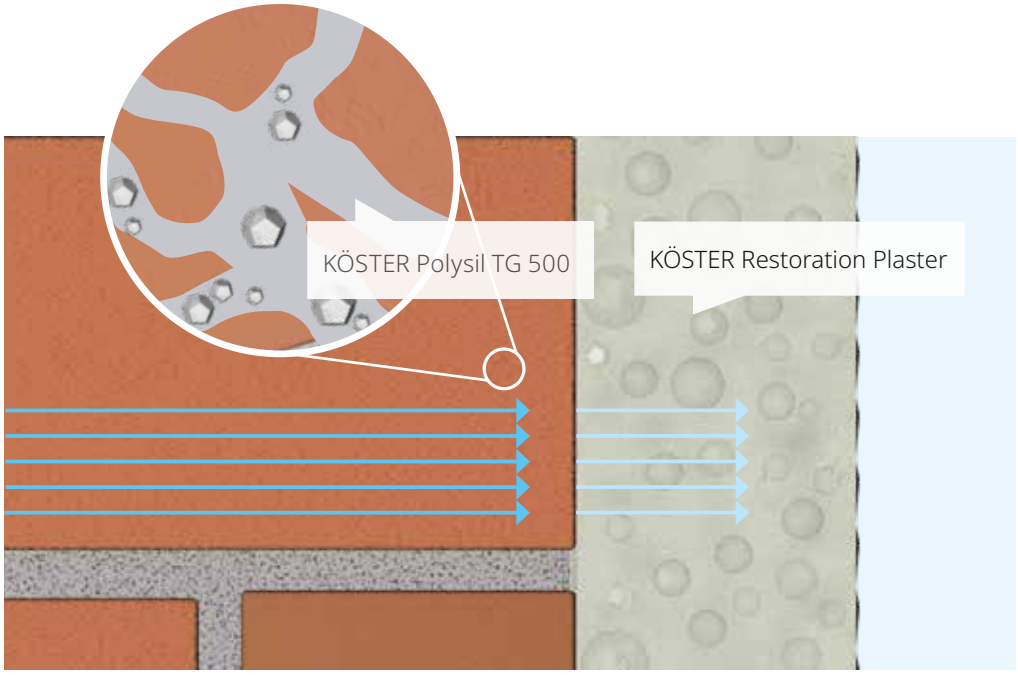
Often masonry burdened by rising damp contains high salt concentrations. Therefore, during the first weeks of drying after the installation of a horizontal barrier, salts may diffuse to the surface causing salt efflorescence. This is part of the drying process. The efflorescence should be removed mechanically (do not use water) after about two weeks.

To fully immobilize the remaining salts, apply KÖSTER Polysil TG 500 and after deep priming plaster the surface with KÖSTER Restoration Plaster. The system is now fully functional and the structure is protected against rising damp and further damage caused by salt efflorescence.

The perfect system: KÖSTER Crisin 76 with WTA certification and KÖSTER Restoration Plaster White

KÖSTER Restoration Plasters are especially designed for the restoration of masonry with high salt and moisture contents. When rising damp is stopped with KÖSTER Crisin 76, KÖSTER restoration plasters help to dry out the wall and it absorbs remaining salts. KÖSTER restoration plasters withstand moist conditions since they do not contain lime or gypsum. They are open to water vapor diffusion and help to create a healthy and comfortable room climate.

The interior walls of these buildings were restored with KÖSTER Restoration Plaster White.



Salts crystallize in the pores of KÖSTER Restoration Plaster and can not cause damage thereby.

They are not effected by high salt contents and prevent salts from being transported to the surface.

Apply KÖSTER Polysil TG 500 as a primer in order to strengthen the substrate and reduce the mobility of the salt molecules. KÖSTER Restoration Plasters are available in grey or white. In historic buildings they can be used as a decorative plaster even without painting. Should it be decided that the KÖSTER Restoration Plasters must be covered by paint, the paint must be open to vapor diffusion not to interfere with the fuctionality of the plasters. They are suitable for interior and exterior use.

The KÖSTER Restoration Plasters have been tested according to EU standards, and KÖSTER Restoration plaster White holds a WTA certification.

Installation

Remove old plaster. Fill breakouts and holes with KÖSTER Repair Mortar. Spray KÖSTER Polysil TG 500 onto the surface to block salts and strengthen the substrate.

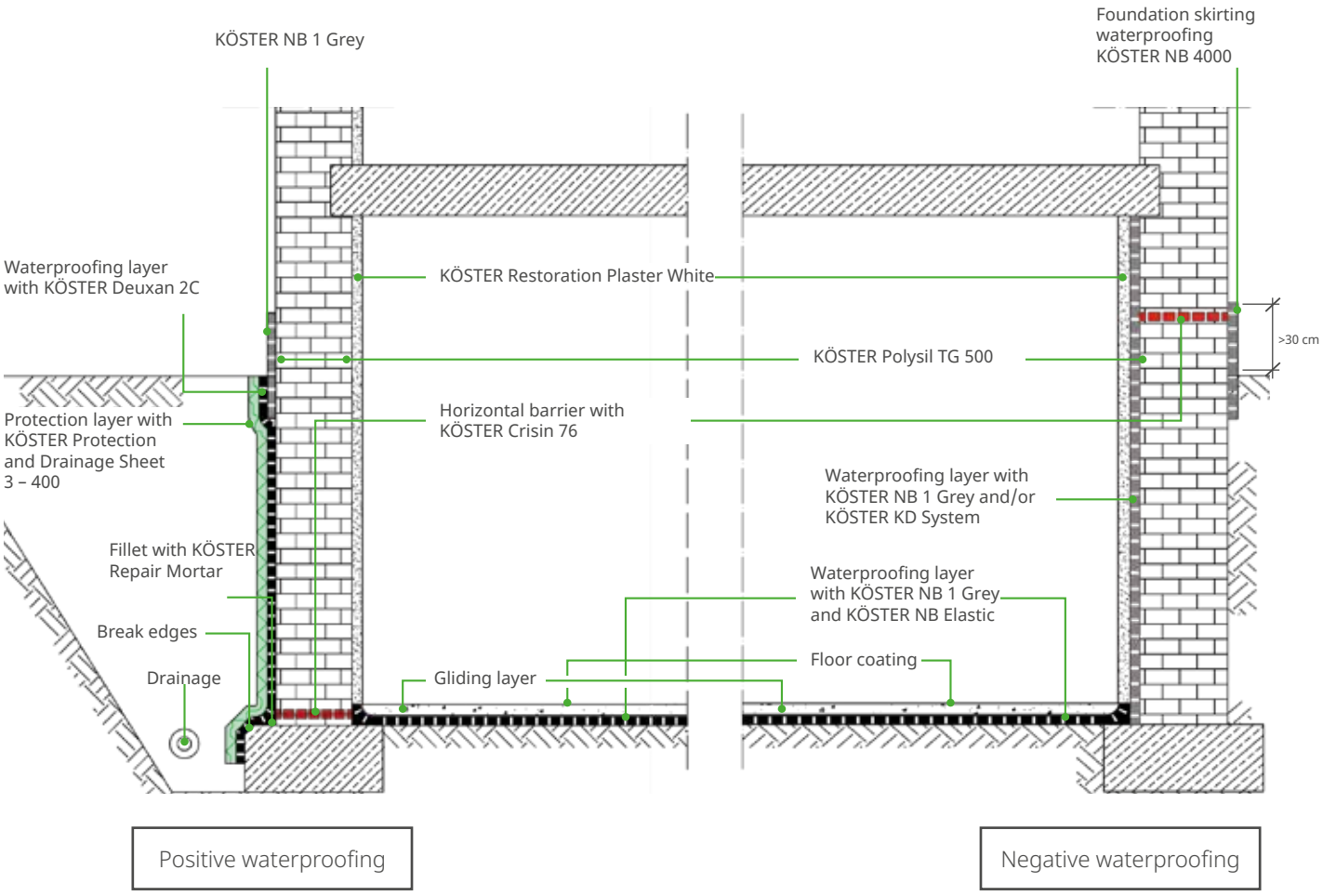
If negative side waterproofing is necessary, KÖSTER NB 1 Grey is applied in two layers.

In the next step KÖSTER Restoration Plaster Key Coarse is applied to ensure the optimal adhesion of KÖSTER Restoration Plasters.

The KÖSTER Restoration Plaster is applied with a trowel or an appropriate mortar pump on the cured layer of KÖSTER Restoration Plaster Key Coarse. In the last step the surface is floated smooth.

How is a horizontal barrier installed in combination with negative side or positive side waterproofing?

Subsequent waterproofing normally includes various measures such as the installation of area waterproofing for walls and floors and the installation of a horizontal barrier within the masonry. The installation of a horizontal barrier is a key element in any restoration waterproofing project.



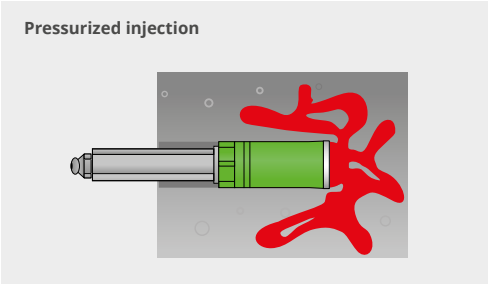
The left side of the drawing shows the solution with positive side waterproofing. It requires that the ground on the outside of the basement wall is excavated and the waterproofing is installed on the exterior of the wall. The advantage is that the wall is dry after the waterproofing has been installed. This solution can be implemented by using the KÖSTER Deuxan system. In this case, the horizontal barrier with KÖSTER Crisin 76 is placed as low as possible. The purpose of the horizontal barrier here is to ensure that moisture can not rise from the foundation into the masonry wall.

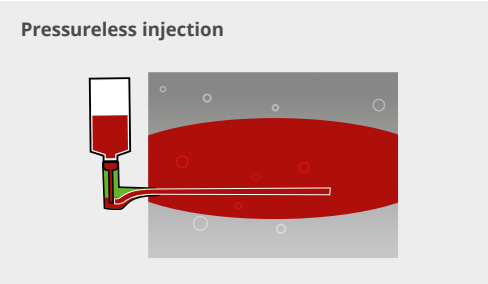
The right side shows negative side waterproofing. It is usually the cheaper and faster possibility because it is carried out from the inside. The KÖSTER KD-System together with KÖSTER NB 1 Grey is the perfect choice for such a solution. The horizontal barrier with KÖSTER Crisin 76 is placed 30 cm above ground level. The waterproofing layer on the inside of the wall ensures that no water can penetrate into the basement. The purpose of the horizontal barrier in this case is to ensure that moisture can not rise anywhere into the constuction members above.

Pressurized or pressureless injection?

Generally, horizontal barriers can be installed with pressurized or pressureless injection. Pressurized injection requires the use of injection ports known as “packers”, which are fixed in the boreholes. With an injection pump, a suitable material is then injected into the wall through these packers. With this method the injection material can be installed very quickly. This advantage is offset though if the masonry contains voids, as these voids would be filled with the injected material during pressurized injection and thus be lost.

To avoid wasting injection material, prior to the main injection the boreholes are filled with KÖSTER Mautrol Borehole Suspension in a preceding work step and the voids and cracks in the masonry are filled. The boreholes are then drilled open again and now the material for the horizontal barriers (i.e. KÖSTER Mautrol 2C / KÖSTER Mautrol 2C Flex) can be injected without uncontrolled loss. Finally the boreholes are sealed with KÖSTER KB-Fix 5.



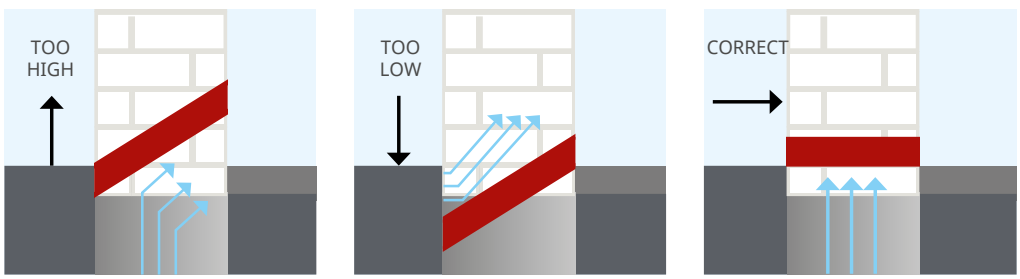


The KÖSTER pressureless injection method with KÖSTER Crisin 76 in contrast utilizes the wall’s capillary action. The material is installed using the source of the problem. Advantages of pressureless injection are:

- The injected liquid is transported effectively into the capillaries which are part of the mechanism that causes rising damp. No material gets wasted in cracks or voids.
- The amount of material that is injected into the masonry is easily controlled. Pressurized injection does not allow such control over the injected material.
- Damage to the masonry and the structural stability due to pressurized injection are avoided.
- Capillary rods bridge the cavities and voids and remain in the boreholes as a material reservoir.

Angled or horizontal placement of the boreholes?

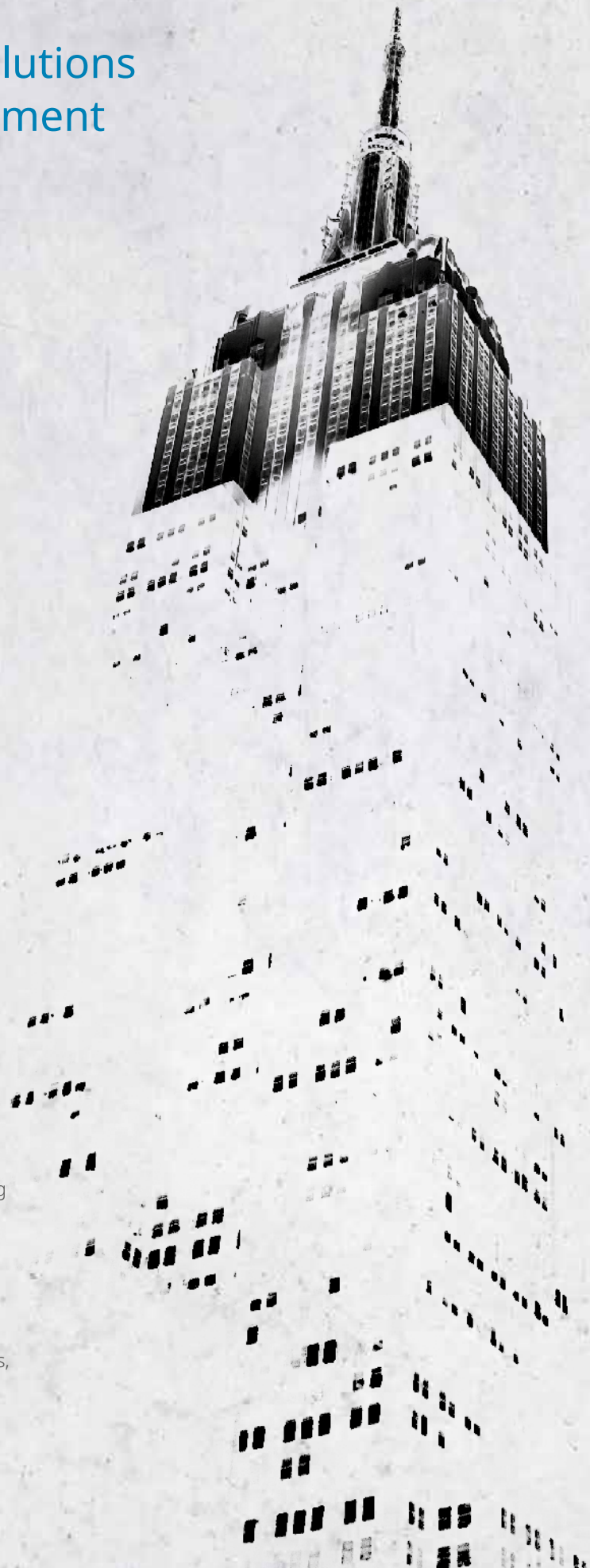
With the KÖSTER Suction Angle System, the boreholes are positioned horizontally. The obvious advantage over diagonal drilling is that with horizontal positioning the length of the boreholes is considerably lower. It is also easier to calculate the required length of the boreholes (wall thickness minus 5 cm). A further problem of diagonal drilling is that the installed barrier has different levels on the inside and on the outside. This is due to the angle of the boreholes and is illustrated in the following graphic. The practical result of this can be that moisture can still migrate over or under the installed barrier.



Diagonal drilling is not only more time and material consuming but also leads to more dust as a result of longer borehole length.

Horizontal drilling leads to having the same height at the beginning and end of the borehole on both sides of the wall and therefore easier positioning.

Waterproofing solutions from roof to basement



We have been developing and producing waterproofing systems since 1982 that protect and preserve valuable building structures, meeting with the highest standards all along the way. In short, where water is a problem, we are there with a solution for the owners, engineers, architects, and all our clients.

We are there for you – worldwide.

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