WATERPROOFING AND TRUTH

It is not always easy to find an appropriate waterproofing system and to use same correctly

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Contrary to other construction activities and services, it can be determined relatively fast whether a waterproofing or waterproofing system has been applied properly and works correctly according to the state of the art. Whereas it takes in general several years until e. g. an insufficient concrete cover becomes „apparent", a waterproofing which has not been applied correctly is quite customer friendly. It simply does not work and the resulting damages to the building structure become visible quickly.

Waterproofing systems which are used throughout above and below ground construction among other things for

- waterproofing against rising damp in absorbent construction materials,
- external basement waterproofing and internal basement waterproofing,
- waterproofing tanks,
- horizontal barriers (also posterior installation of horizontal barriers),
- barriers in the base area of masonry walls as splash guard,
- crack injection,
- waterproofing moving joints and splitlines,
- waterproofing construction joints and expansion joints with joint tapes,
- wet room waterproofing,
- floor coatings,
- facade protection,
- waerprooing tunnels,
- waterproofing balconies and terraces,
- waterproofing roofs.

With the large number of system solutions that are currently available on the market, these two main criteria are of central importance:

- Choosing a suited waterproofing system including the required detailed solutions and
- Applying the products correctly.

Thus, the manufacturers of waterproofing systems disclose with regard to the correct appliaction that e.g. „the proper and thereby effective and successful application of the products is not subject to the producers control." Therefore, the warranty only applies to the the quality of the product but not for their successful application.

Fig. 1: city centre of Hamburg – H & M billboard as protective cover for work scaffolding

The quality of the products themselves can already suffer unwantedly due to inappropriate storage which points out the importance of thoroughly reading and grasping the content of data sheets and other information which the manufacturer published. This includes adherence to the specified application times. Due to individual perception, a „mixing time of 2 minutes" is sometimes considered to be an extremely long period of time while the time period „within 60 minutes" for the application of 2 previously mixed components can be perceived to be a very short period of time.

In practice, failures due to negligence of application guidelines and manufacturer information occur daily in great numbers. If site managers and architects would read design documents regularly themselves, they would require less experts' reports.

On the internet, almost all manufacturers can be easily found via the popular searching engines. Detail drawings, specifications and complete system descriptions are listed these web pages which are continually updated. Via links and the buttons „Home" or „Contact", one can get a connection to

Fig. 2: the classic method – waterproofing the construction joint for the wall-floor junction of a basement with a joint profile (e.g. TRICOSAL). Those who want added security should additionally install an injection hose which can be injected with a resin if needed.

Fig. 3: Important tipp: to prevent the hose ends from being pinched off or from being crushed through formwork elements or precast concrete parts, lead the grouting vents through between two bearing boards.

Fig. 4: When waterproofing a basement from the outside, the following details have to be observed: execution of the base area with rot-proof insulation. The transition from the masonry to the foundation is executed as a rounded out fillet. Important: the fillet must have dried prior to application of the primer. The the thick film sealant can delaminate if it is applied on a fresh fillet which then shrinks during its drying process. The planning folder of the company DÖRKEN on the DELTA-system contains very good detail solutions and drawings.

application engineers or field staff of the respective companies.

The field of waterproofing is too large to be covered in a single article. In the following, 2 waterproofing systems form the areas of above ground construction/restoration and below ground construction/sewer construction will be presented.

Posterior installation of horizontal barriers

When installing posterior horizontal barriers in existing walls (e. g. in restoration of existing buildings, there are generally different approaches:

- Posterior installation of bituminous membranes:

  The existing masonry is carefully removed in sections (width: 80–100 cm), waterproofed and then the hole is closed with masonry again. After the masonry has cured fully, the previously untouched sections are treated respectively. This procedure is very laborious and thus also expensive.
- Posterior insertion of stainless steel plates/steel bands:

  In case of buildings under monumental protection, structural engineers have objected in several cases of using this method because the interconnection/the structure is practically completely cut through. This process results in the masonry standing on a the metal bands/plates.
- Placing cuts in the form of wedges into the masonry from both sides-wedge cut method:

  The cut is made from the surface of the masonry downwards toward the middle of the masonry (leading to a „V" shape in the section of the wall). The cuts are subsequently closed with a grouting mortar. Since this procedure is very laborious, it is rarely used. If this method is used, it is essential to consult the structural engineer in charge.
- electro-osmotic precedures/electrophysical wall damp proofing:

  The systems intention is to stop the capillary water transport by installing electrodes and by maintaining an electric potential.
- injection procedures using boreholes: to prevent the rising of moisture (capillary action).

  The injection procedure using boreholes is uncomplicated, promises success and keeps the intrusion into the building material to a minimum. Even users who are not manually experienced applicators are able to achieve good results.

KÖSTER BAUCHEMIE offers an injection system which among others has met the approval of the public authorities for preserving monuments and historic buildings. Furthermore, this technique is used all over the world. The patented KÖSTER Crisin 76 system is used for installing horizontal barriers against rising damp. It is applied using the suction angle system and offers several practical advantages.

Contrary to conventional angular drilling, the injection material is absorbed pressureless via an absorptive capillary rod into the porous construction material. A special advantage of the use of the capillary rod is that it ensures that injection material is released only where there is building material. Consequently, no costly injection material is lost in cracks, nests or other voids. The injection material is only released into the structural member to be waterproofed where the capillary rod has contact with the wall of the borehole. The boreholes required for the capillary rods can be drilled horizontally and as close to the ground as possible. Especially in case of very thick masonry, the calculated drilling depth can be exactly adhered to, the drilling depth is considerably shorter. Thus, the boreholes can be drilled much faster and with less wear on the drill.

KÖSTER Crisin 76 is a low viscous synthetic resin.It penetrates deeply into even smallest capillaries and pores of the construction material. Due to its very low density and its – in comparison to water - considerably lower surface tension, it displaces water from the capillaries. The so-treated capillaries are lined with the material and are thus made water-repellent. The curing of the injection material is independent of the drying of the masonry. After curing, Crisin 76 remains elastic and is rot proof, acts neutrally, does neither cause efflorescence nor corrosion of steel reinforcements. Especially, the elastic characteristic of the synthetic resin is desirable with respect to settling of the building and tensions. Crisin 76 is resistant against all aggressive media which are commonly encountered in masonry like acids, alkalis and salts, during application and after curing. The field of application is the posterior installation of horizontal barriers against rising damp via borehole injection in all mineral construction materials. It can be used inside and outside as well as with high degrees of moisture penetration and all degrees of salt burden.

Fig. 5: The procedure developed by KÖSTER: the injection substance moves via a capillary stick directly to the place where it is needed. The horizontal joint can be installed directly in the region of the horizontal joint between first and second alignment which represents a further advantage.

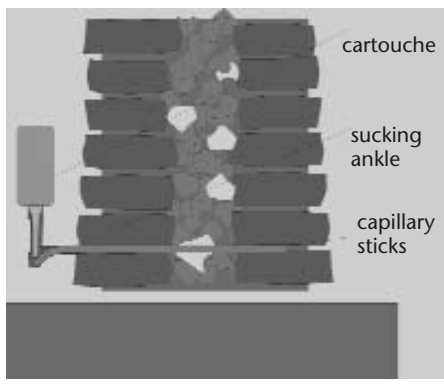

Fig. 6: realisation: Firstly, bring the drilling holes if possible horizontally into the horizontal joint, then push the watered capillary stick into the drilling hole. Move the sucking ankle as connector between capillary sticks and cartouche with injection liquid and introduce the injection substance.

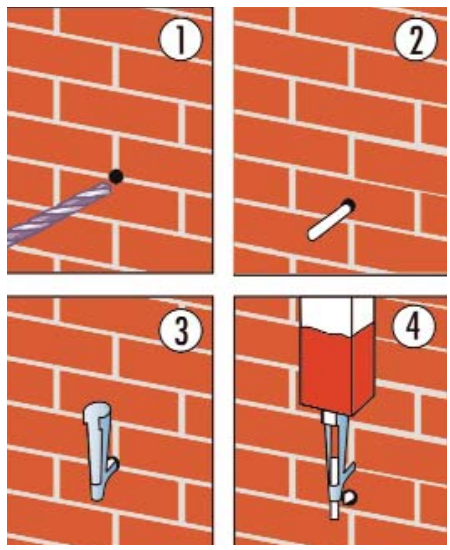

Fig. 8 a, b: Horizontal waterproofing at a listed building

Fig. 7: Renovation of the royal stables of the local court of Aurich with KÖSTER Crisin 76

Restoration and rehabilitation of sewage treatment facilities, channels and manholes

The general state of the sewage systems will increasingly represent a problem in the following years. In Germany, there are about 10 million manholes with an associated sewage system with a length of approx. 450,000 km. Much rehabilitation work will be required according to polls and analyses of work which was carried out. A poll regarding the state of the sewage systems showed the following age ratios of the sewage systems:

30 % max.	25 years
36 % approx.	26– 50years
34 % more then	50 years

Altogether, more then two thirds of the manholes are older than 25 years – which is bad.

The damage ratios (estimated) are distributed as follows:

Manhole tops	31 %
Climbing aids	25 % (first consequence: mobile climbing systems)
Cracks	9 %
Connections	12 %
Leakages	17 %
Rest	6 %

Ground water exfiltration through defects in manholes and thus unwanted leakages of sewage into the ground or, on the contrary, ground water infiltration through damages in bottoms and/or rings of manholes and thus unwanted penetration of ground water into the sewage system are typical problems besides the problem of joint corrosion, damaged clinker in masonry manholes or typical concrete corrosion due to biogenic sulphuric acid.

When restoring a manhole near the town of Norden, the damage analysis showed considerable damages to the substance of the upper inner layer of the concrete rings. As a cause for these damages, hydrosulphide gas release was stated, which reacted together with condensate to sulphurous acid (H_2SO_3) and sulphuric acid (H_2SO_4). The sulphuric acid, in particular, corroded the cement stone and thus damaged the concrete top layer. Processes like this are called concrete corrosion. A laboratory test which was carried out subsequently showed that the corroded concrete had a pH-value of 4.5 (quite acidic).

In addition to the pH-value, the salt content of the sample was tested. Substances which form ionic crystals in their solid state are called salts. In general, salts are neutralisation products of acids and bases. In manholes, the acidic gases come into contact with the alkaline substrate and inevitably form salts.They are absorbed through capillary action and in the course of time the salt content increases.

Salts which damage building materials

The most important salts which affect buildings are sulphates in rainwater and salts from the ground, nitrates from feces (human/animal) and chlorides from deicing salts. Furthermore, there are carbonates, nitrites and phosphates. With respect to their effect, the following general rule applies: the more soluble a salt is in water, the worse is its damaging character.

Crystallizing salts develop a relatively high crystallisation pressure, which destroys substrates and which can e.g. push off whole plaster layers. The explosive force that the crystallization pressure produces depends on the temperature and on the concentration of the salt solution.

Realisation of restoration

Depending on the degree of damage to the respective manholes, certain measures were carried out already prior to the application of the waterproofing/coating itself. In case of cracked construction members or manholes with defects or voids, ground water infiltrations or respectively leakages had to be stopped using suited injection procedures. Using injection procedures, problematic areas had to be waterproofed permanently elastically or rigidly.

In connection with reinforced structural members, considerable anticorrosion coatings and concrete replacement systems are applied. In order to avoid damages caused by biogenic sulphuric acid which often lead to concrete corrosion, KÖSTER BAUCHEMIE uses a cement-free polymer silicate mortar which is able to fulfil the demands at hand.

Basic information on polymer silicate mortar PSM

The protective effect of coating systems on

Fig. 9:
The worn off and chipped off concrete surface of the channel shaft is removed. The removed material, concrete without internal strength, is collected.
(Photo: KÖSTER BAUCHEMIE)

Fig. 10: completely renovated manhole after being coated with polymer silicate mortar (Photo: KÖSTER BAUCHEMIE)

polymer silicate basis depends very much on the quality of the substrate preparation since this kind of waterproofing is quite demanding. According to the manufacturer, mistakes or neglects which are made during the preparation of the substrate which has to be coated, cannot be compensated even with with a high-quality coating.

As polymer silicate mortar does not contain cement - insofar the term "mortar" is misleading. The sole binding material is silicate, i.e.a alkali water glass. The curing takes place due to an anorganic hardener in powder form which is added to the water glass in a preset and exactly measured quantity. It is essential not to change the pre-defined mixing ratio. Neither should water be added nor should additional liquid component (silicate) be added. Due to the penetration of the silicate component, the material has an extraordinary adhesion to all mineral substrates.

Negatively influencing factors for adhesion to the substrate are:

- low porosity of the substrate,
- dust, loose particles, formwork release oils,
- old coatings and old primers of all kinds,
- hydrophobic concrete additives in the substrate and contaminations like oils, fats, solvents, benzenes, etc. respectively,
- strong acidification of the substrate due to previous damage with inorganic and organic acids (have to be completely removed prior to application of the coating).

Positively influencing factors for adhesion to the substrate are:

- Opening of the pores of the substrate through sandblasting or water jetting, milling or chipping off,
- high alkalinity of the concrete,
- increase of the surface finish.

Polymer silicate mortar possesses very good resistance against organic and anorganic acids, solvents, oils and acidic cleaners. They are not long-term resistant against alkaklis and alkaline cleaners. Thus, they should not be used in case where frequent periodic or continuous stresses through these substances can be expected. Silicate mortars are also temperature resistant up to several hundred degrees Celsius. Fast changes in the thermal stress or thermal shocks, however, lead to delamination of the coating due to the different thermal expansion rates of the coating and the substrate.

Waterproofing under legal aspects – example

If there is a way, the water will find it. Even if waterproofing is carried out with utmost care, it can not be excluded that after the work is finished tightness problems may arise. The involved risks of liability of the contractor increase significantly if the exact subject of the contract is not documented in detail in writing. The same applied if the contractor if the contractor agrees to a lump sum or fixed price.

A case study:

The client, a retiree from North Rhine-Westphalia, bought an older single family house in East Frisia. The accessible basement room of this single family house borders on two crawl spaces. The ground water table is high.

Since water penetrates into the accessible basement from the walls between the crawl spaces and the accessible basement, the client instructed the contractor to waterproof the basement. The contractor who recommended waterproofing using injection systems to the client agrees to a lump sum or fixed price. However, no detailed written agreement was made on the areas to be waterproofed. After waterproofing the walls bordering the crawl spaces using the injection system, the ground water surprisingly began to flow into the accessible basement from above the newly installed waterproofing through the openings to the crawl spaces.

Understandably, the client is not willing to accept this failure. The contractor on the other hand, refuses to carry out repairs to remove the defects which exceed the professional completion of the waterproofing carried out. This refusal is definitely understandable because the experts' stated during the judicial procedure of taking evidence that the effective height of the applied waterproofing system was limited by the height of the ground in the crawl spaces.

The same applies with respect to the fact that a moisture penetration into the accessible basement room can only be prevented using further cost-intensive waterproofing measures, like e.g. application of a further waterproofing above the waterproofing already installed.

In the court proceedings, both parties argued about question if and if so in how far the contractor carried out the waterproofing works, with which he was assigned, professionally; and if the client can insist – in the course of the removal of defects – on a compensation for such waterproofing measures which were not planned when the contract was awarded was placed.

In this connection, it has to be taken into account that the contractor principally bears the performance risk (§ 633 section 1 German Civil Code) for the services he promised, regardless the required effort. The contractor does not fulfill this obligation by delivering or providing a service which does not lead to an appropriate and adequate work result. The objective interest of the client has to be considered whereby not only the concretely stipulated contract but also the intended purpose of the work according to the contract is crucial. In addition, the contractor has to fulfill his duty to test the test the site and to notify the client. These duties also are primary obligations of the contractor.

A written contract defining the exact sub-

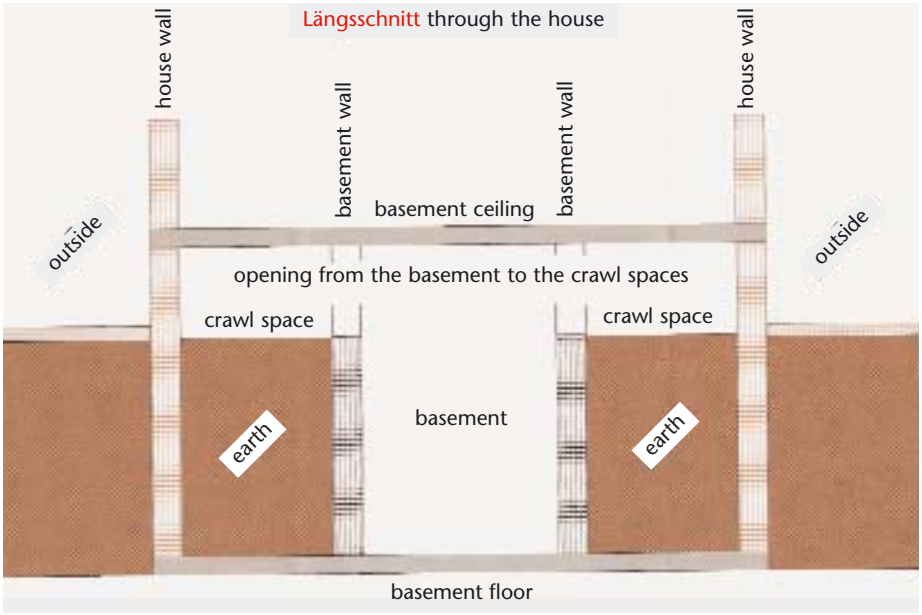

Fig. 11: drawing crawl space

ject of the contract does not exist. During the legal proceeding in court, several witnesses had to be questioned about whether the contractor only had to waterproof the walls which actually were waterproofed by him (as the contractor said) or if and at whichever cost the waterproofing of the accessible basement room was owed (as the client said).

The result of such taking of evidence cannot be judged previously in advance. If the court comes during the legal proceedings to the conclusion that the water tightness as insisted on by the client was owed contractually and that the contractor had to carry out this result on basis of a lump sum or fixed price, then the contractor also would have to pay the customer such waterproofing measures which had not been spoken about before at any time.

The contractor could only demand additional payment for these additional measures from the client (so-called inevitable costs) if the result owed due to a contract of service was not the waterproofing of the accessible basement room using all required measures at a lump sum or fixed price.

The economic risks involved for the contractor can only be minimised by explicit written agreements and information. Thus, the contractor should – especially when carrying out waterproofing works which are in any case burdened with technical risks – keep in mind to document the proceedings well in order to be able to use them as proof later on.

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