6 Factors to Consider When Choosing the Right Waterproofing Coating
The problem: several processes happening at the same time

It is generally accepted that domestic sewage does not attack concrete with which it is in direct contact. However, in the upper part of closed wastewater and sewerage systems, above the water line, attack is often reported on the underside of concrete covers or roofs.

There are various systems available to protect concrete. Choosing the right system can have an enormous effect on the time required for conducting maintenance and the frequency with which it needs to be carried out.

Chemical resistance to both inorganic and organic acids

In urban wastewater treatment plants, especially in closed environments, the process created by different types of bacteria can lead to biogenic sulfuric acid corrosion, also known as microbiologically induced corrosion. These bacteria create drops of concentrated sulfuric acid on the walls of the sewer or tank, which will damage concrete to the extent of causing a structural problem.

However, this is not the only form of chemical aggression that concrete will be exposed to. The fats contained in wastewater can break down into organic acids too.

Abrasion and impact resistance

The constant impact against the walls of large solids transported with the effluent eventually causes defects in the structure of the concrete. This allows chemicals to penetrate the concrete and start the damage. At the same time, finer solids suspended in the effluent sink to the bottom and cause abrasion as they are carried along with the flow.
Cracks on the substrate: Crack-bridging

While chemical resistance is a prerequisite for a membrane, this does not in itself guarantee the long-term durability of the membrane and its ability to protect the concrete.

It is important that the membrane is able to absorb any potential movement within the structure and maintain its integrity across hairline cracks, to stop these cracks appearing through the coating and compromising performance.

The crack-bridging properties of MasterSeal 7000 CR have been tested to EN 1504 Part 2 using both the static and the dynamic methods. The results are shown in the table 1:

<table>
<thead>
<tr>
<th>EN 1062-7 (A) Static</th>
<th>EN 1062-7 (B) Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3 (+23°C)</td>
<td>B3.1 (+23°C)</td>
</tr>
<tr>
<td>A3 (0°C)</td>
<td>B2 (-10°C)</td>
</tr>
<tr>
<td>A2 (-10°C)</td>
<td></td>
</tr>
</tbody>
</table>
Tolerance to moisture: Adhesion to substrate

With the exception of loose linings, all protective coatings and membranes must fully adhere to the substrate to perform as designed. To ensure proper adhesion, the primer and membrane need to be applied in precise accordance with the product instructions. Surfaces must be thoroughly mechanically prepared using methods that remove all contamination, loose particles and existing traces of previously applied coatings that can reduce the adhesive performance of the new treatment.

<table>
<thead>
<tr>
<th>Adhesion</th>
<th>Adhesion after thermal compatibility</th>
<th>Adhesion on wet concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 1542</td>
<td>EN 13687-1 + EN 13687-2</td>
<td>EN 13578</td>
</tr>
<tr>
<td>&gt; 2.9 N/mm²</td>
<td>&gt; 2.7 N/mm²</td>
<td>&gt; 2.2 N/mm²</td>
</tr>
</tbody>
</table>

Because resin-based products are the only choice for such aggressive conditions, levels of residual humidity are of paramount importance. Current technologies (e.g. vinylester, epoxy or polyurethane) usually require a moisture content in the substrate of ≤ 4 % prior to application. This creates difficulties in controlling the environment in structures that had been used to hold water until immediately prior to the refurbishment.

MasterSeal 7000 CR has been tested at varying humidity levels. Even when applied on wet surfaces, it has consistently achieved adhesion values that exceed the surface integrity of the concrete itself. Where the bond fails, it does so because the concrete breaks away:

The results confirm the compatibility of MasterSeal 7000 CR with humid (visibly dry) substrates. This greatly enhances the variety of conditions under which the material can be applied. At the same time, it greatly reduces the failure potential common to resin-based products applied in humid environments.

This level of performance is confirmed by the results of the Poznan treatment plant trials. All tests broke in the concrete substrate, replicating the failure mode of tests carried out in the laboratory.

Figure 3: View of the result of one of the tests in Poznan
Fast return to service: Application downtime

During refurbishment projects, it is important to use application methods, processes and materials that enable the facility to be returned to service as soon as possible, saving time and money for the owner.

Substrate preparation is an important element in ensuring the success of the application. Appropriate drying of the surfaces, either natural air-drying or forced air-drying, affects both the cost and duration of the refurbishment works.

The membrane can only be considered as a protective system after it has been successfully applied, hardened and cured. Restrictions and limitations in the use of conventional resin systems can increase the risk of failure when they are applied close to or outside their specified application limits.

Because MasterSeal 7000 CR can be applied directly to the damp substrates typical of wastewater facilities, refurbishment downtime due to substrate conditioning is considerably reduced without compromising performance.

The fast curing properties of MasterSeal 7000 CR mean that it can be rapidly applied to both complex shaped surfaces and large open areas by spray or roller. To accelerate the process even further, the recoating times between primer and membrane (5 hours at 20 ºC) and between layers of the membrane (8 hours at 20 ºC) are minimized.

The fast curing properties of MasterSeal 7000 CR mean that it can safely come into contact with water just 24 hours after application at 20 ºC. This ensures that the plant is returned to service with minimal downtime.

Figure 4: Application of MasterSeal M 790 by roller

Durability – Proof of performance in laboratory conditions

The purpose of the tests performed at the Fraunhofer Institute in Germany was to measure the durability of MasterSeal 7000 CR against biogenic sulfuric acid corrosion.

The test chamber used optimized the production of bacteria by controlling the H2S concentration, nutrient content, humidity and temperature. Based on the experience of the University of Duisburg-Essen (Biofilm Centre, Prof. Wolfgang Sand), these conditions accelerate the weathering of concrete samples by a factor of 8 to 10. A 6-month period in the chamber equates to between 48 and 60 months in live sewage conditions.
Following this weathering exposure, adhesion, permeability and elongation tests were performed and the results compared with control samples of the same material.

All adhesion tests failed in the concrete substrate itself. There was no reduction in adhesion compared to the control tests, indicating that the concrete beneath the membrane remained protected at all times.

The results of tensile strength and elongation at break, as well as the permeability tests, show no significant change in properties between weathered and control samples.

**Proof of performance in actual operating conditions**

While the results in the laboratory were outstanding, it was important to test the system in actual operating conditions to verify its performance. MasterSeal 7000 CR was applied in a variety of applications in which it was subjected to contact with aggressive wastewater.

One of the most significant test applications involved applying the product to a thickener tank owned by a Polish water management company with several treatment plants across the country. The tank was refurbished after the failure of other protective membranes applied to the inside of the tank. Prior to application of the membrane, the substrate was cleaned, degreased and repaired with a fairing coat. One layer of MasterSeal P 770 and two layers of MasterSeal M 790 were applied to the 470 m² internal surface area in October 2016.

The application was carried out by DUKO Engineering, a company specializing in the renovation of clean and wastewater tanks.

After 6 months of exposure to the conditions inside the tank, the membrane was subjected to a visual inspection followed by mechanical adhesion tests.

Results showed no visible damage to the membrane. Adhesion results of >1.8 N/mm² were achieved, with all test failures into the concrete substrate itself.

![Figure 5: Application of MasterSeal 7000 CR in Poznan (Poland)](image)
**MasterSeal 7000 CR** – the protective membrane based on new Xolutec™ technology. For wastewater treatment plants and other industrial chemical environments.

With its unique combination of application and performance properties, MasterSeal 7000 CR is the ideal solution for waterproofing and protecting concrete wastewater treatment structures and sewers.

MasterSeal 7000 CR is a system based on new Xolutec™ technology. This has been specifically designed to withstand the severe conditions that occur in pretreatment, aeration tanks, digesters and sewers.

Xolutec™ is an innovative and smart way of combining complementary chemistries. When the material is mixed on site, a cross-linked interpenetrating network (XPN) is formed, enhancing the overall material properties.

For example, in MasterSeal M 790 (the membrane of MasterSeal 7000 CR), the properties of Xolutec™ have been adjusted by controlling the cross-linking density to achieve a high degree of toughness, chemical resistance and flexibility.

The product is CE-marked in accordance with EN 1504 Part 2. The chemical resistance of the system has been evaluated following the procedures described in EN 13529 and the requirements of EN 1504-2. The product has been found to be resistant to many of the chemicals in this test.

However, as we observed earlier in this paper, chemical resistance against pure chemicals may sometimes be insufficient to fully evaluate the performance and durability of a protective system exposed to wastewater. This is why MasterSeal 7000 CR has been tested in both specific laboratory and site conditions to measure its performance.

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**Figure 6: MasterSeal 7000 CR build-up:**
- MasterSeal P 770: primer (yellow)
- MasterSeal M 790: membrane (red)
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