

Dr. H-D. Wolf
Mir. T. Clemmensen

An up-to-date approach to refurbishment and protection of concrete in sewage treatment facilities.

The market for concrete waterproofing in Europe basically consists of preventive treatment of new construction and refurbishment of existing structures.

Europe, being an old continent, has a very well established infrastructure for water distribution and sewage treatment. The majority of the modern sewage and waste water treatment infrastructure was established in the 60s and 70s; after several decades of service life most structures are in demand of refurbishment.

The refurbishment of the waste water treatment plant in the southern German city of Offenburg is an example of a refurbishment using environmentally friendly, resin modified, mineral products

At low external impact, concrete construction members only demand a relatively minor degree of protective measures in order to improve their resistance. At higher impact such as in the current case which falls under the category „Strong attacks“ (according to the German industrial Standard DIN 4030 'Evaluation of concrete aggressive waters, soils and gases'), more elaborate protective measures have to be considered already at the time of planning and construction.

Mineral product systems basically fulfil the requirements involved in the refurbishment and protection of sewage treatment plants; single products are not the answer to complex problems, but rather product systems which can be put together to fit the individual case.

Repair Concept: from Structural examination to maintenance programme

At the Offenburg waste water treatment plant, where the refurbishment works lasted for years, the individual steps of the repair concept were:

- Assessment of the state of the individual construction members
- Analysis of the concrete aggressive media
- Estimation of the impact of the aggressive media
- Definition of repair specification
- Selection of products
- Substrate preparation
- Application
- Protective measures
- Definition of inspection and maintenance programme

The assessment revealed that the surfaces of the individual construction members, either exposed to the air or to the waste water, showed signs of corrosion in the form of sanding, leaching or cavitation.

In the planning of the refurbishment measures it was basically decided to lean on mineral based products for environmental reasons, but the analysis of the sewage revealed that purely mineral products (i.e. cement based mortar systems) had to be modified in order to comply with the criteria concerning resistance to aggressive media. The products finally selected are listed in Table 1.



Preparation for the spray application
Sewage plant prior to refurbishment



Application of the
protective coating

Client	Sewage authority of Offenburg
Consulting engineers	Hans-Eckart Zipfel, Kroningen
Contractor	Roser GmbH Offenburg
Refurbishment products	VANDEX CORROSION PROTECTION M VANDEX UNI MORTAR 1 Z VANDEX BB 75 Z VANDEX BB 75 E Z VANDEX MINERALIT

Table 1

The system specification, i.e., the combination of the products for the individual construction members was decided according to the actual impact.

Repair Concept: From substrate preparation to protective measures

Special emphasis was placed on the bond between the substrate and the coating systems as a means to secure functionality which led to the specification for the substrate preparation.



Levelling the freshly applied mortar coating

The demand for a substrate free of cement laitance, grease and remains of old coating systems was satisfied by the use of sand blasting and high pressure water jetting.

Whereas purely mineral products demand a saturation of the substrate prior to application, polymer modified mortar systems need a slightly damp substrate in order to unfold their features.



Spray application

The application of the mortar and coating systems was realised using compressed air driven spray equipment. Skilled workers are able to spray to the specified layer thickness leaving a uniform coating without pinholes.

Concerning post treatment, mineral based products basically demand the same measures as concrete and mortars. It is important to ensure that no condensation or water film formation takes place on the coating surface during the initial curing and hardening period. Polymer modified coatings reach their mechanical strength partly through evaporation of excess moisture. It is therefore important that a certain air circulation is established following the application, especially when the construction members are not directly exposed to the air.



Treated areas before curing measures

The Offenburg waste water treatment plant

The Offenburg plant receives a combination of city sewage and industrial waste water coming from wineries, distilleries as well as from fat and gasoline processing. The actual waste water processing is determined through continuous testing of the incoming media to be treated.

Construction of the plant started in 1976 and the original plant became operational in 1979. Since the inauguration the plant has successively been extended: in 1981 a sludge dewatering system was added, in 1982 a 2000m³ gas tank and an energy converter which transforms methane gas to electricity. In 1986 the aeration tanks were modified to cope with nitrates.

In the period following, up until 1994, the plant was upgraded to match the new legal requirements concerning remains of phosphates and nitrogen in the treated water and the biological treatment was extended.

The plant treats an average of 110 mio. m³ of waste water per year. The sludge extracted amounts to 700,000 m³/year, the daily methane production is in the range of 3000 m³ which results in an annual energy production of approx. 2 mio kW.

Cementitious surface applied protective systems

Cementitious mortar and coating systems are supplied as ready-to-use, dry mixtures which only need the addition of water or polymer dispersions prior to application on site. In the way the systems perform, similarities to waterproof concrete can be recognised.

The major difference between the cementitious coating systems and waterproof concrete is the thickness at which the system becomes effective as well as the versatility of the cementitious coating systems, which can be adapted to almost any structure.

Surface applied cementitious protective systems have been on the market since approx. 50 years and enjoy an increasing degree of recognition and importance, not least due to their relatively simple and safe method of application as well as their ease of maintenance.

The products consist of high quality cement according to DIN 1164, oven-dried quartz aggregate with optimal grading as well as inorganic additives which contribute to giving the individual products their specific features, and to the workability.

In waste water processing installations the before mentioned features alone are not sufficient because the waste water often has a pH-value below 7. Alternating acidic and alkaline impact on the construction members is often encountered.

In particular, in an acidic environment, cement as a binding agent is the weakest link in the chain, so cements with, for instance, a higher degree of sulphate resistance are required.

As a further step in the development, the cement matrix is reinforced with other types of binding agents such as resins.

Polymer modified mortars with extended range of application

In recent years modifications of purely mineral systems through polymer dispersions has led to an extension of the product features, in particular in terms of elasticity.

Essentially the polymer dispersions form a three dimensional film which fills the vacant space around the hydrated cement particles.

The flexural strength of polymer modified mortars or coatings is increased and the modulus of elasticity reduced. This combination leads to a decreased tendency of crack formation.

An important feature of the polymer modified products is their higher impermeability rating, which is owed to the combination of fine cement and aggregate particles and the polymer film in the matrix.

The chemical resistance of the polymer modified products is increased when compared with purely mineral systems because the polymer film acts as a shield for the soluble cement hydrates. Also an increased resistance to freeze - thaw can be expected when using polymer modified products.

Last but not least, it should be mentioned that mineral systems - with or without polymer dispersions - are environmentally friendly and do not require any particular protective measures for the applicators.



Refurbishment with polymer modified mortar completed: the aeration tank is in operation

Summary

Mineral protective mortar and coating systems fulfil the basic requirements concerning durable solutions to concrete corrosion problems in waste water and sewage treatment installations. In several cases the classic, purely mineral products however, do not meet the requirements.

System modifications involving organic and inorganic additives on the other hand offer the optimal features to cover most demands concerning corrosion proofing and protection found in waste water plants.

The application of the polymer modified systems compares to the application of purely mineral systems whereby certain modifications concerning substrate preparation and curing may be necessary.



CONCRETE PROTECTION AND WATERPROOFING

HEADOFFICE AND INTERNATIONAL SALES: VANDEX INTERNATIONAL LTD

P.O. Box, CH-4501 Solothurn/Switzerland
Phone: +41 (0)32 626 36 36, Fax +41 (0)32 626 36 37
E-mail: vandex@vandex.com www.vandex.com

PRODUCTION AND LOCAL SALES: VANDEX ISOLIERMITTEL-GESELLSCHAFT m.b.H.

Postfach 1406, D-21487 Schwarzenbek/Germany
Phone: +49 (0)4151 89 15-0, Fax +49 (0)4151 89 15 50
E-mail: vandex@vandex.de www.vandex.de

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P.O. Box 200, Guildford, Surrey GU2 4WD/United Kingdom
Phone: 0870 241 6264, Fax: 0870 241 6274
E-mail: info@vandex.co.uk www.vandex.co.uk

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