Water Repellent Treatment of Building Materials
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Chemical Waterproofing -Sensible Use of Organosilanes

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Abstract

It is outlined that water repeelent surface treatment is cheap as compared with repair of available damage. The aim of a surface impregnation is briefly described. Reasons for unsatisfactory performance are indicated. A new approach for quality management is briefly presented. It is mentioned that this concept is available on CD.

Keywords: economic effect, quality control, quality management, apllication

1 Introduction

The modern building and construction industry is tending to use more and more of the large range of organic products available from the chemical industry. Fortunately, this also includes the use of water repellent agents. For more than four decades organic silicon compounds have been successfully used for the protection and preservation of concrete building structures. Can we, however, as suppliers of waterproofing agents, be really satisfied with the quantities sold? For example, let us consider the annual demand for 1,5 billion tonnes of cement. This quantity would be sufficient to build a concrete wall around the equator, running 8,5 metres high and 10 metres deep. Without any doubt concrete is *the* construction material of the 20th century. As reinforced concrete it is used by architects and civil engineers in realising unique objects of architecture. Nevertheless, despite its high resistance, a penetration of harmful salts, such as chloride ions, may cause serious damage to the building concerned, thus strongly limiting its durability and utilisation. Less than 2 % of the total area is treated with waterproofing agents, even though we all agree within this Congress that impregnation with organic silicon compounds, especially silanes, helps to increase the life span of building structures. During this lecture, the usual mode of reporting on product innovations, technical requirements or successful case studies will not be employed. The occasion for this unusual approach was provided by critiques of users and planners like architects and civil engineers.

However, in the mid to late eighties confidence was lost, even in the use of hydrophobization agents, as quality defects on building structures started to emerge. This sparked off a wave of discussion and a flood of regulations on the part of the authorities and legislators to define the "right" requirements for impregnation agents.

Within the framework of this lecture we would like to examine the reasons why waterproofing or "hydrophobising" is not more widely accepted as a means of surface protection and show possibilities to enhance confidence in this method.

2 On the aim of a surface impregnation

It is state of the art that waterproofing strongly reduces the absorption of water and, consequently, of chloride in absorptive building materials. This allows us, for example, to slow down or even prevent corrosion of reinforcing steel inside the concrete. Waterproofing with organosilanes requires much less technical efforts than treatments using other materials, like coatings (EP, PU). The economic as well as ecological advantages of hydrophobising have been proved in various studies[1,2]. These have clearly shown that corrective maintenance - as carefully as it may be planned - has a significantly higher environmental impact than waterproofing with silanes. Furthermore, within the service life of a building (generally 100 years), early waterproofing may completely save, or at least delay, a necessary repair; these are cost savings that should not be underestimated in life cycle considerations[3]. Our goal must therefore be to ensure the effectiveness and resistance of waterproofing over the entire life cycle of a concrete building component.

3 Some reasons for insufficient performance

There are many reasons why waterproofing measures may fail, and such failures cannot always be put down to product properties, product categories or the manufacurer. A few reasons for the loss of confidence and the lack of durability are listed below:

- non-awareness of the detailed corrosion problems by the people responsible for design, execution and use,
- poor practice experiences on surface treatment with organic silicon compounds by civil engineers, architects, owners,
- lack of documented material specification, approval procedures for products and technical guidelines for application procedures
- non-existing realistic design for durability,
- insufficient durability due to missing quality assurance and quality control procedures
- pricing, not technical properties, was sales argument no. 1.

Now, if one takes a closer look at examples from practice, it becomes obvious that more than 70 % of all complaints can be put down to faulty applications. In Switzerland, for instance, a motorway made of concrete slabs was impregnated a few hours after a longer period of rain; subsequent investigations revealed that the protective agent had not penetrated deep enough into the material. It is rather doubtful if this object will be able to last for more than two years. In another practical example, a planner in Singapore relies on the water-repellent effect for which particularly siloxanes/silicones are known. What he did not know, however, was that marine surroundings and a high moisture content in the concrete lead to an accumulation of active ingredients in the near-surface area, thus causing the water-repellent effect. In a third practical example, a civil engineer in France relies on reference lists of the raw material manufacturer and simply on setting up test surfaces. That test surfaces laid out in summer do not say much about a material's suitability in late autumn or that reference lists give little information about the suitability of a product in a special application, was something he did not know either. The decisive argument for the engineer was ultimately the product's price and not quality or the associated durability.

The bad workmanship can largely be attributed to lack of information exchange of all partners involved in waterproofing: raw material supplier/manufacturer, builder/civil engineer/planner and processor/painter. As appropriate product information is missing, the civil engineer is often not able to plan waterproofing measures for the building concerned. The requirements to be met by waterproofing measures are insufficiently described in regulations and standards (such as ZTV-SIB); also quality control procedures are often not available. Weather and climatic conditions before and after the application are generally not considered in the invitation to tender. The civil engineer often uses the performance data of the manufacturer (water-repellent effect, penetration depth, reduction of water absorption). When applying the material at the location, the executing company (processor, paint shop) is often confronted with unrealistic specifications (required penetration depth or required reduction of water absorption) regardless of the actual conditions at the construction site. This lack of practical field-oriented information leads to faulty applications, which then cause differences of opinion between planners, processors and raw material suppliers. This may even end up in court, which makes little sense for all those involved. The consequence of this is clear: a civil engineer will tell at least seven more colleagues that he is sceptical about the effectiveness of the waterproofing.

4 A new approach towards a quality management

To make this type of surface protection more widely accepted, water proofing must be predictable and calculable for both engineer and processor. On closer examination three criteria can be established:

- Reference lists and product data sheets are no substitute for preliminary investigations of the building if effectiveness and durability are to be guaranteed. Product data specifying the substrate, such as porosity, moisture and chloride content, must be correlated in view of the engineering work. Also the limits from when waterproofing can no longer be recommended must be clearly indicated.
- The water-repellent effect, the "ordinary" person's quality assurance method, does not admit any conclusions regarding durability. Appropriate field-oriented test methods on the construction site are urgently needed and must become part of a universal quality management.

The communication of existing specialised knowledge among people involved in planning and execution must be clearly improved.

Together with the Federal Institute of Technology (ETH/ IBWK), an attempt has been made at establishing an integral quality management system to enable all those involved in the "area of conflict" between raw material supplier, planner and processor to safely plan waterproofing measures and protect themselves against complaints. In our opinion, a quality management concept should include the following elements:

- evaluation of performance criteria,
- preliminary investigations of the construction/ construction elements to determine the current concrete quality,
- set-up test surfaces on larger projects,
- visual inspection of cracks,
- object-specific substrate preparation,
- determining the type of application and the application's conditions,
- detail documentation of used protection system and the application conditions in accordance the manufacturer's instructions,

- quality control to check for compliance with the requirement profile (water absorption, profile of active ingredient by FT-IR or GC)
- regular inspections to check on the effectiveness to minimize service life cost

This concept has been described in detail on a CD-ROM with the title of this lecture. It contains an interactive program consisting of the following segments:

- type, age and use of the building/ building element
- suitability of the material for waterproofing
    * water/ cement ratio of the concrete
    * porosity
    * risk of corrosion (reinforcement)
        - carbonation
        - chloride corrosion
    * surface treatments already carried out (coating, paint)
    * risk of other aggressive components
    * frost damage
- climate conditions
    * moisture content
    * temperature
    * wind speed

The user will be guided through a variety of questions and, at the end, be provided with an extensive text containing product recommendation, preliminary investigation, application conditions and quality control (including a description of the method and literature references). The text can be used for an invitation to tender and also be individually styled.

Furthermore, user will be informed in detail of typical damage mechanisms and of the principle advantages of waterproofing materials. The information is completed by a survey of published references, a technical dictionary and instructions for architects and engineers relating to public tender.

5 Conclusions

This lecture is intended to provide some general information about the causes of the loss of confidence in working with waterproofing agents. The cummulative technical, ecological and economical costs of applying waterproofing agents is significantly lower than restoration and repairing of unprotected concrete structures. A change in thinking has to take place to relieve our environment as well as departmental budgets. Despite many years of experience and the availability of efficient products, we have to stress explicitly that there is no "cure-all" for hydrophobic treatments. However, risks can be reduced to a minimum if the substrate material, its moisture content and distribution, damage caused by previous treatments, the structural situation and local climatic parameters are carefully taken into consideration. Treatment must be preceded by careful examination of the prevailing general conditions and accompanied by a comprehensive quality control system. We have tried to contribute to make waterproofing calculable by computer-aided support.

There is no doubt any longer that professional waterproofing is a preventive action to defer the need for comprehensive repair by many years. In addition, substantial cost savings are realised for the benefit of longer lasting surface protection.

References

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