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Fresh Concrete Curing Treatment for Horizontal Surfaces

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Summary

One of the most important factors for final surface quality in concreting of large dimension slabs is to secure minimum vaporization of water and limit the undesirable tensile and compressive stresses in concrete structure which can be formed by quick drying of the concrete surface. Only purpose of ordinary type of treatment for fresh concrete is to secure sufficient amount of water during hydration. These materials have to be removed or left on place to be worn off. New material based on polymer resin has been developed to keep necessary amount of water to secure proper hydration process in concrete. The intended use of the newly developed product is mainly for horizontal concrete slabs, floors. Polymer is applied onto fresh concrete before or during final surface treatment. Main aim of the research described in the proposed paper is to evaluate effect of polymer on vaporization and with consequences on hydration process. Different amount of dosage of treated and not treated concrete were compared. Paper also describes three different testing methods of evaluation. Main advantage of this product is that this product can be also used as final treatment of concrete with good quality and appearance but also as bonding agent for following polymer layers.

KEYWORDS: polymer coating, excessive drying

1. INTRODUCTION

One of the main factors for a final surface quality, at the process of concreting large slabs, is a guarantee of minimum evaporation of water necessary for hydration. Therefore a new material based on polymer resin was developed for protection of hydrating concrete. The goal of this work is a comparison of resistance of treated and untreated concrete and evaluation of applicability of specific tested materials including a determination of testing methodology. During a proper treatment of concrete it is necessary to provide enough of water for hydration and reduce undesirable tensile and compressive stress in concrete structure, which can be caused by rapid drying of concrete surface.

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2. SURFACE PROTECTION OF CONCRETE

In the long term the concrete is deteriorated by physical (abrasion, frost in connection with moisture) and chemical (aggressive liquids and gasses) effects of environment.

In most cases an active protection, i.e. composition and processing of concrete, is not sufficient to prevent an intensive effect of aggressive media and it is necessary to use a passive protection based on a surface treatment.

As a protection against corrosion, the concrete surface is impregnated with penetration agents. Impregnation reduces water absorption through capillaries, the concrete surface is hydrophobed but diffusion of water vapor is not limited. Hardening stops penetration of water and water vapor into the porous structure of concrete and then there are applied paintings or coatings on the concrete surface. Refinishing methods of surface treatment of monolithic concrete as well as reinforced concrete elements, where not only durability but also esthetic appearance is required, can be also classified as a passive protection. [2] On one hand a surface protection of concrete increases its resistance, but on the other hand some defects can occur which can be caused by a number of influences.

2.1. Mechanisms of defects

Defects of impermeable layers, with long-term moisture effect, can have chemical or physical nature. Their most often manifestation is the following:

- softening of flooring (in larger extent at parts with bigger porosity or smaller diffusion resistance).
- development of cracks (the most often at surface and final layers), see fig. 1; separation of flooring from the base and creation of bulges (bubbles) filled with liquid and their perforation.

All these defects worsen or eliminate original advantages of flooring (protection layer), speed up destruction of flooring during its mechanical loading, decrease its esthetic appearance and damage its hygiene and biological quality.

Figure 1: Separation of flooring from the base and creation of bulges

3. EPOXY RESIN TREATMENT OF CONCRETE

Impregnation agent for treatment of concrete based on epoxy resin is two component low viscous material, water soluble. It is specially formulated hardening system with additives controlling hardening according to temperature of the surroundings.

3.1. Procedure for application of coating material

After concreting, laying and leveling, the concrete is let to mature and when it achieves such tensile strength that adult can carefully walk over it without any deformation, machine or manual processing must be immediately started. In the first phase, unification of surface with drawing of cement grout to surface and creation of homogenous even layer of cement paste is carried out. An even layer of polymer epoxy coating is then applied without any delay by pouring and spreading on surface of the paste.

4. RESULTS OF EXPERIMENT MEASUREMENT

So far there were no effects, of treatment by above mentioned polymer agent, determined and/or documented, therefore the experimental part is focused on determination of surface moisture for specially treated concrete and implementation of testing which can characterized properties of treated material.

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4.1. Monitoring of moisture under the surface coating by resistance method

The hydrometer GANN H-85 was used for measuring. Moisture was measured through the resistance by two stabilized probes embedded into the sample. The calibration curve of the instrument was applied and according to it, a new regression curve considering measured values was subsequently created, see fig. 1. Percentage moisture is then solution of given function.

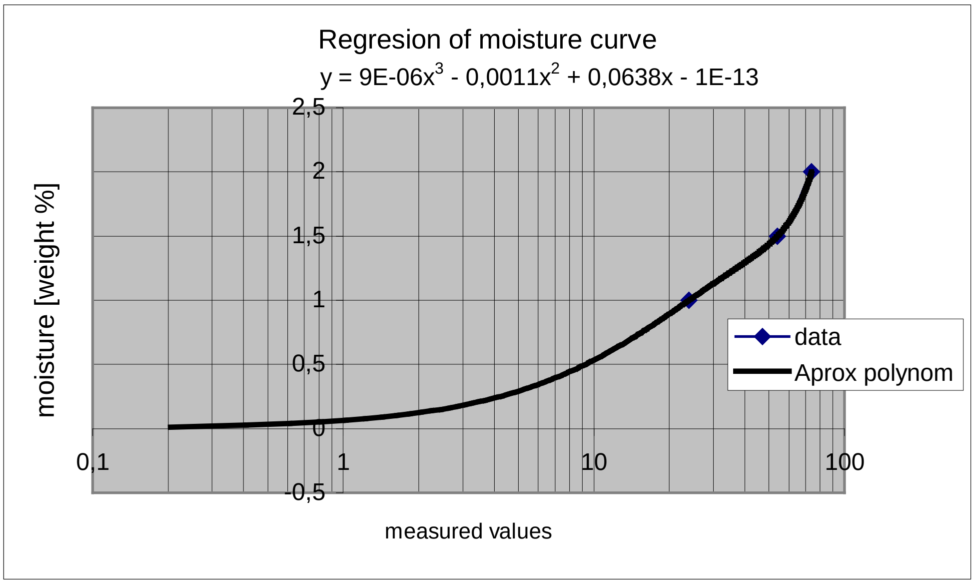

Figure 2: Regression curve showing relation between measured values of instrument and moisture of samples, which was created according to calibration curve of the instrument

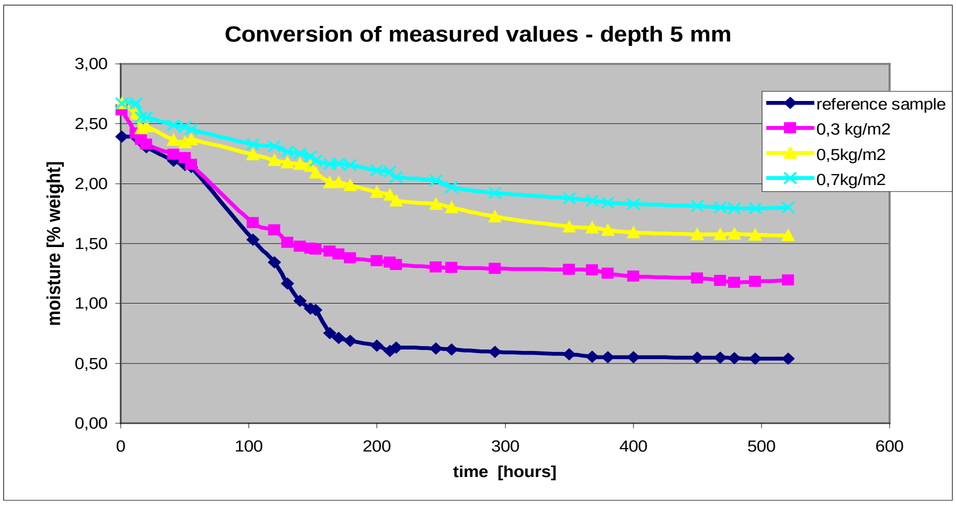

Figure 3: Moisture-time relationship; moisture was measured by two probes (embedded 50 mm deep in the sample underneath a surface polymer layer) in time intervals. Moisture is given in weight percentage

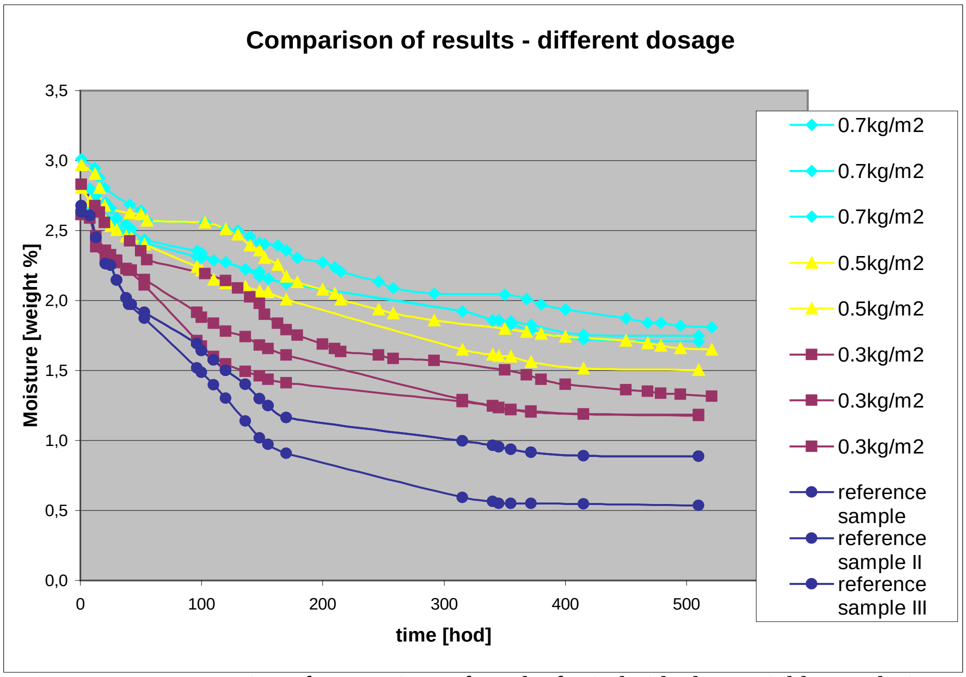

Figure 4: Demonstration of comparison of results for individual material layers during repeated moisture measurement by two embedded probes which scanned electric current running between them in time intervals

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4.2. Gravimetric method – weighing of silicagel weight increase

An apparatus consisting of glass container, size 0.7 x 0.4 x 0.6 m, electric scale, thermometer, hygrometer, dish with annealed silicagel, PVC pad and sample of concrete was assembled at the laboratory.

The joint between the pad and glass container was filled with silicone in order to achieve, inside of container, constant conditions unvarying in time and particularly to avoid any penetration of environmental moisture to weighed silicagel. The sample with polymer surface coating was installed into one set and sample without polymer surface coating into the other.

Measured weight increase of silicagel was then directly proportional to absorbed moisture which evaporated from the sample. Measurement of silicagel weight increase was carried out in period of 360 hours until weight increases were stabilized.

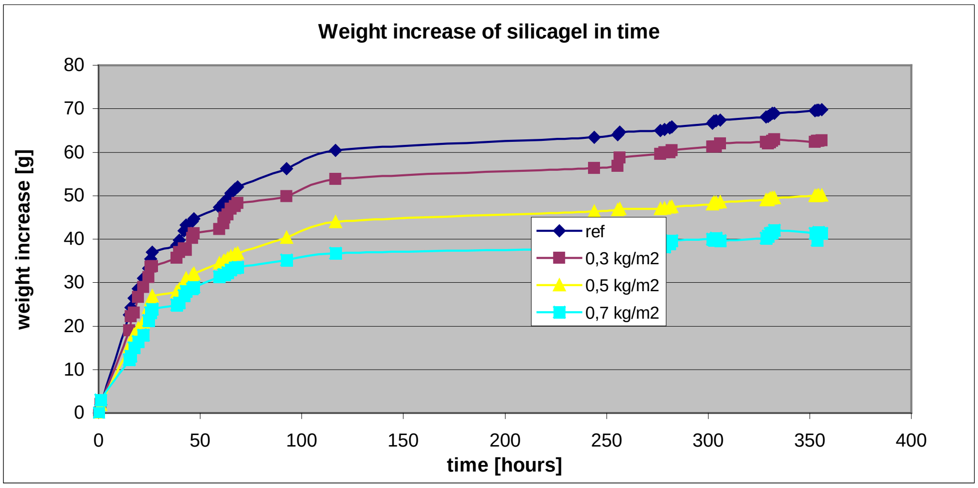
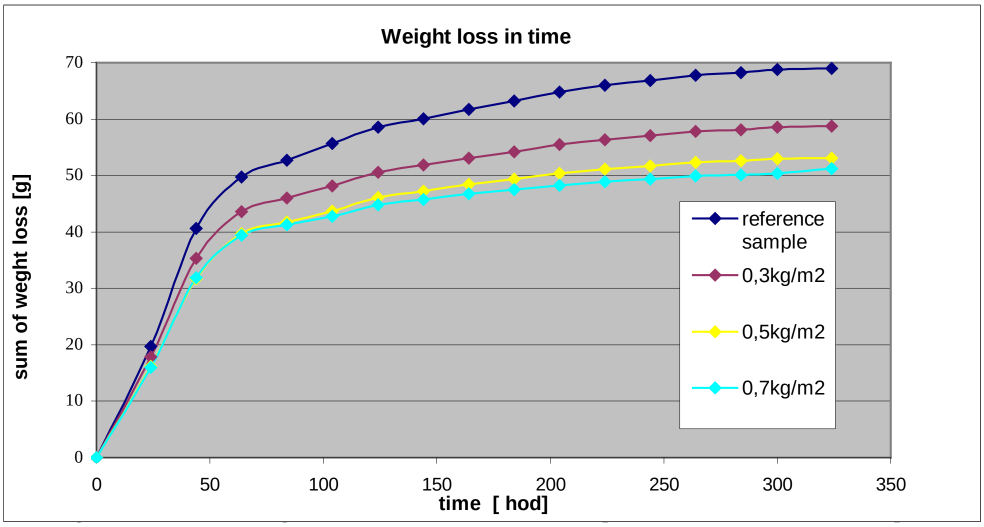


Figure 5: Weight increase of silicagel in time. Weight increase of silicagel was directly proportional to moisture evaporated from the sample and absorbed by silicagel

4.3. Gravimetric method – weighing of weight decrease of sample

Four samples with polymer surface coating of 0.3 kg/m^2; 0.5 kg/m^2; 0.7 kg/m^2 and reference sample were prepared.

These samples were weighted in regular time intervals on electric scale with an accuracy of two decimal places. Weight decrease of sample detects an evaporation of water from sample. Temperature in laboratory was 20°C and relative humidity 40%.



4.4. Additional tests characterizing properties of concrete treated with impregnation

Determination of abrasivity resistance:

This test was implemented according to standard EN 67 3073 and EN 73 1324

Determination of permeability for water vapor:

Test of material permeability for water vapor was carried out according to EN ISO 7783-2. This test is proving ability or disability to create barriers for moisture transport through materials. The foundation of the method is a determination of weight increase of reacted absorber – silicagel diffused by water vapor through tested material placed in a measuring unit closed by tested sample with given area.

Test for surface finish adhesion of building structures to the base:

Test was carried out according to ČSN 73 2577. The foundation of this test is a measurement of force needed for separation of surface layer with a specific area by perpendicular traction. Testing steel plates with diameter of 50 mm are glued to surface coating. Plates are glued to surface with appropriate adhesive and afterwards the surface layer is cut with cutter. The depth of cut is such as cut does not reach the base but goes through the whole surface coating layer. The testing device DYNA was used for separation.

Adhesiveness was also determined on samples which were exposed to 10-month impact of petroleum products.

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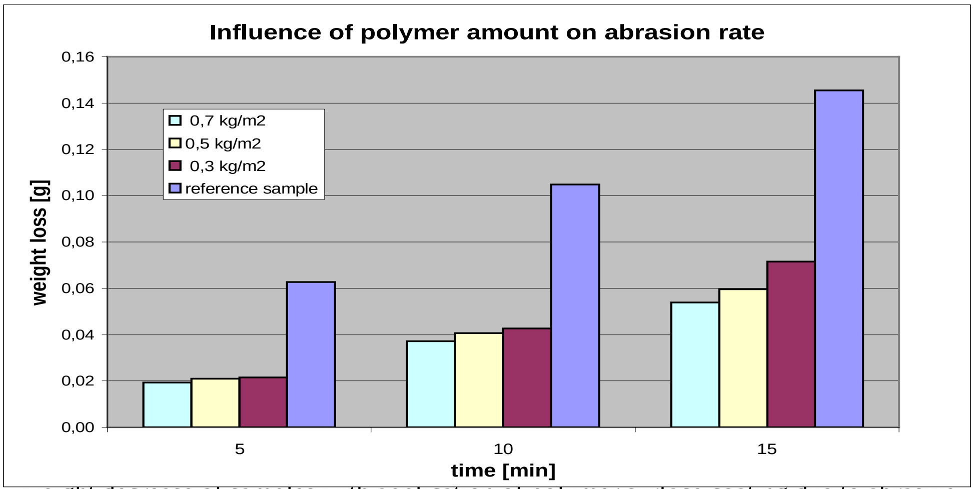
4.5. Results of additional tests



weight decrease of samples with application of polymer surface coating due to abrasive impact on sample

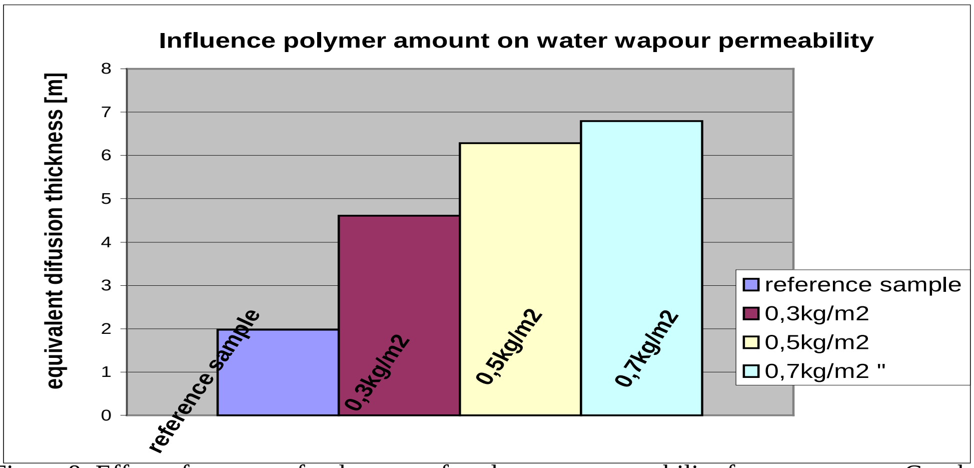


Figure 8: Effect of amount of polymer surface layer on permeability for water vapor. Graph is showing increasing equivalent diffusion thickness with higher dosage. An essence of the method is a determination of weight increase of reacted absorber – silicagel diffused by water vapor through tested material placed in a measuring unit closed by tested sample with given area

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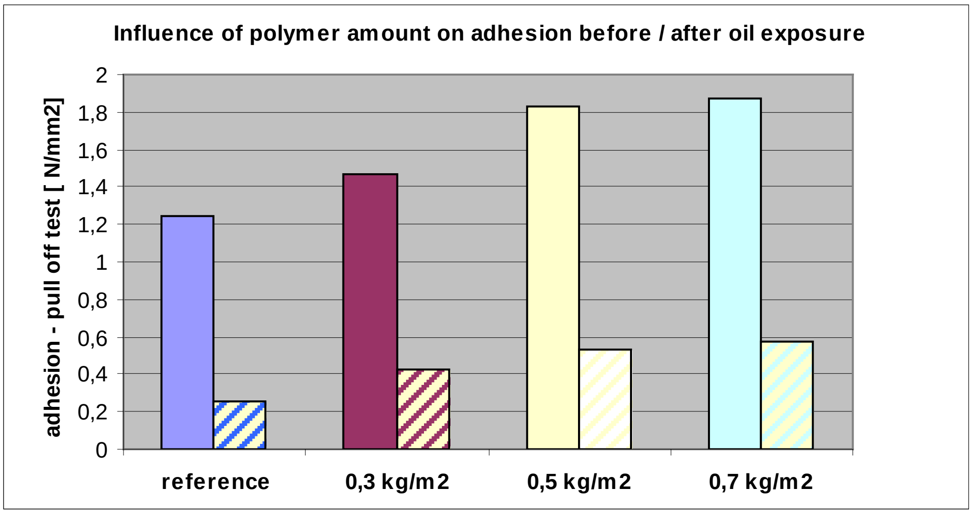

Figure 9: Effect of amount of polymer surface layer on adhesiveness of surface layer. Adhesiveness was measured on samples treated by polymer surface coating and compared with untreated samples; hereafter they were compared with samples exposed to 10-month impact of petroleum products

5. CONCLUSIONS

Based on all results obtained by measurement of moisture under impregnation agent, type: water-based epoxy resin, it can be stated that the biggest moisture decrease occurred during first 250 hours and moisture curve became stabile after 25 days. At measured polymer surface layer, i.e. treated samples, moisture release was slower than at untreated sample. A number of micro-cracks (noticeable through magnifying glass with 15-times optic enlargement) occurred on surface of untreated samples. Cracks were caused by fast water evaporation from sample due to hydration heat.

Coming out of evaluation of individual methods from the viewpoint of their implementation, the gravimetric method - weighing of weight decrease of sample – can be determined as the easiest for execution. For the resistance method with stabilized probes embedded into the sample and hydrometer GANN H-85, it is necessary to maintain a stable position of probes and prevent any power failure. It is also necessary to create relatively complicated regressive curve according to curve of instrument and recalculate a given function, which prolongs time needed for this method. Very varying data with no value were obtained after three-day measurement. This was due to large transitional resistances at individual metal probes.

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Generally it can be said that with an increasing amount of polymer concrete coating, the permeability for water vapor decreases. This is due to epoxy resins, which have excellent resistance against penetration of water vapor. In the case of adhesiveness test of surface layer, samples treated by polymer surface coating demonstrated higher adhesiveness of surface layer than untreated samples. Further there was evident relationship between measured value of adhesiveness and amount of applied polymer layer. Adhesiveness of surface layer was increasing with increasing amount of applied polymer.

From presented results it is obvious that polymer surface coating significantly decreases water evaporation from concrete and improves its physical mechanical properties as well as increases a resistance of concrete against various corrosion effects. For example, from the progress of measurement of samples, which were exposed to 10-month impact of petroleum products, it was evident that degradation of treated samples was lower than for reference samples.

Acknowledgements

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