INFLUENCE OF A WATER REPELLENT TREATMENT ON DRYING OF CONCRETE

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ABSTRACT

It is known that moisture transport in a drying concrete specimen is by liquid water transport in the nearly saturated state and by vapour transport in the dried state. It can therefore be expected that a treatment with a water repellent agent has a significant influence on the drying process as liquid water transport is prevented from the zones near the surface. Experiments have been carried out in order to investigate this influence. Results are presented and the relevance for durability is pointed out.

1 INTRODUCTION

Drying of concrete can be described reasonably well by diffusion theory [1]. The diffusion coefficient depends on the moisture content which means that the nonlinear differential equation can be solved numerically only. An exponential function can be used to describe the influence of moisture content on the diffusion coefficient with fair approximation for concrete with most usual water-cement ratios [2]. If the skin effect can be neglected it is reasonable to assume the diffusion coefficient to be independent of the depth from the surface. In case the surface of a concrete element has been treated with a water repellent agent, however, this assumption is not valid any more. In untreated concrete, during the drying process liquid water can be sucked by capillary forces close to the surface where it will evaporate. In a treated companion specimen the liquid water can only come close to the zone which is water repellent. There it will evaporate and migrate as water vapour through the impregnated layer. This means that we ought to expect a lower rate of water loss in impregnated elements as compared to untreated drying concrete.

This effect has been associated with damage of impregnated surfaces of brick masonry and mortar by numerous authors. Grobe and his co-workers [3, 4] have found that the treatment of a surface with a water repellent agent accelerates drying in the case of a coarse porous sandstone but slows down the drying rate in the case of micro-porous sandstone.

It has often been questioned if the surface treatment with a water repellent agent has a significant influence on the rate of carbonation of concrete.

A reliable answer can only be expected if the influence on drying is better understood.

So far, few results of the influence of an impregnation on the drying rate of concrete have been published. First results of ongoing research will be presented in this report.

2 PREPARATION OF SPECIMENS AND EXPERIMENTAL PROCEDURE

Concrete with a water-cement ratio of 0.5 has been prepared. The maximum aggregate size is 16 mm and the cement content 350 kg/m^3. Ordinary Portland cement has been used. From large concrete blocks prisms with the following dimensions have been cut:

Series A: 30 x 75 x 30 mm
Series B: 30 x 75 x 150 mm

Before the treatment with two different water repellent agents (WRA I and WRA II) the specimens were cured for more than one year in an environment having 70% RH. WRA I is a micro-emulsion of a siloxane and WRA II is an emulsion of a silane. After the treatment, the specimens have been water cured for five days (series A) or vacuum saturated with water (series B). The depth profile of the penetrated water repellent agent has been determined with the FT-IR method as described recently [5]. Then, five surfaces were covered with aluminium foils leaving free only one drying surface with 30 x 75 mm. These specimens were then placed at 20°C in three different climatic chambers with 75%, 60% and 45% RH. The water loss has been determined by weighing the specimens in regular intervals.

3 RESULTS AND DISCUSSION

The weight loss of untreated and impregnated specimens is shown in Fig. 1 as function of the duration of drying for series A. It can be seen that the drying rate of concrete is considerably slowed down by an impregnation. This behaviour was expected. The resulting time-dependent moisture distribution in an impregnated concrete element can be predicted on this basis numerically.

While specimens of series A were water saturated those of series B were vacuum saturated. Typical results are shown in Fig. 2. In this case, drying specimens were cured in an environment of 45% and 60% RH. In both cases, the impregnation leads to a increased weight loss as compared to the untreated specimens. Further investigations are needed to elucidate this observation.

FIG. 1 Weight loss of drying concrete specimens of series A as function of duration of drying. The results observed on untreated reference specimens are shown together with results of specimens treated with two different water repellent agents: WRA I = micro-emulsion of a siloxan WRA II = emulsion of a silane

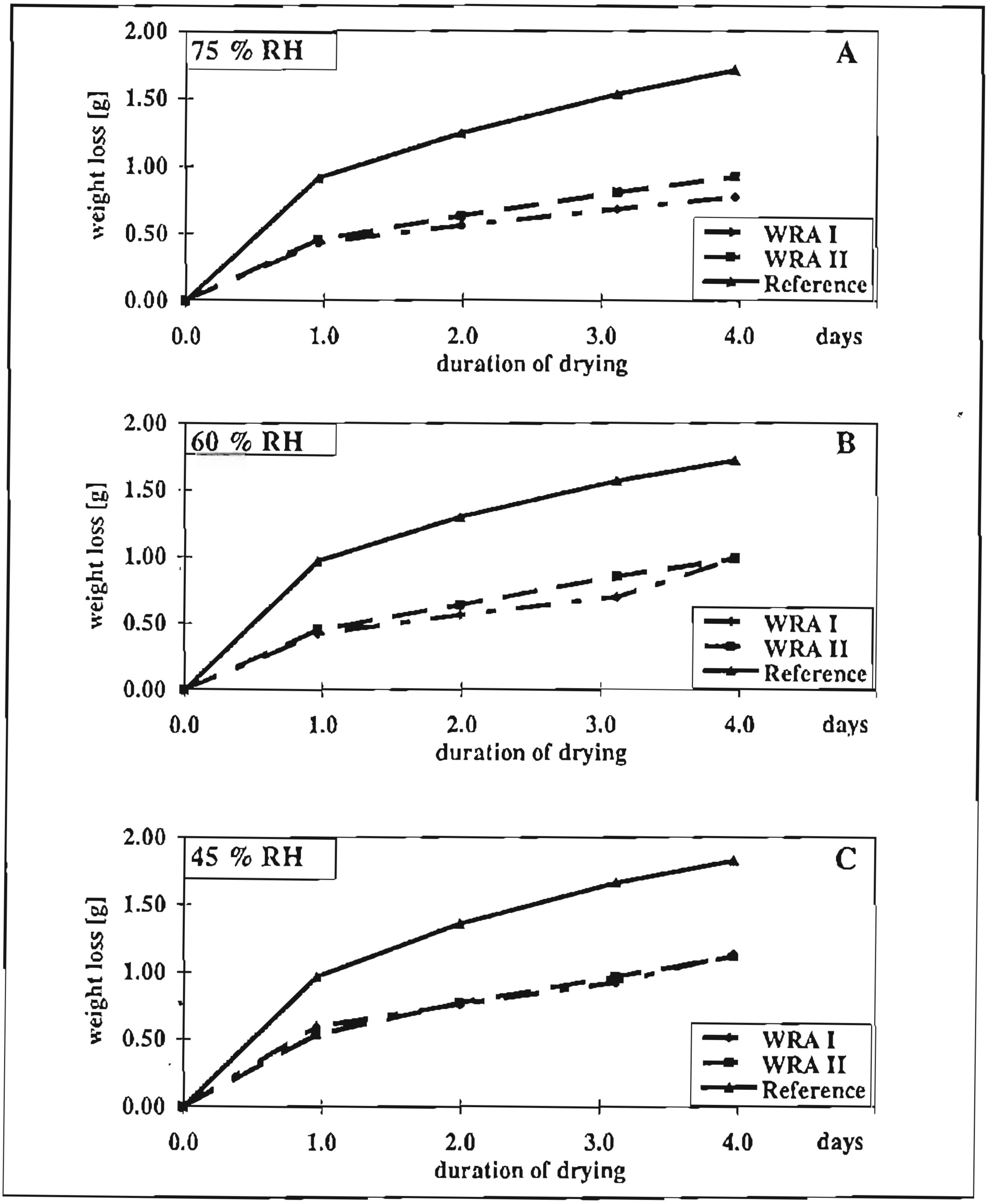
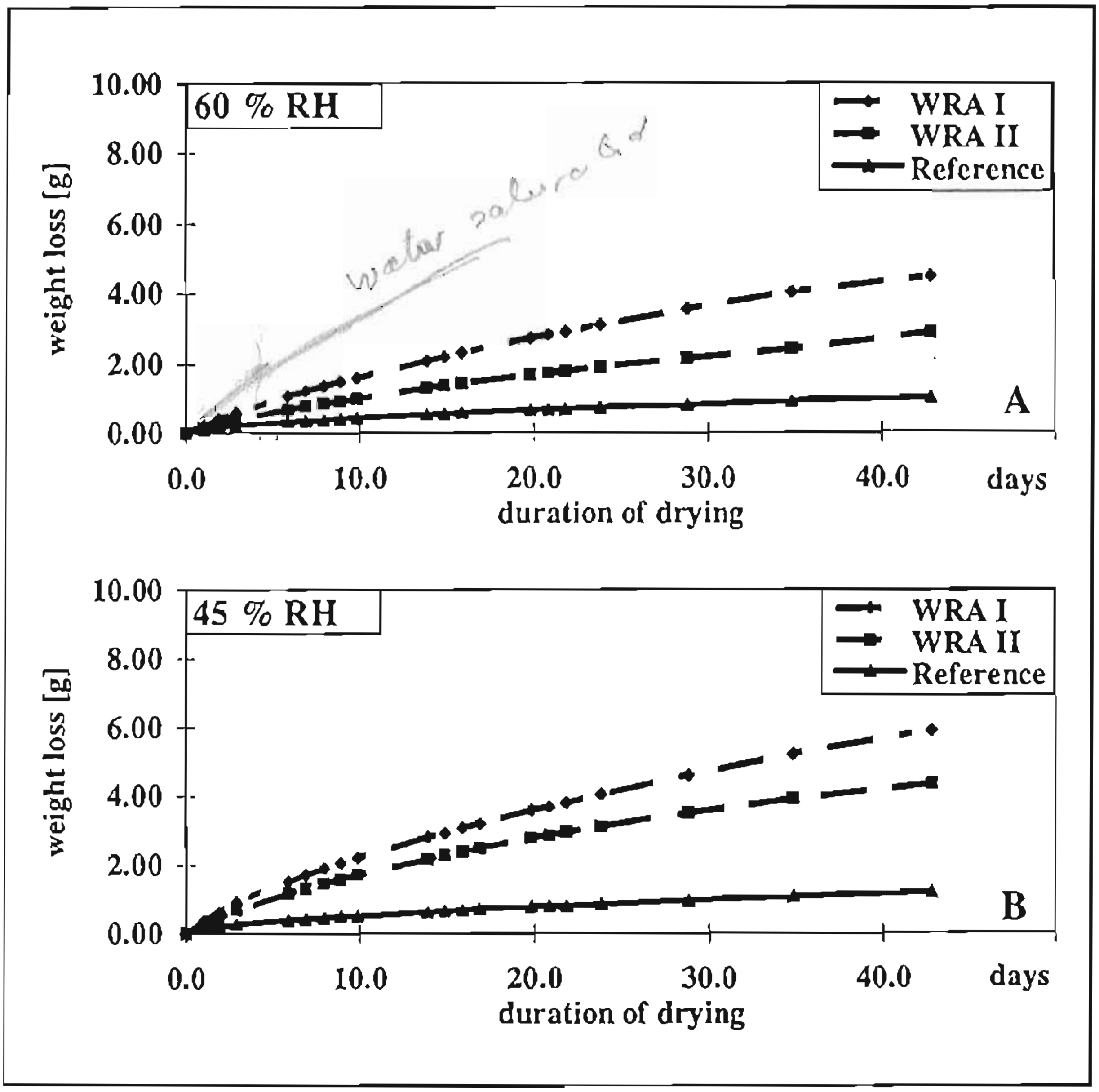


FIG. 2 Weight loss of drying concrete specimens of series B as function of duration of drying



It can be concluded that a surface treatment with a water repellent agent has a significant influence on the rate of drying. As the drying process dominates major aspects of durability of concrete this effect has to be taken into consideration in relevant prediction models.

4 REFERENCES

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