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Investigation Into the Effectiveness of Efflorein in Minimising Efflorescence in Concrete

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Introduction

At the request of Ability Building Chemicals Co, manufacturer of Efflorein, some trials have been carried out with the intention of gauging the effectiveness of this concrete admixture in minimising the occurrence of efflorescence. Concrete specimens, made with and without Efflorein Mark 2, have been tested using a modified version of AS/NZS 4456-2003 Masonry units, segmental pavers and flags Methods of test: Method 6: Determining potential to effloresce.

Summary of results

The use of Efflorein Mark 2 (at 1.5% of cement content by mass) had the following effects:

- The water demand of the concrete was reduced by approximately 10%.
- The rate of water absorption into the concrete was reduced by approximately 40%.
- There was a significant (although less quantifiable) reduction in efflorescence (see photos).

Details of the trials

Specimen preparation

Concrete mixes were made from type GP cement and washed concrete sand, at about 300 kg cement / m^3. Given the lack of coarse aggregate and the high water/cement ratio (>1) the concrete was expected to be quite porous, even after curing. This mix design was chosen so that the control concrete (without Efflorein) would be likely to show substantial efflorescence.

Efflorein was added to half of the concrete at the rate recommended by the supplier. At water contents judged by eye to give the same workability, the water/cement ratios were 1.19 (control) and 1.08 (with Efflorein).

Concrete was poured into wooden moulds with plastic sheeting underneath, to make slabs 40 mm thick. The slabs were cured for 2 days, including 5 hr at 35°C, and then cut into 200 x 100 mm specimens for the efflorescence trials.

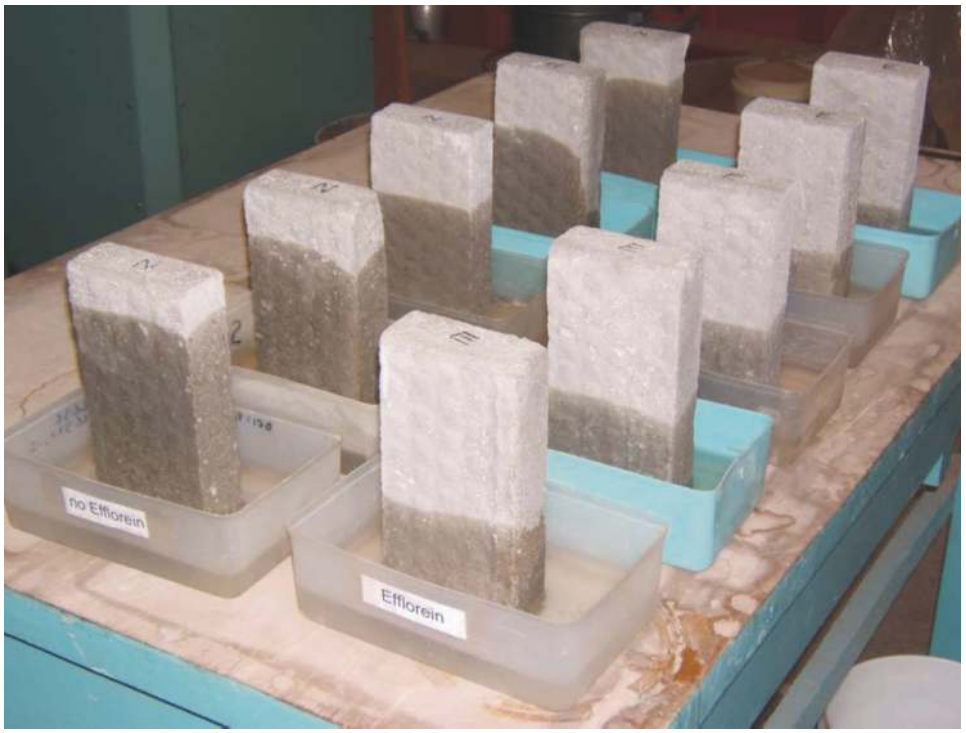

Photo 1:
Control and Efflorein specimens after 18 hr in 1% salt solution

Efflorescence testing

The Australian Standard test method for efflorescence, AS/NZS 4456.6, is designed to measure the potential of a masonry unit or paver to exhibit efflorescence from salts originating within the unit. The procedure involves standing the unit, or a segment cut from one, on end in 25 mm of distilled water for a week and then assessing the amount of efflorescence, if any, visible on the surface of the unit after allowing the unit to dry.

In practice, most cases of efflorescence result from salts originating from ground water. To make sure there was some efflorescence visible in the control concrete, salt water was used instead of distilled. The salt was a 50/50 mixture of sodium sulfate and potassium chloride. Solution concentrations of 0.1, 1 and 10% by mass were tried; all gave visible salt encrustations on the specimen surfaces after 3 to 4 days soaking.

It was found that the control concrete became saturated with water right to the top of the specimen when the trials were located in still air. To increase the evaporation rate so that the salt would be concentrated near the middle of the specimens for both control and Efflorein concrete, later trials were exposed to wind through an open door.

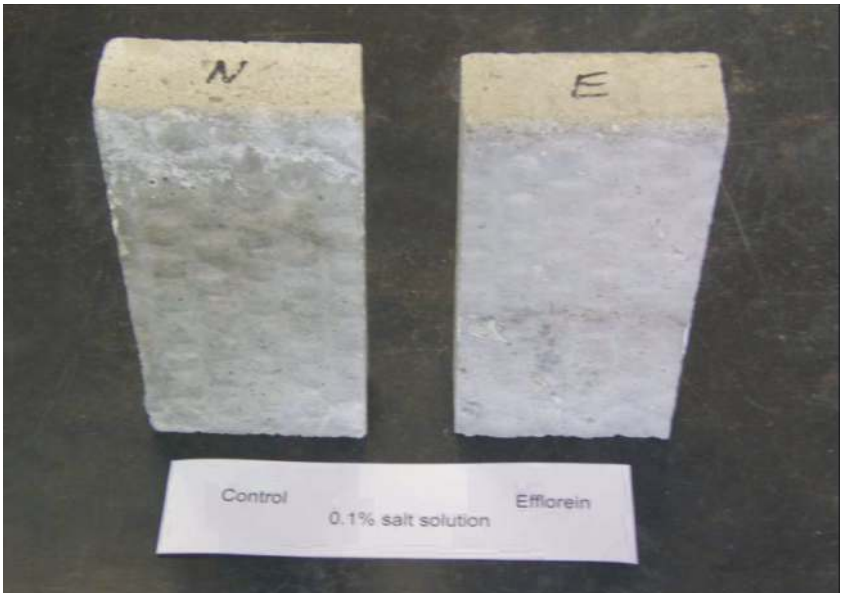

Photo 2:
Specimens after 4 days in 0.1% salt solution, then air-drying

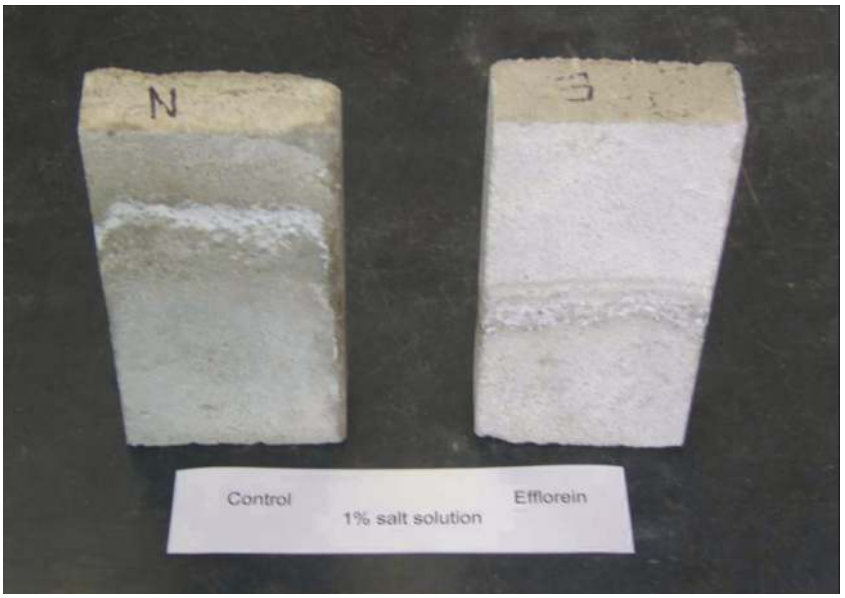

Photo 2:
Specimens after 4 days in 1% salt solution, then air-drying

Results and discussion

Water was observed to migrate up the specimens through the internal porosity until the rate of evaporation from the wet surface equalled the rate of uptake from the solution. This rate of uptake was nearly twice as fast in the control concrete as in the Efflorein concrete (see photo 1).

At both 0.1 and 1% salt concentration, significantly less efflorescence was seen in the Efflorein concrete (compared to the control) after the specimens had dried (photos 2 and 3). At 10%, the efflorescence was so great that it was difficult to make a quantitative judgement. Salt can be seen in photo 4 having fallen off the specimens onto the workbench.

It is not possible to estimate how much less salt there is on the surface of the Efflorein specimens in photos 2 and 3, but it is reasonable to assume that the quantity of salt is in proportion to the amount of water absorbed by the concrete. On this basis there would be a reduction in efflorescence, caused by the use of Efflorein, of about 40%.

The reduction in water and salt uptake would be expected to vary depending on the quality of the concrete. At lower, and more commercially realistic, water/cement ratios (eg more cement and some coarse aggregate) there may be better relative gains to be made by the use of Efflorein.

Further work

A trial currently under way is examining whether the use of Efflorein offers some improvement in salt attack resistance.

Photo 4: Specimens after 3 days in 10% salt solution, then air-drying