Effect of Saltwater on Cementitious Capillary Crystalline Waterproofing

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ABSTRACT - The present studies examine the performance of cementitious capillary crystalline waterproofing coating(CCCW) with Saltwater. As Sri Lanka is a developing country, many underground constructions are being built in coastal areas. This paper aims to review the waterproofing ability of coating on concrete with water, saltwater and seawater. As the main component of seawater is NaCl and the average salt concentration of seawater is 35000 ppm, different concentrations from 8750 ppm to 70000 ppm of saltwater samples are examined. Additionally, a seawater sample is examined as well. Existing results show that there is an effect from saltwater.

Keywords: CCCW; Waterproofing Ability

INTRODUCTION

Concrete is widely used as a construction material due to its high durability and strength. Waterproofing of concrete is essential in many industries for basement protection, water storage protection, petroleum storage tanks, wet room coating etc. Such protection is the prerequisite for sustainable and durable construction. Normally, waterproofing coating is special cement, quartz sand as the base material, the incorporation of a variety of active chemical substance made from powdered rigid waterproofing material, waterproofing effect of the coating occurs with the operation of active chemicals.

There can be several factors that influence waterproofing such as environmental conditions, reactions with active reagents, variations of water etc. Here, we examine the ion concentration effect of seawater on waterproofing coating when applied to concrete. Previous studies report that the addition of chloride ions to sulphate solutions cause increased expansion of cement pastes, but the combined effect of chloride and sulphate ions is less than that of the sum of the separate components. [1] Expansion of the material itself promotes the formation of cracks in concrete, the spread of chloride ions to surface and accelerate the corrosion damage in reinforced concrete structure and Na+, K+ increase the pH value of solution. Chloride ions occur for steel corrosion as well. It is a common problem related to the durability of concrete structures. We hope to study how salt concentration varies with seawater in Sri Lanka and how it can influence the waterproofing effect of the concrete.

There are different kinds of methods to measure waterproofing effect of concrete such as X-ray diffraction (XRD), scanning electron microscopy (SEM), Energy-dispersive X-ray spectroscopy (EDX), Fourier-transform Infrared Spectroscopy (FTIR) analyses method, water absorption test and electrical resistivity method. Electrical resistivity method was selected because the experiment could be implemented clearly and accurate results could be taken easily with our requirements throughout the research. Before the coating is applied on the surface of the specimen, blocks should be wetted with water. When applying coating it is essential to coat the same layers in each specimen.

Then crystals called needle shaped crystals will be formed and will change the pore structure of concrete [$Ca_2(CaO_2).3H_2O$],[$3CaO\ Al_2O_3.Ca(OH)_2.12H_2O$] type of complex will be formed. When the coating reacts with saltwater, ability of crystal formation is reduced because chloride ion will replace the active components in complex.

METHODOLOGY

The experimental program performed was focused on the evaluation of the reliability of crystalline coating under seawater and saltwater conditions with respect to normal water conditions. A couple of measurement methodologies were carried out to quantify the crystalline effect of the introduced surface treatment.

Testing concept

This method is called Electrical resistant method. It was used to find moisture content inside the concrete. An electricity resistivity moisture meter was used to find the moisture content inside the concrete. Numerical values of weight moisture can be taken in this testing method. It was possible to create hydrostatic water pressure easily in this method using PVC pipes.

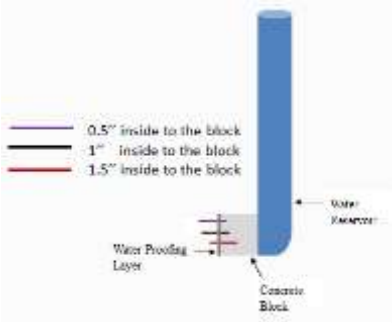


Figure 1. Final structure of model

Water level was kept the same during the experiment to keep the same water pressure, and one concrete block was used as a reference block. Normal water was filled into the reference block. Different concentration of Saltwater (8.75,17.5,35, and 75 ($x10^3$)ppm) and Seawater was filled into another block as reservoir.

This method is most suitable method for our experiment as we could get correct results for moisture meter and the

results analysis could be done more accurately from this method.

Finally, we designed the best specimen for this experiment. The diameter was 4 inches, length of the concrete block was 3 inches and the length of the reservoir was 6 feet. From trial experiments, we found the most suitable length for the concrete block, reservoir and what places we need to select to create holes on the concrete block. Insulated 4 inches two steel rods were submerged and fitted to the concrete blocks same distance and 6 steel rods were fitted according to the above diagram.

Steel rod arrangement in concrete block

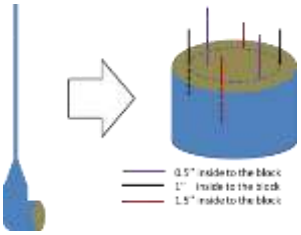


Figure 2. Configuration 1

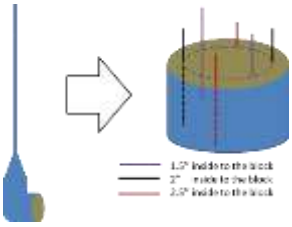


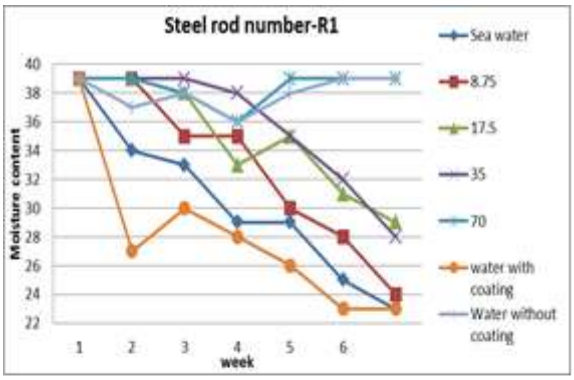
Figure 3. Configuration 3

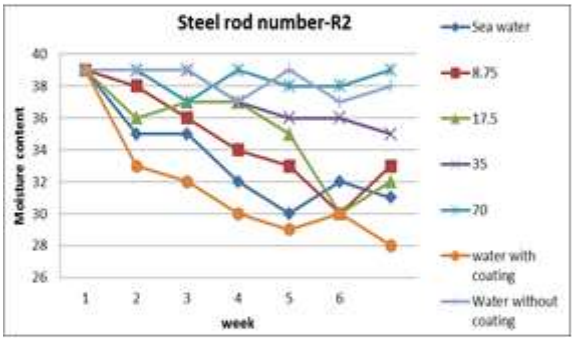
Firstly, the experiments were done according to configuration 01. The moisture meter reading had been taken by every week throughout a month. The moisture meter readings were not changed. In this configuration, insulated steel rods were submerged and fitted to the concrete block and steel rods near to the inside surface of concrete block contact to the reservoir. There was crystal formation in that area and this configuration was taken unsuitable for the experiment.

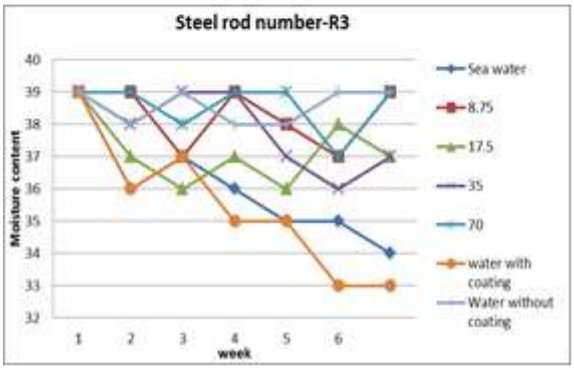
In the configuration 2, insulated steel rods were submerged and fitted to the concrete block and steel rods were fitted near the outside surface (coated surface) of the concrete block. The Crystal formation happened near the inside of the coated surface. This configuration was used to execute the experiment.

RESULTS AND DISCUSSION

According to the graphs below, it shows that moisture readings of water with coating are less than water without coating. It was found that there is a waterproofing effect. Overall graphs show that moisture readings for NaCl samples are higher than water with coating sample. The moisture meter reading has increased with NaCl concentration. It was not a gradual increment. There is an especially high moisture content in the 70 ppm (NaCl) sample. There can be a resistance with the formation of crystals for waterproofing coating based on these existing results.







CONCLUSIONS

The experiment results identified that crystal formation is reduced from coated surface and waterproofing ability is improved when water penetration time is increased. Mainly experimental results proved that is the effect of Chloride ion concentration on the crystal formation and waterproofing ability is inhibited when salt water concentration is increased.

REFERENCES

Characterization of chloride penetration in hydraulic concrete structures exposed to different heads of seawater: Using hydraulic pressure tank. Retrieved from,

https://www.sciencedirect.com/science/article/pii/S2215098618313594

Pavel Reiterman and Jiri Pazderka, Crystalline Coating and Its Influence on the Water transport in Concrete, Available http://dx.doi.org/10.1155/2016/2513514