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CHLORIDES AS INHIBITORS OF SULPHATE CORROSION OF CONCRETE

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ABSTRACT

Sulphate corrosion of concrete is a reaction aluminate hydrates with gypsum formed with sulphates which penetrate from the environment into the concrete. Product reaction aluminate hydrates with gypsum is ettringite, voluminous phase of concrete which construction leads to a state of destruction. In this work are presented results that show how chlorides in solutions with sulphates act as inhibitors sulphate corrosion of concrete.

Keywords: inhibitors, sulphates, chlorides, concrete, corrosion

1. INTRODUCTION

Testing concrete exhibited seawater, it was found that chlorides slow action sulphates on concrete. Chlorides react with aluminate hydrates where it forms of chloroaluminates hydrates [1, 2, 3], so the amount of aluminate hydrates available for forming ettringit is reduced. Ettringit ($C_6A\hat{S}_3H_{32}$) represents expansive, (voluminous) phase, creates a reaction aluminate hydrates with gypsum, which concrete construction leads to a state of destruction. Formation ettringit in the concrete presenting sulphate corrosion of concrete [2].

Investigation confirms that chlorides in the presence of sulphates rich solutions reduce effect of sulphates on concrete prepared from clean cement and cement with additions [4]. This is a logical reason why on some concretes, in soil contaminated with chlorides are not visible effects of sulphates.

Confirmation blocking the effects of sulphates on aluminate hydrates or blocking sulphate corrosion of concrete is testing compressive strength and expansion of samples treated in sulphates solutions and solutions with common sulphates and chlorides ions (Figures 1 and 2). For testing were used two types of cement, ASTM C 150, Type I and Type V (Type I - 8.1 mass % C_3A, Type V - 3.5 mass % C_3A).

Figure 1 shows the variation of compressive strength of Type I and Type V mortar specimens with the immersion period. The trend shows an increase in compressive strength with the increase of immersion period in water and sulphates-chlorides environments for both Type I and Type V cements with water immersion are showing higher rate of gain in strength compared to sulphates-chlorides immersion. On the other hand, the sulphates immersion shows an increase in compressive strength up to about 91 days but beyond 91 days strength decreases for both Type I and Type V cements. The strength of Type I cement mortar is found to be higher than Type V cement mortar in water, sulphates or sulphates-chlorides environment. The strength of mortar specimens (both Type I and Type V) immersed in sulphates or sulphates-chlorides environment is lower compared to water immersed specimens with sulphates immersed specimens showing the lowest strength.

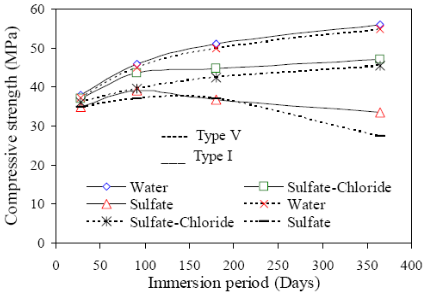

Figure 1. Variation of compressive strength with immersion period [4]

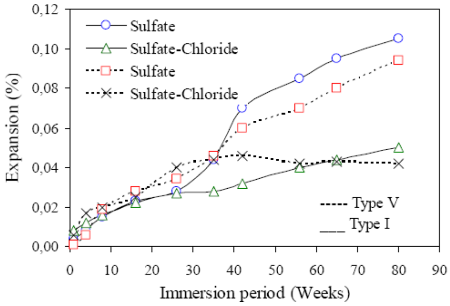

Figure 2. Variation of expansion with immersion period [4]

The expansion of Type I and Type V plain cement mortars specimens in sulphates and sulphates-chlorides environments with immersion period is compared in Figure 2. The general trend shows an increase in expansion with the increase in immersion period. The expansion in Type V mortar specimens is lower than that in Type I mortar specimens as immersion period in both sulphates and sulphates-chlorides solution exceeds beyond 50 weeks. The expansion of both Type I and Type V cement mortar specimens is lower in sulphates-chloride solution compared to sulphates solutions. The reason for this is the formation of ettringite in greater quantity in the samples treated in sulphates solutions.

2. EXPERIMENT

To test the influence of chlorides on sulphate corrosion of concrete were used cement whose mineralogical analysis (Table 1) done on the device X-Ray Diffractometer Siemens D 5000.

Tabela 1. X-ray analysis of cement [5]

Mass percentage minerals of cement			
C_3S	C_2S	C_3A	C_4AF
59,8	19,8	7,5	11,9

For testing were prepared cylindrical samples of cement paste, thermostated 60 days at 21 ˚C, which are added chlorides the amount of 2.6% by weight of cement. After 60 days samples were grinded and them in the analysis confirmed the presence of free chlorides. Grinded contents of samples were treated 24 h in sulphates solutions different concentrations (0.1, 0.01 and 0001 moledm^{-3}). Suspensions were periodically mixed. After 24 h sediments were separated and them are made the X-ray analysis.

3. RESULTS AND DISCUSSION

In Figure 3 are given X-ray diffractograms of the cement paste samples treated in solutions with sulphates and chlorides ions. On diffractograms (Figure 3) are not noticed diffraction lines of ettringite.

Evidence that the chlorides blocking forming ettringite are diffraction lines of portlandite, that not changed the intensity with increasing concentrations of sulphates (Figure 3 a, b, c). Ettringite forms by reactions aluminate hydrates and gypsum. In the process of forming ettringite first will be formed gypsum, reaction of sulphates with portlandite. Gypsum obviously is not formated, because there was not registered reduction of intensity diffraction lines of portlandite.

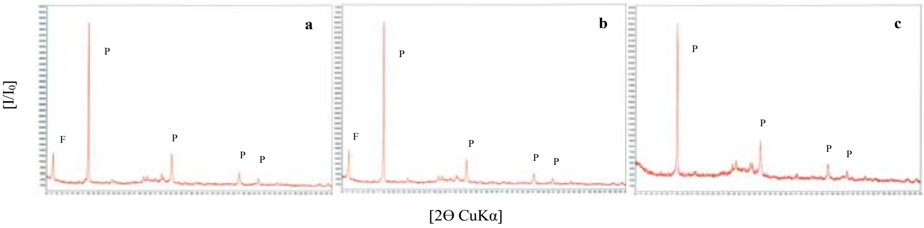

Figure 3. X-ray diffractograms of the cement paste samples treated in solutions with chlorides and sulphates ions [5]

a- 0,001 moledm^{-3} H_2SO_4, b-0,01 moledm^{-3} H_2SO_4, c-0,1 moledm^{-3} H_2SO_4

P – portlandite; F – Friedel's salt (chloroaluminate hydrate)

4. CONCLUSION

In solutions with a common SO4^{2-}and Cl$^-$ions, the dominant is reaction chlorides with aluminate hydrates where it forms chloroaluminates hydrates. Chlorides spend aluminate hydrates blocking their reactions with sulphates, which results in reduction of sulphate corrosion of concrete. Etringit will form only after spend all the free chlorides.

5. REFERENCES

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