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INFLUENCE OF CONTENT TRICALCIUM ALUMINATE IN THE CEMENT ON CORROSION STEEL REINFORCEMENT IN CONCRETE

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ABSTRACT
In this paper is tested rate of corrosion of steel reinforcement in the concrete depending on the content tricalcium aluminate in the cement used. How is chlorides chemical bonding for the aluminates, the amount of free chlorides is relevant to threats to the steel reinforcement. Results of tests show that the intensity of corrosion decreases with increasing tricalcium aluminate content in cement, or a reduction in free chlorides in concrete.
Keywords: corrosion, steel reinforcement, tricalcium aluminate, anode polarization

1. INTRODUCTION
Literature datas indicate that cement with a higher content tricalcium aluminate (C_3A) is bonding more chlorides. The main product of this bonding is monochloride-aluminate ($C_3A{\cdot}CaCl_2{\cdot}H_X$) [1] .
Concentration of free chlorides decreases with increasing the share of C_3A in the cement, independing of the quantity of chlorides additional of time in preparing the concrete (Figure 1). Monitoring the content of free chlorides (Figure 1) in relation to the total amount of chlorides added while preparing the concrete, as well as to the content of C_3A in the cement, can be seen that the free chlorides present in the concrete in which the time of preparing adds 0,4% chlorides by weight of cement, with the C_3A content in cement by 14%. These data confirm that the reaction of chlorides and aluminates equilibrium.
Free chlorides present in the concrete can cause corrosion of steel reinforcement. It has been proved to increase the free concentration of chlorides in the concrete leads to increase in intensity of corrosion [2]. Chlorides connected to monochloride-aluminate not affect on activation corrosion of steel reinforcement.

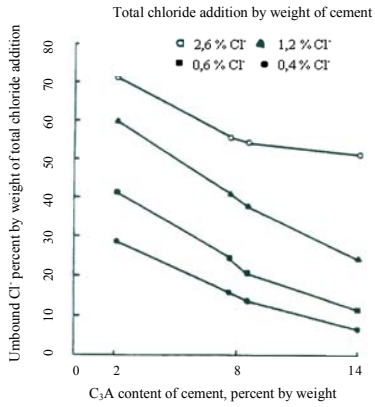

Figure 1. Effect of C_3A content on the free chloride concentration of pore solution in cement pastes [3]

2. EXPERIMENT

Testing the speed of corrosion of steel reinforcement taking the scanning of anode polarization curves the working electrodes. The working electrodes is a cylindrical shaped body in which is embedded steel reinforcement. Working electrodes were prepared from cement mortar in which the mass of cement and aggregates is equal to 1:3. Preparation and fostering working electrodes and the rate of corrosion testing is carried out by the process that prescribes the standard HRN U.M1.044.

Results of experiments are presented in form of anode polarization curves of working electrodes, using linear voltmeter method. Electrolyte used in this case is saturation solution $Ca(OH)_2$. The system for the anode polarization consists of potentiometer EG&G PARC MODEL 263 A, computer and printer. Working electrodes are thermostated 30 days at 21 ˚C, before corrosion testing. During the preparation of working electrodes in them are added chlorides, over $CaCl_2$, the amount of 0,4 % by weight of cement.

To test the influence of C_3A content in cement on the corrosion of steel reinforcement in concrete caused by the influence of free chlorides, were used cements tags FCL1, FCL2, FCL3, whose mineralogical (X-ray) analysis done on the device, "X-Ray Diffractometer Siemens D 5000.

Table 1. Mass percentage of C_3A in the cements used [2]

Tags of cements	Mass percentage of C_3A
FCL1	3,7
FCL2	6,0
FCL3	7,2

To test the speed of corrosion of steel reinforcement in concrete, used the smooth steel reinforcement, whose chemical composition is given in table 2.

Table 2. Chemical composition of steel reinforcement [2]

Element	C	Si	Mn	P	S	Cr	Cu	Ni
Mass %	0,10	0,16	0,43	0,016	0,035	0,08	0,36	0,11

As the C_3A content of cement close (especially with cements tags FCL2 and FCL3), in order to examine the impact of C_3A content in cement on the corrosion of steel reinforcement, when preparing cement mortar, the same must be to add low concentrations of chlorides.

3. RESULTS AND DISCUSION

The results of testing the influence of C_3A content in cement on the corrosion of steel reinforcement in concrete, caused by the free chlorides, are shown in Figure 2.

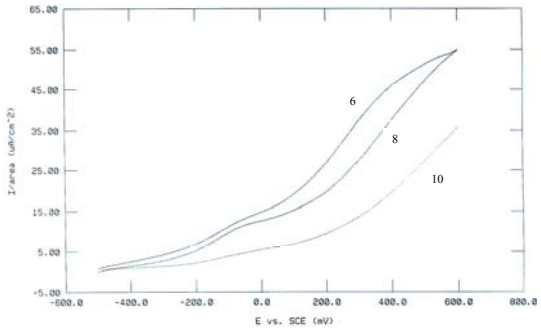

Figure 2. The anode polarization curves for working electrodes [2]

6- FCL1, 8 - FCL2, 10 - FCL3

The results (Figure 2) shows that at concentration of chlorides of 0,4 % by weight of cement, added directly in cement mortar during the preparation of working electrodes, the lowest intensity of corrosion noted on the working electrode preparated of cement FCL3, with the largest cement C_3A content (7,2 mass %). Greatest intensity of corrosion was noted on the working electrode preparated of FCL1 cement, cement with the lowest content of C_3A (3,7 mass %).

These results agree with literature datas by which the cement with the greatest content of C_3A bonding the maximum amount of chlorides, preventing their penetration to the steel reinforcement.

That the amount of free chlorides cause corrosion on steel reinforcement, the proof is to repeat the trend growth of the intensity of corrosion on steel reinforcement with increasing concentration of chlorides (Figure 3), looking at the working electrodes thermostated at the same temperature, 30 days at 21 ˚C.

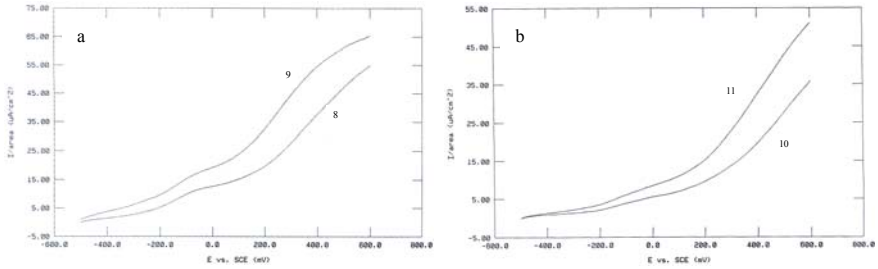

Figure 3. The anode polarization curves for working electrodes [2]

a (FCL2 , 8 – 0,4 % Cl^-, 9 – 0,8 % Cl^-), b (FCL3 , 10 – 0,4 % Cl^-, 11 – 0,8 % Cl^-)

Trend growth of intensity of corrosion on steel reinforcement, the increasing concentration of chlorides, repeated at both the cement used (FCL2 and FCL3).

4. CONCLUSION

Testing the influence of the content of aluminates on the corrosion of steel reinforcement in concrete, the results show that at concentrations of chlorides of 0,4 % by weight of cement, added directly in cement mortar during the preparation of working electrodes, the lowest intensity of corrosion noted on the working electrode preparated of cement with C_3A content of 7, 2 mass %.

Greatest intensity of corrosion was noted on the working electrode preparated of cement with C_3A content of 3,7 mass %.
These results agree with literature datas, according to which the increase in the C_3A content of cement is increasing the amount of chlorides bonding to concrete, which results in reduction of corrosion on steel reinforcement

5. REFERENCES

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