

THE EXPERIMENTAL RESEARCH ON POLARIZATION OF TENSIONED REBARS COATED WITH SULPHUR POLYMER COMPOSITE

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1. Introduction

In order to demonstrate the suitability of sulphur polymer composites for the surface protection of concrete steel experimental research was carried out in the Institute of Building Engineering at Wrocław University of Technology. The research included: the experimental determination of sulphur polymer composite composition and manufacturing conditions, tests of the composite's selected physical, chemical and mechanical properties, tests of its tangent and normal adhesion to plain and ribbed reinforcing bars and to standard cement mortar and concrete, the determination of the mass decrement resulting from storage in aqueous solutions of acids, hydroxides and salts and in water and the polarization investigation of rebars subjected to tension in a solution modelling the pore liquid in carbonated concrete contaminated with chlorine ions.

2. Description of investigations

Polarization investigations of tensioned rebars coated with the sulphur polymer composite were carried out on plain St3S reinforcing steel samples immersed in a solution modelling the porous liquid in carbonated concrete contaminated with chloride ions. The samples were 10 mm in diameter and 290 mm long.

The results of the preliminary tests were analyzed and the sulphur polymer composite having the best properties among the tested composites was selected for further studies.

3. Test results and their analysis.

Polarization investigations of tensioned rebars coated with sulphur polymer composite

Investigation results have been obtained as standard computer diagrams with stationary potentials E_0 and corrosion currents I_0 indicated.

An overview of all corrosion current densities i_0 , stationary potentials E_0 , at loads P , tensile stresses σ_0 and corrosion rates H_t is presented in

[1, 2]. Corrosion rate H_t has been calculated basing on current densities i_0 measured prior and with using a formula:

$$H_t = 1.123 \cdot k \cdot i_0 \quad (1)$$

where: $k = 1.042 \text{ g/Ah}$ means the electrochemical equivalent for iron.

Figure 1 shows corrosion rate H_t versus time (in a time interval of 3-168 hours) at a constant rebar tensile stress σ_a of 194.5 MPa. The rebars are plain rebars 10 mm in diameter, coated with a 0.5 mm and 1.5 mm thick layer of the sulphur polymer composite, immersed in a solution modelling the pore liquid in carbonated concrete contaminated with chloride ions.

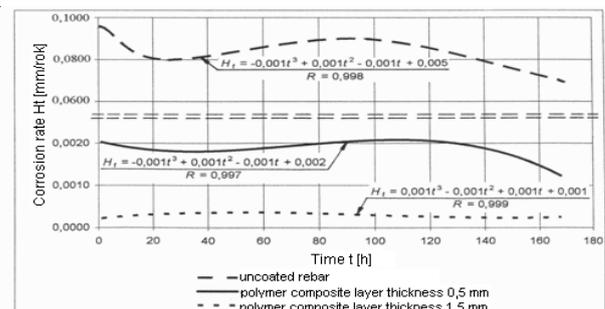


Fig. 1: Corrosion rate versus time at constant tensile stress $\sigma_a=194.5 \text{ MPa}$ for plain rebars 10 mm in diameter, coated with sulphur polymer composite and for uncoated rebars.

According to the figure, after a tensile stress (σ_a) of 194.5 MPa is reached, the corrosion rate (H_t) changes in a time interval of 3-168 hours as follows: it increases initially and after 90 hours from the beginning of the test it starts decreasing, amounting to about 0.0010 mm/year after 168 hours. It is lower in the case of the rebars coated with a 1.5 mm thick layer of the sulphur polymer composite. At this layer thickness, the corrosion rate is only very slightly dependent on time and on the increasing tensile stress in the rebars. Within the test time interval it remained at an almost constant level of 0.000186-0.000242 mm/year. As the figure shows, the corrosion rate for the uncoated rebars is by three orders of

magnitude higher. The corrosion rate over time is described by the equations given in fig. 1.

The very low, nearly constant corrosion rate in the case of the rebars coated with a 1.5 mm thick layer of the sulphur polymer composite is beneficial. Therefore such a layer can be considered as contributing to the protection of the reinforcing steel against corrosion in the solution modelling the porous liquid in carbonated concrete contaminated with chloride ions.

Figure 2 shows the dependence between stationary potential E_o , time and tensile strength for the tested rebars coated with a 0.5 mm and 1.5 mm thick layer of the sulphur polymer composite. For comparison purposes, stationary potential E_o in similar uncoated rebars is shown. The dependencies are described by the included equations.

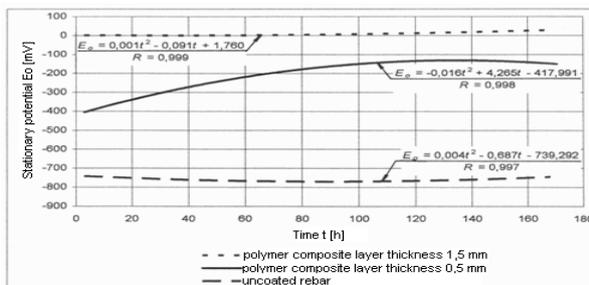


Fig. 2: Stationary potential versus time and constant tensile stress $\sigma_a=194.5$ MPa for plain rebars

10 mm in diameter, coated with sulphur polymer composite and for uncoated rebars.

According to the test results, once tensile strength σ_a of 194.5 MPa is reached in the rebars, a slight increase in stationary potential over time is observed. In the case of a 1.5 mm layer, potential E_o remains constant (close to 0 mV) in the whole test period. It also remains constant for the uncoated reference rebars, but at a level much different from 0 mV.

4. Conclusion

It can be concluded from the test results that the tested sulphur polymer composite can provide surface corrosion protection to the reinforcing steel in concrete. Sulphur composites have not been applied for this purpose before.

The aim of investigation that has been led was to evaluate tendencies of the corrosion process for St3S reinforcing steel when covered with polymer sulphuric coating and exposed to tensile stress. Steel samples were loaded in a way that their yield points were much exceeded; in the same time these samples were exposed to an action of the solution the composition of which is similar to that of pore-liquid of concrete is and additionally contaminated with chloride ions (pH = 9.14). The composition said was as follows: 0.015 M NaHCO_3 + 0.005 M Na_2CO_3 + 0.001 M NaCl . Corrosion rate for the steel has decreased by 2÷3 orders of magnitude when covered with protective coating even though this latest became unseal at load exceeding 88.5 MPa.

References

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