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Analysis of the Long-term Service Life of Coatings Based on Alkali-activated Matrices Exposed to Chemically Aggressive Environments

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Abstract

The paper deals with the possibility of using materials with an alkali-activated matrix for the secondary protection of reinforced concrete structures. Attention is primarily paid to the resistance of this type of coating to the effects of chemically aggressive environments. The long-term effect of selected types of aggressive environments on the coating based on alkali-activated substances was monitored using a set of physico-mechanical and physico-chemical tests. For comparison, a commercially produced epoxy coating with an increased resistance to the effects of chemically aggressive environments, as declared by its manufacturer, was subject to an analogous set of tests.

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Keywords: Long-term; service life; coating; alkali-activated; matrix; aggressive environment.

1. Introduction

The service life of a building structure primarily depends on the conditions in which it is operated. Typically, secondary protection systems are used to limit the effects of exploitation conditions on structural materials. These,

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for example, include coating systems, screeds and, above all, coating materials. At the present time, it is just the polymer materials-based coating systems that dominate.

The matrix of these coating systems is, for example, composed of epoxy or acrylate resins, their copolymers, etc. It can be said that the currently used coating materials feature high quality and good service life. However, these materials show considerable limits under extreme conditions. The effects of chemically aggressive environments represent a typical factor that can significantly decrease their properties, or service life.

The paper presents research that analyses the possibility of using the coatings based on alkali-activated materials in chemically aggressive environments. In general, we can say that the coatings based on alkali-activated materials are made by the polycondensation of aluminosilicates at temperatures up to 100 ºC. Polymerization consists in chemical reactions of aluminosilicates (Al^{3+} in tetrahedral coordination) and alkaline polysilicates forming polymeric bindings Si – O – Al. It results in the creation of a solid and compact structure forming a dominant component of the matrix of the coating system. This type of coating is hereinafter referred to as AAM coating.

The experimental part includes the testing of the effects of selected types of aggressive environments not only on the coating itself; the protective function of the coating is also evaluated through an assessment of the degradation of the underlying concrete, on which the coating was applied. For comparison, a commercially produced epoxy coating with an increased resistance to the effects of chemically aggressive substances, as declared by its manufacturer, has been subject to an analogous set of tests.

2. Methods for experiments

A methodical procedure used for the experiments performed is described in the following text. As already mentioned above, the paper deals with the development of a coating based on alkali-activated materials in terms of its resistance to the effects of chemically aggressive environments.

The composition of the presented AAM coating followed the development previously made in the Institute of Technology of Building Materials and Components, as well as the knowledge mentioned in [1, 2]. The binder of AAM coating consisted of blast furnace slag combined with metakaolin; and Vinnapas dispersion was used to increase the cohesion with the substrate. In addition, water glass was applied to enhance the activation of polycondensation reactions.

For the characteristics of the applied raw materials, refer to the following tables:

Table 1. Composition of metakaolin Mefisto L05.

Component	Component content [%]
Al_2O_3	41.90
SiO_2	52.90
K_2O	0.77
Fe_2O_3	1.08
TiO_2	1.80
MgO	0.18
CaO	0.13
Loss due to annealing	1.40
Moisture	0.10

Table 2. Composition of slag.

Component	Component content [%]
CaO	35.9
SiO_2	40.1
K_2O	0.9
Fe_2O_3	6.9
Al_2O_3	8.2
P_2O_5	1.4
MgO	2.1
Ca	35.9