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ScienceDirect

Procedia Engineering 189 (2017) 650 – 653

Procedia Engineering

www.elsevier.com/locate/procedia

Transportation Geotechnics and Geoecology, TGG 2017, 17-19 May 2017, Saint Petersburg, Russia

Effective Repair and Refurbishment Compound for the Strengthening of a Road Concrete Pavements

T.I. Boykova[a]*, V.Y. Solovyova[a], D.V. Solovyov[a]

[a]*Emperor Alexander I St. Petersburg State Transport University, Moskovsky pr. 9, Saint Petersburg, 190031, Russia*

Abstract

Road pavements for various purposes are constantly exposed to high traffic loads, high temperature changes and aggressive influence of ice-reagents during winter, which cause a negative effect on the durability of concrete. To restore the weakened concrete properties and further protection an effective multifunctional material is needed.
A composite repair-protective material modified by a mixture of developed complex additive has a compressive strength not less than 55,0 MPa, the abrasion resistance mark corresponds to an abrasion brand G1, frost resistance corresponds to brand F2400, and wherein has a high adhesive strength equal to 3,2 MPa for concrete B40 pavement providing a monolithic composition. This material also has a high corrosion resistance. The designed repair material has a protective penetrating ability, thereby increasing the strength of the concrete pavement on 2 classes, and increasing the frost resistance on 100 cycles. The designed repair and protective material successfully passed the pilot tests at the seaport territory.

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology

Keywords: road pavement; resistance to abrasion; frost-resistance; corrosion resistance.

1. Introduction

The repair and refurbishment compound mainly consist of Portlad cement, latex polimer and special purpose components. As an additional components used:

* Corresponding author. Tel.: +7-812-310-1725; fax: +7-812-457-8644.
E-mail address: tiboykova@yandex.ru

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology
doi:10.1016/j.proeng.2017.05.103

- Magnesian limestone with specific surface area, SSA = 250 m^2/kg to increase crack resistance and corrosion resistance of protective material. Use of magnesian limestone based on the electronic structure of magnesium and its ability to forge strong covalent links of sp-configurations. Hydrate compounds on the basis of magnesium are non-soluble and provide increased corrosion resistance for this material.
- Bentonite clay to improve the water-holding capacity of the mortar and provide increased flexural strength. The reinforcing mineral and organic mineral fibers, which created in the synthesis process to increase crack resistance.
- High alumina cement AC-40 to regulate the times of setting and provide increased flexural strength.
- Sand fractioned 0-0,63 mm to form strong and homogeneous structure.

In order to reestablish physical-mechanical characteristics of concrete to design strength, it is necessary to provide permeation of components from repair-refurbishment compound deeper into concrete base. For this purpose, we injected modifiers in repair-refurbishment compound.

The particles of modifier must have the high mobility to increase penetration effect.

As a modifier we applied electrolytes based on cation of potassium K(I): K_2SO_4; KNO_3; KNO_2; KCl.

Cation of potassium K(I) have a large radius, but small hydrate cover, see Fig. 1 (the dashed circle is outer limit of ions hydrate cover).

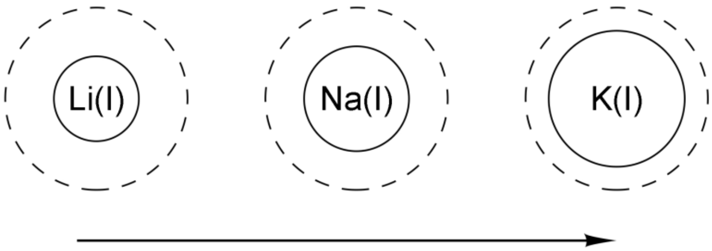

Fig. 1. Improving the mobility of the cations.

It was established experimentally that mobility of cations and ability to penetrate deeper into concrete base as much as possible increased from Li(I) to K(I); this fact is concur with the data generated by other scientists [1, 2].

As a second modifier used colloidal solution of silicic acid (H_4SiO_4). On the basis of the sol H_4SiO_4 includes a nanoparticles of $SiO_2 \cdot nH_2O$ [3, 4].

The nanoparticles of $SiO_2 \cdot nH_2O$ have well-developed surface and as a result, big energy of surface which increases the ability to high mobility and high reactivity. Also it helps to create organic mineral fibers, which reinforced structure of protective pavement and increased crack resistance.

2. Methods

The rational number and effectiveness of modifier assessed by the performance of compressive strength and flexural strength of test specimens to the sizes 4×4×16 cm. The test specimens made from concrete. The upper surface of the specimen with the size 4×4 cm was covered repair-refurbishment compound by test modifiers with different nature. Test specimens harden under normal conditions (temperature 20±2 °C and humidity ≥ 95%) within 28 days.

It was experimentally established that the test electrolytes was nearly the same effectiveness. In this study we preferred KNO_2. Potassium nitrate had a positive impact on the physical-mechanical characteristics of concrete and increased corrosion resistance to the rebar, what is important to protect and refurbishment of concrete constructions [5-7].

From the experience we confirmed that modifiers: potassium nitrate KNO_2 and sol of silicic acid really improved the flexural strength. The results of studies are presented in Table 1.