Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 189 (2017) 569 – 575

Procedia Engineering

www.elsevier.com/locate/procedia

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

Transportation Structures And Constructions With Geoecoprotective Properties

Antonina Sakharova[a] *, Marina Baidarashvili[a], Andrei Petriaev[a]

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

Abstract

In this article the authors examine the construction wastes using autoclave foam concrete, silicate brick and an artificial mineral substance such as cement clinker as an example. Studies have shown that these materials have geoecoprotective properties and they can neutralize heavy metal ions. Therefore the authors suggest applying these materials in geoecoprotective technologies of transport construction to reduce environment pollution. The aim of this research is in agreement with the principles of sustainable development.

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

Keywords: geoecoprotective materials, heavy metals ions, construction wastes, railway transport, geosynthetic materials

1. Introduction

Environment pollution near railway structures results from unsafe transportation of dangerous loads. Heavy metal ions and petroleum products are the most dangerous pollutants from railway transport. Thus, the aim of this research is to develop geoecoprotective technologies in the sphere of transport construction. This purpose can be achieved by using following construction wastes: autoclave foam concrete, silicate brick or an artificial mineral substance such as cement clinker [1].

* Corresponding author. Tel.: +7-904-643-2110
E-mail address: anshelika@inbox.ru

Peer-review under responsibility of the scientific committee of the International conference on Transportation Geotechnics and Geoecology
doi:10.1016/j.proeng.2017.05.090

The main tasks of the research are to determine the geoecoprotective properties of listed materials and to develop technologies in order to protect the environment from harmful effects of heavy metal ions.

Studies [2] have proved that the railway transport is one of the environment pollution sources. Environment pollution which is caused by heavy metal ions is particularly dangerous. As opposed to other pollutants heavy metal ions are kept in soils for a long time even when a pollution source is eliminated. The ability of heavy metal ions to migrate into soil, lakes and rivers and then through food and drinking water into human body makes an adverse impact on human health [3]. The heavy metal ions are carcinogenic. They are genetic poisons that are accumulated in human body with a long-term effect [4, 5].

The analysis of modern transport structures has shown that some of them can be considered to be geoecoprotective. These structures are railway substructure and drainage gutters. Modernization of technological operations during the construction of such structures are based on the replacement of natural materials which are used in their constructional design for geoecoprotective ones. The use of these geoecoprotective transport structures will make it possible to solve two ecological problems [6]. Firstly they minimize negative impacts on the environment near railways. Secondly they contribute to the utilization of construction wastes [7].

2. Determination of construction wastes and cement clinker geoecoprotective properties

Geoecoprotective properties of clinker and some technogenic wastes are considered to be absorbing properties of heavy metals ions. The Engineering Chemistry and Natural Sciences Department of Emperor Alexander I St. Petersburg State Transport University headed by Professor L.B. Svatovskaya has carried out such a research for the last 20 years. Department scientists have identified geoecoprotective properties of such materials as non-autoclave foam concrete [8], granulated blast-furnace slag, phosphogypsum [9], crushed shungite ballast and others construction materials [10, 11].

2.1. Laboratory experiment conditions

Four fractions of materials were selected for the research: 0.14-0.315 mm, 0.315-0.63 mm, 0.63-1.25 mm, 1.25-2.5 mm. Studies of artificial and technogenic material geoecoprotective properties were carried out with the standardized test solutions of heavy metal salts. Those solutions had concentration of 10^{-5}, 10^{-4} and 10^{-3} mol/l that exceeded maximum allowable concentration (MAC) 200 times and more. The following salts were used for the solutions: $Cd(NO_3)_2$ and $Pb(NO_3)_2$. Laboratory experiment conditions are presented at Table 1.

Determination of heavy metal ion concentration in a solution was performed with the help of an electronic analyzer «Expert- 001», using «ALICE» series ion selective electrodes, before and after the interaction of that solution with the tested materials. During the experiment the measuring flasks were filled with 100 ml of the standardized test solution which contained heavy metal ions of different concentrations. Then 1 gram of various fraction tested materials was added in the flasks. The suspensions were stirred up every 5-10 minutes. The contact time was 1 hour that was specified by the adsorption-desorption equilibrium. As the time passed the materials were separated from the test solutions and put on a filter paper. The final concentration of heavy metal ions was determined in each sample. It was a self-reaction at the air temperature of 293 K.

Table 1. Laboratory experiment conditions.

Measurement units of the initial concentration of HMI	Initial concentration of heavy metal ions (HMI)					
	Cd(II)			Pb(II)		
mol / l	10^{-5}	10^{-4}	10^{-3}	10^{-5}	10^{-4}	10^{-3}
mmol / l	0.01	0.1	1	0.01	0.1	1
mg / l	1.12	10.75	104.43	2.28	24.40	250.64
The excess ratio of maximum allowable concentration (MAC)	224	2150	20886	380	4067	41773