UDC 666.973.2

COMPOSITES BASED ON ORGANIC MATERIALS AND METHODS OF REMOTE CONTROL OF THEIR QUALITY DURING EXPLOITATION

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Green building is gaining more and more activity in the world. A number of countries are already introducing environmental design and construction standards. Such indicators as environmental friendliness, economy, energy efficiency, ensuring a healthy lifestyle and comfort are increasingly coming to the fore. Microscopic analysis of wood concrete cement stone with various additives was carried out. A schematic diagram of software for remote material quality control is proposed. The main approaches to monitoring the state of building materials or structures, incl. made of wood concrete or other organic materials.
Keywords: *composites, organic materials, woodconcrete, methods, remote control, quality, exploitation, microstructure, green building*

Introduction. In recent years, green building is gaining more and more activity in the world. A number of countries are already introducing environmental design and construction standards [1]. Such indicators as environmental friendliness, economy, energy efficiency, ensuring a healthy lifestyle and comfort are increasingly coming to the fore [2]. Increasingly, medical research on health hazards from buildings and structures is emerging. So with an increase in height (from the 7th floor and above), due to the shielding of reinforced concrete structures, the impact of the earth's geomagnetic field decreases, which leads to cardiovascular diseases [3]. In multi-storey buildings, interference from wi-fi and bluetooth networks leads to cancer and developmental retardation in children [4]. Narrow small rooms cause a tendency to depression, alcoholism; in children - isolation, autism. In rooms made of reinforced concrete structures, low humidity, which leads to asthmatic diseases.In rooms with aerated concrete walls, high humidity during the first 3 years of operation leads to allergies, fungi, and infectious diseases. When airing the room, expanded polystyrene can emit vapors that irritate the eyes and mucous membranes. Polyvinyl chloride (PVC) gives off gases that affect the nervous system. Silicate bricks and phosphogypsum give off a gas that affects the respiratory system, therefore constant ventilation is necessary. For bonding mineral wool fibers, substances containing phenols and formaldehydes [5].

The recognized leader in environmental friendliness is organic materials, incl. wood concrete. This material has spread and is actively used throughout the world [6-12].

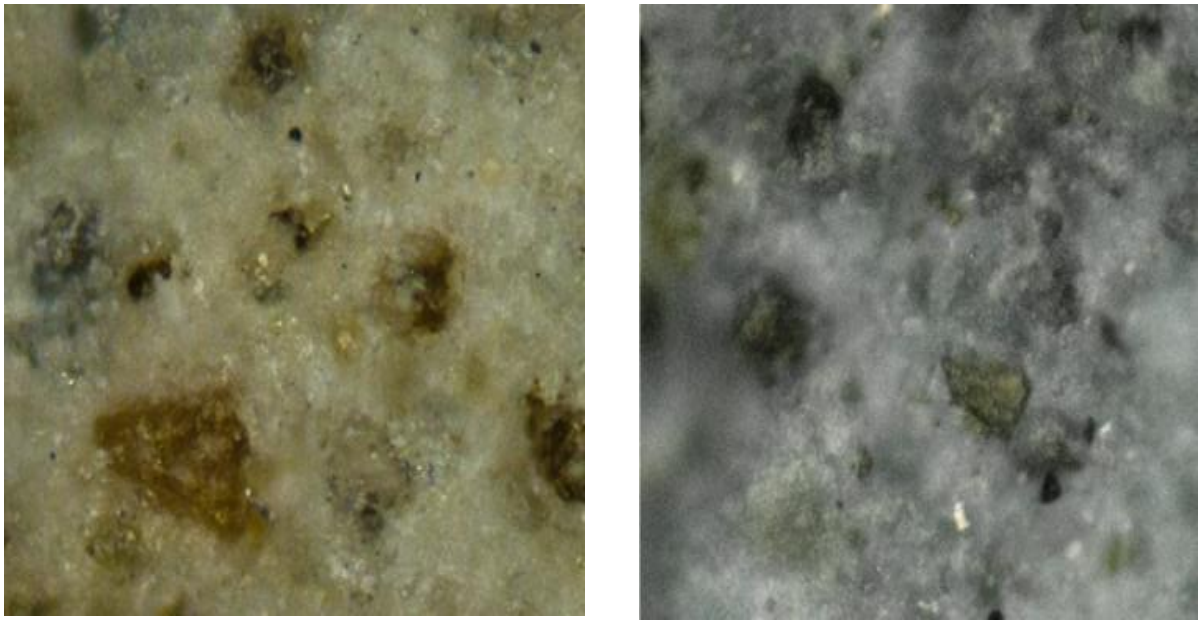
The combination of cement and wood leads to the creation of a material that is able to regulate the indoor climate, incl. regulation of humidity occurs due to the plant origin of the aggregate [6]. Moreover, the material has a high durability [7]. As a filler, various plant wastes can be used [8], as a partial replacement for cement - ash or clay [8, 9]. Another feature of using this material is the use of only local raw materials. So, in China, pine sawdust is used [10], in the Republic of Belarus - agricultural waste [11].

To correctly determine the residual life of structures, the initial data must be determined by the results of field tests and measurements, which is not always possible. The solution is the creation and application of control and monitoring systems for the state of objects [13]. Strain gauges, ultrasonic sensors, temperature, humidity, ph sensors, etc. are used as primary sensors to obtain information characterizing the parameters of the state of the structure. [14].

Main part. The microstructure of wood concrete with various additives is as follows.

In samples with the addition of calcium chloride (Figure 1a), reducing substances are blocked in the form of large yellow clusters. This allows us to conclude that the harmful effect of reducing sub-

stances on the processes of setting and hardening of cement stone will be reduced. In samples with the addition of potassium sulfate (Figure 1b), reducing substances are also blocked in the form of yellow clusters, which allows us to conclude that this additive is effective.



a) b)

Figure 1. – Microscopic analysis of modified additive
calcium chloride (a) and potassium sulfate (b) cement stone (magnification 100 times)

A high-quality monitoring system for the state of a material or structure should monitor all of the following parameters:

– type and number of sensors;
– location of the sensors installation;
– density of data collection;
– positioning;
– data transfer;
– storage and processing of data;
– implementation of a data and decision-making system;
– information system.

Distinguish between mechanical and physical groups of methods for controlling the quality of building materials or constructures [15]. Mechanical methods are based on local destruction of structures at test points. The strength properties of the material are assessed by the force required to destroy a part of the product (when strength test for shearing ribs or for pulling off an anchor device), for hardness according to surface (when tested by impact methods). These methods are quite simple, from the point in terms of testing, however, they differ in low accuracy, do not provide information on the availability of defects in the structure, are not very suitable for a detailed examination of the layers of a rigid road clothes during operation. Physical methods are more informative. These include radiometric, electrical tricheskikh and vibroacoustic control methods. The use of these methods makes it possible to obtain read data on the strength properties of the structure, thickness and density, the presence of hidden defects, evaluate its reliability [16].

The ultrasonic method was developed primarily for assessing the quality of cement concrete of civil engineering products, where testing on the main scheme - end-to-end sounding of structures. In cases where the use of such a scheme is difficult, a sounding scheme was developed for one-way access to the product. However, using such a test scheme is possible when determining the sounding coefficient based on a series of tests on laboratory samples for each type of mixture. Currently, in the context of limited funds for the diagnosis of building materials and structures for the subsequent planning of repair and reconstruction is of particular relevance to economical and mobile inspection methods based on the use of non-destructive testing (NDT) devices.

The main element of remote monitoring of the quality of material or construction should be software. The features of the program will be: the ability to automatically connect to the previously selected bluetooth device to the sensor, voice recognition of the text, displaying the values read from the sensors in real time. The program interface and connection diagrams of some sensors are shown in Figure 2.

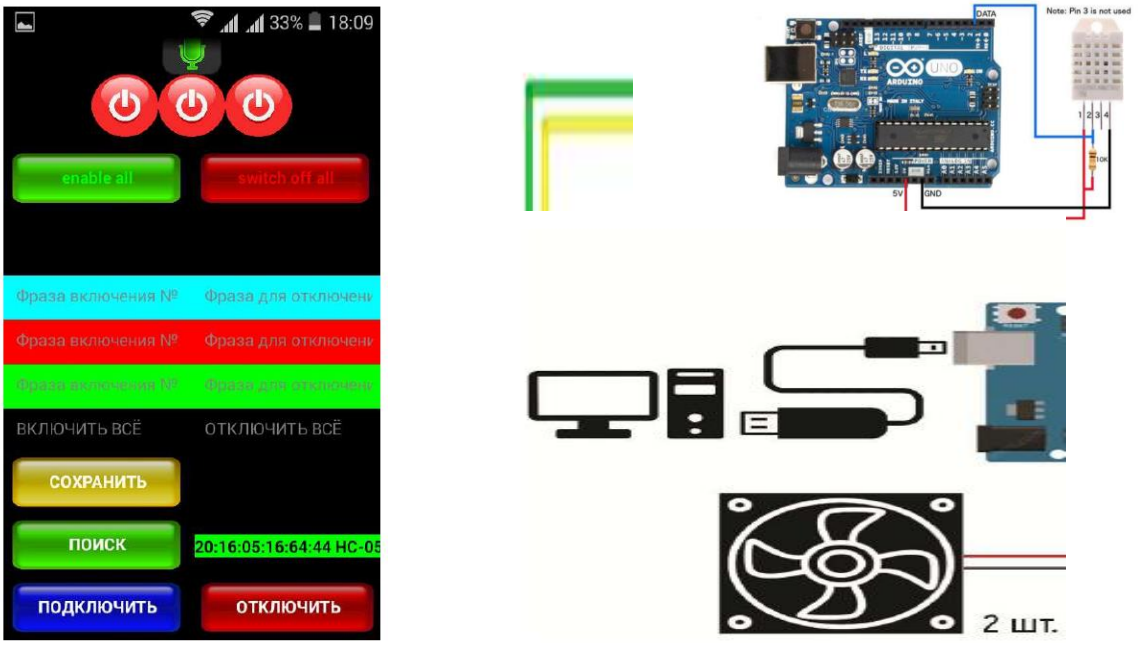


Figure 2. – Program interface and connection diagrams of some sensors

Also one of the modern monitoring methods is laser scanning. Sensors register laser signals reflected from various surfaces; each reflected signal is recorded in the system memory as a point in three-dimensional space. The main advantage of the laser scanning method is the ability to quickly survey in conditions of non-stop moving traffic, without blocking roads and disrupting the operation of transport infrastructure.

During the operation of a building structure, fatigue damage accumulates in concrete due to the effects of moisture and corrosive environments, various strengths and time durations of loads, leading to micro fractures in the material, temperature fluctuations, periodic freezing. Defrosting and thawing, as well as due to disruption of contacts between the cement stone and the aggregate. These damages at the initial stage of development are not detected by means of magnetic, eddy current and ultrasonic control, because such active methods do not carry information about the dynamics of the development of defects and the behavior of the object during the influence of the listed influences. The question of the safe operation of such structures can be resolved only with the use of non-destructive testing (NDT) devices that are sensitive to insignificant developing defects. In this regard, the task of identifying growing cracks, including those at the initial stage of development, seems to be especially urgent. To solve

such a problem, an integral survey method based on the phenomenon of acoustic emission (AE) has proven itself well [17].A fairly rapid course of physical processes of structural change in a limited volume of material (plastic deformation, destruction, formation and growth of cracks, movement of dislocations, phase transformations, friction, etc.) is accompanied by the emission of acoustic waves. Described the phenomenon is called the AE of the material and is used in nondestructive testing (NDT) to detect defects actively developing under load. An important advantage of the presented method is the direct connection of the informative parameters of the AE signals with the destruction processes, which is not characteristic of traditional methods. This allows one to obtain direct information about the stage of development and growth rate [10].

At present, the method of acoustic emission is one of the most widespread and widely developed methods of non-destructive testing. It is used in various industries for non-destructive testing and research of technological processes [12]. As the analysis of the state of modern physical methods of non-destructive testing shows, at present, the method of acoustic emission (AE), shown in Figure 3, is most promising for diagnosing the corrosion process directly at the facility during its operation.

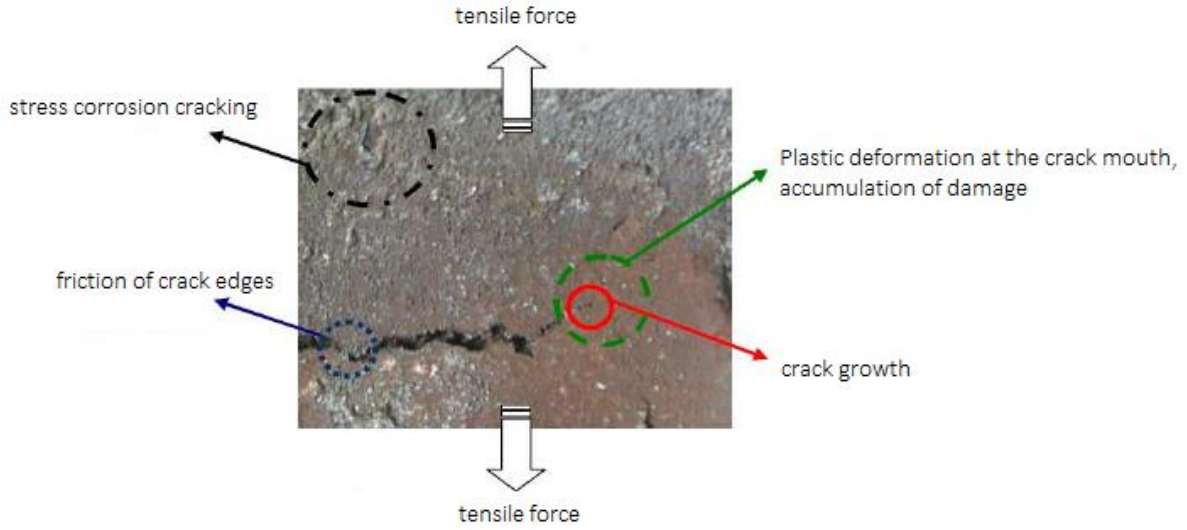


Figure 3. – Fragment of material with a defect and typical sources of AE material

Conclusion. Microscopic analysis of wood concrete cement stone with various additives was carried out. A schematic diagram of software for remote material quality control is proposed. The main approaches to monitoring the state of building materials or structures, incl. made of wood concrete or other organic materials.

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МИНИСТЕРСТВО ОБРАЗОВАНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«ПОЛОЦКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ»

АРХИТЕКТУРНО-СТРОИТЕЛЬНЫЙ КОМПЛЕКС: ПРОБЛЕМЫ, ПЕРСПЕКТИВЫ, ИННОВАЦИИ

ЭЛЕКТРОННЫЙ СБОРНИК СТАТЕЙ
III МЕЖДУНАРОДНОЙ НАУЧНОЙ КОНФЕРЕНЦИИ

(Новополоцк, 29–30 апреля 2021 г.)

Текстовое электронное издание

Новополоцк
Полоцкий государственный университет
2021

Об издании – 1, 2

1 – дополнительный экран – сведения об издании

УДК 72:624/628+69(082)

Одобрено и рекомендовано в качестве электронного издания
Советом инженерно-строительного факультета (протокол № 8 от 27.10.2021 г.)

АРХИТЕКТУРНО-СТРОИТЕЛЬНЫЙ КОМПЛЕКС: ПРОБЛЕМЫ, ПЕРСПЕКТИВЫ, ИННОВАЦИИ [Электронный ресурс] : электрон. сб. ст. III междунар. науч. конф., Новополоцк, 29–30 апр. 2021 г. / Полоц. гос. ун-т ; Редкол.: Д. Н. Лазовский (председ.) [и др.]. – Новополоцк : Полоц. гос. ун-т, 2021. – 1 электрон. опт. диск (CD-ROM).

ISBN 978-985-531-779-2.

Рассмотрены вопросы архитектуры и градостроительства в современных условиях, прогрессивные методы проведения инженерных изысканий и расчета строительных конструкций. Приведены результаты исследований ресурсо- и энергосберегающих строительных материалов и технологий, энергоресурсосберегающие и природоохранные инновационные решения в инженерных системах зданий и сооружений. Проанализированы организационные аспекты строительства и управления недвижимостью, проблемы высшего архитектурного и строительного образования.

Для научных и инженерно-технических работников исследовательских, проектных и производственных организаций, а также преподавателей, аспирантов, магистрантов и студентов строительных специальностей учреждений образования.

Сборник включен в Государственный регистр информационного ресурса.
Регистрационное свидетельство № 3671815379 от 26.04.2018 г.

211440, ул. Блохина, 29, г. Новополоцк, Беларусь
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№ госрегистрации 3671815379
ISBN 978-985-531-779-2

2 – дополнительный титульный экран – производственно-технические сведения

Для создания текстового электронного издания «Архитектурно-строительный комплекс: Проблемы, перспективы, инновации» использованы текстовый процессор Microsoft Word и программа Adobe Acrobat XI Pro для создания и просмотра электронных публикаций в формате PDF.

АРХИТЕКТУРНО-СТРОИТЕЛЬНЫЙ КОМПЛЕКС:
ПРОБЛЕМЫ, ПЕРСПЕКТИВЫ, ИННОВАЦИИ

ЭЛЕКТРОННЫЙ СБОРНИК СТАТЕЙ
III МЕЖДУНАРОДНОЙ НАУЧНОЙ КОНФЕРЕНЦИИ

(Новополоцк, 29–30 апреля 2021 г.)

Технический редактор *И. Н. Чапкевич.*
Компьютерная верстка *А. А. Прадидовой, С. Е. Рясовой.*
Компьютерный дизайн обложки *Е. А. Балабуевой.*

Подписано к использованию 16.11.2021.
Объем издания: 13 Мб. Тираж 3 диска. Заказ 736.

Издатель и полиграфическое исполнение:
учреждение образования «Полоцкий государственный университет».

Свидетельство о государственной регистрации
издателя, изготовителя, распространителя печатных изданий
№ 1/305 от 22.04.2014.

ЛП № 02330/278 от 08.05.2014.

211440, ул. Блохина, 29,
г. Новополоцк,
Тел. 8 (0214) 59-95-41, 59-95-44
http://www.psu.by