

INNOVATIVE MATERIALS AND SMART TECHNOLOGIES FOR ENVIRONMENTAL SAFETY, IMATEH

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ABSTRACT

Use of innovative and advanced materials is a driving force in many sectors of economy. Results of research on materials are significant for improving building and transport infrastructure and ensuring climate, environmental, health safety. Systems of smart materials provide the preconditions for a breakthrough in creation of innovative constructions, thus contributing to the use of future technologies in urban environment and providing a significant economy of energy in the construction sector. In addition to the impact on economy created by the use of innovative materials, they should be environmentally friendly, i.e. materials used in infrastructure projects should be safe against potential chemical and biological risks during all life-cycle. Taking into account that every material can lose its properties with time, it is vitally important to create and apply methods for detecting ageing of the material at early stages.

Keywords: *innovative materials, smart technologies, environmental and human safety*

INTRODUCTION

According to the latest EU standards, the sustainability and safety are among key demands for building materials and structures. Therefore, attention should be paid not only to the direct costs of structures and infrastructure objects but also to the growing maintenance costs of these structures and objects. Annual growth in maintenance costs of buildings and infrastructure objects is observed in Latvia, which can be explained by both construction of new objects and ageing of the existing buildings, infrastructure, proper and regular maintenance. For example, expenses for maintenance and repair works of the EU transport infrastructure will amount up to 11 billion euros during next 20 years. It should be noted that the amount of financial investments in buildings and infrastructure objects for preventive measures was insignificant and irregular since Latvia had gained its independence. Therefore, current safety can be doubted for infrastructure objects and buildings built 50–60 years ago and having reached the end of their planned service life. Being aware that in the nearest future it would be impossible to pull down all objects and buildings after expiry of their exploitation period, it is necessary to take into account economic considerations, standards, methods and recommendations for safety assessment in these buildings, which would be based on scientific research and recognized by experts in order to use them in the process of decision-making

according to legislative norms. Similar tendency can be observed in recently constructed buildings, namely, the quality of construction design and construction works is questionable due to the lack of consistency in legislation regarding the construction sector. Overall quality of construction works has decreased during the last few years, which is associated with a strong focus on the lowest costs in national and municipal tenders and lack of qualified labour force in the construction sector leading to the use of unqualified labour force. Consequently, a synergy can be noticed with the National Research Programme priority “**INNOVATIVE AND ADVANCED MATERIALS, SMART TECHNOLOGY**”, which is one of the priority directions in 2014-2017. In addition, conformity of the National Research Programme with other priority directions - “**LOCAL RESOURCES RESEARCH AND SUSTAINABLE USE**” and “**ENVIRONMENT, CLIMATE AND ENERGY**” can be observed [1].

National Research Programme has a practical orientation: each of its tasks will contribute to the important sectors of the Latvian economy - Construction, Transport, Material Processing. At the same time, the main task of the research programme is to create new knowledge about use of innovative materials, ensure safe living environment, facilitate technology transfer to the economy by contributing to the restructuring of the national economy according to the smart specialization strategy for a long-term development in Latvia.

Six projects are included in the National Research Programme IMATEH, being interrelated and integral parts of the whole programme in order to fulfill the tasks of the programme:

Goal of the project “**Innovative and Multifunctional Composite Materials from Local Resources for Sustainable Structures**” is to create and investigate composite materials for sustainable buildings, for example, CO₂ neutral composite materials from textile plants, high-performance concrete composite materials and bitumen composites. [2], [3], [4].

Innovative composite materials for construction purposes, which are made from the local resources and are well suited for the Latvian climate with a high air humidity, as well as recommendations and guidelines for production and casting of these products will be developed within the framework of this project. Fulfillment of the project will contribute to the transformation of economy to production of construction products with a high added value.

Forests, being one of the most important renewable resources, wood construction materials and composite materials play an important role in the construction sector. Within the framework of the project „**Layered Wooden Composite with Rational Structure and Increased Specific Bending Strength**”, it is planned to develop the principles of ribbing technology as well as demonstration models of wood composite plates. Creation of layered wood composite material with a rational structure with increased specific bending strength will lead to reduction of expenses, materials and energy compared to conventional wood materials. These innovative materials will have a potential not only to enter the local market but also contribute to the export capacity of wood processing companies [5]. Another project - “**Innovative and mul-**

tifunctional composite materials for sustainable buildings” is being implemented in relation to wood construction materials. Within this project, it is planned to develop plywood I-core type sandwich panels, which are composite materials alternative to conventional plywood boards having improved heat resistance, vibration/impact damping and environmental stability. Such structural solution has several advantages over conventional plywood boards: weight and material savings are only some of them [6].

National Research Programme is oriented to the development of innovative composite materials for construction sector, thus assessment of safety and sustainability of the existing buildings and infrastructure objects as well as the increase in their safety level and service life by using innovative materials and technologies is an integral part of it. Within the framework of the project “**Risk Consideration for Safe, Effective and Sustainable Structures**”, dynamic characteristics of road bridges in Latvia will be investigated and technologies for control of active and hybrid vibrations aimed at reduction of unwanted vibrations will be developed. Besides, methods and technologies for structural health monitoring of real applications that can increase safety, extend serviceability, reduce maintenance costs and operating limits of structures will be developed, contributing to the increase of knowledge about building safety and its assessment methods [7].

Mechanical destruction of materials begins at nano and micro scale. Early destruction is researched in the project “**Material Mechanical Micro- Nano- Scaled Features and Their Impact on Human Safety**” which goal is to develop methods for early diagnostics of destruction of polymers and polymer composites and analyse application of these methods in enterprises in order to improve quality of the materials. The planned results of this project will be methods for early diagnostics of destruction of polymer and polymer composite materials and recommendations on how to choose the composite materials and polymers for mechanical constructions and drinking water systems. Development of the above-mentioned methods will create a world-class knowledge and contribute to improved quality and increased safety level of materials as well as to the solutions of economic problems and possible creation of competitive products [8].

In order to prolong the life cycle of dynamic constructions operated in conditions of movements, vibrations and mutual influence, the task of scientific research is to reduce the friction-caused fatigue impact of materials.

Goal of the project “**Processing of Metal Surfaces to Lower Friction and Wear**” is to develop a methodology and criteria for optimization of metallic material properties for improvement of surface treatment and coating and reduction of friction and wear of friction pairs. To achieve this goal, it is necessary to determine the relationship between metal alloys and their sliding ability, to develop a method for measurement of sliding ability, as well as to determine the main factors that influence the increase in the sliding ability. Surfaces with improved sliding ability will be created in this project with involvement of local metal working companies and use of new surface modification methods [9], [10].

CONCLUSIONS

In the course of this research realized within the framework of the National Research Programme, innovative and multifunctional materials and technology will be created, as well as legislative and normative base for safe application of materials and structures in Latvia will be developed.

The accumulated knowledge in the form of publications, recommendations, technologies, methodology and other scientific documents as well as scientific conferences (student conference, 2nd International Conference "Innovative Materials, Structures and Technologies") will be available to producers of construction materials, civil engineers, students, planners, as well as legislative and supervisory institutions resulting in economic development and direct improvement of human living environment safety for the existing and future infrastructure.

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KOPSAVILKUMS

Publikācija veltīta valsts pētījumu programmas "Inovāatīvi materiāli un viedās tehnoloģijas vides drošumam (IMATEH)" projektu īstenošanai. Šīs programmas ietvaros tiek radītas jaunas zināšanas inovatīvo un daudzfunkcionālo materiālu un tehnoloģiju jomā, kurai ir liela ietekmē uz industrijas attīstību, ražojot sarežģītus produktus un attīstot zināšanu pārneses vidi, veidojot labāku izpratni par nākotnes tehnoloģijām, palielinot bāzes pētniecības kapacitāti viedo materiālu un konstrukciju sektoros. Projekta īstenošanas gaitā tiek veicināta uz zināšanām balstītas tautsaimniecības attīstība, sniedzot ieguldījumu Latvijas apstrādes rūpniecības ilgtspējīgā attīstībā, diversificējot apstrādes rūpniecību un panākot straujāku vidēji augsto un augsto tehnoloģiju nozaru attīstību, kā arī sekmējot augstākas pievienotās vērtības produktu ražošanu tradicionālajās tautsaimniecības nozarēs un jaunu nišas produktu ražošanas attīstību.