PART 2: PROGRAMME PROJECT INFORMATION

2.1. Project No. 1

Title	***Innovative and Multifunctional Composite Materials from Local Resources for Sustainable Structures***		
Project leader's name, surname	Diana Bajare		
Degree	Dr.sc.ing.		
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2.2. Tasks and deliverables

(List all tasks and deliverables that were planned for reporting period, list responsible partner organizations, give status, e.g. delivered/not delivered)

Target: ***Create and investigate multifunctional materials and composites, including composite materials for sustainable buildings, and bio-materials such as CO_2 neutral or negative fibre composite.***

The Project consists of research divided in three parts each having its own core task to be completed in the framework of NRP IMATEH:

Core task 1: *To develop high performance concrete composite materials for infrastructure projects and public buildings, focusing on their permanence (freeze resistance, corrosion resistance, etc.) and sustainability in the local climate in Latvia, which differs from the climate in other European countries with high level of relative humidity and swift temperature fluctuations around 0 ^oC in winter and autumn, etc.;*

Core task 2: *To develop compositions of bitumen composites characterised by economy, environmental friendliness and permanence using lower quality local aggregates, recycled asphalt concrete as well as warm-mix asphalt concrete technologies;*

Core task 3: *To develop CO_2 neutral composite materials made from textile plants for use in energy-efficient buildings, thus contributing to a comfortable and healthy climate inside the building.*

Time frame for the core tasks is given in Annexes 1-A, 1-B and 1-C.

In addition, specific tasks related to completing core tasks of each Project parts are defined in every Period of the Project corresponding to the calendar year.

No.	Tasks	Deliverable	Responsible partner	Status
1.1.	To create production method of high	Production method of innovative and advanced cement composite with microfillers materials for infrastructure	D. Bajare, Department of Building materials	Delivered Annex-

	performance concrete composites (compression strength >100MPa) for use in infrastructure and public buildings, partly replacing concrete with microfillers having local origin.	projects and public buildings (30.09.2015) Annex 1-A	and Technologies, Institute of Materials and Structures, RTU	NN
1.2.	To develop recommendation on increase of the corrosion and freeze resistance properties for the concrete produced from the Latvian cement.	Recommendation on increase of the corrosion and freeze resistance properties for the concrete produced from the Latvian cement (31.12.2016) Annex 1-A	D. Bajare, Department of Building materials and Technologies, Institute of Materials and Structures, RTU	In progress
2.1.	To create production method for high performance asphalt concrete mixes from local low quality components.	Production method for high performance asphalt concrete mixes from low quality components (30.09.2015) Annex 1-B	V. Haritonovs, Centre of Construction Science, RTU	Delivered Annex-NN
3.1.	To develop production method for ecological composite materials from textile plants and local mineral binders.	Production method for ecological composite materials from textile plants and local mineral binders (30.03.2016) Annex 1-C	G. Sahmenko, Department of Building materials and Technologies, Institute of Materials and Structures, RTU	In progress
3.2.	To develop and write guidelines for data collection system, which is suitable for heat and humidity migration control in energy-efficient buildings .	Guidelines for data collection system (30.12.2017) Annex 1-C	G. Sahmenko, Department of Building materials and Technologies, Institute of Materials and Structures, RTU	In progress

In case of non-fulfilment provide justification and describe further steps planned to achieve set targets and results

The planned targets of the NRP IMATEH Project 1 „*Innovative and Multifunctional Composite Materials from Local Resources for Sustainable Structures"* were fully achieved in the reporting period from 01.01.2015 till 31.12.2016. The planned tasks are completed and the main results obtained.

2.3. Description of gained scientific results

(Describe scientific results achieved during reporting period, give their scientific importance)

Target of the Project 1: ***Create and investigate multifunctional materials and composites, including composite materials for sustainable buildings, and bio-materials such as CO2 neutral or negative fibre composite.***

Target of the Project 1 within the National programme IMATEH is to create innovative and sustainable materials (cement, bitumen and fibrous composites) by using local raw materials. Targets set for this reporting period are fully achieved.

Core task 1: *To conduct research on the high performance cement composite materials for use in infrastructure and public buildings stressing their durability in the Latvian climate.*

Time frame for the Core task 1 is given in Appendix 1-A.

Task for the Period 2: *To test durability of high performance cement composite materials (compressive strength >80MPa) made from local raw materials and intended for infrastructure and public buildings.*

The microfillers added to the high performance concrete mix impacts its durability. Typically concrete without microfillers is weaker with regard to its mechanical and durability properties, thus by using microfillers it is possible significantly increase the concrete quality and to obtain high performance concrete. Due to the impact of microfillers on the concrete properties it is possible to optimize the composition of concrete reducing consumption of energy-intensive and uneconomical materials. Portland cement is highly energy-intensive raw material used to produce concrete with 0.8-1.0 t CO_2 emissions on 1 t of cement clinker produced. In addition, emissions from cement production constitute 5-7% of total CO_2 emissions in the world. In 2015 emissions coming from the cement clinker production industry in Latvia were equal to 648 000 t of CO_2 which is 5% of the total amount of 12 820 000 t of CO_2.

In the Period 1 of the project economically reasonable and technologically applicable formulations of the high performance cement composite materials with compressive strength exceeding 80 MPa for use in infrastructure and public buildings from local raw materials has been developed by using microfillers available in the Baltic region and especially in Latvia. The volume and availability of these microfillers correspond to the sustainable construction principles.

The use of microfillers is aimed at reducing the costs per unit of the concrete by replacing certain amount of the cement and in the same time improving its mechanical and physical properties and improving durability indicators. In addition, it contributes to the environmental protection as reduced amount of cement per unit of the concrete favours the decrease of CO_2 emissions and use of non-renewable natural resources in the cement production.

In the reporting period high performance concrete has been prepared and impact of the microfillers on properties of fresh and hardened concrete has been determined. Concrete mixes with metakaolin containing waste, cenospheres, microsilica, disintegrated quartz sand as well as quartz and dolomite sand have been prepared; these microfillers were used to replace 5; 10 and 15% of cement in the total volume of cement mass. When replacing cement with microfillers, their impact on the workability of fresh concrete has been assessed. Workability of the self-compacting concrete and constant water/cement (w/c) ratio were kept stable by adding plasticiser to the mix. The increase in compressive strength of hardened concrete was determined after 7, 28 and 180 days including the impact of microfillers on the compressive strength indicators. In the reporting period testing of concrete durability was started and continued, including resistance to the freeze-thaw cycles (freeze resistance),

resistance to the migration of chloride ions in the concrete structure (chloride test) as well as alkali silica reaction (ASR) in the concrete structure was assessed.

Core task 2: *To conduct a research on compositions of bitumen composites, where lower quality local mineral materials, recycled asphalt concrete as well as warm-mix asphalt concrete technologies were used.*

Time frame for the Core task 2 activities is given in Appendix 1-B.

Task for the Period 2: *To develop formulations of the high performance bitumen composites using reclaimed asphalt pavement (RAP) and to continue developing bitumen composites from lower quality local aggregates.*

With the rising costs of bitumen binder and aggregates, there is a growing interest in using increased quantities of reclaimed asphalt pavement (RAP) in the production of hot mix asphalt (HMA). The use of RAP has increased significantly in the last 20 years.

Road construction sector is characterised by very material-intensive processes and it has significant consumption of energy resulting in lasting effects on the environment. Use of RAP in the production of new HMA mixes is not only cost-efficient and environment friendly, it also leads to saving of non-renewable natural resources. The most visible are the financial benefits but there are other benefits as well. By recycling the asphalt pavement it is possible to reduce consumption of energy necessary for producing, transporting and using new aggregates in the construction processes, which allows directly save the environmental resources.

Other benefits form the use of recycled asphalt pavement in the production of new pavements are the following:

- reduced construction costs;
- less wasted materials;
- reduced transportation costs;
- reduced consumption of aggregates and binder;
- energy savings;
- saving of the environment (lower levels of toxic and gas emission);
- maintenance of the existing road geometry;
- lower road wear due to decreased transportation of the materials.
- Using 20–50% of the RAP in the mix allows to save 14–34% of the costs on each ton of the road pavement which is produced.

Use of RAP in the production of new HMA mixes is in the development stage in Latvia; therefore the research focuses on the trends of production, recycling and storage methods of the RAP material. Formulation for the asphalt pavement mix with high RAP content will be developed. Restoration of the RAP bitumen will be done with the lowest viscosity bitumen (B70/100 or B100/150), while local dolomite shiver will be added to the RAP aggregate. Optimisation of the amount of RAP will be based on the exploitation properties (rutting resistance, fatigue and thermal cracking resistance).

Core task 3: *To develop CO_2 neutral composite materials made from textile plants for use in energy-efficient buildings, thus contributing to a comfortable and healthy climate inside the building.*

Time frame of the Core task 3 activities is included in Appendix 1-C.

Task for the Period 2: *To develop data collection system, which is suitable for heat and humidity migration control in energy-efficient buildings.*

In order to achieve the tasks set for the Period 2, data collection system, which is suitable for heat and moisture migration control in energy-efficient buildings, has been developed. It consists of 11 sensors (5 for temperature, 5 for moisture and 1 for heat flow), which are designed for integration into the envelope structures of the experimental structures or in the structures of existing buildings, and of data collecting/processing device which allows to save data to the FTP server. The developed system has been tested in the field and laboratory settings and has been improved in order to ensure full operation of the system. Its operation in the test mode has been compared to the standard heat flow measurement system, which have led to the conclusions that the results are stable and variations do not exceed 10%.

After its improvement and approbation, the system for data collection was integrated into experimental wall panel; which was installed on the existing wall in the part intended for a window. The wall panel was made of laboratory tested mix of fibres and binder, allowing to compare the results obtained in the laboratory settings with those obtained in the field settings. The measurements started immediately after installing the panel thus allowing to assess and study the heat flow and moisture migration processes caused by the external conditions as well as caused by the vaporization of the water related to the technological processes.

In addition, the system was used to assess the current moisture migration and heat flow for the part of the wall, where heat isolation blocks made of fibre plants will be installed for improving the thermal parameters of the wall in the later stages of the project.

In the previous research it has been concluded that there is considerable potential for the production of lime-based materials with natural fibre in Latvia but its use is limited due to the insufficient strength and climate factors. In order to improve the physical and mechanical properties of materials, new compositions of fiber composite materials were created in the Period 2 of the project and their physical and mechanical properties were tested. The specimens were made from hemp shives supplied by the biggest hemp producers. In addition, the research has been continued on finding and assessing alternative mineral binders from local raw materials which could improve mechanical properties of the materials. One of the most promising solutions is gypsum-cement-pozzolanic binder which shows better strength and moisture resistance compared to the lime based binders. Sapropel is considered as an alternative for the composite material with hemp as it is an environmentally friendly renewable resource.

Both industrially produced wall panels and fiber composite materials were tested with regard to their mechanical strength using 3 point flexural test. Thermal conductivity of all experimental mixes has been determined and thermal conductivity density curve has been created. Fire resistance test of the hemp composite material plate has been performed according to the LVS EN 13823:2010.

The obtained research data were summarised and presented in conferences and conference proceedings. In addition, calculations with regard to the natural fibre composite material life cycle as well as extraction and processing of data were started during this project period.

Tasks for Period 2	Main results
1. To test durability of high performance cement composite materials (compressive strength >80MPa) made from local raw materials and intended for infrastructure and public buildings.	***Review on durability of high performance cement composite materials. 2 publications have been submitted.***

High performance concrete with improved compressive strength is a logical stage of development following the conventional concrete widely used for the construction purposes today. The improved compressive strength and durability allows building lighter structures which are more efficient compared to the ones built with traditional materials and methods; in the same time these structures comply with the safety, durability and aesthetic requirements. As production of high performance concrete typically us associated with higher consumption of cement, reduced amount of w/c, plasticizer and microfillers, it is necessary to assess the possible microfillers in order to find the most efficient ones for creating rational compositions of high performance concrete with the lowest possible consumption of cement.

In the reporting period efficiency of the microfillers and their impact on the physical and mechanical properties of the concrete were assessed as well as concrete durability parameters, such as freeze resistance, chloride migration, alkali-silica reactions, were tested. It has been concluded that microfillers (calcined kaolin clay, microsilica, cenospheres, dust coming from the cement production) can be used to partially replace cement (in certain cases even up to 15% from the cement mass) without reducing or even improving the compressive strength indicators in the same time. The most efficient microfiller with regard to the concrete strength is microsilica; replacing 15% of the cement mass with microsilica the mechanical properties increase significantly. Concrete mixes with metakaolin containing waste show equivalent compressive strength results as the control mix without microfillers, while the compositions with cenospheres and dust coming from the cement production do not improve the mechanical properties. They even decrease slightly, which can be explained with the high porosity of cenospheres and fine consistency of the dust.

In the Period 2 of the project the durability properties of the designed concrete mixes have been tested and the impact of microfillers on structural changes in materials was assessed. Concrete specimens with various microfillers were tested regarding resistance to the freeze-thaw cycles. Freeze resistance test with concrete mixes, where cement was partially replaced with metakaolin containing waste, show that replacing 10% of the cement mass is the most efficient. This concrete is able to withstand 500 freeze-thaw cycles according to the LVS 156-1:2009 with the maximum permitted loss of strength, while basic mix and the mix with 5 and 15% added did not withstand 500 cycle tests with regard to the strength. Freeze resistance for high performance concrete with microsilica and cenospheres is also tested.

Adding microfillers to the concrete mix shows positive results regarding such durability indicator as chloride migration. Basic mix without microfillers show even up to 3.5 times deeper chloride penetration compared with the mixes, where up to 15% of cement were replaced with metakaolin containing waste. The low coefficient of chloride penetration is important for the steel reinforced concrete, where it is essential to protect the steel used to reinforce concrete against the chlorine ions creating aggressive environments that leads to the corrosion and disintegration.

Alkali-silica reactions are limited, if microfillers are included in the composition of concrete. By adding 15% of microfillers it is possible to reduce more than twice the number of harmful deformations from the expansion in the concrete structures, which causes cracking and makes the concrete vulnerable to the impact of the harmful environmental factors.

Other durability tests as well as durability experiments with different microfillers were started and continued in the reporting period.

2. To develop formulations of the high performance bitumen composites using reclaimed asphalt pavement (RAP) and to continue developing bitumen composites from lower quality local aggregates.	***Recommendation on the optimisation of the bitumen composite mixing process parameters Participation in international conference with a report, 1 scientific publication.***

Formulation for the asphalt pavement mix with high RAP content is developed in the reporting period. Restoration of the RAP bitumen will be done with the lowest viscosity bitumen (B70/100 and B100/150) while local dolomite shiver was added to the RAP aggregate. Optimisation of the amount of RAP will be based on the exploitation properties (rutting resistance, fatigue and thermal cracking resistance). Development of the high modulus asphalt concrete (HMAC) compositions by using local gravel shiver.

Physical and mechanical properties of the new and RAP raw materials (bitumen and aggregate) have been determined. For the bitumen (RAP bitumen and new bitumen) softening temperature, needle penetration and fragility temperature have been determined. Obsolete bitumen (RAP bitumen) has been renovated with B 70/100 and B 100/150 bitumen. The proportion of the new bitumen and RAP bitumen has been determined for obtaining the target bitumen B50/70. Granulometry, form, surface roughness (texture), crushing resistance (abrasion), freeze resistance and water absorption of aggregates have been measured (for RAP and new dolomite shiver). The granulometric composition has been calculated using RAP aggregate and new dolomite shiver. Theoretical asphalt concrete composition (development of formulation) - amount of bitumen, additives and aggregates of various fractions - has been calculated. The experimental mixes have been prepared in the laboratory settings. Optimisation of composition has been performed with Marshall method based on analysis of volume parameters (pores, porosity of mineral carcass, and pores filled with bitumen).

In the Period 3 of the project the designed bitumen composite material compositions with RAP will be checked in pilot tests of deformative properties by using testing methods intended for the concrete exploitation properties - wheel tracking test, stiffness test and fatigue test, thermocrack formation tests as well as water sensitivity (adhesion of the bitumen and aggregate). Compositions of warm mix asphalt (WMA) will be developed in the Period 3.

3. To design and create data collection system, which is suitable for the heat and moisture control in the structures of energy efficient buildings.	***The data collection system has been designed, data processing has been started. 1 publication has been submitted.***

In order to reach the goals set for the Period 2, data collection system, which is suitable for heat and humidity migration control in energy-efficient buildings has been developed. It was tested in the field and laboratory settings and improved accordingly.

- In order to ensure separate measurements for the relative humidity of the environment and temperature on the surface of structure, which is necessary for calculating its heat conductivity, two Sensirion SHT75 sensors were added to the existing system.
- Separate grounding conductor was added to the system as testing with various current sources revealed that the system not being electrically connected to earth shows possible deviations in the heat flow measurements.
- Half-finished system and method for the convenient data processing has been developed.
- The system is tested and regularised both in the laboratory settings with heat flow meter FOX600 and in the field settings with data logger Ahlborn Almeno 8590-9.

After improvements of the system it was used to measure moisture migration and heat flow processes in the wall block immediately after its production. Natural fibers, namely hemp shives from the local producers, as well as lime based local mineral binder, were used for the production of this block. The initial data confirm the data obtained in the laboratory settings - heat conductivity coefficient and drying time are similar.

In parallel, mechanical and physical properties of the fiber composite materials were measured in the Period 2. Various local raw materials, such as lime base, gypsum base, etc. together with hydraulic additives, such as metakaolin, microsilica, etc. were used for creating compositions. In addition, various types of hemp shives in different processing stages supplied by the local producers were used. The mechanical and physical properties were determined, such as compressive and flexural strength, heat conductivity, fire resistance, and compared with the properties of similar materials.

2.4. Further research and practical exploitation of the results

(Describe further research activities that are planned, describe possibilities to practically exploit results)

To achieve the project target, it is planned during the Period 3 of the project:

1. To continue durability testing of the high performance cement composite materials (compressive strength > 100 Mpa) made from local raw materials and intended for infrastructure and public buildings and to develop methods for increase of concrete corrosion resistance.
2. To develop formulations for the high performance bitumen composites using reclaimed asphalt pavement (RAP) (result - formulations, method. 1 publication has been submitted.)
3. To obtain and analyse data coming from the heat and moisture migration collection system as well as to develop method for calculating the natural fiber composite material life cycle.

During the Period 3 of the project it is planned to continue high performance cement composite material durability testing - determine resistance against alkali-silica reactions, sulphate resistance, freeze resistance, resistance against the destructive impact of chlorides, etc.

To continue or to start testing freeze resistance of the produced concrete specimens according to the standard LVS 206 and recommendations RILEM TC 117-FDC (CDF test). This research will involve testing of the concrete, which has passed testing with 500 standard freeze-thaw cycles by testing the specimens in 5% NaCl solution and therefore can be characterised as high-quality concrete being able to withstand the temperature fluctuations typical for the winter season in the Latvian climate, as well as surface testing in 3% NaCl solution (CDF test).

Chloride penetration depth will be determined according to NT BUILD 492 methodology. Ability of the concrete to withstand the penetration of chlorides in the concrete will be tested, which is important in the Latvian climate, especially in areas, where anti-icing or deicing compositions are used and chloride solutions are in contact with the concrete surfaces fostering corrosion of its reinforcement, concrete crushing and loss of the load bearing capacity of the load-bearing structures. Concrete resistance to the migration of chloride ions is characterised by the chloride migration coefficient.

Impact of the alkali-silica reactions on the concrete mixes will be determined according to the standard RILEM AAR-2 – method of ultra-accelerated mortar-bar test.

Sulphate resistance of concrete specimens will be determined according to the standard SIA 262/1 Appendix D: Sulphate resistance.

Recommendation for increase of the concrete corrosion and freeze resistance will be developed based on the results of durability testing (deliverable).

To conduct a research on the bitumen composites, in the Period 3 of the project bitumen composite material (HMAC and RAP) compositions will be used in the experimental testing by applying methods intended for the concrete exploitation properties - wheel tracking tests, stiffness tests and fatigue tests, thermocrack formation tests as well as water sensitivity (adhesion of the bitumen and aggregate). In addition, it is planned to develop innovative compositions of bituminous composite materials by using local gravel shiver as well as dolomite shiver from other quarries and to compare their properties with those of the various types of conventional asphalt concrete.

By developing innovative compositions of bituminous composite materials, where various types of local aggregates and imported conventional aggregates are used simultaneously, it will be possible to compare their properties to the various types of conventional asphalt concrete and to develop compositions of bituminous composite materials (formulations) using polymer-modified bitumen.

Based on the data, which are previously obtained in the laboratory settings, it is planned to develop high strength bituminous compositions with high RAP content (partly replacing the typical aggregates used in Latvia with the RAP). Likewise it is planned to use warm mix asphalt (WMA), technologies for developing formulations of the warm mix asphalt having 15 - 25°C lower workability temperatures (for easy workability) compared to the conventional asphalt concrete.

Summarising the obtained results in the end of the Period 2 of the project it is planned to prepare economic assessment and recommendations for designing, production and application of the bituminous composites, which were created in the framework of the project.

Third task for the Period 3 of the project is to obtain and analyse data coming from the heat and moisture migration collection system as well as to calculate the natural fiber composite material life cycle.

According to the defined task it is planned to obtain and collect heat and moisture migration data from the natural fiber composite materials as well as to start developing a model based on the obtained data. Data will be collected from the materials, which are applied in various settings. The initial collection of the experimental data on the heat and moisture from the wall panel will be done for assessing the processes taking place in the constant microclimate inside the building.

Sensors will be integrated in the newly built building, where natural fiber composites are used, in order to assess them in the stage after integration is completed as well as in the real conditions of exploitation. The obtained data will serve as a base for heat and moisture migration control model for the energy efficient building structures, which will verify that the created composite materials are intended for energy efficient buildings ensuring favourable climate for the human health and well-being.

Life-cycle calculations of the natural fibre composite materials are also planned in this stage. Product life-cycle model will be developed, the data about materials, energy resources and emission factors will be obtained from the literature and databases, calculations and impact assessment will be completed. It is planned that the developed method will provide easier way to assess, if the offered material is CO_2 neutral, which is one of the basic tasks of the project.

In the Period 3 of the project it is also planned to develop a method for production of ecological composite materials from the fiber plants and local mineral binders. The method will be developed by using the previously obtained information coming from the development of the fiber composite material compositions and testing of their mechanical and physical properties. The method will allow the existing and potential producers of the natural fiber composite materials to select parameters (various binders, productions technologies, etc.) to obtain the desired properties in the final product.

2.5. Dissemination and outreach activities

(Describe activities that were performed during reporting period to disseminate project results)

In the project Period 2 of the Project „Innovative and Multifunctional Composite Materials from Local Resources for Sustainable Structures" **9 conferences were attended and 9 full papers were published** (see Annex PP):

1. Bumanis G., Bajare D., Korjakins A. Durability of High Strength Self Compacting Concrete with Metakaolin Containing Waste, Key Engineering Materials, Volume 674, 2016, 65-70
   a. http://www.scopus.com/record/display.uri?eid=2-s2.0-84958213606&origin=resultslist&sort=plf-f&src=s&st1=bajare&st2=&sid=825680C2EBD50EF96A423542C8B86583.Vdktg6RVtMfaQJ4pNTCQ%3a210&sot=b&sdt=b&sl=19&s=AUTHOR-NAME%28bajare%29&relpos=0&citeCnt=0&searchTerm=
2. Bumanis G., Toropovs N., Dembovska L., Bajare D., Korjakins A. The Effect of Heat Treatment on the Properties of Ultra High Strength Concrete, In Proceedings of the 10th International Scientific and Practical Conference "Environment. Technology. Resources" Volume 1, 2015, 22-27
   a. http://journals.ru.lv/index.php/ETR/article/view/209
3. Baronins J., Setina J., Sahmenko G., Lagzdina S., Shiskin A. Pore Distribution and Water uptake in a Cenosphere – Cement Paste Composite Material, IOP Conference Series: Materials Science and Engineering,Volume 96, 2015
   a. http://iopscience.iop.org/article/10.1088/1757-899X/96/1/012011/pdf
4. Haritonovs V., Zaumanis M., Izaks R., Tihonovs J. Hot Mix Asphalt with High RAP Content, Procedia Engineering, Volume 114, 2015, 676-684
   a. http://www.scopus.com/record/display.uri?eid=2-s2.0-84946042865&origin=resultslist&sort=plf-f&src=s&st1=haritonovs&st2=&sid=8C1DC23548743E315805D68F5791B7D8.euC1gMODexYlPkQec4u1Q%3a10&sot=b&sdt=b&sl=23&s=AUTHOR-NAME%28haritonovs%29&relpos=4&citeCnt=0&searchTerm=AUTHOR-NAME%28haritonovs%29
5. Haritonovs V., Tihonovs J., Smirnovs J. High Modulus Asphalt Concrete with Dolomite Aggregates, IOP Conference Series: Materials Science and Engineering,Volume 96, 2015
   a. http://iopscience.iop.org/article/10.1088/1757-899X/96/1/012084/pdf
6. Sinka M., Radina L., Sahmenko G., Korjakins A., Bajare D. Enhancement of lime-hemp concrete properties using different manufacture technologies, In Proceedings of 1st International Conference on "Bio-based Building Materials (ICBBM)", 2015

7. Sinka M., Radina L., Sahmenko G., Korjakins A., Bajare D. Hemp Thermal insulation Concrete with Alternative Binders, Analysis of their Thermal and Mechanical Properties, IOP Conference Series: Materials Science and Engineering,Volume 96, 2015
    a. http://iopscience.iop.org/article/10.1088/1757-899X/96/1/012029/pdf
8. Pleiksnis S. Sinka M., Sahmenko G. Experimental justification for sapropel and hemp shives use as thermal insulation material in Latvia, In Proceedings of the 10th International Scientific and Practical Conference "Environment. Technology. Resources" Volume 1, 2015, 175-181
    a. http://journals.ru.lv/index.php/ETR/article/view/211
9. Obuka V., Sinka M., Klavins M., Stankevics K., Korjakins A. Sapropel as Binder: Properties and Application Possibilities for Composite Materials, IOP Conference Series: Materials Science and Engineering,Volume 96, 2015
    a. http://iopscience.iop.org/article/10.1088/1757-899X/96/1/012026/pdf

Participation in conferences:

1. Bumanis G., Bajare D., Korjakins A. Durability of High Strength Self Compacting Concrete with Metakaolin Containing Waste, 24th International Baltic Conference Baltmattrib, Tallinn, Estonia, November 5-6, 2015;
2. Bumanis G., Toropovs N., Dembovska L., Bajare D., Korjakins A. The Effect of Heat Treatment on the Properties of Ultra High Strength Concrete, 10th International Scientific and Practical Conference "Environment. Technology. Resources", Rezekne, Latvia, June 18-20, 2015;
3. Baronins J., Setina J., Sahmenko G., Lagzdina S., Shiskin A. Pore Distribution and Water uptake in a Cenosphere – Cement Paste Composite Material, 2nd International Conference "Innovative Materials, Structures and Technologies", Riga, Latvia, 30.September -2.October, 2015;
4. Haritonovs V., Zaumanis M., Izaks R., Tihonovs J. Hot Mix Asphalt with High RAP Content, 1st International Conference on Structural Integrity, ICSI 2015 Funchal, Portugal, September 1-4, 2015;
5. Haritonovs V., Tihonovs J., Smirnovs J. High Modulus Asphalt Concrete with Dolomite Aggregates, 2nd International Conference "Innovative Materials, Structures and Technologies", Riga, Latvia, 30.September -2.October, 2015;
6. Sinka M., Radina L., Sahmenko G., Korjakins A., Bajare D. Enhancement of lime-hemp concrete properties using different manufacture technologies, 1st International Conference on "Bio-based Building Materials (ICBBM)", Clermont-Ferrand, France, June 21-24, 2015;
7. Sinka M., Radina L., Sahmenko G., Korjakins A., Bajare D. Hemp Thermal insulation Concrete with Alternative Binders, Analysis of their Thermal and Mechanical Properties, 2nd International Conference "Innovative Materials, Structures and Technologies", Riga, Latvia, 30.September -2.October, 2015;
8. Pleiksnis S. Sinka M., Sahmenko G. Experimental justification for sapropel and hemp shives use as thermal insulation material in Latvia, 10th International Scientific and Practical Conference "Environment. Technology. Resources", Rezekne, Latvia, June 18-20, 2015;
9. Obuka V., Sinka M., Klavins M., Stankevics K., Korjakins A. Sapropel as Binder: Properties and Application Possibilities for Composite Materials, 2nd International Conference "Innovative Materials, Structures and Technologies", Riga, Latvia, 30.September - 2.October, 2015;

In the project Period 2 of the Project „Innovative and Multifunctional Composite Materials from Local Resources for Sustainable Structures" **4 conference abstracts or full papers were prepared and submitted**:

1. L. Vitola, D. Bajare, G. Bumanis, G. Sahmenko, Evaluation of Puzzolanic Properties of Micro- and Nanofillers Made from Waste Products, 18th International Conference on Concrete, Structural and Geotechnical Engineering, 25.-26. January 2016, Istanbul, Turkey
2. D. Bajare, G. Bumanis, Chloride Penetration and Freeze-Thaw Durability Testing of High Strength Self Compacting Concrete. Materials, Systems and Structures in Civil Engineering – August, 2016, Copenhagen, Denmark
3. V. Haritonovs, J. Tihonovs, J. Smirnovs. High Modulus Asphalt Concrete With Dolomite Aggregates, Transport Research Arena Conference -TRA 2016, Warsaw, Poland, 18.04-21.04.2016
4. V. Haritonovs, J. Tihonovs, J. Smirnovs. Use of low quality aggregates in hot mix asphalt concrete, 6th Eurasphalt and Eurobitume Congress, Prague, Czech Republic, 1.06.-3.06.2016.

4 master's thesis and 13 bachelor's thesis were prepared and defended within Project

Master's thesis:

1. M.Jaungailis-Gailis „ The use of nanomaterials and nano-systems in production of building materials";
2. R.Latkovska „ Concrete deterioration in reinforced concrete structures exposed to aggressive environments";
3. N. Pleiko, „ High performance concrete with dolomite by products";
4. I. Talanovs „ Development of Innovative Construction Materials using Nano-System Basis".

Bachelor's thesis:

1. M.Luriņa „ Nanomaterial development and use in construction material field";
2. E.Namsone „ Heat insulation material made of two - component aggregate";
3. J.Jankovskis "The impact of composition and microstructure of high-performance cellular concrete on material properties";
4. I.Cikanovičs "Reinforced concrete construction reinfrocing with carbon fibre composites";
5. V.Stirāne "Various building matreials mass, density and standart mass per storage volume corectness in construction designing";
6. M.Šķēle "Evaluation of layup orientation effect on bending behaviour of fiber reinforced composite materials";
7. V.Politiko "Concrete floors with dispersed reinforcement";
8. V.Ignatjevs "Design of self-compacting concrete with recycled concrete aggregates";
9. J.Krauklitis "Ecological SCC concrete with reduced Portland cement amount and recycled concrete aggregate":
10. J.Umbrovskis "Methodology for optimal choice of wall heat insulation materials".;

11. I. Klasa “Investigation of Bitumen Structure and Properties with Atomic Force Microscope”,
12. A.Riekstina “Thin layer pavement wearing course layer (AC-TL) properties and usage research”;
13. Ie. Zaharava “Determination and analysis of bitumen and aggregate interaction”.

The following doctoral thesis were written:

1. J. Justs „Ultra high performance concrete with diminished autogenous shrinkage technology”, supervisor D. Bajare, planned to defend in 2016
2. J. Tihonovs „Aphalt concrete mixes from the local mineral material with high exploitation properties” supervisor J. Smirnovs, V. Haritonovs, planned to defend in 2017
3. M. Shinka „Natural fibre insulation materials”, supervisor G. Shahmenko, planned to defend in 2017
4. N. Toropovs „Fire resistance of high performance concrete”, supervisor G. Shahmenko, planned to defend in 2016

18.06.2015. U. Lencis defended the doctoral thesis „ Methodology for use of ultra sound impulse method in assessment of construction strength” (supervisor A. Korjakins) and obtained PhD in engineering.

10.04.2015. A. Sprince defended the doctoral thesis “Methodology for determination of long-term properties and crack development research in extra fine aggregate cement composites” (supervisor A. Korjakins) and obtained PhD in engineering.

Deliverables under titles “Production method of innovative and advanced cement composite with microfillers materials for infrastructure projects and public buildings” and “Production method for high performance asphalt concrete mixes from low quality components” are include in Annex NN.

The performance indicators of the programme and project promotion

Project representatives participated in the NRP IMATEH meetings on the Project progress and implementation on 26.05.2015., 2.07.2015., 9.09.2015 and 02.10.2015.

Seminar for students was organised on 27.01.2015 in order to present aims, tasks and benefits related to the NRP Project 1.

Non-technical publication “Innovative materials and smart technologies for environmental safety, IMATEH” was prepared and published in the magazine of the Riga Technical University “Safety and security”, Vol. 4 p. 10-12.

In addition, the Project members were involved in organising of two scientific conferences in 2015 - IMST „Innovative Materials, Structures and Technologies” (30.09.2015-02.10.2015) as well as **56th Scientific and Technical Conference for Students (**28.04.2015).

The participants of conference „Innovative Materials, Structures and Technologies (scientists, students and industry representatives from Latvia and abroad as well as representatives of the scientific committee) were informed about the project achievements and the obtained scientific results.

To promote the programme, Concrete Contest (Stage 1, concrete preparation competition) will take place on 16.04.2015. Teams of 3 participants will prepare concrete specimens, which will be tested on the compression strength after 28 days, determining teams having the strongest specimens. Aim of the concrete contest is to encourage students to practical application of the knowledge obtained in the university and technological development.

Stage 2 of the Concrete Contest will take place on 12.05.2015, when the winner will be determined among 7 teams by testing the specimens on compression strength.

Upon launching the NRP programme IMATEH website was created, where information on programme achievements and activities is constantly updated. On IMATEH website http://imateh.rtu.lv/ detailed information on Project 1 is available as well as information on NRP IMATEH activities and updates.

The co-financing coming from the private sector and income from contract work based on the results of the Project 1 constitutes Euro 231397.34 Eur in the Period 2.

Leader of the project No. 1 _______________ Diana Bajare_______

__________________ *(signature and transcript)*

(date)