



Annual Report on the Activities of the AdMaS Centre 2020

Foreword by the Dean

Dear colleagues,

The AdMaS Regional Research Centre, which has grown to become an integral part of the faculty, has now been fully integrated into the organizational structure of the faculty. 2020 is the first year of its operation within that new structure and with the new Centre Statute in force. These documents came into effect after the end of the sustainability period of the project as of 31. 12. 2019. The "AdMaS" brand has thus remained, and the results of contract research and other economic activities are still being reported through the AdMaS Centre. Likewise, R&D project investigators are continuing to use the facilities and equipment of the AdMaS Centre. It is now up to all of us to use this research potential for the benefit of the entire faculty.

In 2020, an external evaluation took place for the NPU 1 AdMaS UP project from the National Sustainability Programme, which provided significant support for the operation of the AdMaS Centre. I am very pleased to be able to state that the project received the highest possible rating from the assessment, and we would like to thank all of the staff who contributed to this result.

At the end of 2020, the Technology Agency of the Czech Republic approved our application to extend the NCC project Centre for Advanced Materials and Efficient Buildings, or CAMEB for short. This project has received funding until the end of 2022, and 11 out of the 12 constituent research projects which were investigated as part of the NCC will continue. We would also like to thank all of the staff who took part in the preparation of the application for the project extension.

2020 was also a year when FCE BUT, and thus also the AdMaS Centre, just like other universities faculties and indeed the whole republic, had to deal with the worsened health situation caused by the COVID-19 pandemic. Many negotiations had to take place using remote communication tools. It turned out that both the FCE BUT staff and the external collaborators involved were able to adapt to this new situation very quickly, and it can be said that the effectiveness of the negotiations wasn't greatly affected by the change in communication methods, although (of course) personal participation in the meeting would have been more pleasant.

Today, the AdMaS Centre is a highly sought-after and reliable partner for a number of cooperating companies and authorities. The creation of the AdMaS Centre has provided the Faculty of Civil Engineering with a modern workplace that is one of the best-equipped scientific and technical facilities in the field of civil engineering in Europe. Now it is only up to us how we will use this technological advantage and further develop it.

Thank you all once again for the work done so far, and I would especially like to thank Assoc. Prof. JUDr. Ing. Zdeněk Dufek, Ph.D., who resigned as the director of the AdMaS Centre at the end of 2020 after several years, for everything he has done for the AdMaS Centre. I wish the new director, Ing. Zdeněk Krejza, Ph.D., a lot of success in his work. I would also like to highlight the work of the coordinators of the interest groups who play a significant role in the operation of the AdMaS Centre. It is my belief that in the next period the long-lasting successful journey of both the AdMaS Centre and the Faculty of Civil Engineering at BUT shall continue.

Prof. Ing. Miroslav Bajer, CSc., Dean

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1. Organizational structure

Head Office

Deputy Director, Financial Manage Ing. Zdeněk Krejza, Ph.I
Administrative Manager Assoc. Prof. Ing. Jiří Zach, Ph.I
Lawyer JUDr. Sylva Pochopov
Facility Manager Ing. Michaela Ulbrychov
Secretariat Zlatuše Dokoupilov

The Advanced Building Materials interest group

Group coordinator

Prof. Ing. Rostislav Drochytka, CSc., MBA, Dr.h.c.

The Advanced Building Structures and Transport Constructions interest group

Group coordinator

Assoc. Prof. Ing. Pavel Schmid, Ph.D.

The Economics and Environment interest group

Group coordinator

Prof. Ing. Petr Hlavínek, CSc., MBA



2. Activities in the area of management and monitoring

At the end of January 2020, the fifth monitoring report from the sustainability period was produced. It was approved by the Regulatory Authority in April 2020.

The horizontal integration of research teams and the involvement of the AdMaS Centre in promotional events, which has been typical in previous years, took place only in the first two months of 2020 due to the unfavourable epidemiological situation, after which they were suspended or very limited in scope.

The HR policy elements which were introduced in previous years, involving, e.g. the provision of support to young research workers, were implemented only in closed groups when dealing with specific projects and contract research. With a few exceptions, all foreign visits were either cancelled or took place online (see Chapter 3).

Active cooperation with industrial entities still took place, albeit to a lesser degree, in the field of both contract research and applied R&D projects.

Despite all complications, the meeting of the AdMaS Centre Council took place twice in 2020 – on 13 February and 22 June 2020. All traditional meetings organised for AdMaS Centre employees as well as the Researchers' Night were cancelled this year.



3. Events, training and seminars

In 2020, activities at the AdMaS Centre were severely limited due to the epidemiological situation. Despite that, quite a few activities still took place there. These were the following:

- The Institute of Road Structures welcomed a new intern, Brazilian student César Viapiano, who studies Civil Engineering at the Federal University of Rio Grande do Sul. The student's stay in Brno took place via the UNIGOU 2020 programme, organized by INCBAC. During the two-month internship, he participated in research projects being investigated at the road laboratory at the AdMaS Centre.
- On 8th and 9th January, ČEZ a.s. staff underwent a basic preparatory course of laboratory training. The course timetable comprised 16 hours of tuition, most of which was in the laboratory. During the course, issues were covered related to the design, preparation and quality control of fresh and hardened concrete. Destructive and nondestructive concrete tests were presented and then conducted on fresh and hardened concrete. Attention was given to the inspection and remediation of the concrete structures of nuclear power stations, the surface finishes of materials, and the pore structure and internal structure of materials. Another part of the course provided familiarization with the most modern laboratory methods for the evaluation of building materials. The theoretical foundations of X-ray diffraction analysis, electron scanning microscopy and computer tomography were presented.
- On 28th and 29th January 2020, the seminar "TDS Concrete" was held at the AdMaS Centre. It was attended by 38 employees of the Railway Infrastructure Administration. The subject of the seminar was a series of lectures and practical demonstrations regarding basic concreting techniques, the required properties of concrete, requirements for input raw materials and special concretes, transport and concrete treatment. The lectures were led by Prof. Hela, and the railway workers were further trained by Assoc. Prof. Hubáček, Assoc. Prof. Brožovský and Ing. Ťažký, who also showed them the Centre's laboratories.
- The director of the AdMaS Centre, Dr. Dufek, together with Assoc. Prof. Apeltauer and other experts in the field, contributed to the writing of the publication "Ochrana měkkých cílů" (Protection of soft targets), which was published in January 2020. In the introduction, these issues are set into the context of the legal framework in the Czech Republic, after which information is given on state policy regarding the protection of soft targets. It also contains practical information from the perspective of the Fire Rescue service of the Czech Republic, and particularly from the viewpoint of risk analysis and crisis management. The end of the publication is dedicated to information on human evacuation models and the options for their application. The aim of the authors was to present different perspectives on the issue and provide methodological support to all who come into contact with the topic of the protection of soft targets.
- On 15th February 2020, the training of BEST a.s. employees took place on the premises of the AdMaS Centre with the topic *Concrete products produced using vibropressing technology*. The training concerned the production, evaluation of properties and conformity assessment of concrete paving blocks, slabs, curbs, masonry elements, blocks of lost formwork, palisades, and other products. The training also included a practical demonstration of tests conducted on concrete products in laboratories.

- On 23rd February 2020, Prof. Kudrna appeared on the Czech television channel ČT1 programme "Otázky Václava Moravce" (Václav Moravec's Questions). He participated in a debate with the Minister of Transport, Karel Havlíček, and the Governor of the Liberec Region, Martin Púta. The topic was the budget of the Ministry of Transport for transportation structures on Czech roads.
- Young research workers specializing in water management investigated several research projects financed from the TACR Zeta programme. Many tests and verifications were conducted at the AdMaS Centre on technologies focused on using the potential of wastewater (in terms of energy or technology), and selected supplementary laboratory analyses also took place here, e.g. the testing of a technological unit for obtaining thermal energy from greywater in combination with its cleaning for the purpose of its further use in buildings, for technical purposes, the watering of green roofs and facades, etc. This technology for the recycling of grey wastewater, which is investigated in the project *TJ02000190 "Recovery and use of thermal energy from wastewater in combination with the use of treated water*", is a highly topical issue due to the prevailing dry climatic conditions and the need for careful water management. Another of the tested technologies is a functional sample of a thermal pyrolysis unit investigated within the project *TJ02000262 "Processing of gastro waste into a solid carbonaceous product for material use"*.
- On 10th June 2020, a board of opponents composed of employees from the MEYS project department visited the AdMaS Centre to evaluate the now completed, five-year project NPU AdMaS UP Advanced building materials, structures and technologies, which lasted from 1st January 2015 to 31st December 2019, and whose investigator was Professor Novák. The board of opponents stated that the individual research groups and divisions of the AdMaS UP project not only met, but significantly exceeded the Threshold conditions of the NPU I. programme, and also praised the drawing of funds. In their conclusion, the board of opponents also praised the number of projects involving cooperation with industrial entities and the number of foreign internships and visitors, as well as international projects. Overall, the board rated the project as excellent.
- Archaeologists turned to the Centre for Radiation Defectoscopy for help with the determination of the origin of a sword which was discovered near Znojmo and which is estimated to be from the Iron Age, or the Roman period. The sword was transported to the defectoscopy laboratory and subjected to an X-ray examination under the direction of Prof. Hobst. The X-ray examination proved that the sword is made of one material and is very heavily corroded, and thus no engravings or inlays from another metal have been preserved. Only in the connection of the hilt to the blade is there a visible structure (in the shape of the letter "π"). It would seem a good idea to clean it mechanically and determine its origin. The material from which the sword is made is not visible anywhere on the sword. If the metal were exposed during further examination, it would be possible to analyse it using the X-ray fluorescence method, which would reveal the exact shape of the sword, production details, possible decorations and extent of corrosion damage.
- In the summer months, another part of the series of training courses on road structures run for employees of the Directorate of Roads and Motorways took place at the AdMaS Centre for what is already the fifth year. The training was organized by Consultest s.r.o. under the auspices of the AdMaS Centre. Due to the anti-epidemic measures that came into force, the remaining training sessions had to be postponed indefinitely.

- On 16th and 17th September 2020, a "Transport Infrastructure Conference" was held in the castle brewery of the town of Litomyšl. It was attended by 21 exhibitors and 470 delegates this year. The director of the AdMaS Centre, Assoc. Prof. Dufek, gave a total of 51 lectures during the main programme. Ing. Dobiášová and Prof. Kudrna also took part in the conference, where they presented the research and activities of the AdMaS Centre and the FCE as a whole at our exhibition stand, and established new contacts for possible future cooperation.
- In the autumn of 2020, the employees of the Economics and Environment interest group at the AdMaS Centre, in cooperation with the company Satturn Holešov and the Institute of Telecommunications at the Faculty of Electrical Engineering and Communication at BUT, monitored the coverage of the sewerage network as concerns leak localization (particularly from industrial plants, infectious water and especially in the context of unexpected exceptional leaks, whether unwanted or deliberate). At present, sewerage networks for municipal and industrial wastewater are standardly built using single-skin pipes, and this is also true in higher-risk areas (exposed sites within areas requiring increased protection of groundwater sources or where there are other environmental or safety risks with regard to water treatment and transport, drainage and cleaning). As a result, possible contamination of the soil and groundwater is not prevented in those areas with increased safety risks, and the ad hoc removal of any problems that may arise is also not enabled. The aim of the online monitoring was to cover the sewerage network in as much detail as possible for the localization of leaks.
- Under the auspices of the group of specialists "Odvodnění urbanizovaných území CZWA" (Drainage of urbanized areas CZWA) and the AdMaS Research Centre, the company ARDEC organized the 20th year of the Urban Water conference, entitled "Městské vody Urban Water 2020", in Velké Bílovice on 1st and 2nd October 2020. The conference has traditionally been a showcase for presented papers with a high professional level. This year, there were a total of 24 of them, some of which were presented by the employees of the AdMaS Centre, who also represented the Centre at the conference with the help of information leaflets distributed from an exhibition stand.
- On 15th October 2020, the General Meeting of the CAMEB National Competence Centre project was held online. The meeting was opened by the Chairman of the Board, Assoc. Prof. Ferkl from the CTU in Prague, who informed the participants that in connection with the information provided by the Technology Agency of the Czech Republic, it is possible to request an extension for the existing centre of competence by two calendar years, which enables the bridging of the transition period of 2021 and 2022. It was confirmed by the investigators of sub-projects that they have both the finances and sufficient subject matter to carry out research activities during those years. Some members were no longer interested in continuing the project from 2021, while other entities showed an interest in joining, which was approved by the General Meeting and taken into account in the amendments to the contract. The wording of the Annual Report of the National Centre of Competence was approved, as well as the resignation of Ing. Kroupa from the NCC Board and the election of his successor, Ing. Bureš, to the Board, as well as the subsequent re-election of all board members.
- In November, the AdMaS Centre answered a call for help from the management of a retirement home in Rajhrad, Domov Matky Rosy (Mother Rosa's Home), which was struggling not only with a lack of staff but also with a dwindling supply of protective equipment. The Centre supplied the home with several dozen protective shields, which

were printed on the FCE's 3D printer. The shields are used in the home by both the permanent staff and also by a number of volunteers who have decided to help the home in these difficult times. Ms Dokoupilová, a secretary at the AdMaS Centre, was also involved in helping out.

- On Saturday, 14th November 2020, Prof. Kudrna spoke on the Czech Television news • programme "Studio CT Weekend" about his opinion on the construction of a tunnel next to the world-famous monument Stonehenge in England, which is a topic that has provoked a lot of controversial opinions from both experts and the public. After a long period of preparation, the British government decided to build a continuation of the A303 4-lane road between London and the south-west of England, which runs just past Stonehenge. The road has only 2 lanes at this point, and there are traffic jams in front of this narrow section, with a significant impact on the environment, and therefore a generous solution was proposed using a tunnel excavated from the local rock massif, with a length of 1.7 km and high investment costs. Despite these facts, many protests and expert discussions have been presented in the British media, especially from amongst the ranks of historians. Prof. Kudrna is of the opinion that the proposed structure would solve the transport and environmental problems and would not disrupt the work of historians, as archaeological finds are located only in the surface layers.
- The head of the Institute of Building Testing and coordinator of the AdMaS Centre interest group Advanced Building Structures and Traffic Constructions, Assoc. Prof. Schmid, appeared on the "Černé ovce" (Black Sheep) programme broadcast by Czech Television on 2nd December 2020. The television crew approached him in his capacity as an expert assessing the quality of the structure of a panel house in Krásného Street in Brno, which was examined and subsequently evaluated under the leadership of Dr. Krejza under a contract for the Statutory City of Brno with the title "Zhotovení návrhu sanačních opatření objektu Krásného 2-4-6" (Preparation of a proposal for rehabilitation measures for the building Krásného 2-4-6).
- In December 2020, the Technology Agency of the Czech Republic approved our application for the extension of the CAMEB National Centre of Competence project, which thus received funding until the end of 2022. 11 out of the 12 original sub-projects will continue.
- On 9th December 2020, the Deputy Director of the AdMaS Centre, Dr. Krejza, took part in the international webinar "*Spotlight on European GreenTech: Green Building*". He presented those activities of the AdMaS Centre that are connected mainly with the circular economy to his colleagues from Italy, Austria, Ireland and Greece.



4. Mobility of researchers and cooperation with foreign entities

The extent of the coronavirus pandemic also affected the AdMaS Centre in terms of mobility. The majority of business trips to cooperating institutions and visits from abroad to the AdMaS Centre were cancelled or postponed indefinitely.

Despite this, some planned meetings took place in the form of conference calls or online seminars. Cooperation was established with, e.g. Kalashnikov Izhevsk State Technical University, Bauhaus University Weimar, TU Wien, and Universität Rostock in Germany, and with the companies Precious Plastic Amsterdam, Precious Plastic Wien and Smile Plastics London. The AdMaS Centre was personally visited by, e.g. representatives from the Norwegian University of Science and Technology and the Norwegian Institute for Water Research (NIVA).

Detailed information and examples of mobility are provided for individual interest groups later in the report.



5. Research staff mobility in terms of collaboration with industrial entities

Research staff mobility in terms of collaboration with industrial entities took place throughout the year, but with regard to the worldwide situation, such visits were very limited in scope. In the majority of cases, this entailed one-day trips for the purpose of carrying out particular experiments, taking measurements, consultation, etc.

Detailed information and examples of mobility are provided for individual interest groups later in the report.



Fulfilment of the monitoring indicators and leading indicators for 2020

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In 2020, all research activities continued in accordance with the scientific research focus of the AdMaS Centre, just as in previous years.

The majority of the planned monitoring indicator values were attained, and in some cases, the annual planned values were significantly exceeded.

The monitoring indicators were fulfilled as follows:

Indicator	Value for 2020
Number of students in all years who used the constructed infrastructure / were involved in the AdMaS Centre's activities	92
Number of newly created job positions, R&D employees - total	107.35
Number of newly created job positions, R&D employees - women	30.41
Number of newly created job positions, researchers - total	95.70
Number of newly created job positions, researchers - women	26.33
Number of newly created job positions, researchers up to the age of 35	41.09
Number of newly created job positions, researchers up to the age of 35 - women	8.83

Table 1: Personal indicators

Table 2	2.	Financial	indicators	(in	thousands	of	CZK)
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Indicator	Value for 2020
Amount of contract research	51.4
Amount of funds for R&D obtained from foreign sources	0.5
Number of collaborative projects involving industrial entities and regional R&D centres	20
Amount of funds obtained from public tenders for the targeted support of R&D national resources	92.2



7. Research activities

7.1. Interest group: Advanced Building Materials

7.1.1. Activities of the IG in the area of management

IG coordinator - Prof. Ing. Rostislav Drochytka, CSc., MBA, Dr.h.c.

The goals of the Advanced Building Materials interest group were completely fulfilled in accordance with its professional focus in 2020. For the purpose of the planning and coordination of research activities in 2020, quarterly meetings took place (in person or online) with the participation of the group head, key researchers and also other employees. During the meetings, information about current activities was briefly presented, including the acquisition of financing from public funds (coordination of the preparation of projects for competitions currently announced by the Czech Science Foundation, TACR, Ministry of Education, Youth and Sports, H2020, etc.), as well as contract research projects with industrial partners, or other information with regard to current needs.

Social gatherings and other activities were significantly curtailed by the coronavirus crisis and the limitations associated with it.

7.1.2. Training and seminars

The training courses and seminars held by the IG are described in Chapter 3, "Events, training and seminars", in greater detail.

7.1.3. Research staff mobility and cooperation with institutions abroad

In 2020, due to the coronavirus crisis, activities involving staff mobility to institutions abroad were significantly suppressed, and the amount of research worker mobility from foreign universities to the AdMaS Centre also decreased.

New partnerships in the area of international cooperation thus emerged rather sporadically and were deepened via remote communication (e.g. with Kalashnikov Izhevsk State Technical University, Fels Vertriebs and Service GmbH & Co. KG, TU Wien, Bauhaus University Weimar, the Faculty of Civil Engineering in Košice, Universität Rostock in Germany, etc.).

One special example of important cooperation with entities abroad is the three-year international grant project GA20-09072J entered into with Prof. Dr. Ing. Grigorij Yakovlev from the Kalashnikov Izhevsk State Technical University. Another example of such cooperation is our joint research with Fels Vertriebs und Service GmbH & Co. KG, which is focused on the development of new mixtures for the production of autoclaved aerated concrete. As part of this cooperation, the joint experimental verification of new raw material variants took place at the AdMaS Centre on 24th and 29th August 2020.

As far as student mobility is concerned, the following can be named:

- Bc. David Fittl, 1st year student in the subsequent master's study programme internship via the Erasmus+ programme at Sinteff Narvik AS, Norway
- Bc. Vojtěch Uher, 2nd year student in the subsequent master's study programme study visit via the Erasmus+ programme at Universidade do Minho, Portugal
- Ing. Cecílie Mizerová, 3rd year student in the doctoral study programme internship via the Erasmus+ programme at the Karlsruhe Institute of Technology, Germany
- Ing. Dorothea Sklenářová, 4th year student in the doctoral study programme internship financed from DP 3.2 at Hochschule Wismar, Germany

As far as staff mobility is concerned, the following can be named:

• Assoc. Prof. Ing. Jiří Zach, Ph.D., teaching placement via the Erasmus + programme at TU Wien, Austria, and at the University of Žilina, Slovakia

Remote online lectures financed from DP 2.2.1 "Support and involvement of experts from the academic field in education at BUT" included, e.g.:

- a lecture by Prof. Dr. Ing. Ulrich Diederichs from Hochschule Wismar, Germany
- two lectures by Assoc. Prof. Mariaenrica Frigione from Universita del Salento, Italy

7.1.4. Research staff mobility: collaboration with industrial entities

Research staff mobility in terms of collaboration with industrial entities took place throughout the year. In the majority of cases, this entailed one-day trips for the purpose of carrying out particular experiments, taking measurements, the verification of functional samples or verified technologies that were developed during collaboration, training, consultations, etc.

7.1.5. Research activities conducted by the IG

The goals of the Advanced Building Materials interest group were completely attained in accordance with the professional focus and planned aims of the group in 2020:

 One of the key projects of the year 2020 was sub-project No. TN01000056/04, entitled "Advanced Materials and Technologies" which was investigated in connection with the National Centre of Competence "Centre for Advanced Materials and Efficient Buildings". In 2020, activities concerning seven research topics were completed and results were generated in the form of a utility model (2pcs), a functional sample (8 pcs), a prototype (1 pc), a certified methodology (5 pcs) and a verified technology (4 pcs). At the end of the year, the extension of the investigation period by another two years was approved and the scope of planned results was expanded.

- In 2020, researchers also studied the effect of mechanical activation on the formation and stability of various polymorphs of alite and belite, and also performed an analysis of the processes involved in the formation of the structure of silicate composites with organic fillers and their behaviour under specific stress conditions. In the field of ceramics, research focused on the controlled modification of the mineralogical composition of ceramic bodies in order to improve their functional characteristics, and also on the production of mullite tempers in a shaft kiln and on the elimination of sulphur dioxide emissions during the firing of ceramic bodies fabricated using power plant fluidised bed combustion ash. 2020 saw the completion of research into the possibilities offered by the liquefaction of soil before its subsequent use in excavation work, resulting in two functional samples and one verified technology. Additionally, one utility model was registered and, on top of that, a patent was approved which will be registered in the database in February 2021. Other projects which were successfully completed in 2020 were, e.g. Advanced technology for aerated sandy concrete with a proportion of secondary raw materials and more efficient use of natural resources, as well as Advanced adhesives with a higher proportion of secondary raw materials for extremely stressed environments, during the investigation of which a number of functional samples, verified technologies and utility models were developed.
- The use of secondary raw materials is a very important topic for the Advanced Building Materials IG, and in 2020 it focused on the development of an advanced waste-free technology for high-performance aerated concrete produced using renewable resources, as well as research into advanced polymer materials using secondary raw materials and hazardous waste for chemically highly aggressive environments, and also the use of waste from the production of cement-bonded particleboards in the production of competitive building materials.
- In the field of insulation materials, researchers were engaged in research and development concerning advanced thermal and acoustic insulation materials based on waste textiles and natural fibres, and also the development of types of vacuum insulation based on secondary raw materials. Very interesting results were also obtained during research activities focused on the study of the internal microclimate present in the interiors of buildings with green walls, and the impact of such walls on human health. Space was also given to the development of light modern building materials using light aggregates based on waste glass flour.
- One of the very important areas of research of the Advanced Building Materials IG is concrete technology. Research workers focused on, e.g. the development of highperformance concretes resistant to chemically aggressive environments found in special agricultural buildings, and the optimization of the granulometry of fine particles in concrete in order to obtain high-performance concretes. A very interesting area turned out to be the application of laser and radar road measurements in the diagnostic analysis of cement concrete pavements of motorways, during which microscopic and chemical analyses are performed on concretes in order to limit concrete degradation processes that lower the lifespan of highway pavements. Another very current topic concerns construction systems for silicate-based paved surfaces and roads which are designed for ecological rainwater management.
- In 2020, several specific research projects were implemented in which Ph.D. and master's students were heavily involved. As far as the possibilities offered by the use of secondary raw materials are concerned, areas of activity included the development of a chemically resistant material for the reverse injection grouting of sewers using

secondary raw materials, and the development of lightweight filler mixtures for ceramic fittings, which mainly involved the use of waste thermal insulation materials. Furthermore, in the field of concrete, investigations are underway in a project focused on the development of high-resistance concretes for the XA environment produced using fly ash, or the use of high-performance concretes (HPC) in contemporary civil engineering. There are also projects focused on the study of laboratory preparation, the structure and stability of tricalcium silicate, the influence of genesis and type of limestone on the process of decarbonation and sintering of CaO, and research into the options for the use of the sol-gel method in cement-free refractory concrete. As far as other projects are concerned, it is also worth mentioning the study of the physicomechanical properties of modern silicate and polymer composites, with a focus on the monitoring of volume changes, and the study of the properties of composite materials for trenchless pipeline renovations using the CIPP method.

The staff of the Advanced Building Materials IG constantly and actively publish the programme's achieved results at significant scientific conferences and in important international journals, and thus present not only the latest findings from the area of research and development, but also the AdMaS Centre itself. This also involves acquiring new contacts for future cooperation in the area of R&D, and sub-contracts. Achieved results are also verified in the form of functional samples and verified technologies, and registered in the form of utility models and patents. It is not only important research workers in senior researcher positions that are significantly involved in the activities, but also (and indeed mainly) young people in junior researcher positions, who additionally cooperate closely with bachelor's, master's and Ph.D. students, and pass on their experience to them.

As far as the fulfilment of goals according to the TA is concerned, the following examples can be listed:

- Within the project "Advanced waste-free technology for the re-use of soil in the form of self-compacting grouts", a utility model entitled "Admixture for the liquefaction of soils" was registered under No. 34029, and a patent application was filed: PV 2020-196, entitled "Self-compacting soil-based grout", for which it has already been decided that a patent (No. 308679) will be granted. As far as applied results are concerned, the functional samples "Additive for the liquefaction and stabilization of clayey soils" and "Additive for the liquefaction and stabilization of sandy soils" were also verified. Last but not least, the technology "Technology for the use of soil in the form of grout" was verified.
- In the area of "Advanced technology for aerated sandy concrete with a proportion of secondary raw materials and more efficient use of natural resources", a utility model (No. 34203) was prepared with the title "Aerated sandy concrete fabricated using secondary raw materials." 2 functional samples were registered, these being "Aerated sandy concrete with a fluidized bed combustion ash admixture" and "Aerated sandy concrete fabricated using secondary raw materials". A verified technology named "Technology for the production of aerated sandy concrete with secondary raw materials" was developed.
- In the thematic area "Advanced adhesives with a higher proportion of secondary raw materials for extremely stressed environments", a utility model entitled "System of adhesives for the installation of basalt elements on a metal substrate" was registered under No. 34524. Furthermore, a "Technology for the production of adhesive mixtures for the installation of basalt elements in conditions of high chemical and physical stress" was verified as part of the project in 2020.

- Basic research primarily entailed the investigation of Czech Science Foundation projects, such as:
- 18-02815S Elimination of sulphur dioxide emissions during the firing of ceramic body manufactured using power plant fluidized bed combustion ash,
- 18-25035S A study of the effects of flowing fluids on the erosive wear of cement composites, and the subsequent modelling of mechanical corrosion,
- 19-00291S Analysis of processes during the formation of the structure of silicate composites with organic fillers, and their behaviour under specific stress conditions.

Cooperation with partners in projects awarded by the Ministry of Industry and Trade, Technology Agency of the Czech Republic and Czech Science Foundation, as well as with contract research partners, took place at an excellent level in 2020. The activities of the individual cooperating organizations complemented one another efficiently. Collaboration occurred with producers of raw materials, manufacturers of materials and components, organizations planning to apply for research funding in the future, and other research organizations. The key project of 2020 was sub-project No. TN01000056/04, entitled "Advanced Building Materials", upon which the Advanced Building Materials IG cooperated with the companies INFRAM a.s., KOMA MODULAR s.r.o. and Wienerberger s.r.o.

As far as other projects are concerned, the following can be named:

- MIT FV10118 Advanced waste-free technology for the re-use of soil in the form of self-compacting grouts; cooperation with Komfort, a.s.
- MIT FV10284 Advanced technology for aerated sandy concrete with a proportion of secondary raw materials and more efficient use of natural resources; cooperation with PORFIX CZ a.s.
- MIT FV20530 Unique formwork system with a protective anti-corrosive function; cooperation with FEVA, s.r.o.
- MIT FV20149 A comprehensive system for the remediation of chemically attacked and stressed building structures; cooperation with BETOSAN s.r.o.
- MIT FV20019 Optimization of fine particle granulometry in concrete to obtain highperformance concretes; cooperation with Skanska and Transportbeton, s.r.o.
- MIT FV20303 Progressive polymer materials utilizing secondary raw materials and dangerous waste for use in chemically highly aggressive environments; cooperation with Redrock Construction s.r.o.
- MIT FV20595 Reinforced concrete structures of precision machine tools; cooperation with TOS KUŘIM OS, a.s.
- MIT FV20086 Development of light modern building materials using light aggregate based on waste glass flour; cooperation with REFAGLASS s.r.o.
- MIT FV30325 Application of laser and radar road measurements in the diagnostic analysis of cement concrete pavements of motorways, implementation of physical and chemical analyses of concretes in order to limit degradation processes of concretes which lower the lifespan of highway pavements; cooperation with CONSULTEST s.r.o.

- MIT FV30072 Effective optimization of the use of waste from the manufacture of cement-bonded particleboards in the production of competitive building materials; collaboration with CIDEM Hranice, a.s.
- MIT FV30327 Progressive waste-free technology for high-performance porous concrete utilizing renewable resources; cooperation with PORFIX, CZ a.s.
- MIT FV30239 Advanced materials improving earthing in a lightning and overvoltage protection system; cooperation with BETONCONSULT, s.r.o.
- MIT FV40081 Advanced technologies for the establishment and restoration of structural layers of a railway track bed with efficient use of secondary raw materials; in cooperation with INFRAM a.s.
- MIT FV40343 Silicate-based structural systems of paved surfaces and roads for ecological rainwater management; cooperation with Lias Vintířov, lehký stavební materiál k.s.
- TACR TH02020321 Production of mullite temper in a shaft kiln; cooperation with P-D Refractories CZ a.s.
- TACR TH02020415 Advanced adhesive materials with high proportions of secondary raw materials for extremely stressed environments; cooperation with Redrock Construction s.r.o.
- TACR TH03020072 Development of high-strength porous concrete resistant against the chemically aggressive environments of special agricultural structures; collaboration with ZAPA beton a.s.
- TACR TH04020378 Development of new technologies and products for sustainable construction in the area of masonry structures; cooperation with Wienerberger s.r.o.
- TACR TH04030425 REIZO Development of a technological line for the recycling and material use of waste from insulating materials; cooperation with VIA ALTA a.s.

In 2020, new cooperation began not only in the execution of basic and applied research projects, but also within the framework of contract research. Newly commenced projects include:

- TACR FW01010061 Comprehensive technology for the processing of ore mining residues for the stabilization of excavated areas and for the base layers of linear structures; cooperation with TVAR COM, spol. s r.o.
- TAČR FW01010197 Research and development activities concerning new progressive materials for the rehabilitation of utility networks using secondary raw materials; cooperation with IN-CHEMIE Technology s.r.o.
- Czech Science Foundation 20-00676S Effects of mechanochemical activation on the formation process, structure and stability of selected clinker minerals
- Czech Science Foundation 20-01536S Controlled modification of the mineralogical composition of a ceramic body in order to improve its functional properties

• Czech Science Foundation 20-09072J - Structure formation of advanced silicate composites with reduced impedance (international project with Kalashnikov Izhevsk State Technical University)

Selection of photo documentation from the verification of a technology for the use of soil in the form of grouts:



Figure 1: Excavation of a trench



Figure 2: Transportation of soil to a container



Figure 3: Dosing the ingredients in the mixer



Figure 4: Determination of optimum spread using an Abrams cone in situ



Figure 5: Collection of grout specimens in moulds



Figure 6: Even pouring of the mixture into the trench



Figure 7: The grout 24 hours after pouring



Figure 8: Testing of the fire resistance of a concrete segment at temperatures above 1 000°C. The material contains polymer fibres to increase the fire resistance and prevent explosive spalling of the concrete: the image shows the tested segment when it was remo



Figure 9: Testing of the response to fire of a cement-bonded particleboard with a chipboard underlay not treated with fire retarders, with consideration given to the butt joint: composition of the specimen before the test (top left), effect of the initia





Figure 11: Testing of the fire resistance of concretes containing organic fibres obtained from recycled raw materials at temperatures above 1 000°C



Figure 12: Testing of the fire resistance of a wooden structure suitable for use in wooden buildings, with plasterboard cladding, with a higher temperature resistance and inserted mineral thermal insulation: a test specimen placed on the oven during the test (above) and after test (bottom)

7.2. Interest group: Advanced Building Structures and Transport Constructions

7.2.1. Activities of the IG in the area of management

IG coordinator - Assoc. Prof. Ing. Pavel Schmid, Ph.D.

The Advanced Building Structures and Transport Constructions interest group is organised into the following divisions:

Modelling division

Mathematical Modelling (MAT) - Prof. RNDr. Josef Diblík, Dr.Sc. Structural Mechanics (STM) - Prof. Ing. Drahomír Novák, Dr.Sc. Computer-aided Engineering and Computer Science (AIU) - Assoc. Prof. Mgr. Tomáš Apeltauer, Ph.D.

Structures division

Geotechnics (GTN) - Assoc. Prof. Ing. Lumír Miča, Ph.D. Concrete and Masonry Structures (BZK) – Prof. RNDr. Ing. Petr Štěpánek, CSc., Dr.h.c. Concrete and Timber Structures (KDK) - Prof. Ing. Marcela Karmazínová, CSc. Diagnostics of Structures and Building Testing (SZK) - Assoc. Prof. Ing. Pavel Schmid, Ph.D.

Building Structures division, Architecture

Building Structures (PST) - Prof. Ing. Miroslav Novotný, CSc. Architecture - Assoc. Prof. Ing. arch. Antonín Odvárka, Ph.D. Technology, Mechanization and Construction Management (TST) - Assoc. Prof. Ing. Vít Motyčka, CSc.

Transport Structures division

Road Structures, Road Engineering (PKO) - Assoc. Prof. Dr. Ing. Michal Varaus Railway Engineering (ZEL) - Assoc. Prof. Ing. Otto Plášek, Ph.D.

The operation of individual laboratories in terms of the lab work schedule and the ensuring of trouble-free operation (necessary servicing, maintenance and calibration of equipment) is guaranteed by the heads of the individual laboratories.

As far as work safety is concerned, each laboratory has declared binding Operating and Safety Rules approved by the FCE's safety technician. Only trained persons listed in the list of Authorized Persons are authorized to work in laboratories with individual devices, including handling equipment (bridge cranes, mobile mechanical lifting machines and transportation equipment). The training and listing of persons are the responsibility of the laboratory managers. Operational Logs are kept for strategic equipment.

Heads of Laboratories at the AdMaS Centre:

Head of Laboratories, Structures Section (P1-115, Hall H, storage and workshop facilities P1) - Assoc. Prof. Ing. Petr Daněk, Ph.D.

Head of Laboratories, Road Engineering Section (P1-121) - Ing. Pavla Nekulová

Head of Laboratories, Railway Structures Section (Hall H) - Assoc. Prof. Ing. Otto Plášek, Ph.D.

Head of the Outdoor Test Polygon - Ing. David Bečkovský, Ph.D.

Head of Laboratories, Radiation Defectoscopy Centre (Hall P1 - 014, monitored zone approved by the SUJB - State Office for Nuclear Safety) - Ing. Ondřej Anton, Ph.D.

Head of the Fire Resistance Testing Laboratory (Hall H - test polygon near Hall H, mobile furnace) - Ing. Martin Zlámal, Ph.D.

7.2.2. Training and seminars

Activities in these areas were cancelled or postponed indefinitely due to the global pandemic.

7.2.3. Research staff mobility and cooperation with institutions abroad

Transport Structures division, Architecture

Architecture - ADMAS

Joint workshops with the companies Precious Plastic Amsterdam (NL), Precious Plastic Wien (AUT), Smile Plastics London (UK).

7.2.4. Research staff mobility: collaboration with industrial entities

Research staff mobility in terms of collaboration with industrial entities took place throughout the year. In the majority of cases, this entailed one-day trips for the purpose of carrying out particular experiments, taking measurements, verification of collaboratively developed functional samples or verified technologies, training, consultations, etc.

7.2.5. Research activities conducted by the IG

Transport Structures division, Architecture

Institute of Building Structures - ADMAS

With regard to the global health situation, for the Institute of Building structures -ADMAS, 2020 unfortunately did not involve much active participation in the AdMaS Centre. Testing and experimental activities which had been planned for projects had to be moved to the places of residence of employees who were working from home (outside Brno) for the reasons mentioned above. Some other activities took place at the FCE's premises at Veveří 95 or were cancelled completely and moved to 2021 after an agreement with the provider.

The experiments to be conducted as part of OPEIC, TACR or MIT TRIO4 projects which were moved to 2021 are:

- Implementation of the roofing of blue containers with an 8 x 8m test roof for TOPWET vacuum systems (assuming the submission of the new projects Trend, Application, etc.)
- Construction of a façade made from cement fibre boards TACR EPSILON project
- Study of the phase transformation of water and its effect on the thermotechnical properties of green roof structures
- Construction of green facades (of the green wall, green facade and living wall type) project MIT TRIO4
- Applied research in the field of green and blue infrastructure (ENVILOPE)

The Building Structures division at AdMaS is researching the options for 3D printing on a larger scale, which includes cooperation in R&D concerning the 3D printing of concrete and concrete elements. A large-volume 3D printer is now being constructed at the Institute of Building Structures, thanks to which it will be possible to carry out semi-scale or even full-scale experiments.



Figure 13: Demonstration of the possibilities of full-scale 3D printing at the Institute of Building structures

Architecture - ADMAS

The ARC AdMaS research team consists of: Head of the research team: Ing. arch. Viktor Svojanovský Members of the team - students: Bc. Ondřej Venclík (1st year master's study) Bc. Marco Aulisa (1st year master's study) Štěpán Macek (4th year bachelor's study) all students at the Institute of Architecture.

During regular meetings, the team has been dealing with coordination procedures concerning tests and experiments aimed at determining the processability of waste thermoplastic. The aim is to offer the option of using this "waste" raw material and thus prevent the generation of new waste. In other words, to change the perception of the general public that this material is waste; instead, it should be seen as a resource. The research also has potential in the business/commercial zone, as it could lead to a new marketable product or products with environmental overlap. Interdisciplinary testing of the mechanical and chemical properties of samples is also planned.

• Participation in the international competition The Trail by Vinci Construction. The project Plastic Crystal won the national round on 1st April 2020, and was shortlisted for the international round. The project was presented at the international conference Architecture in Perspective 2020. The paper from the conference is included in the conference proceedings:

SVOJANOVSKÝ, V. Innovative use of waste plastic in architecture and civil engineering. Architecture in Perspective 2020. Ostrava: VSB - Technical University of Ostrava, 2020. P. 322-325. ISBN: 978-80-248-4450-3.

The topic received considerable media attention. Some examples are shown in the following table:

PLASTIC CRYSTAL AND THE FACULTY OF CIVIL ENGINEERING IN THE MEDIA				
Name of medium	Reference			
vutbr.cz	https://www.vutbr.cz/vut/aktuality-f19528/plasty-z-cernych-skladek-meni-v-utulny- d187532			
Startitup.sk	https://www.startitup.sk/skupina-vysokoskolakov-premiena-plasty-zo-skladok-na- autenticke-lesne-utulne/?			
Positive news	https://pozitivni-zpravy.cz/plast-z-cernych-skladek-najde-vyuziti-studenti-ho- promeni-v-utulny/			
TV BRNO 1	https://tvbrno1.cz/zpravy/jihomoravsky/brno/517/studenti-z-vut-buduji-chatku-z- plastu			

Table 3: Plastic crystal in the media

Institute of Building Technology Mechanization and Construction Management – ADMAS

R&D outputs of the RIV Jimp type:

- LIŠKA, P.; NEČASOVÁ, B.; ŠLANHOF, J.; SCHMID, P.; MOTYČKA, V. Impact of manufacturing imperfections and surface defects on stress-strain behaviour of flexible adhesive joints. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART E-JOURNAL OF PROCESS MECHANICAL ENGINEERING, 2020, ed. 234, No. 5, pp. 499- 510. ISSN: 0954- 4089
- NEČASOVÁ, B.; LIŠKA, P.; ŠLANHOF, J.; SEDLÁK, P.; MOTYČKA, V. Long adhesive joints in façade applications exposed to wind suction. PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART E-JOURNAL OF PROCESS MECHANICAL ENGINEERING, 2020, ed. 234, No. 5, pp. 488- 498. ISSN: 0954- 4089

Important R&D projects with industrial entities, and other activities:

• **MPO TRIO FV20606 - Technology for the gluing of large format tiles** In February 2020, Stage No. 6 - Tests on structural models - was completed. At the beginning of the year, the last stage, Stage No. 7, was launched - Pilot application of the new technology, ending in May 2020, when the whole project also ended. The project investigators were the company Profibaustoffe CZ s.r.o., and the Institute of Technology Mechanization and Construction Management and the Institute of Building Structures at Brno University of Technology's Faculty of Civil Engineering.

The main aim of the project was the development of technology for the gluing of largeformat tiling elements, i.e. tiles and floor tiles, using a thin-layer cement-based gluing mortar. The large-format tiling element was a ceramic tiling element with at least one dimension exceeding 1000 mm.

The completed Stage No.6 took place in a hall at the AdMaS site on a large-area test specimen of approx. 6x4 m in size, which was concreted on site, directly in the hall. Tiling elements with cut-outs in 5 different material combinations of ceramic element and mortar bed were installed on a mature reinforced concrete base. Strain gauges were placed on the surface of the tiles. After placement of the ceramic tiles, the test specimens were monitored during the maturing of the mortar bed using a non-destructive ultrasound method.



Figure 14: Positions of composites (left image), positions of tensometers (right image)

After maturing was fully complete, the panel was supported in a line along its longer six-meter edges on the vacuum table. When vacuum was induced under the panel, it bent downwards over a span of 4 m, theoretically into the shape of a cylindrical surface. The element was gradually cyclically loaded, with subsequent unloading.





Figure 15: Loading method (upper image), view of the tested element (lower image)

During the test, monitoring and evaluation was performed regarding maximum deflections of the construction model achieved during the individual test cycles in the middle of the panel span, as well as the relative deformations measured on the tensometers and the number of acoustic emission overshoots. After the completion of the loading cycles, tensile strengths were measured via tear tests and acoustic tracing was performed.

STRUCTURES DIVISION

CONCRETE AND MASONRY STRUCTURES - ADMAS

"J" type outputs (according to Apollo), or "Jneimp":

- ZLÁMAL, M.; ŠTĚPÁNEK, P.; ČAIROVIĆ, D.; GIRGLE, F.; ZLÁMALOVÁ, P.; LAGIŇ, J. Využití FRP výztuží pro rámové styčníky. PROCEEDINGS FOR THE CONFERENCE 27th CONCRETE DAYS. 1. Praha: Česká betonářská společnost CSSI, 2020. ISBN: 978-80-907611-3-1
- ZLÁMAL, M.; ŠTĚPÁNEK, P.; ČAIROVIĆ, D.; ROZSYPALOVÁ, I.; ZLÁMALOVÁ, P.; VENCLOVSKÝ, J. Vlastnosti FRP výztuží za zvýšených teplot. PROCEEDINGS FOR THE CONFERENCE 27th CONCRETE DAYS. 1. Praha: Česká betonářská společnost CSSI, 2020. ISBN: 978-80-907611-3-1
- ZLÁMAL, M.; ŠTĚPÁNEK, P.; GIRGLE, F.; JANUŠ, O.; BÁRTOVÁ, D.; LAGIŇ, J.; PREKOPOVÁ, P.; ČAIROVIĆ, D. Chování otevíravých rámových styčníků vyztužených FRP výztuží. Beton TKS, 2020, ed. 20, No. 1, pp. 62- 67. ISSN: 1213- 3116
- JUŘÍČEK, L.; ZICH, M.; HASA, M.; BOBEK, L.; KOMÁRKOVÁ, P. Precast Dapped End
 Nonlinear Analysis. In 27th Concrete Days. Solid State Phenomena, 2020.
 p. 234- 239. ISBN: 978-80-907611-3-1

- JUŘÍČEK, L.; ZICH, M.; HASA, M.; BOBEK, L.; KOMÁRKOVÁ, P. Prefabrikované nosníky uložené ozubem - nelineární řešení. Praha: Česká betonářská společnost ČSSI, 2020. Pp. 240- 246
- ŠIMEK, O.; ZICH, M.; JANDA, M.; DANĚK, P. TESTOVÁNÍ PREFABRIKOVANÝCH ŽELEZOBETONOVÝCH PILÍŘŮ. In Juniorstav 2020. Brno: ECON Publishing, s.r.o.; Pod nemocnicí 590/23; 625 00 Brno, 2020. pp. 1-6. ISBN: 978-80-86433-73-8
- ŠIMEK, O.; ZICH, M.; JANDA, M.; DANĚK, P.; NEČAS, R. Testing of the Prefabricated Reinforced Concrete Pillars. In 26th Concrete Days. Solid State Phenomena, 2020. p. 234- 239. ISBN: 978-3-0357-3668-7
- ŠIMEK, O.; ZICH, M.; JANDA, M.; NEČAS, R. ÚNOSNOST PREFABRIKOVANÝCH PILÍŘŮ V ZÁVISLOSTI NA ZPŮSOBU VYZTUŽENÍ. Concrete Days 2020 Conference proceedings.
 1. Bratislava: SPEKTRUM STU, 2020. pp. 169-174. ISBN: 978-80-227-5047-9
- ŠIMEK, O.; ZICH, M.; JANDA, M.; NEČAS, R. VLIVY ROZDÍLNÉHO VYZTUŽENÍ PILÍŘŮ PREFABRIKOVANÝCH PANELŮ S OTVOREM. 27. Concrete Days 2020, Conference proceedings. 1. Praha: Česká betonářská společnost ČSSI, 2020. pp. 483- 489. ISBN: 978-80-907611-3-1

Type "D" outputs (according to Apollo):

- KOCÁB, D.; TERZIJSKI, I.; STRNAD, J.; LOUDA, P. Comparison of Resistance of Concrete for Sewage Pipes to Sulphate Corrosion Using Model Mortars. In Solid State Phenomena: 26th Concrete Days. Solid State Phenomena. Switzerland: Trans Tech Publications Ltd, 2020. p. 44-50. ISBN: 978-3-0357-3668-7. ISSN:1662- 9779
- ŠIMŮNEK, P., ŠTĚPÁNEK, P., ŠVAŘÍČKOVÁ, I., PROKEŠ, J., LANÍKOVÁ, I., ŽÍTT, P., MENDES, J. M. Influence of an Acidic Environment on a Glass Fibre Reinforced Polymer Grid. MATEC Web Conf. 310-00022(2020); DOI: 10.1051/matecconf/202031000022

Type "Ffunk" outputs (according to Apollo):

ZLÁMAL, M.; ČAIROVIĆ, D.; ŠTĚPÁNEK, P.; PROKEŠ, J.; ŠEVČÍK, M.: Fire simulation furnace; Fire testing furnace. AdMaS Research Centre, Brno University of Technology, Purkyňova 139, 612 00 Brno (functional sample) Utility model name: Prefabricated wall panel Authors: Zich Miloš, Nečas Radim, Miloslav Janda, Jiří Huml. Grant output: TH3020446 Development of a more dispositionally variable panel system for apartment buildings Recipient: S.O.K. stavební, s.r.o. Ing. Radek Karásek Co-recipient: Brno University of Technology - Ing. Miloš Zich Ph.D. The subject is the arrangement of the panel shape, the system of reinforcement and the static action of prefabricated reinforced concrete panels enabling the execution of additional openings without the need for additional reinforcement, and thus enabling a more variable layout for an apartment building, with the freer interconnection of rooms or individual apartments.

Example of an output from the project TH02020548 Progressive assembled composite structures from pultruded profiles (cooperation with PREFA KOMPOZITY, a.s.):

 As part of the project investigation, methods of coupling a 280 mm-high three-chamber GFRP beam DWB 80 (Double Web Beam) with a composite slab (reinforced concrete or GFRP reinforcement) were developed and tested. After previous tests of coupling efficiency performed on partial segments of a beam with a slab on both sides (according to EN 1994-1-1, Annex B), experiments were designed and implemented to verify coupling efficiency on a real beam structure stressed by bending with a span of 3.45 m with a composite over-concrete slab. A total of 3 types of coupling were tested on a total of 6 specimens. The test configuration is shown in Figure 16.

In the area of possible use, i.e. for loads up to 106 kN, which is defined by the limit deflection, consistent results were achieved with a slight decrease in efficiency with increasing load.





Figure 16: Test configuration, view of the coupled element at the support location (above) and its horizontal (below)

INSTITUTE OF METAL AND TIMBER STRUCTURES - ADMAS

Selected outputs of contract research (Institute of Metal and Timber Structures):

- SR122057077 Evaluation of material parameters of steel for provided samples from truss structures of masts. Sample identification: V555 and New 3 Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: EGÚ Brno, a.s.
- HS122054048 Resistance test of a ventilated facade under full-surface loading Investigator: Ing. Josef Holomek, Ph.D.
 Customer: The Technical and Test Institute for Construction Prague, SOE
- SR122057109 Evaluation of material parameters of steel for provided samples from truss structures of masts. Sample identification: V1161 and Čebín Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: EGÚ Brno, a.s.
- HS122054065 Execution of a detailed inspection of the load-bearing structure of winter stadium roofing Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: G G ARCHICO a.s.
- SR122057141 Evaluation of material parameters of steel for provided samples from truss structures of masts. Sample identification: V6820 and V1311-2 Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: EGÚ Brno, a.s.
- SR122057163 Evaluation of material parameters of steel for provided samples from truss structures of masts. Sample identification: V8769 / 70 Sk and V400 Sk Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: EGÚ Brno, a.s.
- HS122054090 Testing of resistance to whole-surface loading of cement fibre boards connected by rivets
 Investigator: Ing. Josef Holomek, Ph.D.
 Customer: The Technical and Test Institute for Construction Prague, SOE
- SR122057190 Evaluation of material parameters of steel for provided samples from truss structures of masts. Sample identification: V501 Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: EGÚ Brno, a.s.
- HS12954121L Monitoring the behaviour of the steel structure of roofing of the winter stadium in Uherské Hradiště - stage 2019 - 2020 Investigator: Prof. Ing. Miroslav Bajer, CSc. Customer: G G ARCHICO a.s.

Projects:

• TN01000056 Advanced wood and composite structural elements for civilian buildings (a sub-project within the framework of NCC CAMEB)

Workplaces involved: Brno University of Technology - Faculty of Civil Engineering, Institute of Metal and Timber Structures + Institute of Concrete and Masonry Structures*); Mendel University in Brno - Faculty of Forestry and Wood Technology, Kloboucká lesní, s.r.o., Agrop NOVA a.s., PREFA KOMPOZITY a.s.*)

*) The Institute of Concrete and Masonry structures at FCE is investigating its own material content in cooperation with PREFA KOMPOZITY a.s.

Period of project investigation: 2019 - 2020, extended to 2021 - 2022

Part of the project being investigated by the Institute of Metal and Timber Structures deals with issues concerning load-bearing wood-based structural elements in two areas:

1) reinforced composite structural elements fabricated from glued laminated timber in cooperation with Kloboucká lesní, s.r.o.

2) large-format wall and ceiling structural elements with improved acoustic and fireretardant properties in cooperation with Agrop NOVA a.s.

Ad 1) The first stage of research (2019 - 2020) was focused on the development of a load-bearing structural element for horizontal load-bearing structures made of glued laminated wood, both coniferous (spruce) and "combined" (spruce + beech), reinforced with external reinforcement (e.g. CFRP lamellas or steel tape). The aim is to effectively increase load-bearing capacity, especially under bending stress, i.e. with an emphasis on the required reliability of the structural element as well as its economy. Apart from extensive theoretical studies and analyses of load-bearing capacity and their evaluation, experimental analyses of the load-bearing capacity and real effect of the developed structural elements have been performed on sets of a total of 77 test specimens to date. The results of the load tests, which were evaluated in detail and compared with the results of theoretical calculations, showed a visible trend of increasing load-bearing capacity when steel strip reinforcement was applied (at a reasonable cost). The work continues with the implementation of further load tests to confirm the results obtained so far, with a focus on the quality of gluing and the verification of the real properties of the wood. In the next stage, the research will focus on the use of other hard woods and combinations of woods in structural elements made from glued laminated wood with external reinforcement.



Figure 17: Illustration of load tests on glued laminated timber beams with steel strip reinforcement

Ad 2) In 2020, research and development was carried out with regard to Novatop surface system elements. In the area of reaction to fire, acoustic panel variants of the NOVATOP ACOUSTIC type were treated with transparent fire protection spray and compared. In the area of airborne soundproofing, a functional sample of a wall panel was created, entitled "A large-format wall structural element with improved acoustic properties." In the area of the mechanical properties of NOVATOP panels, interim analytical, numerical and experimental analyses were performed, the results of which will be used in the subsequent phase of the project investigation, which will concern the development of panels with improved acoustic and static properties. Research and development in this area also focuses on the improvement of the mechanical and structural properties of NOVATOP Element ceiling/roof panels. A detailed analysis of the behaviour of Element panels under load is currently being produced, on the basis of which the key components of the panel will be modified

in order to improve its mechanical properties and the design of connections between the system elements.



Figure 18: Details of the failure of test specimen Eswp1 after the performance of a load test via four-point bending, and a close-up view of the failure of test specimen Elwl2 after the execution of a vacuum loading test.

TRANSPORT STRUCTURES DIVISION

INSTITUTE OF RAILWAY STRUCTURES AND CONSTRUCTIONS - ADMAS

"J" type outputs (according to Apollo), or "Jneimp":

- SMUTNÝ, J.; JANOŠTÍK, D.; PAZDERA, L.; NOHÁL, V. THE USE OF UNTERBERGER TRANSFORMATION ON ANALYSIS OF DYNAMIC PARAMETERS OF RAIL FASTENINGS. Akustika, 2020, ed. 35, No. 1, pp. 31- 38. ISSN: 1801-9064
- JANOŠTÍK, D.; NOHÁL, V.; SEELMANN, H.; SMUTNÝ, J. The Continuous Monitoring of Selected Railway Structures using the Autonomous Data Logger. Communications, 2020, ed. 22, No. 2, pp. 88-96. ISSN: 1335-4205

- SMUTNÝ, J.; JANOŠTÍK, D.; NOHÁL, V.; PAZDERA, L. The analysis of dynamic effects in the exchange part of turnouts. Experimental Stress Analysis 2020, Book of full Papers. 1. Ostrava: VSB - Technical University of Ostrava, 2020. PP. 464-470. ISBN: 978-80-248-4451-0
- JANOŠTÍK, D.; NOHÁL, V.; SMUTNÝ, J. MONITOROVÁNÍ VÝHYBEK AUTONOMNÍM DATALOGGEREM. Nová železniční technika, 2020, ed. 28, No. 5, pp. 12- 21. ISSN: 1210- 3942
- JANOŠTÍK, D.; NOHÁL, V.; SMUTNÝ, J. Monitorování drážní infrastruktury cenově dostupným dataloggerem. Vědeckotechnický sborník Správy železnic, 2020, ed. 2020, No. 3, pp. 43-52. ISSN: 2694-9172
- SMUTNÝ, J.; JANOŠTÍK, D.; NOHÁL, V. APPLICATION OF UNCONVENTIONAL METHODS FOR FREQUENCY ANALYSIS IN ACOUSTICS. Akustika, 2020, ed. 36, No. 2, pp. 24- 31. ISSN: 1801- 9064

Impact factor - RIV Jimp

- MARTINA KRATOCHVÍLOVÁ, JAN PODROUŽEK, JIŘÍ APELTAUER, IVAN VUKUŠIČ AND OTTO PLÁŠEK, "Train Type Identification at S&C", Journal of Advanced Transportation, vol. 2020, Article ID 8849734, 12 pages, 2020. https://doi.org/10.1155/2020/8849734
- ROSTISLAV KRČ, JAN PODROUŽEK, MARTINA KRATOCHVÍLOVÁ, IVAN VUKUŠIČ AND OTTO PLÁŠEK, "Neural Network-Based Train Identification in Railway Switches and Crossings Using Accelerometer Data", Journal of Advanced Transportation, vol. 2020, Article ID 8841810, 10 pages, 2020. https://doi.org/10.1155/2020/8841810

Important contract research outputs:

 SR122057177 - Perpendicular crossings of tram tracks and sidings Investigator: Assoc. Prof. Ing. Otto Plášek, Ph.D. Customer: Dopravní podnik města Brna, a.s.

Important R&D projects with industrial entities and other activities:

- CK01000091, Switch 4.0, launched: 01. 04. 2020, completion: 29. 03. 2024. TACR -1st public tender Funding Programme for Applied Research, Experimental Development and Innovation in Transport - TRANSPORT 2020+. Recipient DT -Výhybkárna a strojírna, a.s.
- CK01000095, Risk management plan for selected critical structures of transport infrastructure, launched: 01. 03. 2020, completion: 31. 12. 2022. TACR - 1st public tender Funding Programme for Applied Research, Experimental Development and Innovation in Transport - TRANSPORT 2020+. Recipient BUT, Institute of Forensic Engineering
- TM01000016, Affordable smart sensing system for railways 4.0, launch: 01. 03. 2020, completion: 31. 12. 2022. TACR 1st public tender for the Programme for applied

research, experimental development and innovation DELTA 2 2019. Recipient BUT, Faculty of Mechanical Engineering

MODELLING DIVISION

Computer-aided Engineering and Computer Science - ADMAS

Specialised book

 PILNÝ, O.; REMEŠ, J.; GOTTVALDOVÁ, J.; JUN, D.; PILNÝ, P. a kol. Virtuální realita ve stavební praxi. Brno: BRNO UNIVERSITY OF TECHNOLOGY, 2020. 419 p. ISBN: 978-80-214-5912-0

Article in the journal Web of Science, Jimp

 VESPALEC, A. NOVÁK, J. KOHOUTKOVÁ, A. VOSYNEK, P. PODROUŽEK, J. ŠKAROUPKA, D. ZIKMUND, T. KAISER, J. PALOUŠEK, D. Interface Behavior and Interface Tensile Strength of a Hardened Concrete Mixture with a Coarse Aggregate for Additive Manufacturing. Materials, 2020, ed. 13, No. 22, pp. 1- 20. ISSN: 1996-1944

Journal article - others, Jost

 VUKUŠIČ, I.; VUKUŠIČOVÁ, D.; ZAPLATÍLEK, K.; PODROUŽEK, J.; APELTAUER, J.; KRATOCHVÍLOVÁ, M. Diagnostika dynamických účinků ve výhybkách v rámci projektu S-CODE. Vědeckotechnický sborník Správy železnic, 2020, ed. 2019, No. 1, pp. 1- 26. ISSN: 2694- 9172

Article in proceedings in the WoS or Scopus

- KRATOCHVÍLOVÁ, M. Machine Learning Based Train Type Identification at Railroad Switch Using Vibration. In 22. Professional conference for doctoral studies. 22. Brno: Econ Publishing s.r.o., 2020. pp. 211-216. ISBN: 978-80-86433-73-8
- UHLÍK, O.; APELTAUER, T. Analýza reakční doby při ochraně měkkých cílů v podmínkách ČR. In Sborník příspěvků - JUNIORSTAV 2020. Brno: Brno University of Technology, 2020. pp. 222- 227. ISBN: 978-80-86433-73-8.

Research activities

Projects focused on safety and additive production announced by the Technology Agency of the Czech Republic and the Ministry of the Interior of the Czech Republic.

- VI20192022118, Protection of soft targets in the security environment of the Czech Republic
- TH04010335, Vacuum plating system for additive technologies

Cooperation with industrial entities

• Analysis of the railway hub of Prague - main railway station: https://www.linkedin.com/feed/update/urn:li:activity:6630078334170738688/ Simulation of the evacuation of people and spread of fire as part of preparations for the project ARENA Brno: https://www.linkedin.com/feed/update/urn:li:activity:6745744990971932672/

Publications

- DIBLÍK, J.; MENCÁKOVÁ, K. A Note on Relative Controllability of Higher-Order Linear Delayed Discrete Systems. IEEE TRANSACTIONS ON AUTOMATIC CONTROL, 2020, ed. 74, No. 12, pp. 1-8. ISSN: 0018-9286 (high-impact publication, partially supported by project No. LO1408, AdMaS UP - Advanced Materials, Structures and Technologies (Ministry of Education, Youth and Sports of the Czech Republic, National Sustainability Programme I)
- DEMCHENKO, H.; DIBLÍK, J.; KHUSAINOV, D. Optimal control of the heating process with delay. In Proceedings of the International Conference on Numerical Analysis and Applied Mathematics 2019 (ICNAAM-2019). AIP Conference Proceedings. Melville (USA): American Institute of Physics, 2020. s. 340016-1 (340016-4 s.) ISBN: 978--0-7354-4025-8. ISSN: 0094-243X. (paper in conference proceedings registered in SCOPUS, partially supported by project No. LO1408, AdMaS UP - Advanced Materials, Structures and Technologies (Ministry of Education, Youth and Sports of the Czech Republic, National Sustainability Programme I)
- MENCÁKOVÁ, K.; DIBLÍK, J. Relative controllability of a linear system of discrete equations with single delay. In ICNAAM 2019 Proceedings. AIP Conference Proceedings. Melville (USA): American Institute of Physics, 2020. s. 340009-1 (340009-4 s.) ISBN: 978--0-7354-4025-8. ISSN: 0094-243X. (paper in conference proceedings registered in SCOPUS, partially supported by project No. LO1408, AdMaS UP Advanced Materials, Structures and Technologies (Ministry of Education, Youth and Sports of the Czech Republic, National Sustainability Programme I)
- HALFAROVÁ, H.; DIBLÍK, J.; ŠAFAŘÍK, J. On the number of arbitrary parameters in the general solution to a weakly delayed planar linear discrete system with constant coefficients. In Proceedings of the International Conference on Numerical Analysis and Applied Mathematics 2019 (ICNAAM-2019). AIP Conference Proceedings. Melville (USA): American Institute of Physics, 2020. s. 340008-1 (340008-4 s.) ISBN: 978--0-7354-4025-8. ISSN: 0094-243X (paper in conference proceedings registered in SCOPUS, partially supported by project No. LO1408, AdMaS UP - Advanced Materials, Structures and Technologies (Ministry of Education, Youth and Sports of the Czech Republic, National Sustainability Programme I)
- VALA, J. Nonlocal damage modelling of quasi-brittle composites. 17th International Conference on Numerical Analysis and Applied Mathematics 2019 (ICNAAM 2019) in Rhodes, AIP Conference Proceedings 2293 (2020), 340008/1-4, American Institute of Physics, 2020. ISSN 0094-243X (paper in conference proceedings registered in SCOPUS, partially supported by project No. LO1408, AdMaS UP - Advanced Materials, Structures and Technologies (Ministry of Education, Youth and Sports of the Czech Republic, National Sustainability Programme I)

7.3. Interest group: Economics and Environment

7.3.1. Activities of the IG in the area of management

IG coordinator - Prof. Ing. Petr Hlavínek, CSc. MBA

Coordination meetings involving all employees, where the activities of the interest group are discussed, took place only once every 2 months due to fact that everything was running smoothly - during the Covid 19 pandemic, video conferencing and email communication was used to the maximum extent in order to minimize physical contact between individuals.

Furthermore, workshops were organized as required, especially with regard to the current needs of investigated projects - in 2020, 4 national research projects were investigated, as well as one international project.

It remains typical for an interest group that aside from specific topics, interdisciplinary and comprehensive themes are sought throughout the entire scope of operations of the AdMaS Centre. In relation to the diagnostic analysis of the technical condition of sewerage networks, the IG works in close cooperation with the Advanced Building Materials IG. Similarly, when it comes to contract research in the area of green car parks, the group closely cooperates with the Advanced Building Structures and Transport Constructions IG.

As regards the promotion of the AdMaS Centre and the EGAR group, presentations have been taking place for selected partners from the construction industry, the operators of water management systems, waste handling companies, etc.

7.3.2. Training and seminars

Activities in these areas were cancelled or postponed indefinitely due to the global pandemic.

7.3.3. Research staff mobility and cooperation with institutions abroad

The majority of planned visits were cancelled due to restrictions related to the Covid 19 pandemic.

As far as academic staff mobility is concerned, the following examples can be named:

 Visit by Assoc. Prof. Thomas Meyn and Prof. Stein Wold Østerhus from the Norwegian University of Technology (NTNU), Department of Civil and Environmental Engineering in Trondheim, Norway, on 10. 2. 2020 The visit concerned the coordination of work and subsidiary activities during the investigation of project EHP-ICP-CZ-1-009 - Curriculum for the Czech-Norwegian doctoral program in the field of water management and water engineering.

- During February 2020, the preparation of tender proposals for two international projects for a programme administered by the Technology Agency of the Czech Republic (TACR) took place – the KAPPA programme, which supports applied research, experimental development and innovations
- with the Norwegian University of Science and Technology and other partners in the field of the utilization of waste as an absorbent for the treatment of specific polluted waters
- with the Norwegian Institute for Water Research (NIVA) and other partners in the area of monitoring and removal of antibiotics from various wastewaters.

7.3.4. Research staff mobility with regard to industrial entities

- Ing. Ivo Korytář at the company VH atelier spol. s r.o. for the purpose of cooperation on the design of a project concerning the treatment of wastewater from the process of tunnel cleaning
- Ing. Kristýna Velikovská at VH atelier spol. s r.o. for the purpose of cooperation on feasibility studies concerning the use of heat recovery (winter stadiums, swimming pools)

7.3.5. Research activities conducted by the IG

The development of new technologies in the area of wastewater disposal and cleaning, drinking water treatment and distribution, the handling of waste, and the development of new procedures for the use of energy from wastewater, waste, and sludge created during the cleaning of wastewater.

The fulfilment of goals stated in the technical annex of the AdMaS Centre is accomplished by the Economics and Environment interest group via the investigation of a number of research projects, especially those supported by the Technology Agency of the Czech Republic, and the performance of contract research linked to the Ministry of Industry and Trade's Innovation Vouchers funding programme, as well as direct contract research with technology companies, operators of water management facilities, and others.

In the area of waste and treatment plant sludge management, the most important projects are TACR Zeta, i.e. projects intended mainly for young scientists:

- "Processing of gastro waste into the form of a solid carbon product for material use"; project identification code: TJ02000262 Instrumental equipment: equipment of a stationary analytical laboratory for urban engineering technologies
- "The potential of using torrefaction in the treatment of sewage sludge for further use"; identification number: TJ02000261 Instrumental equipment: equipment of a stationary analytical laboratory for urban engineering technologies

In the area of the development of new procedures for the use of energy from wastewater, the most important project is TACR - Zéta, i.e. again, a project intended especially for young scientists:

 "Acquisition and use of thermal energy from wastewater in combination with the use of purified water", identification number: TJ02000190 Instrumental equipment: equipment of a stationary analytical laboratory for urban engineering technologies; Hall P4; flow measurement devices

The interest group deals with a number of Ministry of Industry and Trade innovation vouchers where the topics of the goals described in the TA blend together, for example:

- Innovation voucher specialised study: "Conceptual solution of automation measures with remote online monitoring for a small and medium wastewater treatment plant" Instrumental equipment: Hall P4; flow measurement equipment
- Innovation voucher specialised study: "Technical and economic study of sludge management in a catchment area"
- Innovation voucher specialised study: "Options for the utilization of sewage sludge from small sources of pollution within green infrastructure, and its agricultural use"

Here are some examples of contract research tasks that were investigated with industrial entities in 2020:

- Contract research in the field of Implementation of a campaign measuring the drainage conditions of selected parts of the sewer network of the city of Kroměříž (Vodárny a kanalizace Kroměříž, a.s.)
 Instrumental equipment: equipment for flow measurement in sewer networks
- Contract research for Brněnské vodárny a kanalizace, where a conceptual design and recommendations for remediation were produced based on a technical engineering survey of a selected part of trunk sewer E.
 Equipment: equipment for flow measurement in sewer networks
- Contract research into the testing of double-walled piping as a part of safety measures for WM infrastructure, sewer network area Instrumental equipment: Hall P4 of the AdMaS Centre, equipment of a stationary analytical laboratory for urban engineering technologies.
- Contract research in the area of the microwave depolymerisation of waste materials with a focus on the processing of sludge from wastewater treatment plants and waste with carbon content
 Equipment: Hall P4 of the AdMaS Centre, equipment of a stationary analytical laboratory for urban engineering technologies.

Overview of results in 2020

 HLAVÍNEK, P.; CHORAZY, T.; ŽIŽLAVSKÁ, A.; RAČEK, J.; VELIKOVSKÁ, K. Koncepční řešení automatizačních opatření se vzdáleným on-line monitoringem pro malou ČOV - Výzkumná zpráva č. SR12957244L/12501/2020. Brno: Brno University of Technology, Faculty of Civil Engineering, AdMaS Centre 2020, pp. 1-122.

- RAČEK, J.; ŠEVČÍK, J.; CHORAZY, T.; KUČEŘÍK, J.; HLAVÍNEK, P. Biochar: the new black gold?, Buckinghamshire, GB: Judd and Judd Ltd, 2020
- ŠEVČÍK, J.; ŽIŽLAVSKÁ, A.; RAČEK, J.; CHORAZY, T.; HLAVÍNEK, P. Příprava čistírenského kalu pro materiálovou transformaci pomocí mikrovlnné torefakce. MĚSTSKÉ VODY 2020. Brno: ARDEC, s.r.o., pp. 165-174. ISBN: 978-80-86020-91-4
- VELIKOVSKÁ, K.; POLÁŠEK, K.; RAČEK, J.; MRAVCOVÁ, L.; HLAVÍNEK, P.; KOCIFAJOVÁ, M.; KORYTÁŘ, I. Testování účinnosti čištění a rekuperace tepla šedých odpadních vod. MĚSTSKÉ VODY 2020. Brno: ARDEC s.r.o., pp. 144-149. ISBN: 978-80-86020-91-4
- RAČEK, J.; VOLAŘÍK, T.; HANOUSEK, J.; MACSEK, T.; HLAVÍNEK, P. Fotogrammetrie a laserové skenování vodohospodářských objektů pro praktické využití. Vodní hospodářství, 2020, ed. 70, No. 1, pp. 12-13. ISSN: 1211-0760
- RAČEK, J.; CHORAZY, T.; VRŠANSKÁ, M.; BRTNICKÝ, M.; PRAX, O.; HLAVÍNEK, P. Materiálová transformace gastro odpadu termickou pyrolýzou. MĚSTSKÉ VODY 2020. Brno: ARDEC s.r.o., pp. 104-109. ISBN: 978-80-86020-91-4
- ŠEVČÍK, J.; RAČEK, J.; CHORAZY, T.; HLAVÍNEK, P. Možnosti nakládání s vysušeným čistírenským kalem. MĚSTSKÉ VODY 2020. Brno: ARDEC s.r.o., pp. 88-95. ISBN: 978-80-86020-91-4
- KORYTÁŘ, I.; MRAVCOVÁ, L.; RAČEK, J.; VELIKOVSKÁ, K.; MACSEK, T.; ÚTERSKÝ, M.; HLAVÍNEK, P. Využití biocharu pro čištění odpadních vod z tunelů. MĚSTSKÉ VODY 2020. Brno: ARDEC, s.r.o., 2020. pp. 110-115. ISBN: 978-80-86020-91-4
- ŽIŽLAVSKÁ, A.; MACSEK, T.; HLAVÍNEK, P.; SUKOVÁ, P.; LANDOVÁ, P.; HANUŠOVÁ, V.; NÝČOVÁ, B. Testování účinnosti eliminace léčiv z odpadní vody pomocí biologického nosiče Levapor. Vodní hospodářství, 2020, ed. 70, No. 9, pp. 5-10. ISSN: 1211- 0760
- MACSEK, T.; CHORAZY, T.; MÜNSTER, P.; TOMŠŮ, J.; HLAVÍNEK, P. Online monitoring technického stavu dvouplášťové kanalizace. MĚSTSKÉ VODY 2020. Brno: ARDEC, s.r.o., pp. 150-155. ISBN: 978-80-86020-91-4
- CHORAZY, T.; ŽIŽLAVSKÁ, A.; MRAVCOVÁ, L.; HLAVÍNEK, P.; NOVOTNÝ, M.; BOUBÍNOVÁ, M. Biologická dostupnost fosforu z čistírenského kalu. MĚSTSKÉ VODY 2020. Brno: ARDEC, s.r.o., pp. 156-164. ISBN: 978-80-86020-91-4

Description of R&D activities in 2020

- Researchers in the Economics and Environment interest group have been dealing with a number of research projects financed mainly by the Technology Agency of the Czech Republic. In addition to the abovementioned activities, which are directly linked to the objectives set by the technical annex of the AdMaS Centre, these projects are mainly:
- Continuous investigation of the TACR project "National Centre of Competence Centre of Advanced Materials and Efficient Buildings"; identification No: TN01000056, and

the investigation of the sub-project: "Recycling of water and waste within green urban infrastructure"; reg. No.: TN01000056/03 Instrumental equipment: equipment for measuring flows in the sewer network, technical equipment of Hall P4 (system for the separate collection of grey water)

- Contract research is ongoing in the area of the microwave depolymerisation of waste materials with a focus on the processing of sludge from wastewater treatment plants and waste with carbon content, this being with Applied Sunrise Technologies, a.s. Equipment: Hall P4 of the AdMaS Centre, the equipment of a stationary analytical laboratory for urban engineering technologies, equipment for the inspection of sewer systems
- Contract research has been taking place continuously with companies and municipalities in the area of the optimisation of wastewater treatment plant operation and the remediation of utility networks. Examples of collaborating entities: Brněnské vodárny a kanalizace, a.s., SATTURN Holešov, s.r.o. VODA CZ, Vodárenská akciová společnost Kroměříž, a.s., and others.
- The most important partner in the area of cooperation with urban areas is the town of Třešť, where a methodology for smart water management in a municipality with less than 10 thousand inhabitants has been developed during the implementation of NCK project-related activities.
- The options for the further financing of research projects are being monitored on an ongoing basis, and the researchers in the interest group are preparing scientific projects for both national and international programmes. As far as the national programmes are concerned, these are mainly applications for programmes run by the Technology Agency of the Czech Republic, which also administers international projects from the "Norwegian funds" (projects for the KAPPA programme with Norwegian partners are prepared here) as well as calls made under the auspices of the European Commission as part of the programmes LIVE, H2020, COST, etc. With regard to cooperation with industrial entities, mechanisms administered by the Business and Innovation Agency under the Ministry of Industry and Trade are utilised in particular.

Examples of R&D activities

 Coordination of work to ensure the operation of an extraction system for grey water and its purification for the irrigation of a green roof module at the AdMaS Centre is in progress. The operation and testing of the system is currently taking place, as is the processing of Ztech – a verified grey water treatment technology Instrumental equipment: Hall P4 of the AdMaS Centre (system of separate grey water collection), the equipment of a stationary analytical laboratory for urban engineering technologies.



Figure 19: Grey water treatment system - AdMaS site

 Organisation of the testing of qualitative parameters of treated grey water - white water for the irrigation of green roof modules at the AdMaS site.
 Equipment: device for measuring flow in a sewer network (automatic samplers)



Figure 20: Automatic samplers during white water quality testing during the irrigation of green roof modules -AdMaS site

Testing and verification of the efficiency of grey water treatment (GWT) using a technical process of sand and membrane filtration (MBR - membrane bioreactor) and heat recovery from wastewater (HRFW) using a heat exchanger in a shower tray (decentralised system - DS) and a spiral heat exchanger in the reactor of the membrane filtration unit (centralised system - CS). One TG set was designed, comprising both TG units with fully functional technical processes. Investigated within the aforementioned TACR - Zéta project with a partner who dealt with the manufacture, installation and commissioning of the equipment, i.e. the company ASIO NEW. Instrumental equipment: Hall P4 at the AdMaS Centre



Figure 21: Testing of technical units at the AdMaS Research Centre, Brno University of Technology



Figure 22: Horizontal heat exchanger in a shower tray at the AdMaS Centre, BUT



Figure 23: A variant connection of the recuperation system within TG units (blue route on the left, yellow route in the middle, red route on the right) at the AdMaS Centre, BUT

Example of an excellent output:

- Fuzit utility model; Growing medium for roofs based on recycled materials Description: A growing medium for extensive green roofs which contains a proportion of recycled construction materials and stabilised pyrolysed sewage sludge. The utility model is patented under No. CZ 34637 U1. Investigated in cooperation with UCEEB Prague as part of the REVOZIM project
- Fuzit utility model; Growing medium based on recycled materials Description: A growing medium for extensive green roofs which contains a proportion of recycled construction materials and stabilised pyrolysed sewage sludge. The utility

model is patented under No. CZ 34638 U1. Investigated in cooperation with UCEEB Prague and SEDUM TOP SOLUTION s.r.o. as part of the REVOZIM project

Examples of collaboration with industrial entities on R&D and contract research

 An expert assessment of the operation of a test bench of a double-walled sewerage pipeline was carried out for the company SATTURN Holešov. It concerned safety measures for water management infrastructure in the area of sewer networks. Specifically, it is an evaluation of various methods of monitoring sewer networks online for the detection of faults in double-walled sewer pipes.

Instrumental equipment: equipment of a stationary analytical laboratory for urban engineering technologies



Figure 24: Recording made by odour sensors during a subsidiary experiment involving measurements taken on double-walled sewer pipes



8. Conclusion

The AdMaS Centre has been in full operation at the Purkyňova 651/139 site in Brno for six years now. In 2020, the AdMaS Centre continued to investigate R&D projects from previous years, and also began new projects in both basic and applied research. A total of 67 projects were investigated in 2020, including some which involved cooperation between industrial entities and regional R&D centres, and two international projects. The AdMaS Centre continued its intensive cooperation with industrial entities in the areas of both contract research and joint R&D projects.

Despite the global situation, new partnerships were established in 2020, and international cooperation commenced in new areas. The AdMaS Centre management considers the development of international collaboration and internationalisation to be one of the highest priorities for the coming years.

Number of jobs (FTE) for R&D staff:	107
Number of successful Ph.D./master´s degree graduates:	*
Publications in high-impact journals:	*
Publications in periodicals rated with regard to R&D methodology:	*
Results of applied research (pilot operation, prototype, functional sample, e	tc.): *
Number of contract research projects: 561 contracts (of which * contra	ct research)
Number of R&D projects: 67 + 2 international (He	orizon 2020)
Total income from commercial activities: 5	1.4 mil. CZK
From the above, commercial income gained from contract research commercial activities:	and other *
Income from non-commercial activities:	*
Total income:	*

Generally, our cooperation with industrial entities has undergone significant development and stabilised turnover has occurred at the Centre in the area of contract research. Another positive phenomenon is that the contract research we are doing is taking place in all of the areas of focus of the research centre, and the many individual projects that are underway are being conducted with a good number of clients. It is thus not the case that the prosperity of the Centre is linked to just a few clients, and so the diversification of risks is possible.

*Will be added as soon as we obtain the data

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