3RD SCIENTIFIC CONFERENCE

ENVIRONMENTAL CHALLENGES IN CIVIL ENGINEERING (ECCE)

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Opole, Poland
April 23rd- 25th, 2018

Book of Abstracts

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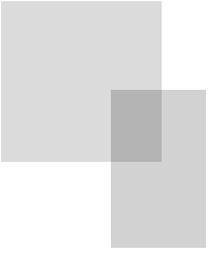

INTRODUCTION

Dear Conference Participants,

3rd Scientific Conference on Environmental Challenges in Civil Engineering ECCE 2018 is organized by the Faculty of Civil Engineering and Architecture of the Opole University of Technology, Polish Association of Civil Engineers and Technicians - Opole Branch, Opole District Chamber of Civil Engineers, with the support of the Commission of Civil Engineering, Katowice Branch of the Polish Academy of Sciences.

This Conference have an international dimension and is seen as a continuation of conferences previously organized: the 1st one in 2014 and 2nd - in 2016 on the same issues. 3rd ECCE Conference 2018 be held in a special period for the Faculty of Civil Engineering and Architecture of the Opole University of Technology (OUTech). This year, the Faculty celebrates the 50th anniversary of its existence. Thus, the ECCE 2018 conference is part of the rich program of celebrating this jubilee.

139 papers from 16 national research centers and 11 foreign ones from the Czech Republic, Germany, Greece, Italy, Malaysia, Norway, Russian Federation, Slovakia, Thailand, Ukraine and USA were submitted to the conference. Selected and reviewed works are divided into 4 thematic groups:

I. Sustainable civil engineering, impact on environment, durability and protection of buildings and structures, energy consumption in civil engineering, unconventional energy sources;
II. Material engineering, waste management in civil engineering;
III. Design of buildings, including reconstruction and renovation of historic buildings;
IV. Innovative construction technologies and exploitation of buildings and structures (including industrial, hydrotechnical, communal, transportation and geotechnical), BIM in civil engineering, legal and organizational issues of preparation and implementation of construction projects.

Finally, after positive reviews, 99 papers are accepted for the Conference, of which 43 will be referred during the conference at one plenary and eight thematic sessions. The remaining 56 papers will be presented at the poster session. The full texts of the papers accepted by the Scientific Committee will be published in the volume issued in the MATEC Web of Conferences online conference network (https://www.matec-conferences.org).

The main aim of the ECCE2018 conference is to exchange experiences and views of the scientific staff and the civil engineers in the area of environmental conditions of the designing, implementation and maintenance of buildings and structures. The conference will give an opportunity to exchange ideas between scientists and engineers – practitioners from the country and abroad on the latest research and solutions in civil engineering. As part of the conference, a technical trip to see the construction of blocks 5 and 6 of the Opole Power Plant is also planned. It will be an opportunity to compare technological and material achievements used in practice in relation to currently conducted research in Poland and abroad.

The scientific papers presented at the ECCE 2018 Conference contain the results of interdisciplinary scientific research in the field of construction, engineering and environmental protection and can be used by the scientific community for further research and analysis. Whereas, by engineers – practitioners involved in the designing of buildings and structures, they can be used to implement the latest techniques and technologies in construction industry and activities related to the reduction of energy consumption in construction industry, while maintaining the principles of sustainable development. I also hope that, the Conference will contribute to the deepening of international cooperation between domestic and foreign centers in the field of research, joint projects, networking and exchange of experience.

I would like to thank all our Sponsors and Partners for their financial support and involvement in the organization of the conference. It will also be an inspiration for us to further develop international scientific cooperation. I appreciate the enormous commitment of the academic staff of the Faculty of Civil Engineering and Architecture of OUTech. I would like outline the hope the Faculty to become a permanent meeting place for scientists, engineers - practitioners, investors and entrepreneurs from Poland and abroad.

Special thanks are delivered to authors of submitted full papers, reviewers, members of scientific committee, chairs of conference sessions, members of organizing committee (under the leadership of Wiesław Baran), keynote lecturers (Maciej Chojnacki, Giovanni Bosco and Pranshoo Solanki), editors of the conference proceedings (Damian Bęben and Zbigniew Perkowski) and scientific secretaries of conference (Dominika Pilarska and Volodymyr Boychuk).

On the behalf of Organizational and Scientific Committee
3rd Scientific Conference on Environmental Challenges in Civil Engineering
Adam Rak, PhD, D.Sc., Assoc. Professor.

EDITORS OF THE CONFERENCE PROCEEDINGS

Damian BEBEN, Ph.D., D.Sc., Associate Professor. He works at the Faculty of Civil Engineering and Architecture, Opole University of Technology, Poland. An author and co-author of 3 books and over 150 publications on the national and international conferences as well as in the peer-reviewed scientific journals indexed in the Journal Citation Reports. He has a Hirsh Index of 8, according to the Web of Science Core Collection. He is a reviewer in many scientific international journals and the National Centre for Research and Development. Member of the International Association for Bridge Maintenance and Safety (IABMAS); International Association for Life-Cycle Civil Engineering (IALCCE); International Association of Computer Science and Information Technology (IACSIT); Transportation Research Board (TRB) of the National Academies, Committee on Subsurface Soil-Structure Interaction (AFS40).
He was the scholarship holders of the Foundation of Polish Science for the young prominent scientists; scientific scholarship for outstanding young scientists awarded by the Ministry of Science and Higher Education; 2011 Outstanding Reviewer for the Journal of Bridge Engineering (ASCE); and the European Social Found for Ph.D. Research interests: analysis of soil-steel bridge, durability of engineering structures, field load tests of structures, non-destructive evaluation of structures, environmental protection in transportation engineering.

Zbigniew PERKOWSKI, Ph.D., D.Sc., Associate Professor. He has been working since 1999 at the Faculty of Civil Engineering and Architecture of Opole University of Technology (Poland) where he is currently the head of the Mechanics of Materials Team in the Materials Physics Department. He is an author and co-author of 3 books, and over 60 publications including proceedings of the national and international conferences as well as articles in the peer-reviewed scientific journals. He is a member of two sections of the Committee of Civil Engineering and Hydroengineering of the Polish Academy of Sciences – Section of Building Physics and Section of Mechanics of Structures and Materials, and a chairman of the Commission of Civil Engineering at Katowice Branch of Polish Academy of Sciences in the term of office 2015-2018. In 2013, he received the Prof. W. Żenczykowski's Award of Polish Association of Civil Engineers and Technicians (PZITB) for the achievements in research in the field of Civil Engineering. Research interests: damage mechanics, mechanics of concrete, composite structures, building physics, ultrasonic testing of concrete structures.

Adam Rak, PhD, D.Sc., Assoc. Professor, Head of Department, Department of Civil Engineering and Construction Processes Faculty of Civil Engineering and Architecture, Opole University of Technology, Poland. Research activities focus on conducting researches on the application of modern mathematical methods in the modeling of technological processes in environmental engineering and construction, construction of numerical models to optimize the procedures of supervision and control of investment processes, analysis of the issues of engineering and environmental protection in construction, environmental conditions of preparation and the implementation of investment and the problems of processes that shape the quality of surface and underground waters. Author or co-author of more than 100 studies, concepts, designs and expertise in the field of water and sewage management, agricultural waste management and environmental impact assessment. The current scientific achievements include 185 publications and studies. 44 of these works have been published, including: 2 books, editing of 4 multi-authorial monographs, 31 original works. Some of the works were published in English in scientific journals: Polish Journal of Environmental Studies, International Journal of Engineering Research and Application, International Journal of Water Sciences, Open Journal of Architectural Design, Water Supply - Water Practice and Technology, Wulfenia Journal, and as chapters in monographs: Cutting Edge Research in New Technologies and Environmental Engineering III - Taylor & Francis Group.

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Part I

Sustainable civil engineering, impact on environment, durabilityand protection of buildings and structures, energy consumption in civil engineering, unconventional energy sources

ENVIRONMENTAL IMPACT OF INTENSIVE FARMING IN SLOPING AREAS

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ABSTRACT

In the past 50 years, the increased demand for food has caused a progressive replacement of traditional agricultural techniques with intensive farming, often requiring large volumes of water for irrigation purposes. Depending on the species grown, the agricultural and irrigation techniques, the soil properties, the seasonal rainfall, the surface drainage and available water resources, different scenarios are possible. If the consumption-infiltration balance is negative the water table might raise, the pore water pressures might increase and the stability conditions might be endangered. Instead, when water consumptions are relevant and runoff losses during precipitations and irrigation are significant, the water table might be lowered and soil suction might increase, with a significant improvement of the stability conditions. Within this framework the paper presents the results of a study on the modified stability conditions of sloping grounds when grassland is replaced with high yield apple farming. Growing apples requires frequent watering, especially during the spring and summer seasons to meet qualitative and quantitative productive standards. In addition, sprinkler irrigation is often used against hail. The study is applied to the Val di Non region near Trento (Northern Italy), where thousands of hectares originally producing grass for cattle breeding have been replanted with a variety of high yield apple trees. To follow the variation of the stability conditions, the change of pore pressures is calculated during an average history of rain and temperature at the ground surface from registered data. Within this average four season time span the calculations consider precipitations and irrigation with relative runoff losses, water evaporation from the soil and induced by plant transpiration, infiltration due to irrigation. Evaporations and infiltration are related to the climate time history at ground level and to the suction-saturation response in case of grass (not irrigated), of young and mature apple trees. Transpiration is calculated with the Penman-Monteith relationship, as modified by Jarvis and McNaughton; it increases from newly planted (1 year old) to mature (5 years old) apple trees. Two irrigation methods are considered, sprinklers and dripping with different root developments, runoff, transpiration. The maximum pore water pressure increase is registered in the time span between the end of the Summer season and the first half of the Fall season for young apple trees; their reduced consumption via evapotranspiration causes the water table to rise and soil suction to drop to the lowest values. Stability analyses are performed using the Mhor-Coulomb criterion for saturated conditions and the relationship proposed by Bishop to calculate the shear strength of unsaturated soils. Results of the analyses show that deep seated slides are most likely in case of young apple trees, due to the greatest rise of the water table. is registered and slopes having inclinations greater than 22° become unstable. Shallow slides with slip surfaces above the water table are most likely with young apple trees at the end of Spring when irrigation is initiated. Unstable conditions for mature trees are possible during Autumn and when heavy rains are registered and the suction is at its lowest.

Keywords: Intensive farming, plant evapotranspiration, irrigation, pore pressures, sliding.

THE USE OF SUBSTATIONS WITH PCM HEAT ACCUMULATORS IN DISTRICT HEATING SYSTEM

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ABSTRACT

The main objective of the article is to indicate the directions of development of new generations of supplying buildings with heat, by using phase change materials, referring to the technical possibilities of applying available heat storage technologies. The analysis concerned the connection of PCM accumulators to substations, treated as a heat source for buildings, and supplied from the district heating network. The taken problem is due, among others, from the necessity of searching for a new idea of the heating system operation in the conditions of intensive thermo-modernization processes of buildings and the construction of new buildings with current and future energy standards. As a detailed objective of the work, the determination of the impact of using a PCM accumulator on the temperature of the heat carrier on the return in the substation of the district heating system was adopted. Range work included determination of parameters of heat distribution network as a function of outdoor air temperature range of -20°C to +12°C. As the analysis object, the heat substation has been selected with the following parameters: supply 80°C and return 60°C. It was found that thanks to the use of PCM accumulators on heat substations, it is possible to save energy by up to approx. 6.7% and achieve economic benefits in the form of a payback period of approx. 13 years. In addition, it was found that the introduction of the PCM accumulator into the heating system allows the return temperature in the heating network to be obtained at a temperature level consistent with the adopted control table for external temperatures of the standard heating season.

Keywords: district heating substation, heat storage, phase change material, temperature regulation.

QUANTIFICATION OF THE INTERNAL SPACE CLIMATE

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ABSTRACT

By means of a simple model the hourly values of indoor air temperature θ and humidity ϕ in dependence on the external climate, the building parameters, the ventilation and the use of the internal space can be determined. Three energy- and moisture balances are necessary: The first two equations contain the storage of energy and moisture on the outside surface by climatic loading. Secondly the energy and moisture transport by conduction, radiation and ventilation through the building parts has been quantified. Thirdly the storage of energy and moisture on the inner surface are to formulate. The results from the source text for the C++ program CLIMT (CLimate-Indoor-Moisture-Temperature). The results are validated e.g. in the Golden hall below the "Zeppelin-terrace" in Nürnberg. The calculated and measured θ and ϕ values agree very well. The paper gives also options for this hall in the future. In order to generate the outdoor climatic dates (e.g. also direct and diffuse radiation on chosen freely surfaces or the driving rain on walls) for the simulation of the room climate and the hygrothermic behaviour of the structures a climate generator CLIG has been developed additionally.

Fig. 1. „Golden hall" below the Zeppelin terrace in Nürnberg.

Fig. 2. Indoor air temperature in 2015, measured (red), calculated by CLIMT (black)

Keywords: Indoor Climate, Software Development, Historic Monument.

THE USE OF SAND DEPOSITS IN BUILDINGS FOR ENERGY STORAGE

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ABSTRACT

The aim of the research is to prepare data for the design of heat stores with sand filling. In buildings without basement, spaces between foundation walls are filled with material easily compacted, which forms a solid and durable basis for the ground level of the building. As a rule, this material is sand of various grain size, and foundation walls are insulated.
In this way, a space filled with a granular material is formed, which, with a properly designed heat exchanger attached, may be used as sensible-heat storage. Such a store makes a good lower level source for heat pumps - source of heat at the time of low temperatures outside, which significantly raises the coefficient of efficiency of the system. Low construction cost of the heat exchanger is an additional argument for the use of the space between the foundation walls for the purpose of building a heat store.
This paper presents the results of studies that allow of the appropriate design of the heat exchanger in a heat store with a granular deposit. The deposit temperature changes in time have been studied, dependent on the distance from the source of heat and humidity of the material. Study was carried out for the sands used for filling the space between the foundation walls

Keywords: TES, energy storage, bulk materials, energy-efficient construction

GYPSUM PARTITIONS IN MEDICAL ROOMS

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ABSTRACT

Development of exhaust fume desulphurization methods took place after signing of the first international agreements by Poland forcing the reduction of sulphur dioxide emissions into the atmosphere. Among all exhaust fume desulphurization methods, the wet lime method has become the most common. In the case of using a calcium-based neutralizing reagent, synthetic gypsum is a by-product of exhaust fume desulphurization. Currently, a considerable amount of cheap synthetic gypsum is appearing in the market which is often processed in the direct neighbourhood of the power plant. Medical areas in hospitals, medical and dental offices, laboratories and x-ray rooms must fulfil additional requirements, such as those regarding the acoustic properties of partitions insulating from airborne and impact sounds, low radioactivity of burning materials and protection from the hazardous effects of ionizing radiation.
The study presents requirements and properties concerning building products made from a calcium sulphate base with respect to their acoustic insulating properties from airborne sounds between rooms, natural radioactivity, and with respect to their utilization in partitions protecting from ionizing radiation. Values required with respect to acoustic properties insulating from air sounds for walls between rooms are considerably higher than for vertical partitions in buildings intended for residential or office purposes. This results directly from the intended application of the rooms they refer to.
The results of work presented in this study indicate that brick walls made of gypsum elements, with their structure and surface mass adapted, fulfil the requirements for medical rooms concerning acoustic insulating properties. Attention should be drawn to the described sandwich layer made of gypsum blocks, with relatively low surface mass 170 kg/m^2, for which it is possible to the rate of weighted apparent sound reduction index with spectrum adaption term R'_{A1} (taking into account lateral transmission of sound) within a range from 50 to 57 dB.
Application of modified products based on synthetic gypsum with the addition of baryte powder allows erection of walls in rooms and spaces with equipment emitting ionising radiation. Depending on the design of the protected walls and the thickness of screening material resulting from calculations, in this case baryte gypsum plasters or drywall panels with baryte core made on steel grid can be used. This type of protection, 20 to 50 mm thick, is sufficient to protect users of exposed facilities in most cases of designed protective walls.

Keywords: Gypsum materials, Partition walls, Medical rooms, Radiation, Acoustic insulation.

METHODOLOGY FOR THE QUANTIFICATION OF CONCRETE SUSTAINABILITY

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ABSTRACT

Efficient sustainability management requires the use of tools which allow material, technological and construction variants to be quantified, measured or compared. These tools can be used as a powerful marketing aid and as support for the transition to "circular economy". Life Cycle Assessment (LCA) procedures are also used, aside from other approaches. LCA is a method that evaluates the life cycle of a structure from the point of view of its impact on the environment. Consideration is given also to energy and raw material costs, as well as to environmental impact throughout the life cycle – e.g. due to emissions. The paper focuses on the quantification of sustainability connected with the use of various types of concrete with regard to their resistance to degradation. Sustainability coefficients are determined using information regarding service life and "eco-costs". The aim is to propose a suitable methodology which can simplify decision-making in the design and choice of concrete mixes from a wider perspective, i.e. not only with regard to load-bearing capacity or durability.
Informed sustainability management demands the employment of effective tools enabling the quantification, measurement or comparison of material, technological and construction variants. In recent years, these tools have seen development around the world and they include various indicators, indexes, certificates, comparison indicators, audits, evaluations and other systems, sometimes using various databases. In an ideal situation, economic, ecological as well as socio-cultural aspects must be included. Such tools can also be used as an effective marketing aid and as support for the transition to what is known as a circular economy.
The paper presents a helpful tool for the management of sustainability, which enables its quantification and the comparison of mixture variants for the production of concrete with an emphasis on degradation effects (e.g. strength, resistance to carbonation, resistance against the penetration of chloride ions, frost resistance, and others) and hence issues of durability. Simple formulae in which service life, performance and eco-costs appear are presented for sustainability coefficients, kTU. The aim of the task is to compare the variants of the group of the mixtures being examined, and not to determine/describe the sustainability value directly.

Keywords: concrete, sustainability, lifetime, eco-costs, optimalization.

CONCRETE PROPERTIES IN DIAPHRAGM WALLS EMBEDDED IN NON-COHESIVE SOILS

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ABSTRACT

The diaphragm walls are massive and responsible constructions, which can be used in a variety of soil and water conditions. This environment has a significant impact on the quality of concrete in the subject objects. The process of one section of the diaphragm wall realization involves the performance of a narrow-space excavation under the cover of a bentonite suspension. This suspension, after putting the reinforcement in the slite excavation, is displaced upward by the concrete mix introduced from the bottom. A significant disadvantage of this technology is limited quality control of the works - which is associated with the lack of guarantees of the homogeneous, free from defects concrete monolith. This is confirmed by numerous leaks, scratches and cracks visible on the realized diaphragm walls. The paper concerns the anaysis of the factors affecting the quality of the concrete in the constructed diaphragm wall. In particular, the possibility of penetration of the groundwater and the particles of residual around ground to the bentonite suspension as well as to the concrete mix was distinguish. The possibility of area mixing of the suspension with the mixture was also considered. The technical parameters of these two substances will be changed under the influence of mentioned factors, which will result in lower quality and durability of the entire structure. In addition, non-cohesive soils are characterized by high permeability, so the flow of the groundwater to the excavation slit is in that situation freer than in the case of cohesive soils. The article discusses the basic physical and mechanical characteristics, specified on concrete samples taken from the realized diaphragm wall around which the non-cohesive soils were found. The results of volume density research, water absorption, the depth of penetration of water under pressure as well as concrete compressive strength were presented. The obtained results clearly indicate the reduction of the quality of concrete in the tested wall, in relation to comparative samples taken during concreting. Attempt to identify bentonite in the concrete structure by determination of the quantitative phase composition test using X-ray diffraction methods was made. However, too small quantity of bentonite in the part of wall to be taken to research, did not allow for a clear assessment in this field. Therefore, the paper presents the descriptive assessment of the effect of bentonite suspension as well as other factors - such as the migration of groundwater to the excavation and the penetration of the soil particles into the monolith structure, based on the analysis of the obtained results of technical tests as well as own observations and literature prerequisites. The observations as well as conclusions contained therein will be a pretext for the further works on the quality of concrete in diaphragm walls.

Keywords: Diaphragm Wall, Bentonite Suspension, Concrete, Concrete mix, Non-cohesive Soils

APPLICATION OF INVERSE METHODOLOGY TO ESTIMATE OF CHLORIDE DIFFUSION COEFFICIENT IN PRECAST CONCRETE OF HC PRESTRESSED CONCRETE SLABS

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ABSTRACT

Work presents an investigation of chloride penetration of HC-500 prestressed concrete slabs made of precast concrete. This type of concrete slabs is widely used to construct floors in steel or reinforced concrete framing buildings. In such solutions ceiling can be considered as a simple-supported beam. Considered precast concrete was made of C50/C60 concrete with use of Portland cement CEM II 52.5 R. Investigated specimens were sampled directly from the upper part of prestressed concrete slabs. The process of chloride penetration in concrete can be described by the non-linear diffusion equation. In the paper Bayesian inverse technique was applied to estimate diffusion coefficient of chloride in concrete treated as a saturated porous material. Unknown distribution of estimated parameters was sampled with use of Metropolis-Hastings algorithm which allowed us to obtain unknown values and their error bounds. Obtained values of diffusion coefficient were confronted against values obtained with use of norms: NT BUILD 443 and ASTM C 1556 – 03 and against previously developed methodology based on the analytical solution of the diffusion equation.
On the basis of measurements of mass density distribution ρ1 of chloride ions migrating in concrete under the influence of the electric field, a reliable value of the diffusion coefficient was determined $\overline{D}_s^1 = 0{,}72 \cdot 10^{-12}$ m^2/s. Using the method of determining the diffusion coefficient described in the standards NT BUILD 443 and ASTM C 1556 – 03 on the basis of the diffusion coefficients was determined $D^1_{ns} = 1{,}44 \cdot 10^{-12}$ m^2/s.
The paper presents Bayesian Inverse approach applied to estimate value of diffusion coefficient of chloride in the precast concrete based on the local values of chloride concentrations. In this approach all unknown estimated parameters are treated as random variables and their distribution is determined in this methodology. Having distribution of unknown parameters their expected values can be easily obtained together with error bounds. The standard deviation which can be treated as an estimate of the error of determined quantity, is equal to around 20% of the expected value for the estimate based on 24 hours measurements. While the standard deviation for estimate based on the 48 hours measurements equals to about 10% of the expected value. Because the value of the diffusion coefficient determined using the inverse method with application of Bayesian methodology was determined based on the results of migration tests and is 10 times greater than the value determined both by the thermodynamic migration model and according to standards NT BUILD 443 and ASTM C 1556 – 03. This agrees with the values of diffusion and migration coefficients published in the literature of the subject

Keywords: Prestressed concrete slabs, Diffusion coefficient of chloride in concrete, Migration coefficient, Bayesian inverse technique, Metropolis-Hastings algorithm

OPTIMIZATION OF VENTILATION SYSTEM IN THE OPEN OFFICE SPACE

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ABSTRACT

The paper presents the results of study into the air parameters in open space offices. As office workers spend about 1/3 of the day in such spaces, it is important to provide them with the right climate comfort, and that is determined, most importantly, by: the temperature and humidity of the air, quality of the air, and the concentration of CO_2. In order to carry out a detailed analysis of air quality in open space offices and to optimize performance of this type of ventilation systems, two research objects were selected, with different ventilation conditions, and varying work intensity of people using them. In the course of study, measurements were taken on the basis of which the distributions of temperature, humidity, and concentrations of CO_2 in the entire volume of the space were determined. The results of the tests carried out by the metabolic method in the additional office room were used to determine the empirical coefficient of CO_2 emission by one employee, relative to 1 m^3 of the office volume. The mean empirical coefficient of CO_2 emission by one employee, relative to 1 m^3 of the volume of the office is 64 ppm CO_2/h. The coefficients were developed at optimal working parameters of fans in the ventilation system; the criterion for optimization being heat loss in the office caused by discharge of the used heated air into the atmosphere. Coordination of control of room ventilation system with the concentration of carbon dioxide allows to reduce ventilation air flow. Thanks to the precisely determined air flow, calculated for the needs of people working in the given office, it is possible to optimize the performance parameters of the ventilation system, and thus reduce heat loss in that space. Results of the conducted studies and simulations have shown that the application of personalized ventilation (PV) in open space offices and the use a recuperator for heat recovery can significantly reduce energy consumption (approximately by 54%), compared to heating and ventilation systems currently used in the analysed objects, while ensuring the required standards of the quality of the air for an office space.

Keywords: ventilation system, office rooms, open space, air quality, carbon dioxide concentration, air humidity

REGIONAL SOLAR CONDITIONS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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ABSTRACT

The issues of social, economic and technological development are closely linked to the permanent increase in energy demand. Getting energy for the consumers daily needs should nowadays be leaded efficiently and rationally with great care for the environment as well as to ensure energy security for the next generations. These issues are part of the priorities of sustainable development of the regions and find a place of reference to this idea in many local documents. Therefore, for their implementation in the Silesia Voivodeship it is assumed, among others, to increase participation of renewable energy sources, including solar energy, for the heat and electricity preparation.

The article presents the perspectives for obtaining solar energy and the potential of this renewable energy source for the Silesia Voivodeship. The basic solar conditions in the region are satisfactory, in relation to the possibility of their utilization, and they can be used, for example in hospital, educational and recreational facilities, as well as in individual buildings. Expanding the market for renewable energy sources can be implemented by introducing, for example, low power systems with photovoltaic cells to obtain electricity, or installations with solar collectors for the preparation of domestic hot water or central heating support.

However, it was pointed out that due to the specificity of the place, the influence of such factors as air pollutants emitted to the atmosphere or coming from other areas, cannot be ignored. Local episodes and weather anomalies also affect the quality of air, and thus limit the availability of solar radiation. All these elements can greatly distort local solar conditions.

Achieving of sustainable energy development is possible through proper planning and rational energy management, that takes into account the use of renewable energy sources, which implementation could reduce negative impacts on the environment and improving its quality. Dissemination of installations using solar radiation, in addition to acquiring energy, also gives the opportunity to reduce the regional emission of pollutants into the air and at the same time increases the transparency of the atmosphere.

The realization of sustainable development priorities in the Silesia Voivodeship, such as implementation of renewable energy sources, low-emission economy and increasing energy efficiency, can significantly contribute to improving the quality of atmospheric air, and thus increase the real availability of local solar potential, enabling more efficient energy acquisition.

Keywords: Renewable Energy Sources, Silesia Voivodeship, Sustainable Development, Irradiation, Solar Conditions, Solar Radiation, Air Pollution, Air Quality.

INTERPRETATION OF THE RESULTS OF MONITORING OF THE DISPLACEMENT OF THE TRESNA DAM IN 2016

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ABSTRACT

In the current era of intensive economic development, great attention is paid to technical requirements which are to be met by building structures. Safety reasons are the dominant aspect, and their satisfaction involves e.g. the analysis of construction materials, construction defects, environmental reaction to the structure being utilized, etc. Changes in the shape of location of a structure may lead to disastrous consequences and huge losses, even with a slight exceedance of certain limit values. The efficient operation of building structures and their equipment can only be monitored thanks to research studies and continuous surveys. Impounding structures are exposed to complex loads. Utilized in various conditions, they are subjected to different kinds of studies and long-term displacement surveys, as they could be exposed to the disturbance of stability principles. Building structures must be verified for safety not only at the operational stage, but at the design stage as well. Therefore, prototype tests are carried out to avoid construction failures and their consequences in the future. The aim of the paper is to assess the technical conditions and level of safety of the Tresna dam located on the Żywiecki Reservoir based on the results of monitoring of the displacement in 2016. The obtained results were confronted with data on displacements from the period 2005-2015. The scope of the research concerns mainly the issue of displacements monitored in the shell of the dam, the bottom outlet, the building of the hydroelectric power plant, the intake tower and the retaining wall. In addition to the measurements carried out at the dam also displacements on the area of the landslide near the building were monitored. In the near future, it would be recommended to supplement the monitored points that are now being used in the surveys. At the design stage 50 years ago, benchmarks were located at characteristic points, and the choice of their location was not supported by any specialized calculations.

Keywords: Dams, Monitoring, Displacements, Safety of hydraulic structures.

THE MOISTURE CONDITION OF THE BRICK WALLS IN THE BASEMENTS OF A MEDIEVAL MONASTERY

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ABSTRACT

The problem of excessive moisture concerns most historic buildings with brick walls. It is the result of direct long-term contact of a wall with the ground, caused by the lack of horizontal and vertical damp insulation that was not used in the past. As a result of the capillary process, this moisture moves into higher and higher parts of the wall, while at the same time dampening and salting it. Bricks and mortar are then damaged and this in turn causes, among others, a reduction of the safety of a structure and the deterioration of the operating conditions in rooms.
The paper presents the moisture condition of the brick walls in the basements of a monastery that was built at the turn of the 13th and 14th centuries in Pomerania in Poland. Tests of the moisture content of the brick walls were carried out using non-destructive and destructive methods since due to the poor technical condition of the basement walls, conservation services agreed to interfere with the structure of the historical walls to the extent that is necessary to obtain the most reliable test results. Non-destructive tests of the mass moisture content U_m were made using a dielectric GANN UNI 2 meter with an active B50 ball probe. The meter was scaled on specimens that were taken from a wall, the moisture content of which was determined using the gravimetric method in laboratory conditions. The number of collected specimens enabled the exact correlative dependency between the X indications of the dielectric meter used in the tests and the mass moisture content U_m of the tested walls, which is described by the exponential mathematical function, to be determined.
The conducted tests showed that in the subsurface zone the brick walls in the monastery basement are wet on their entire height, and their moisture content exceeds 12.0%. The conducted research also showed that the mass moisture content of a wall across its thickness is higher than that found in the subsurface zone. Research of the mass moisture content of the walls of the rooms located directly above the basement showed that in the zone that is adjacent to the floor, the tested walls qualify to be very damp due to their mass moisture content ranging from 8.0% to 12.0%. In the higher parts, however, they have an acceptable humidity of about 3.0%, while the level of the moisture content is higher in the walls from the side of the interior of the rooms than from the outside of the building.
It was found that the main reason for the excessive moistening of the brick walls of the monastery's basements is the capillary rising of water from the ground through the walls and floor due to the lack of horizontal damp insulation and the subsequent moistening of these barriers with moisture from the air. It was also determined that the lateral capillary action of water from the ground has little effect on the moisture status of the walls. The conducted tests were used to develop recommendations that can be useful in determining the scope of renovation and construction works that aim at restoring the utilitarian function of the building's underground. This includes, first and foremost, the development of methods of executing vertical and horizontal damp proof insulations of walls.

Keywords: Basements, Brick Walls, Mass Moisture Content, Medieval Monastery, Non-Destructive Tests, Destructive Tests.

ENERGY EFFICIENCY OF THE ACCUMULATION WALL WITH A TRANSPARENT INSULATION

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ABSTRACT

Accumulating solar walls with transparent insulation (ASW-TI) are becoming a more common project option for new low-energy buildings and renovations of passive buildings. The use of a passive solar wall is aimed at collecting solar energy in order to reduce energy consumption in traditional thermal insulation. This partition stores heat during the sunny period and releases it with a time lag.
A transparent material is characterized by high solar radiation transmittance and low infrared losses. These materials were developed in order to increase solar radiation transmittance and to enhance thermal resistance of wall systems. In this case, higher heat losses compared to walls with traditional insulation are compensated by heat gains, while the accumulating solar wall acts a heat source in a room.
This paper presents a numerical model of an accumulating solar wall with transparent insulation. The objective of the simulation was to evaluate the energy efficiency of ASW-TI for different climatic conditions in Poland, i.e. for high (Racibórz), medium (Opole), and low (Szczecinek) irradiation. Simulated ASW-TI consists of: transparent insulation (celluloseacetat with the honeycomb structure + double glazing) of thickness 108 mm, unventilated air gap of thickness 20 mm, Silka blocks of thickness 240 mm, cement and lime plaster of thickness 12 mm.
The calculations were made on the basis of the finite-difference method. The authors of the paper used the Matlab environment to develop a program that calculated necessary values. For each climate, the simulation was carried out for the entire heating period (from September to May). As a result, temperature distributions in a wall at different times of the process and the energy balance of the wall in individual heating period months and during the entire heating period were obtained.

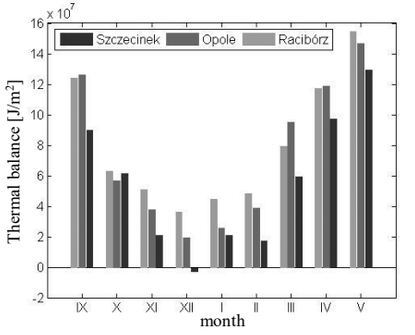

Fig. 1. Thermal balance of the partition in particular months of the heating season.

Keywords: Transparent insulation, accumulating solar wall, energy efficiency.

THE INFLUENCE OF TYPE OF CEMENT ON THE DEGRADATION OF MICROSTRUCTURE AND TRANSPORT PROPERTIES OF CEMENT MORTARS EXPOSED TO FROST INDUCED DAMAGE

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ABSTRACT

The evolution of transport properties of cement-based materials due to the environmental loading is essential for a profound understanding of damage phenomena. The frost destruction is caused by freezing of liquid in pores, hence, it depends on the pore structure of material, the degree of saturation, pore water chemical composition, rate and length of the freezing cycle. The processes of gradual material deterioration also depend on water penetrating and they are various if we consider transport through porous material or cracked cement matrix. The transport properties depend mainly on the hydrated cement paste structure, including size, distribution, shape, tortuosity and continuity of pores. Therefore, the relationship between microstructure, transport properties and durability of cement-based materials is of particular importance when the ice-induced deterioration is considered. The parameters characterizing the inner structure of the cement-based materials, such as porosity or permeability, determine not only their strength, but also risk of degradation of cement matrix due to aggressive environment.

The purpose of the study is to understand how the cyclic water freezing (0, 25, 50, 75, 100 and 150 freeze-thaw cycles) impacts on microstructure and transport properties. Tests are conducted on cement mortars with different water/cement ratios (w/c=0.45 and 0.40) and on two types of cement (CEM I and CEM III) without air-entraining admixtures. In the presented research the mercury intrusion porosimetry (MIP) method has been used to determine influence of the ice formation on the pore size distributions in mortars. Additionally, the relationship between intrinsic permeability and the water absorption coefficient of unaffected cement mortar samples is analysed. The water absorption coefficient and gas permeability are determined using capillary absorption test and the modified RILEM-Cembureau method. The evolution of transport coefficients with growing number of freeze-thaw cycles are determined on the same specimens. The results of conducted tests enable to assume that the degradation processes influence heavily the material transport properties. It is also established that change of pore structure (a decrease of small pore volume <100nm and increase of larger pores >100nm) induces an increase of water transport parameters such as permeability and water absorption coefficient. The higher gas permeability corresponds to the higher internal damage. In particular, it is associated with the change of cement mortar microstructure, which indicates damage of narrow channels in the pore structure of cement mortars. The positive impact of CEM III on ice-induced microstructure degradation is visible.

Keywords: Frost-induced damage; Pore size distribution, Permeability, Water absorption coefficient, Cement mortars.

COMPARISON OF RESISTANCE TO DAMAGE OF UNALLOYED STRUCTURAL STEELS UNDER THE INFLUENCE OF HYDROGEN

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ABSTRACT

Hydrogen degradation of materials includes all processes resulting from the presence of hydrogen in their structure. Hydrogen degradation is determined by several processes, namely adsorption and absorption (hydrogen charging), diffusion (transportation of hydrogen in steel), and location of hydrogen in steel (trapping). The processes of sorption, transportation and trapping of hydrogen in a material of a certain level of stress and strain, which take place in a continuous way, contribute to its total destruction. Hydrogen degradation takes different forms, depending on the type of material, environment, temperature and mechanical loads. In metallic materials it may result in delayed cracking, deterioration of plastic properties, decarbonisation, delamination, or hydrogen blistering filled with molecular hydrogen. To assess the degree of hydrogen degradation, next to the basic mechanical criterion based on degradation of mechanical properties, structural criteria are also used, in which the key role is played by the changes caused by the presence of hydrogen in the microstructure and on the surface of the fractures.

One of the most commonly used construction material in industry is unalloyed steel S235 and S355. These types of steel are used for construction of ships, bridges, coastal construction, welded tanks, and in buildings. Due to the operating conditions, these types of steel may undergo hydrogen degradation in the process of manufacturing of welded structures (in the form of cold cracks) or when operating the structures (in the form of hydrogen induced cracks HIC).

This paper presents the results of study into resistance of selected types of non-alloy structural steels to hydrogen degradation. Tests were carried out to determine changes in mechanical properties in the static trials of stretching without hydrogen, and after saturation with hydrogen. Parallel fractographic and electrochemical studies were carried out. Hydrogen saturation was carried out at the time from 3. up to 24. hours in a solution of 0.1N sulphuric acid (VI) with the addition of 2 mg/dm^3 arsenic oxide (III) at an electric current density of 20 mA/cm^2.

The results of the tests have shown that the impact of hydrogen on the tested steels S235JR and S355J2 leads to a significant deterioration in their mechanical and electrochemical properties. At comparable concentrations of hydrogen, steel S235JR is less susceptible to hydrogen degradation and has greater corrosive resistance measured in 3% NaCl solution, in comparison with steel S355J2.

Keywords: hydrogen content, hydrogen-charging, corrosion resistance, hydrogen degradation.

EXPERIMENTAL INVESTIGATIONS OF WOODEN AND CONCRETE COMPOSITE BEAMS SUBJECT TO LONG-TERM LOAD

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ABSTRACT

The issue of reinforcing wooden beams via their joining with a concrete upper slab is still being widely discussed in the literature. The basic set of differential equations describing the behavior of a composite beam of this type in the linear-elastic range can be found e.g. in [1]. On the other hand, the first real scale studies for a wooden and concrete composite beam structure, which included also the coefficient inverse problem formulation for a determination of its elastic properties in the view of the model presented in [1] based on the analysis of the displacements and ultrasonic measurements in the four-point bending conditions, were published in the article [2]. The present work is extended version of such a type of analysis for next authors' experimental research conducted in this subject area and taking into account also a qualitative assessment of two-year behavior of the structure based on the measurements of its creep, and temperature and relative humidity of the ambient air in typical in-door conditions. It presents also a proposition of a convenient method of loading beams using water tanks from the point of view of the construction of the measuring stand. Particularly, for four simply supported and four-point bent composite wooden and concrete beams with the joint made of steel wood screws, the measurements of their deflection and curvatures of layers' axes in the mid-span and mutual slips of their layers at the contact over the support and at the quarter of span are presented. In order to obtain basic information about possible variability of these quantities due to a random distribution of properties of pine wood used in the experiment it was taken from different batch of material. All the beams were 4 m long and under total load of 10 kN. Their layers had the cross-sectional dimensions equal to 95 mm x 195 mm and 300 mm x 50 mm for the wooden rib and reinforced concrete upper slab, respectively.

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2. M. Czabak, Z. Perkowski, K. Gozarska, B. Jędraszak, Badania zmian sztywności belki zespolonej drewniano-betonowej, Inżynieria i Budownictwo, **11** (2016) 604-608

Keywords: Composite Wooden and Concrete Beam, Long-term Load, Creeping, Experimental Measurements.

EVALUATION OF CHANGES IN THERMODIFFUSION PROPERTIES OF MINERAL WOOL RESULTING FROM TREATMENT WITH WATER AND RE-DRYING

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ABSTRACT

Mineral wool is one of the basic materials for thermal insulation in civil engineering. It combines very advantageous features in normal operating conditions: it is a very good thermal insulator, does not resist water vapour transport and hardly absorbs moist. Its properties are additionally improved by striving to produce a material with the optimal fibre orientation and use of special admixtures. Particular attention should be paid to the hydrophobization or hydrophilization process from the point of view of controlling the thermodiffusion properties. The use of hydrophobic agents reduces the possibility of moisture absorption in the hygroscopic range and is a beneficial phenomenon in typical operating conditions. However, if there is a relatively large moisture mass flux and no temperature gradient, it may unexpectedly lead to the precipitation of water drops in the space between fibres of the wool and to its significant dampness. Such a situation may occur particularly in insulations inside buildings in the lower parts of insulation boards. In this case, the use of hydrophilic admixtures will improve the transport of moisture and may avoid the described situation. On the other hand, in the literature, one can find primarily works oriented on the study of thermal conductivity of mineral wool. Less often one can find works devoted also to detailed investigations of its hygric features (sorption isotherms, parameters determining moisture diffusivity and liquid water transport), and there are basically no works devoted to direct determination of coefficients describing coupled thermodiffusion moisture transport in mineral wool with hydrophobic or hydrophilic properties and formulations of effective inverse problems for this purpose. However, it should be noted that the subject matter of coupled heat and moisture transport in porous materials is generally well described from the theoretical point of view, as well as from the side of numerical modelling and experimental measurements both in homogeneous and complex (layered) systems. Hence, the current paper is devoted to the presentation of an effective and relatively quick way to evaluate the basic parameters describing the most important coupled thermodiffusion characteristics of mineral wool in the hygroscopic range. In the range of experimental research presented in the paper, samples of stone wool available in trade and dedicated for the internal applications were used. In the mathematical model of the process, a unilateral coupling the influence of heat transport on moisture transport was only included in order to simplify the considerations. In addition, due to the practical aspect of the problem, the effect of water saturation and re-drying on changes in the thermodiffusion parameters of the wool was examined because, in many situations as a result of improper storage at construction sites and inattention of contractors, the product is exposed for direct rain before or during inserting into building envelopes. In particular, for the wool impregnated with hydrophilic agents, it should be expected that this process can change the original beneficial thermodiffusion characteristics, even though the wool has dried up again.

Keywords: Coupled Thermodiffusion, Mineral Wool, Water Immersion, Re-drying, Experimental Measurements.

ENERGY PERFORMANCE OF BUILDING HEATING - THEORY AND REALITY ON THE EXAMPLE OF EDUCATIONAL BUILDINGS

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ABSTRACT

The calculative methods, which are applied in various fields of engineering, are usually a certain kind of theoretical approximation of reality. The main problem, which occurs here, is the degree of consistency of theoretical description of some phenomenon or process with the actual conditions of its course. The deviations from a full consistency of actual conditions and theoretical assumptions occur also in case of building's heating. The building is considered as a constructional and installation entirety and constitutes a set of many installation, architectonic-building, constructional-material and operational properties, which have a direct or indirect connection with its heating. The appearing discrepancies are visible even in quantitative characteristics of heating, i.e. the amount of heat theoretically needed and actually used for that purpose.

The annual energy consumption C_H for building heating, the amount of which was determined by measurement and, in a sense, "describes the actual conditions of heating". The value of energy consumption C_H is the effect of, inter alia, the duration of the heating season and the conditions inside and outside of a room. The obtained results of calculations (for example $Q_{k,H}$) should correlate with the results of measurements (measured directly or indirectly) (C_H). The connection between discussed quantities should be the stronger, the better are rendered the heating conditions and the specificity of an operated object. Bearing in mind the above, the purpose of the conducted analyzes is to initially examine the relationship between the theoretical quantity $Q_{k,H}$ and the actual quantity C_H and use of results to improve the methodology of energy performance of buildings.

This work presents the selected results of examinations connected with an annual energy consumption C_H and annual final energy demand $Q_{k,H}$ for heating and conducted on the group of educational buildings. The presented analysis and its results regard the group including 46 of 50 educational buildings, which form a municipal group of the buildings of this type and in which the educational institutions are located. The purpose of presented analysis was to examine the influence of possible occurrence and level of differences between the annual energy consumption C_H and annual final energy demand $Q_{k,H}$ for heating of examined buildings. Calculated annual final energy demand $Q_{k,H}$ for n=3 h^{-1} is bigger by 11.4% and 192.2 GJ, on the average, than the actual energy consumption for heating C_H , but final energy demand $Q_{k,H}$ for n=1 h^{-1} is smaller by 20.9% and 450.0 GJ, on the average, than the actual energy consumption for heating C_H. However, there are few buildings, in which the situation is opposite.

The cubic capacity of examined objects has a significant and often dominant influence on analyzed relationships. Certainly, an accurate determination of the operation of a building's ventilation system is very important for the correctness of its energy performance. The adoption of an incorrect amount of ventilation air will cause too unfavorable or advantageous energy characteristics of the analyzed building.

Keywords: Educational buildings, Energy performance of building, Heating, Energy consumption, Energy demand.

SENSITIVITY ANALYSIS OF FIRE RESISTANCE OF A COMPOSITE FLOOR SLAB

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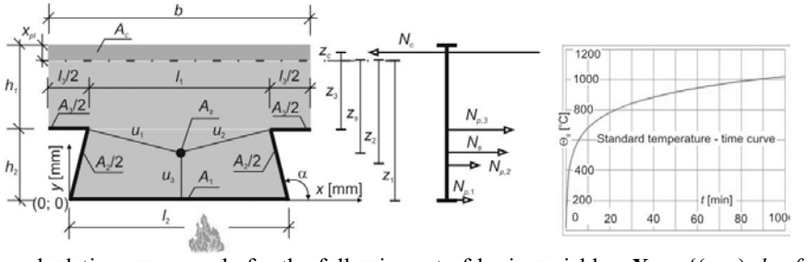
ABSTRACT

The paper presents the results of sensitivity analysis of fire resistance of a composite floor slab to a change of the value of the selected basic variables. Calculations were made for a composite steel-concrete slab with Cofrastra 40 steel sheet. The slab is an element of the reinforcement of the renovated timber floor. Fire resistance of the slab was referred to the design bending resistance for fire $M_{fi,t,Rd}$, determined for a separated rib according to the figure below.



The calculations were made for the following set of basic variables: $\mathbf{X_1} = \{(y, z), h_1, f_{y,a}, f_{y,s}, f_c\}$, where: (x, y) are the coordinates of the location of the reinforcement bar in the rib; h_1 – the thickness of the concrete slab above the steel sweet; $f_{y,a}$ –the nominal yield strength for the elemental steel area A_i, i = 1, 2, 3; $f_{y,s}$ - the nominal yield strength for the area of reinforcing bar; f_c – the design strength for concrete area. The design moment resistance $M_{fi,t,Rd}$ was defined accoding to the simple calculation model, for simple supported slab with profiled steel sheet and reinforcement when heated from below according to the standard temperature-time curve. Basing on the analysis of the results obtained it was fund that:

- A varied sensitivity of the calculated bending resistance $M_{fi,t,Rd}$ to a change of the value of particular basic variables from the set $\mathbf{X_1}$ is found.
- The biggest changes of $M_{fi,t,Rd}$ value come along with changes in thickness of the slab above the steel sheet h_1.
- The lowest sensitivity can be observed with changes of the value of concrete compression strength f_c.
- The bending resistance $M_{fi,t,Rd}$ shows a similar sensitivity to a change of the value of yield strength of steel sheet $f_{y,a}$ and the yield strength of the reinforcement bar $f_{y,s}$.
- Three areas of the location of the reinforcement bar can be distinguished, for which sensitivity of bending resistance $M_{fi,t,Rd}$ to a change of location within the area of each of them is different.

Keywords: Bending Resistance for Fire, Composite Floor Slab, Sensitivity Analysis.

THE PARAMETERS OF THE ACOUSTIC INSULATION CAPACITY OF A REINFOCED WOODEN CEILING

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ABSTRACT

Protection against noise, i.e. unwanted, annoying and harmful sounds is now required by law, but unfortunately this requirement is often not observed. Buildings built in the past had to meet only the requirements concerning load capacity and stiffness, no attention was paid to acoustic or thermal insulation capacity. The traditional wooden ceiling is characterized by poor acoustic insulation capacity. During modernization of old buildings with wooden ceilings, construction partitions should be properly designed to comply with legal requirements. The article describes the acoustic insulation capacity against airborne and impact sounds determined for the ceiling of a historical building from the beginning of the 20th century.

The analysis was carried out for four wooden ceiling options and a ceiling reinforced with two symmetrical C-bars with the use of Cofrastra 40 composite steel and concrete slab, including appropriately designed floors and a suspended ceiling. In order to obtain good acoustic insulation capacity against airborne and impact sounds, the ceiling should be characterized by good tightness, high surface mass, and it should consist of at least two layers. Moreover, the floor part has to be separated from the ceiling part. In addition, acoustic insulation capacity also strongly depends on the presence of mineral wool in the space between the beams. This work concerns only the sound insulation capacity of the partition dividing flats (the ceiling), without the influence of lateral transmission. In order to fully assess the acoustic insulation between premises, it is necessary to consider both the ceiling and the construction of the adjacent walls and joints between the partitions. The value of acoustic insulation capacity was reduced to single-number indicators. Numerical simulations were carried out using the software Insul 8.0. The input data defined in the software Insul for calculating the specific acoustic insulation capacity (R, dB) are: thickness, density, Young's modulus, the internal damping coefficient, the type and thickness of the separation between the layers. Based on the calculations carried out, it has been shown that the current traditional wooden ceiling does not meet the requirements of the standard, as previously assumed. The present traditional wooden ceiling does not meet the requirements of the standard, as previously assumed. The ceiling after reinforcement with composite steel-concrete slab, but without appropriate layers of floor and a suspended ceiling does not meet the requirements of the standard either. The ceilings made with the use of concrete and wooden floors as well as a suspended ceiling and mineral wool layers in the space between the floor and the ceiling will meet the standard requirements provided that the lateral transmission will be controlled by applying appropriate wall structures adjacent to the ceiling.

Keywords: acoustics, wooden ceiling, composite steel-concrete slab

SUSTAINABLE TRANSPORT DEVELOPMENT AND PASSENGER TRANSPORT DEMAND IN POLAND

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ABSTRACT

The sustainable development of transport is considered a process that involves the promotion of efficient transport, meeting social expectations, and at the same time minimizing the sub-optimal or harmful impact of transport modes on public health, the natural environment, economy and urban planning. Therefore, in the case of passenger transport, a large share of public transport seems to be the most effective action to achieve sustainable transport development. The paper analyses the trends of changes in the demand for passenger transport in the EU Member States, in Poland and in the Kuyavian-Pomeranian Voivodeship, including cities, suburbia and rural areas. Simulation transport models developed by the authors, were the most important tools to carry out all analyses. Performing such analyses in a professional manner required the use of appropriate IT tools. This is due to the complexity of transport processes, their high variability in time and the impact of many factors such as spatial planning, external and internal conditions, layout and characteristics of individual transport networks, transport behaviour of residents, including transport preferences, demography, traffic conditions on the road network, etc. By simulation calculations the developed transport models allow to reconstruct the current and possible future transport processes in the area, including the size of passenger flows, with various variants of investment and non-investment activities, including activities with socio-economic impact and environmental status. In order to build the above-mentioned transport models, several hundred thousand data were collected describing the entire analysed area of the selected voivodship and a huge range of transport research was carried out, including:

- questionnaire surveys carried out among residents of communes and cities of the analysed areas, as well as among economic zone managers, employees of large production and service companies, and members of transport associations;
- measurements of car traffic volumes;
- measurements of passengers in means of public bus transport, including all interchanges and bus stations;
- 24-hour measurements of passengers of railway at all stops and railway stations.

The most important conditions determining the considered transport demand in selected areas of the Kuyavian-Pomeranian Voivodeship were determined basing on the analysis of the above mentioned data and simulation analysis. Moreover the transport demand was forecasted in three different economic development scenarios (optimistic, stabilizing and regressive) for different forecast years. The results of these calculations have led to surprising conclusions indicating unfavourable trends in changes in the transport demand under consideration and insignificant differences in anticipated transport needs, regardless of the selected scenario of the country's economic and the voivodship development. These conclusions have a huge impact on the achievements of sustainable transport development in Poland.

Keywords: Environmental protection, Urban planning, Transport Models.

CASE STUDY OF NEGATIVE IMPACT OF CONCAVE COAL BASIN ON LONG RIBBON BUILDING DEVELOPMENT

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ABSTRACT

A newly built development consisting of four ribbon buildings, five and four units each, started to display considerable and serious irregularities, which in consequence led to endangering the safety of the structure and users.
In 2012-2016 the complex was affected by the influences originating from mining exploitation, being influenced by the concave basin almost the entire time. As a result of the mining activity, the terrain became considerably deformed and sloped.
The most visible changes were shown due to tilt of some segments, by C between 10–25 mm/m. The units moved in relation to each other at the movement joints, and their structure suffered heavy damage, mostly in the form of cracks on the walls. These irregularities, aside from the safety hazards already mentioned, caused considerable inconvenience in usage.
In order to determine the cause of the damage and the consequences of the mining activity, a number of analyses were carried out, some of them upholded by numerical calculations.
The entire building complex was found to be in an extraordinary mining influence situation, very harmful to long buildings. The presence of strong mining activity forces, stronger than expected, and the structure of movement joints that were not adjusted to those forces led to the irregularities mentioned above. Building's tilt was caused exclusively by the mining exploitation. At the same time, the displacement of the units in relation to each other, visible at the joints, as well as the building damage, were a consequence of strong mining influences and construction's defects.
If the case would apply to detached houses, they would have only become tilted. For long ribbon buildings, a correct structure of movement joints is crucial for their stability. They need to have the ability to transfer mining influences along their full height. At the same time they should not be filled with any materials, in order to allow the units to move. It should also be pointed out that influences originating from different, subsequent mining operations may accumulate.
In the case of the buildings being analysed, in order to restore structural safety and safety of usage, repairs need to be undertaken to reinstate building's original state.

Keywords: Mining damage, Mining influence, Ribbon building development, Diagnostics of buildings in mining areas, Long building sequences.

IMPACT OF CHIMNEY ON LOW EMISSION

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ABSTRACT

The air pollution caused by operation of heating devices using solid fuels is a significant problem in Poland and neighbour countries. The pollution level is so high, that some voivodeships impose anti-smog acts, banning the use of heating devices which do not meet requirements of the 5th class according to EN 303-5. By 2023 the ban is going to be imposed nationwide. In order to improve the air quality, heating devices producers take constant measures to improve their products. It is recently expected that those devices meet the strict 5th class emission requirements, as well as other directives' requirements, including the Ecodesign Directive 2009/125/EC However, the emission results achieved during initial product test of heating devices in laboratory may be much worse during operation in real operating conditions. The research included tests proving that the chimney system applied to a heating device might influence the emission of particles exhausted with the smoke. The tests have been perfomed in real-life conditions, on a test rig that was prepared for this purpose. The study covered a range of measurements which allowed us to determine the concentration of combustion gases exhausted through flues. Within the study, we determined the concentration of: oxygen (O2), carbon dioxide (CO2) and carbon monoxide (CO) in the analysed fumes. Moreover, we estimated – in a simplified manner – the concentration of PM by determining the soot count. The soot count value was the main subject of following analyses. The research has proved that emission values of heating devices will change, depending on a chimney system that is applied. The most important conclusions from the research indicate that: 1. The diameter of the chimney has an influence on the concentration of dusts in the flue gas discharged through the chimney. In the case of too small and too large diameters of the chimney duct the soot count increase regardless of the type of stove used during the research. 2. Feeding preheated air through the chimney duct to the combustion chamber allows to reduce the soot count. Moreover, the use of draught regulator significantly reduces the emission of dusts to the atmosphere. 3. The use of secondary afterburning in the stoves does not guarantee the reduction of soot emission with the use of incorrect chimney systems.

Keywords: Chimney, Low emission, Air pollution

CONTEMPORARY BUILD ENVIRONMENT IN THE CONTEXT OF EVOLUTION OF ENERGY-EFFICIENT SOLUTIONS IN ARCHITECTURE

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ABSTRACT

The article is concerned with the subject of energy consumption in construction; it also discusses problems related to creation of sustainable built environment and its links to the natural environment, with special emphasis placed on its links to climate. Selected contemporary European development directions and trends in solutions using solar energy in buildings have been discussed in the paper, as well as various projects, concepts and realisations, mostly related to residential development. The principles of rational and cost-effective management of energy implemented in shaping of the contemporary built environment are based on century-long experience. They follow excellent patterns of construction which have been emerging in various regions of the world over centuries. They came long before "the green revolution" and paved the way for the concept of eco-friendly and now for sustainable construction.The work here is the result of the author's analysis of energy-related concepts suggested in contemporary architectural and urban planning solutions. It includes both individual buildings and residential development complexes, estates and districts, as well as the solar cities that have been built in the last two decades in in European countries. The collected examples present the experiences of previous eras as well as their continuation in contemporary realisations based on the possibilities of using innovative technologies in architecture within the framework of actions undertaken in European countries. They refer both to new development and to transformations of the existing infrastructure in the process of its restoration. Actions are undertaken in different scales from individual helioactive buildings to large urban projects (solar cities), together with buildings that are buried in the ground. Analysis of examples and observation of contemporary trends in creation of sustainable built environment leads to the conclusion that the present time is characterised by a diversity of cost-efficient solutions. At the same time, they may be considered the desired model of architecture for the future, which should be characterised by coherence with natural environment, particularly with the climate. The future of these solutions is to be seen in the introduction of innovative materials, including helioactive ones, which would have the capacity of sunlight transformation and interior shading on the basis of the achievements of physics, biology and bionics (smart materials, among others).

Keywords: sustainable built environment, energy- efficient architecture, solar architecture

ASSESSMENT OF THE LIFE CYCLE OF MASONRY WALLS IN RESIDENTIAL BUILDINGS

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ABSTRACT

Environmental assessment over the course of the full life cycle of a building (LCA – Life Cycle Assessment) covers the environmental burden connected with energy consumption and the accompanying emission of contaminants into the atmosphere from the moment of obtaining a raw material and all stages of its processing and treatment, through the service life of a building, up to the moment that the use value of the building expires and the storage of waste. There are numerous works pertaining to the guidelines for calculating all costs of the life cycle of buildings, i.e. environmental, economic and social costs. In these works, however, not much is said about the means of determining the life cycle of building structures. The article presents a method of predicting the performance characteristics of a building over the course of its use. The application of this method has been illustrated by the prediction of the performance characteristics of masonry walls, verified by studies carried out on existing buildings. The method, the purpose of research, can be applied to determine the life cycle of buildings for which LCCA (Life Cycle Cost Analysis) is carried out. A significant problem pertaining to every object in use is ensuring adequate reliability. The process of modeling reliability should have a mathematical basis enabling the problem to be described in detail. The ultimate aim is applying this description when solving problems connected with planning renovation work.
The PRRD (Prediction of Reliability according to Rayleigh Distribution) model of changes in the performance values proposed is a description of the changes in the performance characteristics of a residential building over the its entire service life. This model may also be applied for predicting changes in the performance characteristics of individual building components. The model is based on the Rayleigh distribution, which is a specific case of the Weibull distribution for the scale parameter $\alpha = 2$.
The presented model of assessing the degradation of a building or its components over time (PRRD) was subjected to validation, making use of the results of periodical inspections of existing buildings in the area of Zielona Góra, Żary and Gorzów. These comprised residential buildings constructed using traditional technology, the periodical inspections of which have been carried out for a few dozen years. The subject of comparative analysis were the load-bearing walls of those buildings which were made of ceramic brick.
The presented analyses of the length of the life cycle of a given structural element - in this case masonry walls - may serve as the basis for more precise determination of the life cycle of buildings in LCCA analyses.
A significant problem pertaining to every object in use is ensuring adequate reliability. The process of modeling reliability should have a mathematical basis enabling the problem to be described in detail. The ultimate aim is applying this description when solving problems connected with planning renovation work.

Keywords: Sustainable development, Service life, Masonry walls.

INTERACTIVE SANDWICH FAÇADE MADE OF RENEWABLE RESOURCES

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ABSTRACT

Globally, the growth of population and economy increase the consumption of natural resources and energy from non-renewable materials, like raw oil, natural gas, coal and uranium. More than 30% of total energy consumption and more than 50% of raw material consumption used for the construction industry with their emerged buildings. This aspect causes growing interests in many countries and international politics for sustainability in the last 20 years. Hence, the building envelope as an integral part of buildings and renewable resources have a key role for the implementation of sustainability. So the use of natural fibre reinforcement and biobased materials contribute the reduction of limited fossil resources and optimize the whole ecological balance sheet and concept of sustainability within the building industry. In this context fibre reinforced polymer (FRP) composites, consisting of natural fibres and biobased resin systems, are predestined being used in facade elements for buildings. They are ecologically beneficial and energy efficient and are supposed to replace less environmental and petrochemical FRP. Current application fields for natural fibre reinforced polymers (NFRP) are for example automotive industry, biomedicine and packaging industry.

The goal of our research project was the development and practical implementation of a free forming facade system, consisting of biobased sandwich elements. The build-up of the sandwich contains face sheets from natural fibre reinforced polymer, using biobased epoxy resin and flax fibres, and a stuck cardboard core structure (Fig. 1a). Furthermore a formwork system was designed enabling biobased sandwich elements to be produced with special needs according to efficiency and architectural design. As a result, the biobased and sustainable sandwich elements exhibit low system weight, high sound reduction and sufficient load capacity for the use of facade elements. Integrating flax fibres in a biobased epoxy resin generated load-bearing face sheets with a positive effect on water vapour diffusion regarding the core component. Proof was furnished in mechanical investigations that the core element of the sandwich facade can be made of coated cardboard structure. Proof was also given of fire retardant, resistance of flame dispersion and flaming droplets, as well as good sound reduction. But, especially in regard to high thermal conductivity further investigations will be realized to comply requirements under practice conditions regarding to EnEV 2016. Furthermore, the integration of illumination was achieved, which builds the unique characteristic of the sandwich facades.

Additionally LED-stripes were integrated for illuminating the facade elements (Fig. 1b). Because of the regular pattern of the stuck cardboard core and the translucent face sheet laminates the facade works like a screen on which each created pixel can be controlled in rgb-colours. Therefore an area of 10 m x 5 m biobased sandwich facade with 25 elements is planned as a reference object in Chemnitz, forming a facade with 100 x 48 pixels (Fig. 1c). In summary the illuminated biobased sandwich elements produced with an efficient technology of production and with the use of renewable resources can replace extensively 3D-formed customary facade systems. ▶

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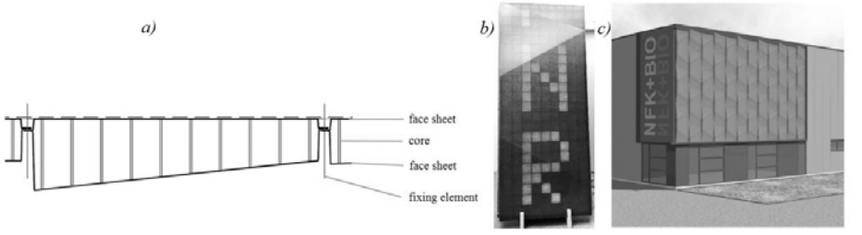

Figure 1: Facade element, horizontal sectional drawing (a), illuminated element (b) and reference object (c)

This new biobased sandwich facade meets requirements as regards resource efficiency in combination with modern architecture. Especially the use of cardboard and natural fibres for facade elements can be exemplary for following projects to increase the use of renewable raw materials.

Keywords: Eco-composite; biobased composite materials; Characterization of NFRP materials.

THE ROLE OF SUSTAINABLE CONSTRUCTION IN SUSTAINABLE DEVELOPMENT

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ABSTRACT

Humans and the actions they take to improve their quality of life lead to the disturbance of the processes occurring in the natural environment. The concept of sustainable development results from three major factors observed in the contemporary times, characterized by the focus on continuous development: devastation of natural environment, depletion of natural resources and social stratification in individual countries. It would be the substantial limitation to link this term only to ecology. This process involves synergy of social, economic and environmental factors in striving for further development while meeting the needs of the generations to come[1]. In Our common future we read "the concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities". Sustainable development has led to the necessity to implement changes towards balancing all areas of human activity, including the construction sector. Factors affecting sustainable development are present in many phases of building creation and use. The article discusses aspects of sustainable development. Article describes the main requirements for sustainable development, contained in laws and regulations, at every stage of building construction: raw material extraction, production of construction materials, construction, use, demolition, project design. Furthermore, the study analysed the share of individual sectors of the economy in consumption of energy resources. The focus was on the consumption of raw materials in the sector of industry and construction and the sector of households. The analysis shows that the industry and construction sector has a large share in hard coal consumption, heat and electricity. The hard coal consumption is increasing in the sector of households.

Keywords: Environmental Protection, Sustainable development, Sustainable Construction.

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GREEN INITIATIVE IN SURANAREE UNIVERSITY OF TECHNOLOGY IN THAILAND

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ABSTRACT

Suranaree University of Technology (SUT) has participated in the Universitas Indonesia (UI) GreenMetric World University Rankings since 2013. It attempts to pursue campus sustainability programs and policies. The rankings is broadly based on the frameworks of environment, economy, and equity. The measurement criteria are divided into six categories with different point weighting i.e. setting and infrastructure, energy and climate change, waste, water, transportation, and education. These criteria heavily and directly involve the tasks and responsibilities of SUT's the Division of Buildings and Ground. A lot of environmental challenges in civil engineering and infrastructure works need to be achieved. The results of this year self-assessment show that although the university is in the developing stage, it can preserve both natural and planted forests more than 90%. It takes seriously role in green initiative by contributing 30% of total budget on sustainable efforts each year. It receives four national awards in the recognition of energy conservation initiative for green buildings. The university establishes the Integrated Solid Waste Management Plant (ISWM Plant) based on mechanical and biological treatment (MBT) which turns general wastes into valuable and sellable refuse-derived fuel (RDF). Moreover, these sustainable movements are in the continuous improvement process.

Keywords: UI GreenMetric World University Ranking, Sustainability development in Higher Education, Waste Management, Green University.

STRUCTURE AND SERVICE SAFETY OF DEEP DISPOSAL LANDFILLS – CASE STUDY

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ABSTRACT

This paper discusses issues related to operation of environment protection facilities in immediate vicinity of natural water reservoirs, including fresh water reservoirs, located above and below ground. The subject of this study is a municipal solid waste landfill located in southwestern Poland and its related facilities included in the technological processes of waste disposal, treatment, and recycling. The paper briefly discusses the construction process stage and the first stage of operation of the studied facility in respect of their future impact on the environment. At the present time, waste is used to obtain landfill gas for electricity generation and materials to be reincorporated or disposed of, i.e. construction debris (brick, concrete), structural steel, firewood, and plastics. The range of topics presented in the paper is in accord with the sustainable development tendency and the paper specifically focuses on potential hazards arising from presence and operation of facilities of this type (built at a time when environment protection regulations were less restrictive as to their location). Continuity and effectiveness of insulation membranes of landfills are important inasmuch as once such landfills are filled with waste and then closed and reclaimed at the final stage, it will be extremely difficult to identify sites of potential leaks of basins, whose expected lifespan is several decades or a few hundred years. If such leaks are found within this period, it will be necessary to remove reclamation layers and strongly thickened waste in order to reach them [12]. Then, new damage resulting from operation of heavy equipment might occur. Therefore, apart from standard protection solutions of landfills, additional warning systems should be applied for maximum elimination of environmental pollution hazards, the range of which can be supralocal or even supraregional. Such systems should precisely indicate the location of probable places of hazards. It is not about damage to facilities, including cells, but about safety of their surroundings. Due to the vastness of the topic referred to herein, the paper has been narrowed down to include only one issue, i.e. tightness of cells intended for non-hazardous and non-inert waste.

Keywords: Landfill, Technical condition.

INVESTIGATION ON APPLICATION OF A TYPICAL MORTAR FOR CLINKER IN PREFABRICATED FAÇADE PANELS – TEST'S RESULTS

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ABSTRACT

Recently, openwork façades have become very fashionable and commonly used in modern public buildings. They are characterised by an outstanding design and a proper lighting of the interior spaces, while providing lightweight solution of the façade. The usage of the ceramic components, most of all a clinker one, made it possible to fit the new erecting enclosure structure, like outside leaflet, to a load-bearing part of the masonry building's wall. The typical erecting method of an openwork facade is in-situ bricklaying using specific mortars dedicated to the clinker elements. Such an execution of the external layer of a building requires sufficient space to conduct the work and proper preparation of the clinker elements. Unfortunately, ensuring such conditions is not always possible. This situation leads to the natural need for replacing, at least partially, the standard way of structure's execution with prefabrication methods. The prefabrication of elevation panels requires application of the mortar in the untypical way – as a filling material between masonry clinker units.

The paper presents the possibilities of using a typical mortar mix (dedicated for clinker elements) for a prefabrication of the finishing layer of building's elevation. The prefabrication process needs to increase the recommended by producer amount of mixing water, therefore, to prepare the prefabricated panels three different water contents were taken into account: 4.0 litres, 4.5 litres and 5.0 litres.

The first part of the paper describes the material tests of a hardened mortar, in particular compressive and flexural strength. The second part presents laboratory tests of prefabricated panels, made of special-shape clinker components and previous tested mortars, supported and loaded similar to the real operating conditions.

The main conclusions derived from laboratory tests conducted were following:

- increasing of the water content caused a significant decreasing in strength properties of the mortar, but significantly improves the execution conditions during prefabrication of an elevation panel;
- the amount of mixing water used in mortar serving to prefabrication of an elevation panel had a significant influence on its stiffness, when loading it out-of-plane, in the entire load range – up to the state of failure;
- in the case of using small amounts of mixing water (4.0 and 4.5 litres) the stiffness of such prefabricated panels was almost similar – up to the reaching the load-bearing capacity – and the first cracks did not cause significant changes in stiffness,
- in the panel made with 5.0 litres of water, after first cracking a significant reduction in the stiffness as well as in bending resistance was observed.

Keywords: laboratory tests, elevation panel, mixing water, mortar, clinker units.

LOG HOUSES MOVING AS AN ELEMENT OF SUISTAINABLE DEVELOPMENT IN ARCHITECTURE

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ABSTRACT

Among the various construction technologies considered to be ecological, log houses moving draws special attention. It consists of an old log house dismantling and reassembling in a new location. The basic problems related to moving wooden houses are presented at the paper, on the example of examined investments.
The distance from the original house location to the destination point, and the differences between the landscape and weather conditions in both places should be taken into consideration before final decision. The assessment of building's technical condition and following inventory of all the construction components, remains the crucial part of the investment process. Replacement of all the damaged or rotten elements is highly advised. Roofing and windows are the most commonly replaced parts of the house, while it becomes a great challenge to disassemble them without harm. To ensure accurate quality of the newly-erected house, meticulous marking of all wooden parts of the structure before moving is necessary. Appropriate transporting and sheltering methods should be provided.
After completing the construction of the walls and roof, the appropriate way of filling the gaps between bales in newly erected wooden house should be considered. Traditionally, sealing of log houses is called moosing. The word comes from the oldest known method: placing moss between wooden balls. It was the cheapest and widely available raw material, with good insulating properties. The technique of filling the gaps between balls with ground moss did not require much skill and was relatively quick. Another simple method of caulking was applying an easily gained clay. Moreover, various other organic fillers as chaffs, straw, tow and decorative chips from spruce wood, have been used. Nowadays, various modern methods of sealing log houses are available (professional putty, hemp cords) some of them will be presented at the paper.
Investors transferring log houses meet many difficulties during the investment process: obtaining a building permit and numerous technical difficulties during the construction of the building. Polish construction law does not include issues for this type of investment. During the design phase and the project approval, the building is treated as newly designed. It reveals numerous complications related to insulation rate, total capacity, fire requirements and many other aspects of transferred house.
The most important idea of moving log houses is to preserve the unique character of the building, while adapting it to the modern needs of residents.

Keywords: Log houses, sustainable development, moving houses.

SUSTAINABLE RESIDENTIAL HOUSING FOR SENIOR CITIZENS – CONTEMPORARY PROJECTS

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ABSTRACT

This paper conforms to themes relating to the shaping of sustainable built environment. It tackles issues connected with the implementation of sustainable solutions in residential housing for senior citizens. It presents selected innovative implemented European projects of new buildings and modernisation projects of the existing development comprising the adjustment to the needs of the elderly and to the requirements of sustainable housing.
Housing for senior citizens constitutes an important group of architectural projects due to the demographic processes we observe today. A considerable increase in the population of the oldest residents in the European Union states over two last decades has decided about a change in the senior citizen policy, economic policy, and about the need to adopt a new approach to the process of shaping spaces for this social group.
There are numerous concepts of housing development being proposed to the elderly, adjusted to the degree of their independence and their lifestyle. There is a broad offer of diversified forms of accommodation, e.g. supported, sheltered housing, community housing 50+, nursing and care homes.
The examples presented in this paper correspond to different models conforming with the requirements of ecology and economy. The social factor is also of key importance for making design-relate decisions. It is manifested in the search of a standard of a functional, healthy, and safe apartment and its surroundings, taking into account the mental and physical comfort of the elderly.
Design concepts satisfy the assessment criteria of sustainable buildings to different extents. The projects discussed in this paper refer to standards, norms, and certificates applicable in individual countries (e.g. MINERGIE®–P - ECO, BBC Effinergie, Passive House). Designers also make references to regional construction patterns and to the local climate. The presented solutions are implemented in new buildings addressed to senior citizens, as well as within the scheme of sustainable renovation of the existing structures.

Keywords: sustainable architecture, eco-architecture, housing for elderly

OPTIMIZATION OF BUILDING DESIGN PROCESS BY USING ENERGY SIMULATION TOOLS

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ABSTRACT

In order to design in a proper manner the heating and cooling sources for the needs of air-conditioning of a building it is necessary to work out the balance of heating and cooling demand for the building. In most of the cases, it does not suffice to make calculations using the traditional calculation methods and methods specified in the regulations in force and Polish standards. In order to make it possible to achieve an in-depth analysis of a building it is necessary to know the energy performance of the building which follows from its construction, its profile, i.e., how it is used, and to understand the operation of heating and cooling sources, as well as of the heating and cooling installations. Therefore, in modern designing, it is extremely important to use advanced computer techniques to develop a detailed balance of energy, which takes into account all its useful forms, including heat and electricity. Only such a comprehensive approach will render it possible to achieve the energy efficiency indicators required by law, as well as an economically efficient operation of the building, with a minimal bad influence on the environment.
The manuscript presents methods of comprehensive computer energy simulation of buildings, which can be used for optimal designing of buildings for any purpose. There are two examples of using a simulation software for the analysis of residential buildings, along with the analysis of the results of energy simulations carried out with its help. In order to analyse the feasibility of optimizing the choice of a heat and/or cooling source for a given building, a simulation of energy performance analysis was carried out for two completely different buildings: a large office building and a small two-family house (a semi-detached house). The buildings under analysis are real buildings, of which one (the office building) has been used for many years and the analysis aimed at suggesting an optimal heat source for the heating needs of the building, whereas the other has been newly designed and has features of a low-energy building, in which it was necessary to design a heat source (or heat sources – separately for each individual part of the building) for the heating needs and domestic hot water supply.
In both buildings the optimal heat sources were designed. The simulation model developed allowed a detailed analysis of the annual changes in the heat load and heat consumption in the office building. This in turn rendered it possible to make an optimal choice of the CHP unit. In the first four months of its operation, a total net profit of approximately 22 500 PLN was generated. In case of two-family house the optimization carried out with the use of computer simulations allowed saving at the stage of investment implementation almost 2/3 of the forecast budget allocated for building the heat source for the two-family building. In addition, the properly selected heat source will work with significantly higher efficiency than it was originally provided for in the construction design, because it will be optimally loaded.

Keywords: Building Designing, Energy Simulation, Heat Sources,

TAP WATER AS A SOURCE OF INDOOR RADON IN HOUSES

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ABSTRACT

Radon is a naturally occurring radioactive gas which may be found in indoor environments of buildings. The main source of radon in buildings is the ground underneath the building. But there are also another sources of this gas such as building materials, domestic water, and gas supplies (EPA, 2017). Outdoors, radon is quickly diluted to very low, not problematic concentrations for human health but indoors, it can concentrate. Places that are particularly exposed to the increasing radon concentration from the water sources, are the places where the water is dispersed eg. bathroom and in other home water facility (e.g. jacuzzi, faucet aerator) (Klosok-Bazan et al. 2014). Whereas, ionizing radiation can cause cellular damages in organisms and in some cases may be transformed to cancer (Lehnert, 2007), so the presented problem is very important. In many countries including Poland, drinking water is obtained from groundwater sources. These sources of water normally have higher concentrations of radon than surface water from reservoirs, but till now there was no obligation to identify the radon in water. Due to the implementation of EU directive to the Polish law, November 30, 2017 such obligation has been introduced. One of the water intake where radon concentration has been higher then recommended level was Mokre intake in Glubczyce district. The permitted level 100 Bq/l (Ministry of Health Regulation, 2015) has been exceeded by almost 100%. The aim of the paper is to present the calculation of the radon escaping from water into the indoor air. The obtained data has been compared with WHO recommendation (WHO, 2009) and literature review. Considering that 300 $Bq \cdot m^{-3}$ are equivalent to 10 mSv per year, which is equal to receiving approximately an annual full chest CT (computed tomography), the risk resulting from the emission of radon from the tap water in Mokre has been assessed as an insignificant.

Keywords: indoor environment, water treatment, radon.

PLANNING THE OPTIMAL SOLUTION FOR WASTEWATER MANAGEMENT IN RURAL AREAS – CASE STUDY

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ABSTRACT

Water management and associated wastewater management is an inseparable element of life and development of modern societies. Collection and treatment of wastewater has a significant impact on the environment and economy, both at the local and global level. It is therefore necessary to proceed to activities that ensure proper wastewater management, especially in rural and low-density areas, where it is necessary to search for optimal solutions with regard to sewage systems, including wastewater treatment plants. One of the solution for wastewater treatment from houses without access to sewerage collection system is the construction of on-site wastewater treatment plants. Construction of on-site wastewater treatment plant poses a number of challenges for municipalities and potential investors and has been discussed by many. Aim of this paper is to draw the current status and perspectives of on-site wastewater treatment systems in Poland, with focus on selected case study from rural areas. The paper presents a way to solve the problem of wastewater management in the municipality of Pietrowice Wielkie using local biological wastewater treatment plants. The commune decided to use INNO-CLEAN domestic wastewater treatment plants from a wide range of devices. Economic and environmental considerations were in favour of choosing this model. In addition, the assembly costs and monthly use were considered when selecting the system. It is still necessary to take into account the costs of long-term operation, repairs, costs of replacing worn components and those of sewage sludge export. The article presents technological, technical and economical aspects of the above-mentioned solutions and analysis of the advantages and disadvantages of the system proposed by the municipality. As of the date of this work, knowing that this system operates in the municipality of Pietrowice Wielkie approximately 3 years, it can be concluded that the problem of sewage management has been partially solved(industrial wastewater have not be considered). This is not an ideal system, and whether it is cheaper than a system based on a sewage system and a collective sewage treatment plant, it will be possible to determine it after several years of operation. An important role will be played by the monitoring of both the correct operation of the domestic sewer treatment plant as well as the preventive monitoring of water quality in the groundwater intakes. Nerveless, the solution to the sewage management problem applied by the Pietrowice Wielkie commune can be considered unique in the country-wide scale.

Keywords: Wastewater Management, Domestic Wastewater, Sewage Disposal System.

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT IN GREECE

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ABSTRACT

During the life cycle of the construction industry projects (construction, renovation, demolition) a significant amount of waste is produced. Excavation, construction and demolition (ECD) waste has been identified as a priority waste stream by the European Union, accounting for approximately one third of all waste generated and a large portion of waste in landfills. ECD waste consists of materials such as concrete, bricks, wood, glass, metals, plastic and excavated soil, some of which may be contaminated, but have a high resource value and a strong potential for recycling and re-use. The level of recycling and material recovery varies greatly across EU. In order to encourage an integrated management of ECD waste with regard to circular economy theory, a strong legislative framework has been established in European Union. All member states, including Greece, must take the necessary measures to achieve that by 2020 a minimum of 70% of non-hazardous construction and demolition waste shall be prepared for re-use, recycled or undergo other material recovery.
In compliance with the European Directive, Greek Law required the development of a sufficient network of treatment facilities that can manage the entire amount of ECDW produced in Greece and the gradual establishment and operation of adequate ECDW managements systems to cover all areas of the Greek territory up to January 1st, 2014.
The paper presents the Greek legislative framework as well as current practices with regard to ECD waste management in Greece. Information is retrieved from yearly reports published by certified Management Systems and personal communication with the Systems representatives, who were required to participate in a survey, providing quantitative and qualitative data concerning the alternative ECD waste management and answering questions regarding the barriers that need to be overcome.
Currently, the network of licensed collectors - carriers in Greece is capable of meeting the country's needs and the treatment facilities' registered capacity exceeds the waste production. However, only half, approximately, of the Greek territory is covered by the network of certified Waste Management Systems. Although there is a specific legislative framework for the management of ECDW in Greece since 2010, there is a high level of non-compliance, by public and private actors. Illegal dumping is still a common practice in many cases. The analysis showed that there are many obstacles to overcome, but it also revealed some positive trends. In most cases, the largest amount of incoming waste to the Systems is subject to treatment, achieving recycling and recovery of materials to a high degree. The main problem lies in the failure of ECDW retrieved materials to be introduced back into the market, especially with regard to the recession of the private building activity and the abundance of natural resources in Greece at low prices. Specific measures such as the review of Technical Specifications and Green Public Procurement could drastically improve their marketing potential. Financial incentives along with a change in people's perception of ECD waste would also boost national performance.

Keywords: excavation, construction and demolition waste management, reuse, recycling

THE BATTERY OF SILOS FOR RAPESEED - THE IMPACT OF THE BUILDING QUALITY AND EXPLOITATION CONDITIONS ON THE TECHNICAL STATE OF THE OBJECT

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ABSTRACT

The subject of the paper is a battery of silos for rapeseed located in oil factory in Bodaczów near Zamość. It consists of 24 cylindrical silos with capacity of 500 tons and 14 star-shaped chambers between them with a capacity of 100 tons each. The silos were supported on the supporting structure in the form of permeating ring beams and columns. The columns were placed on a reinforced concrete foundation grate 2.0 m high, at a depth of 5.0 m below the ground level. The height of a single silo is 25 m, and the diameter about 6.0 m. Detailed macroscopic tests were performed on the battery of silos walls. Throughout the external surface of the silos, circumferential damage was found every 0.3 to 0.7m along the height of the silos, resulting from improper lifting of formwork during concreting. The range of defects and loosening of the concrete cover of the reinforcing bars has considerably increased due to over 50 years acting of unfavorable weather conditions. The strength test and assessment of the homogeneity of structural elements concrete were made on the basis of sclerometrical measurements using the N type Schmidt hammer. The C30/37 concrete class was found, but only in undamaged areas. Pull-off test performed on the same kind of concrete gave good results too. The location of the reinforcement in the external walls of the silos was determined in detail using the magnetic method. Then, in prepared revision holes, the range of corrosion of the reinforcement bars was determined as differentiated and dependent on the quality of the concrete. The degree of concrete carbonation was estimated too. The range of neutralization of the concrete cover was 5 to 20 mm in good quality concrete and 50 mm and more i bad quality concrete. Based on laboratory destructive tests of reinforcing bars taken from the structure, the real steel parameters have been determined and the weldability of these bars for steel rods B500SP and RB500W was confirmed. Static and strength calculations were carried out. Based on the results of observations, tests and analyzes, the technical condition of the object was estimated as poor, locally due to the significant loss of concrete and structural reinforcement it was estimated as pre-failure. However, due to the existing load capacity (in areas with good quality materials), it was considered that sterghtening of silo walls is not necessary. Therefore, renovation solutions were proposed to restore functional efficiency of the object to be implemented in three stages. Stage I - renovation the roofs with the replacement of gutters and downpipes, sealing the dilatation. Stage II - repair of walls of silos, supporting structure and discharge funnels with one of the repair mortar system. Stage III - other works, i.e.: making vertical and horizontal damp-proof insulation of underground part of the object.

Comprehensive repair of silo batteries with the use of proposed solutions is currently being implemented. The approximate area of renovation works is about 1000 m^2, and a supplementation of steel corrosion losses in the amount of about 3 tons.

Keywords: Technical State, Reinforced Concrete, Battery of silos.

IMPACT OF BLUE SPACE IN ARCHITECTURE AND POSSIBILITIES OF USING

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ABSTRACT

Trends in contemporary architecture are design environmentally, economically and socially sustainable buildings. When possible, where space permits, buildings are designed in harmony and contact with nature, water. Human's relationship to water and nature in the course of history changed. Changes in water regimes and the associated changes in landforms, vegetation and wildlife can have significant effects on many different types of human perceptions and values. Water has a very special quality as an element in landscape design. Over many centuries and in many countries it has in turn been acknowledged and exploited, and it has inspired. It has been a great provider not only in physical terms, but also in the many ways it has contributed to both natural and man-made environments through its aesthetic qualities. The presented paper shows the possibilities of using blue spaces in the urban environment but also in the indoor environment. It has been shown that these elements have a high impact on the quality of the environment, but also contribute to reducing the air temperature and thermal islands in cities. The presence of natural elements in an artificial environment is an important aspect of life quality and well-being. Over that 93% of Taiwanese are adherents of a combination of the polytheistic Chinese popular religion, Buddhism, Confucianism, and Taoism. This fact is strongly reflected in architecture and connection to nature. Water carries important metaphors about the energies of life. It is hidden depths are a source of wisdom, so staring into it provides opportunities for contemplating the deeper meaning of life. Traditionally, people believed that water had sacred power and that it flowed from the very source of spiritual life, over time it has retained a nurturing and healthy energy. Water stimulates and refreshes chi energy. Introducing a water feature is the ideal way to enhance the energy of career area. Presented three examples of buildings in Taiwan show the interconnection of architecture and the nature, mainly water, as has been shown by the strong roots in the culture of this country. From this reason the water does not appear only in the religion buildings but also in the commercial buildings in the middle of the city. Water spaces are part of almost every city or building in this country. Three presented buildings show three different designs in the context of water: In the first case (Water-Moon Monastery by Kris Yao) the water symbolizes a strong element of religion, in the second case (Xiangshan Visitor Center by Dan Norihiko) the building is designed in the symbiosis of the surrounding nature and the environment, the third example (National Taichung Theater by Toyo Ito), where the water appears in the form of a fountain and an indoor river, also shows the water itself and the water whirlpool were the inspiration for design and shape of a building. Use of water elements bring the opportunity how put piece of nature into the urban environment, but also inside the buildings. Ignorance of water feature properties results in ineffective use of all the possibilities that can bring. At the same time there is a wasteful use of water. The aim of the present paper is to show the transition of water elements from decorative to functional elements in architecture.

Keywords: blue space, water features, evaporative cooling.

SPATIAL AND ECONOMIC CONDITIONS OF THE SOLAR ENERGY USE IN SINGLE-FAMILY HOUSES – A CASE STUDY

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ABSTRACT

The provisions in the European and Polish law oblige to increase the use of energy obtained from renewable energy sources. In order to meet these demands, it is necessary to take into account the single-family housing sector that has a significant energy potential. Among the unconventional heat sources that have gained the highest popularity, it is worthy to note installations using solar energy for instance to prepare DHW (domestic hot water) or be used in buildings' heating. It is also worth mentioning that this type of technical solutions can be successfully used as well in new as modernized old residential buildings.

Our paper discusses the problems associated with planning of solar installations with flat and vacuum solar collectors mounted on the roofs of the single-family buildings. During the analysis we used GIS&T technology, multi-criteria decision support as well as detailed spatial data obtained by modern remote sensing techniques including airborne laser scanning.

The proposed methodology and tools were used on the example of the selected part of a single-family housing estate located in Bialystok.

The research focused on issues of the multi-criteria assessment of the assembly of use of roofs for solar collectors, including data on a solar potential, exposure, slope, surface and roofs' shape. Additionally, we took into account roof zones on being in a shadow caused by roof elements, roof infrastructure and high vegetation.

Based on the simulation results we analyzed possibility of plate and tube solar collectors application that would provide warm water for 1-4 habitants of houses.

The results of our research showed high utility of the proposed methods in the field of spatial and economic assessment of the use of solar collectors in the single-family housing sector.

Keywords: solar energy, single-family houses, residential buildings

Part II

Material engineering, waste management in civil engineering

STRENGTH AND PERMEABILITY OF PERVIOUS COMPOSITE PREPARED BY USING POST-CONSUMER PLASTIC WASTE BOTTLES

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ABSTRACT

The growing amount of post-consumer plastic bottles has resulted in the accumulation of plastic wastes and causes serious environmental problems due to littering and illegal landfilling or incineration. One of the recycling methods of plastic bottles is using it in concrete which is one of the most widely used construction materials. The review of literature indicated that using plastics in conventional concrete is cost-efficient and improves properties such as toughness and durability. However, to the author's knowledge no study attempted recycling of post-consumer polyethylene terephthalate (PET) waste bottles in sustainable pervious materials. Therefore, the primary objective of this study was to develop and evaluate a novel form of pervious PET composite, called as PPC, by using plastic waste, soil and aggregates (no Portland cement or asphalt).

A mix design was prepared by using different PET to soil/aggregate ratios. Using the mix designs, cylindrical samples of PPC were produced in a steel mold by compacting a mixture containing molten PET and heated aggregates and soil in accordance with proportions determined from mix design. Dry cylindrical samples of PPC were tested for indirect tensile strength and permeability. Indirect tensile strength was conducted in accordance with ASTM standard. However, permeability was conducted in a unique manner by designing and fabricating a new constant-head permeameter.

Both indirect tensile strength and permeability were within the expected values found in the literature for porous pavements. Results showed that indirect tensile strength values increased with PET content. It was also found that using PET alone is not strong enough in binding aggregates and therefore, a soil/PET ratio of one was found optimum for providing maximum strength. Permeability values decreased with the decrease of A/P (aggregate/PET) ratio which in general indicates that lower PET and higher aggregate content is suitable for higher permeability. A soil/PET ratio of one was found to provide higher permeability but strength could compromise.

Findings from this study indicated that developed PPC could be used for low-strength construction such as driveways, sidewalks and parking lots. PPC is a unique alternative in that it addresses two environmental issues: reducing storm water runoff and diverting plastic waste from landfills and incinerators. As we continue our approach to sustainable and green construction materials, PPC is another step towards eco-friendly development.

Keywords: Plastic, PET, Portland cement, compressive strength, tensile strength, permeability, pervious, composite, pavement.

USE OF FLY ASH FROM FLUIDIZED BED BOILERS IN CLINKER-SLAG-ASH BASED BINDERS

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ABSTRACT

The study presents the state of knowledge regarding physical and chemical properties, as well as trends for application of fly ashes from combustion in fluidized bed boilers in building materials. Clinker – slag – ash based binders were tested that contained up to 40 mass % of fly ashes from combustion in fluidized bed boilers. It was demonstrated that fluidized bed combustion fly ashes (FBC fly ash), apart from granular blast furnace slag, could be the ingredient of low clinker Portland cements (ca. 20% by mass).
It was found that presence of fly ashes from fluidized bed combustion in clinker – slag – ash based mortars had higher water demand than in case of cement based mortars. The higher addition of FBC ashes, the higher water demand of mortars is. A reverse relation was observed with the increase of blast furnace slags in the clinker – slag – ash binder, from 10% to 40% by mass. The higher content of slags in the binder, the lower water demand of mortars is.
It was found that the content of FBC fly ashes in the binder should not exceed 30% by mass, due to deterioration of physical parameters of mortars with the increased percentage of this additive in the clinker – slag – ash binder. Production of clinker – slag – ash binders is possible in strength class 32.5.
It was demonstrated that presence of FBC fly ashes and blast furnace slags in the clinker – slag – ash binders affected reduction of mezopores quantity (<50 nm) at the expense of reduced quantity of macropores (>50 nm). It has a beneficial effect on increased corrosion resistance of those mortars.
Obtained results of testing confirm possibility of FBC fly ash management by its use in clinker – slag – ash binders in quantity up to 30% by mass, which was confirmed by results of compressive strength tests and the smallest linear changes observed in the corrosive environment (solution of sulphuric acid).
Based on test results of binders with various content of blast furnace slag and fly ash, the clinker – slag – ash based binder was singled out, which demonstrated the higher durability in the corrosive environment. It was found that production of clinker – slag – ash based binders was possible in the strength class 32.5 even with 30% by mass of FBC fly ash content.

Keywords: Fly ash, FBC fly ash, Acid corrosion, Cement-fly ash durability, Porosity

THE EFFECT OF NANO-ADDITIVE TiO_2 ON THE FAILURE PROCESS OF SELF-COMPACTING CONCRETE ASSESSED USING THE ACOUSTIC EMISSION METHOD

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ABSTRACT

Due to the ever new challenges posed to engineering materials, as well as the principles of sustainable development, research is carried out in many laboratories around the world in order to improve the basic structural material that is concrete. There has recently been a lot of interest in modifying concrete with nano-sized particles. Literature reports indicate that their addition significantly improves the physical and mechanical properties of concrete obtained with their use. At the moment, however, there is no knowledge of the effect of nano-additives on the failure process of temporarily compressed concrete, which is important with regards to fatigue and long-lasting concrete strength. One of the test method that enables to determinate parameters describing concrete stress failure is the acoustic emission method. This work fills the gap in literature and presents the results of the author's own research on the impact of the use of different amounts of nano-additive TiO_2 on the failure process of self-compacting concrete made solely on the basis of granite aggregate. A total of 3 mixes of self-compacting concrete were prepared. One mix was made without a nano-additive as a reference and the other two were modified with the addition of nano-TiO_2 in amounts of 2.0% and 4.0% of the cement weight. Tests using the acoustic emission method were carried out using a Vallen-Systeme Gmbh AMS3 apparatus set, a strength testing machine and two VS 150-M sensors with an available 100-450 kHz frequency band. The stress failure of the tested concrete was described using the levels of stresses that initiate cracking σ_i, and also the critical stresses σ_{cr} that were determined using the acoustic emission method and which delimit the tested process. The descriptors used for this purpose were the rate of counts and the average effective value of the acoustic emission signal (RMS). The obtained test results confirm that the failure process of all the tested concretes has three stages. There are two thresholds that distinguish the individual stages that are visible in both the rate of counts and in the effective value of the acoustic emission signal (RMS). The first corresponds to the level of stresses that initiate cracking σ_i, and the second one to the level of critical stresses σ_{cr}. The obtained levels of these stresses are different depending on the tested series. They are equal respectively to 0.52 σ_c/f_c and 0.78 σ_c/f_c for the reference concrete, to 0.52 σ_c/f_c and 0.82 σ_c/f_c for the concrete with the addition of 2.0% of the nano-TiO_2 and to 0.68 σ_c/f_c and 0.83 σ_c/f_c for concrete with the addition of 4.0% of the nano-TiO_2. It is noted that the addition of 4% of TiO_2 nanoparticles results in a significant increase in the levels of stresses that initiate cracking σ_i and the critical stresses σ_{cr}. It may be the effect of, among others, the improvement of the microporosity of concrete due to the addition of nano-sized particles.

Keywords: Acoustic emission, Self-compacting concrete, Nano-additive, Temporary compression, Failure process.

INFLUENCE OF THE FLY ASH AND THE PRIOR FREEZING AND THAWING ON THE SULPHATE RESISTANCE OF CEMENT MORTARS

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ABSTRACT

The use of fly ash for the production of cement is a typical example of the utilization of by-products (waste) from various fields of production in construction, a significant reduction of CO_2 emissions and reduction of energy consumption. However, in order to be able to determine the suitability of this additive in construction, it is necessary to examine the durability of cement composites with fly ash in various, often complicated, destructive environments. There are known publications regarding the durability of concretes with fly ash in individual environments. However, in natural conditions, several destructive environments are common at the same time. The article presents an attempt to reproduce natural conditions. The samples were divided into two groups. The first group included the samples subjected to forty-six months sulphate attack after 40 freeze-thaw cycles were. The other mortars samples were only subjected to sulphate attack. This paper presents the results of sulphate expansion tests of air-entrained (AE) and non-air-entrained (nAE) Portland and fly ash cement mortars subjected to prior freezing and thawing. Despite significant strains experienced during freeze-thaw cycles, unlike the non-air-entrained Portland cement mortars, the non-air-entrained mortars made of fly ash cement did not exhibit any significant expansion when exposed to Na_2SO_4. For 17 months no expansion was found in the air-entrained mortars made of either of the cement types when immersed in Na_2SO_4 solution after freeze-thaw cycles. The results of the SEM and EDS analyses showed that gypsum and ettringite were the sulphate attack products in all the mortars. The highest amounts of ettringite were found in air voids where there was crystallization of the free so does not cause expansion. Analysis of the fly ash cement mortars microstructure indicates tight packing of hydration products, which hampers the penetration and migration of aggressive solutions. In the non-air-entrained mortar with fly ash numerous cracks were observed, caused most probably by the cycles of freezing and thawing. Despite the cracks, the content of very small ettringite crystals, observed after nearly two years of sulphate attack, were low. Clusters of ettringite crystals could be observed only near the surface of the samples. Most often they grew inside the micro-cracks formed during the initial freezing/thawing, thus they did not cause expansion. The best sulphate resistance evaluated in experimental studies was found in mortars with fly ash. Prior freezing/thawing did not reduce their sulphate resistance. The performance of non-air entrained and air-entrained OPC mortars deteriorated considerably in combined destruction conditions. Use the air-entrained mortars with fly ash was considered optimal for maintaining durability under combined freeze-thaw cycles and sulphate attack. Higher doses of air entraining agents or preparations specially dedicated to specific technologies are required. In air-entrained mortars, ettringite is formed mainly in air voids. Large air voids are assuring the free place for ettringite crystallization. And it is the reason of the resistance to sulphate corrosion improvement.

Keywords: Fly Ash, Cement Mortars, Durability, Sulphate expansion, Freeze/Thaw, Air-entrained.

UTILIZATION OF WASTES FROM MEDIUM DENSITY FIBERBOARDS PRODUCTION AS AN AGGREGATE FOR LIGHTWEIGHT CEMENT COMPOSITE

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ABSTRACT

The possibility of recycling wastes from medium density fiberboard (MDF) production into lightweight cement-based concrete product was evaluated. A large quantity of lignocellulosic wastes is generated worldwide from various sources, including wood and furniture industries, leading to environmental concerns. MDF is an engineered wood product, which is made from wood fibers (mainly form coniferous trees) with wax and a resin binder. This paper presents the outcomes from a tentative research on the development of a lightweight cement composite with the pre-treated MDF wastes (MDFW) as an organic aggregate. These wastes otherwise would be burnt or landfilled. All lignocellulosic substrates have detrimental effects on cement setting so different techniques can be applied to offset the retarding effect of compounds like sugar and tannin present in the bio-based particles before mixing the wastes with cement. Various treatments were proposed in this study to optimize the properties of MDFW-crete. Availability and price of agents used for the pre-treatment as well as complexity of the procedure (device requirement) were taking into consideration while selecting the applied methods. Five different material combinations were used for preparation of the organic fibrous component before mixing it with sand and cement: saturation in water (W), saturation in slaked lime solution (SL), saturation in sodium silicate solution (liquid glass LG), saturation in fly ash suspension (FA) and saturation in combined fly ash and slaked lime solution (FASL). The wastes were screened on #8 mm sieve to exclude big irregular elements which could negatively affect compaction and strength properties. One type of cement CEM I 42,5 R was used in the experiment. Flexural strength, compressive strength in air-dry and wet states, and water absorption of lightweight concrete were tested.

The study shows the feasibility of producing lightweight MDFW-crete. The strength properties can be highly improved by impregnating the bio-based fibrous material. Sodium silicate solution and the combined solution of slaked lime and fly ash proved to be the most effective materials for the pre-treatment of the organic aggregate in this research. The obtained 28-day compressive strength for these two series was over 5 MPa. Considering the economical, ecological and technological aspects, the second type of treatment is more feasible. Dry apparent density was in the range from 780 to 880 kg/m^3, which is comparable with autoclaved aerated concrete. The obtained lightweight concrete is very sensitive to the humid environment. Water absorption exceeded 57% and there was observed a considerable loss in strength when concrete was in the saturated state, so this type of material should be protected and not exposed to moist environment.

Keywords: Lightweight concrete, Medium Density Fiberboard, Wastes, Lime, Fly ash, Sodium silicate.

CEMENT-FLY ASH MORTARS DURABILITY, WITH FLY ASH FROM FLUIDIZED BED BOILERS AND CONVENTIONAL COMBUSTION, EXPOSED TO AGGRESSIVE ENVIRONMENT INFLUENCE

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ABSTRACT

The study shows results of research on the aggressive environment impact (1, 3 and 5% HCl solution) on durability of cement mortars with fraction from 30 to 45% by mass of fly ashes from the fluidized bed combustion (FBC fly ash) and conventional fly ashes used separately and in the form of a mixture. The impact of aggressive environments on durability of cement and ash mortars was tested for a period of 365 days, by testing the compressive strength, linear changes, mass loss and porosity. It has been shown that with increasing (from 30 to 45% mas) content of and fly ashes originated from the fluidized bed boilers, water demand of binder in cement increases while addition of cement mixture containing fly ashes originated from the fluidized bed boilers (25% mas.) and conventional fly ashes (20% mas.) results in the reduction of water demand of binder.It was demonstrated that mortars with the content of FBC fly ashes, after 365 days of tests showed the higher resistance to aggressive environment impact. It is confirmed by e.g. their higher compressive strength, and thus the reduced total porosity. Reduction of total porosity content (<50 nm) was accompanied by the increased compressive strength, which in the aqueous environment was in favour of cement mortars, and in the aggressive environment in favour of cement and ash mortars. It was demonstrated that the content of pores < 200 nm was lower for mortars with FBC fly ashes and mixtures of ashes regardless of environment the mortars were stored in. A beneficial impact of FBC fly ashes was found on physical properties of mortars, i.e. reduction of the shrinkage, lower mass loss and reduced destruction of mortars in the acid corrosion environment. That effect was especially beneficial for the mortar with higher (45% by mass) content of FBC fly ashes, regardless of aggressive character of the environment. As shown by results of this study, application of fly ashes from fluidized bed boilers as an ingredient of mortars, may lead to stop their destruction in the acid aggressiveness environment. It was demonstrated that resistance of mortars to acid corrosion increased along with the higher content of ashes from fluidized bed combustion in the cement.

Keywords: Fly ash, FBC fly ash, Acid corrosion, Cement-fly ash durability, Porosity

PARAMETERS OF HARDENED CONCRETE WITH THE ADDITION OF METAKAOLIN

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ABSTRACT

There is currently no known one recipe for a concrete mix that would be suitable in all operating conditions. At present, in addition to the basic ingredients, mineral additives and chemical admixtures can be found in the formulas of concrete mixes. Each intentionally introduced addition to the concrete mix affects the rheological characteristics of the concrete mix as well as the parameters of hardened concrete. The article applies to laboratory tests of concretes with the addition of 0%, 10%, 20%, 30% metakaolin. The additive was replaced with cement in a concrete mix. The effect of the additive on compressive strength, water absorption and capillary rupture of concretes was investigated. Compressive strength was tested after 14, 28, 56 and 90 days. Water absorption and capillary rupture was tested after 28, 56 and 90 days. Four series of concrete mixtures with a constant w / s ratio = 0.41 were made. From the analysis of the obtained results, it can be noticed that the highest increase in compressive strength was achieved by concrete with the addition of metakaolin in the amount of 10%. Its compressive strength after 90 days is 90,1MPa. Concrete with 20% metakaolin addition has a similar increase in compressive strength to a series with 10% metakaolin. Replacement of cement with metakaolin in the amount of 10% and 20% results in similar strength increases, higher than the reference concrete in the 90th day of puberty, by an average of 12.2%. The lowest strength was recorded for concrete with the addition of 30% metakaolin, whose strength at 90 days of maturation was 76.3MPa. The reference concrete obtained compressive strength after 90 days of maturation of 79.1MPa, lower by 11 MPa than the series with the addition of 10% metakaolin. In the absorbability test, the highest absorption compared to the reference concrete was demonstrated by concrete with the addition of 10% metakaolin. A significant decrease in weight gain can be seen for concrete with 30% metakaolin. It can be noticed that the greater the amount of cement replaced with the metakaolin addition, the smaller the weight gain in the water absorption test. Extending the maturing time of concrete samples has a positive effect on reducing the weight gain. Comparing the maturing times, the largest increase in weight was recorded for all examined series on the 28th day of puberty. Analysis of the results indicates that the addition of metakaolin causes a significant increase in water absorption in the capillary pull of the modified series in relation to the reference concrete. The smallest increase in weight is found in concretes with the addition of 30% metakaolin. The longer the maturation time and more cement was replaced by the addition of metakaolin, the smaller the weight gain compared to the reference concrete. Analyzing the 90th day of maturation, the samples of the reference concrete and concrete with the addition of 30% metakaolin achieved comparable mass increments differing by 5.1%. Considering economic and environmental factors, it is necessary to use a metakaolin addition in the amount of 10% to 20% for concrete mixes. The use of metakaolin as a concrete additive could help solve the problem of excessive CO_2 emission to the atmosphere as a result of cement production.

Keywords: metakaolin, additive, concrete mix, cement, chemical admixture

LIGHTWEIGHT SINTERED AGGREGATE AS CONSTRUCTION MATERIAL IN CONCRETE STRUCTURES

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ABSTRACT

The paper presents the result of testing a new patented lightweight aggregates. The name of this aggregate is Certyd. The only solid material used to manufactured these aggregate is fly ash. Certyd is durable, lightweight and high-strength material. It is environmentally friendly material. It has chance to by future material in concrete use. The laboratory test shown that the concrete made from the Certyd possesses low porosity, high strength and high durability potential. The bulk density, depending on the product fraction, oscillates between 550-830 kg/m3. Certyd has also high resistance to crushing, when we compare to another lightweight aggregate. The use of lightweight aggregate in concrete has many advantages, like: reduction in the sizes of construction elements like columns, slabs and beams, lighter and smaller precast elements needing smaller and less expensive transporting equipment, enhanced fir resistance, high thermal insulation, reduction of reinforcement. The article presents the author's research on reinforced concrete elements, like beams and slabs made of Certyd.

Keywords: Lightweight aggregate, fly ash, concrete, compressive strength, Certyd.

SAND-LIME COMPOSITES WITH BASALT FIBERS

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ABSTRACT

The composites occupy a special place on the building materials market. Fiber-reinforced composites are currently predominant due to their best mechanical and strength characteristics with a minimum weight. Fibers used to reinforce concrete prevent first of all the formation of microcracks and open cracks, increase the strength and resistance of concrete. The fibers are also used in the production of wall building materials such as autoclaved cellular concrete, ceramics or silicate. Autoclaved sand-lime products belong to one of the most popular building materials used in housing construction. Research has been undertaken to determine the effect of basalt fibers on the properties and microstructure of silicate products. Basalt fibers were selected for the research due to their ecology, favorable application possibilities and a good price / performance ratio. Literature shows positive effects of the use of basalt (aggregate and dust) as an addition to autoclaved sand-lime products and the chemical composition of basalt fibers is not significantly different from the chemical composition of the basalt itself. Traditional sand-lime products are made of about 90% quartz sand, 7% lime and 3% water. To obtain modified products, specially prepared basalt fibers with a length of 10 mm were used in a volume to sand-lime ratio. The fibers used in the tested composites have a diameter, the value of which varies from 12 to 18 μm. Samples with the addition of basalt fibers obtained lower compressive strengths compared to the reference sample. Strength decreases with the increase in the amount of fibers from about 35% to 50%. The volume density did not change significantly due to the use of the additive. The brittleness of the materials tested was maintained at a high level and the fiber addition increased it. Products modified with basalt fiber have greater absorbability than the traditional sample. The difference in the compressive strength and absorbability of the sample with the addition of basalt fibers and no additive is probably related to incorrect homogenization of the modified product components. In contrast to concrete, which is well workable (easily fills complex shapes, without a lot of work on compaction), the sand-lime mix has the consistency of moist sand. This significantly impedes the correct distribution of fibers in the matrix, resulting in clusters of fibers. Places of density of fibers in the matrix cause an increase in porosity and weakness of the product structure which translates into lower strengths compared to traditional silicate. In connection with the above, the fiber length used - 1 cm, also turns out to be ineffective. It can not be unequivocally stated that the addition of basalt fibers has a negative effect on lime-sand products. Further attempts should be made to apply basalt fibers more efficiently and to consider how to properly distribute the elements in the matrix. In addition, further testing with different fiber lengths and determining the optimal additive content are recommended.

Keywords: Composites, Basalt Fibers, Sand-Lime Materials.

THE UNCERTAINTY OF A DYNAMIC MODULUS OF ELASTICITY MEASURING IN VIEW OF NON-DESTRUCTIVE TESTS OF CONCRETE COMPRESSIVE STRENGTH

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ABSTRACT

The standard PN-EN ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories states the testing laboratories are obligated to estimate the uncertainties for each used method. It is very important to consider the precision of conducted measurements in order to decide if the result is valuable or not, because the confidence interval makes the result possible to interpret. Thus the evaluating of measurement uncertainty has to be a good practice in every kind of testing methods, even if the laboratory isn't accredited.

In this research, the impulse excitation and modal analysis method, used as a non-destructive method of the dynamic elastic modulus of concrete testing was considered. The evaluation of measurement uncertainty of this method shows, that in case of normal strength concrete the expanded uncertainty is equal ±1.4 GPa, which is the 3,6% of the obtained value.

The conducted evaluation shows that over 40% of the uncertainty is caused by the variability of material. It indicates that in case of concrete testing methods this source of uncertainty can never be omitted.

Except for the variability of material, the biggest contribution in uncertainty takes the fundamental frequency of vibration and length of the specimen measure - about 26% and 19% respectively.

The performed uncertainty budget indicates clearly which sources of uncertainty have to be improved in order to significantly reduce the expanded uncertainty. For example, if the length measure would be made using the apparatus with scale resolution of 0,1 mm, the relative uncertainty would decrease from 3.6% to 3.0%.

The investigation shows that correction factor taking into account a finite thickness of beam and Poisson ratio, in case of the relatively stocky concrete samples, also influences significantly an uncertainty budget (9%).

Based on conducted investigation it has to be concluded the non-destructive, impulse excitation and modal analysis method provides a very good repeatability. The relatively fast and easy procedure made this method potentially applicable to the dynamic elastic modulus of concrete testing, and also the compressive strength of concrete estimation.

Keywords: Concrete, Dynamic Modulus of Elasticity, Measurement Uncertainty

AUTOCLAVED MATERIALS WITH CHALCEDONITE ADDITION

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ABSTRACT

Silicate products along with autoclaved aerated concrete are a healthy and ecological building material. Silicates and AAC are the effect of the reaction of the components from which they are formed under hydrothermal conditions. This process is called autoclaving from the name of the devices in which it runs. Microstructure as well as physical and mechanical parameters of silicate blocks and AAC, the type of mineral phases formed, their crystal morphology, the volume proportion of pores and their shape and size, are shaped basically during processing of products in an autoclave. Modification of the composition of construction products is their decisive development factor. In the study, research was undertaken to determine the effect of the addition of chalcedonite dust on the properties and microstructure of autoclaved lime-sand and limestone-sand-cement products. The tests have shown the effect of the tested additives on the particular properties of autoclaved lime-sand products and lime-sand-cement products. The addition of chalcedonite dust increased both the bulk density and compressive strength of autoclaved silicate and AAC products. Composition modifications have contributed to changing the microstructure of the products. In the traditional production of silicate products, the synthesis products are usually the amorphous C-S-H phase and the crystalline tobermorite ($C_5S_6H_5$). Tobermorite is a binding phase, stable in Ca/Si ratio from 0.8 to 1. Above 200°C, xonotlite, a tobermorite-like phase but containing less water is formed. In the sand-lime product with chalcedonite dust the tobermorite and C-S-H phases were observed. Tobermorite occurs in the form of pointed needles, whereas C-S-H in fibrous form. EDS analysis of this sample showed the dominance of the elements Si, Ca, K, O and in a smaller amount of Al. In traditional products from autoclaved aerated concrete, basic phase products include: tobermorite ($C_5S_6H_5$) and C-S-H phase in submicrystalline form. In smaller amounts, there is also anhydrite (C) and hydrogranates ($C_xA_yS_mH_n$), as well as in small amounts xonotlit ($C_6Si_6H_2$) and pectolite (NC_4S_6H). Similarly to the traditional ACC sample, numerous C-S-H and tobermorite phases were also observed in AAC modificated sample. Numerous clusters of crystals with a lamellar habit have been observed, these crystals are wide and have an oval end. The EDS analysis of AAC samples with the addition of chalcedonite showed the dominance of the same elements as in the case of the traditional ACC sample, but O and Al are present in a smaller amount than in the traditional sample. For both silicates and autoclaved aerated concrete, there is a direct relationship between the total content of these mineral phases and the strength of the autoclaved material. The additive contributed to changes in the structure and pore size. It is reasonable to continue research using different percentages of additives described in order to determine the optimal content of chalcedonite meal and fuller conclusions.

Keywords: Sand-Lime Materials, Autoclaved Aerated Concrete, Microstructure, Chalcedonite Dust.

EFFECT OF SULPHATE CORROSION ON THE DURABILITY OF AIR-ENTRAINED CEMENT MORTARS

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ABSTRACT

Cement composites are exposed to many destructive factors, which may be chemical, physical or mechanical. Corrosion is thus defined as the destructive impact of various environments on the material. Sulphate corrosion is a complex sequence of chemical and physical processes that, when the aqueous sulphate solutions are exposed for a sufficiently long time, irreversibly destroys the microstructure of cement paste. Air entrainment consists in creating air bubbles with dimensions of about 0.01 - 0.20 mm, their uniform distribution in the volume of grout and, what is very important, obtaining adequate stabilization. Air voids may be a place for the precipitation of sulphate corrosion products, resulting in less damage to the cement paste. Therefore, the influence of air entrainment on the sulphate expansion of cement mortars can be significant. In order to determine the durability of Portland cement mortars, mortar resistance tests were carried out on a 5% solution of sodium sulphate by measuring linear deformations. The tests included 1 series of non air-entrained mortars (air content: 5%) and 3 series of air-entrained mortars with air content: 7%, 10% and 13%. Research of selected properties of fresh mortars show a typical influence air entraining. With the increase of air, the density of mortars decreased and the consistency became more and more fluid. Compressive strength tests of mortars after 28 days and 80 weeks of residence in a solution of sodium sulphate were also carried out. The results of the compressive strength test after 28 days of curing show a decrease in strength with increasing air content. The highest strength was therefore recorded for non-air entrained mortar (nAE), the lowest for mortars in which the air content was 13%. For all mortars, the strength measured after 80 weeks immersion in Na_2SO_4 increased in relation to strength after 28 days of curing. However, there is still a tendency to decrease in strength with increasing air content in mortars. The biggest deformations of samples immersed in Na_2SO_4 were observed for non air-entrained samples, the smallest for mortar with an air content of 13%.Observations of the cement mortar microstructure using a scanning electron microscope (SEM-EDS) showed that ettringite was present in both the C-S-H structure and the air pores. By means of XRD analysis, the occurrence of crystalline materials was detected. Based on the research, it was found that air-entrained cement mortars showed greater durability in the context of sulphate corrosion.

Keywords durability, sulphate corrosion, air entrainment, microstructure of mortars.

THE POSSIBILITY OF SHRINKAGE STRAIN REDUCTION IN CEMENTS MORTARS

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ABSTRACT

The aim of the paper is the question of effectiveness estimation of different types of chemical admixtures application onto the control of course of shrinkage for cement mortars and concretes. In the paper there are presented mechanisms of action of basic admixture types that make it possible to obtain mortars and concretes with compensated shrinkage, such as: admixture based on calcium oxide (EXP), organic shrinkage reducer on the base of propylene glycol (SRA) as well as polymer dispersions based on styrene-butadiene latex (SBR) and styrene-acrylic co-polymer (SA). There are described and analyzed tests results for conducted authors research program within which the effectiveness of the application of mentioned admixtures types onto the magnitude of shrinkage strains and strength levels of cement composites was determined. In order to measure shrinkage strains, sets of shrinkage gutters with dimension 50/100/1000 mm, equipped with electronic strain sensors with automatic data acquisition, were used. Conducted tests proved that application of admixture based on propylene glycol (SRA) for mortar modification allows for shrinkage strain reduction within the range 25-30% in comparison with standard mortar. Application of expansive addition on the base of CaO (EXP), thanks to swelling reaction allows for shrinkage compensation within the range equal to 30-60% depending on dosage level. However, the most favorable as to the shrinkage reduction, is simultaneous dosing of EXP and SRA admixtures. Taking advantage of synergic effect of co-operation of these two admixture types makes it possible to produce cement composites with compensated shrinkage. Application of polymer additives for mortars modification (both SBR and SA) results in shrinkage strains reduction up to 60% in comparison with standard mortar, and in increasing the bending strength (even twice) due to favorable modification of grout structure and strengthening the contact zone between grains and cement matrix. For SRA and EXP types of admixtures no significant influence onto resulted strengths (both for compressive and bending) was registered.

Keywords: mortar, concrete, shrinkage, chemical admixture, polymer dispersion

CHANGING THE METHOD OF COMPACTION OF BUILDING MATERIALS MODIFIED BY DIABASE AND BARITE AGGREGATE

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ABSTRACT

The traditional way of producing sand-lime products is connected with the use of three basic raw materials i.e. quartz sand of natural origin, water and quicklime ground lime. During hydrothermal treatment in an autoclave, chemical reactions take place between the calcium and silicon ions. As a result of these reactions, the products are created that provide advantageous appropriable traits. In order to improve the durability attributes of the discussed products, diabase and barite aggregate was introduced into the raw material mass. In addition, the change in the densification method of the silicate mixture was applied. Layering was replaced instead of traditional pressing. The article describes sand-lime products modified with diabase and barite aggregate in an amount up to 15% by weight. Two methods of thickening the sand-lime mixture were used: pressing and layering. The change of the applied technology significantly influences, among others for water absorption. The best result was obtained using 5% and 10% modifiers. Modification with 5% content of diabase aggregate and 5% content of barite aggregate increases the strength by over 60% in relation to the reference sample. The obtained properties are reflected in the image of the microstructure examined by means of the scanning electron microscope. In the sand- lime products, both traditional and modified with diabase and barite aggregates, the C-S-H phase and tobermorite is present. These phases are characteristic for autoclaved products, although depending on the method of thickening occur in varying degrees and intensities.

Keywords: Sand-Lime Products, Barite Aggregate, Diabase Aggregate, SEM, XRD.

SCANNING ELECTRON MICROSCOPY IN THE TESTS OF FIBRE-CEMENT BOARDS

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ABSTRACT

The subject of this article is research on fiber-cement boards, which are most frequently used as building and finishing material for internal walls, but also as roofs and as sidings of ventilated facades assembled on the substructure. When used as facade sidings, the elements are exposed to huge loads as a result of wind pressure load and wind suction. Additionally, variable climatic conditions have influence on them. This is also why this material has to be thoroughly controlled before being used, and most of all, when it is produced. It is then essential to analyse the composition of the mixture and the amount and the way of distribution of cellulose and PVA fibres. Incorrectly distributed fibres do not create spatial mesh reinforcement, and this causes the board not having the required strength parameters, and consequently it does not meet the criteria of durability.

Because of the fact that fibre-cement materials are currently widely used in construction, they are exposed to the influence of environmental conditions, such as the rain and changes of temperatures, and in particular, frequent freeze-thaw events in day and night cycle (regular freezing-thawing). Moreover, fibre-cement materials, most of all those used as siding elements, are exposed to extreme conditions, and these include high temperature caused by the fire.

For many years, an available and common tool in the research on the microstructure of the solids, including various building materials, is scanning electron microscope. Thanks to the use of scanning microscopy, there is the possibility to evaluate the shape and the size of the grains, surface morphology, the presence of joints, inclusions, cracks, the manner the space is structured or the shape of the pores. The main advantage of the method is very simple preparation - the samples are in the form of fractions or splits. The next important feature of scanning electron microscopy is the possibility to obtain extremely large magnifications, even hundreds of thousands times.

The paper presents a proposal for using a non-destructive microscopic method for testing fiber-cement boards using a scanning electron microscope (SEM) with an EDS analyzer. Fiber-cement boards subjected to various environmental factors (moisturizing, freezing-thawing) and exceptional factors (burning at 230°C and setting on fire for 5 and 10 minutes) were tested. Interesting research results were obtained, which allowed to observe changes occurring in the microstructure of the tested boards under the influence of various factors.

Keywords: fiber-cement board, scanning electron microscope, non-destructive method, microstructure.

POST CRACKING BEHAVIOUR OF FIBRE REINFORCED CONCRETE WITH MINERAL WOOL FIBERS RESIDUES

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ABSTRACT

The research analysis, presented in the paper, concerns the possibility of recycling the mineral wool fibres from construction and demolition waste, by incorporating them into a cement concrete. The experimental investigation started with a preliminary study on the applicability of the waste material for its incorporation into a cement matrix on the basis of its physical and chemical characterization. Then the concretes with mineral wool fibres have been subjected to the mechanical tests of flexure and compressive strength. The fracture characteristics for concretes with mineral wool fibers residues, such as critical stress intensity factor K_{Ic} and crack tip opening displacement $CTOD_c$ were assessed on beams with initial notches in three-point-bending test. The mechanical properties of concretes were determined as well. The post-cracking softening behaviour of concrete has been also investigated. The load-CMOD and load-deflection relationships, obtained in three-point bending test, have been used to determine the fracture parameters: fracture energy, critical stress intensity factor, crack tip opening displacement, critical effective crack length. It has been verified that the incorporation of mineral wool waste to a cement matrix can be an alternative for recycling; the new composites analyzed maintain adequate mechanical properties for different applications.
The pre-peak behavior of material was slightly affected by the addition of fibers to the cement matrix. At this stage, the deformation regime was dominated by the cement matrix properties. The fibers caused a slight increase or an almost insignificant effect on the peak-load value, but the post-peak behavior revealed an important improvement compared to the reference concrete. Results of measuring toughness and energy-absorption characteristics showed that specimens with fibers acquire a great ductile behavior and energy absorption capacity, compared to ordinary concrete specimens. The mineral wool fibers residues caused the improvement of the fracture parameters as K_{Ic}, $CTOD_c$ and δ_{max} recorded for maximum load and total fracture energy G_F. The analysis of P-CMOD diagrams proved that the post-peak fracture behavior of the beam was greatly improved by the addition of wool fiber waste. The flexural strength increases with the incorporation of fiber waste in all cases, particularly for fiberglass residue. The compressive strength of composites with fibers decreases about 50% compared to the concrete without fiber residues. It was found that the incorporation of waste of mineral wool to a cement mortar matrix is a viable alternative for its recycling.

Keywords: concrete, mineral wool fibre, post-cracking behaviour, fracture parameters

A STUDY OF SELECTED PROPERTIES OF AUTOCLAVED BRICKS

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ABSTRACT

This research investigated the possibility of using material with different share as an addition to prepare autoclaved bricks. We are looking for such modifiers, thanks to which the obtained materials will indicate suitability for exposure to moisture and highly loaded building elements, e.g. basement walls. As the modifier was used: highly-efficient chemical agent of polymer, silicate and lithium compounds. The research was carried with the cooperation with sand-lime production plant in Ludynia (Poland) belonging to the Sand- Lime Group Corporation. Samples in the shape of beams of 40 x 40 x 160 mm (height x width x length) were formed using hydraulic press with method of double-sided one-stage pressing. the samples were subjected to hydrothermal treatment in industrial autoclaves, where the following conditions existed: saturated steam pressure 1,6 MPa, steam temperature 203˚C, autoclaving time 9,5 hours. At the initial stage of research, after 21 days from the autoclaving of the materials, the compressive strength and the absorbability were determined. Research was repeated after 24 months. The microstructure of the obtained materials was researched using scanning microscope The phase composition of the discussed materials was determined with the method of X-ray diffractometry. The determination of microporosity and distribution of size of pores of obtained materials was made using method of mercury porosimetry. The amount of water necessary to thicken the mixture was replaced by a modifier. The combination showed that the best solution is to use a 50% modifier in relation to the total amount of water. Introduction of modifier in the form of chemical agent into lime-sand mixture causes the increase of the compressive strength by more than 4 MPa in relation to the reference sample, using 1% of additive. In each analyzed case it reduces the water absorption of finished products. The results of compressive strength and water absorption show different values after 21 days and 24 months from the autoclaving process, the longer the time from the moment of production of products, the better result. Regardless of the amount of applied modifier, the distribution of pores is presented in similar way, the number of macropores was noted at level of around 70%.

Keywords: Autoclaved bricks, Porosity, Microstructure.

INVESTIGATION OF MECHANICAL PROPERTIES OF LIME-SAND BRICK UNDER DYNAMIC LOADING

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ABSTRACT

The results of experimental study of mechanical properties of samples of lime-sand brick under dynamic loading are presented. The tests were carried out using the traditional Kolsky method and its modification - dynamic splitting (the so-called «Brazilian test»). The setup for dynamic tests consisted of a pneumatic loading device - a gas gun with a control system a complex of measuring and recording equipment and a replacement set of measuring bars with a diameter of 20 mm. Samples were made in the form of cylinders with a diameter of 20 mm and a length of 10 mm for compression tests and also a length of 20 mm for tensile tests (splitting tests). Registration of initial experimental information was carried out using strain gauges glued on the lateral surface of measuring bars signals from which using schemes of dynamic tensometry were transferred to a digital storage oscilloscope. Next the oscillograms were saved digitally and processed using the original software.

The laws of the change in the strength, strain, time properties and energy intensity of lime-sand brick are established in the range of strain rate $5 \cdot 10^2$-$2.5 \cdot 10^3$ s^{-1} at compression and in the range of stress rate $2 \cdot 10^1$-$3 \cdot 10^2$ GPa/s at tension. The obtained experimental results are characterized by a temperate scatter and show the influence of the strain rate and the stress rate on the strength, strain, time properties and energy intensity of the tested material. The basic premise of the Kolsky method is the realization of a uniaxial stress state with a uniform distribution of stresses and strains along its length. This premise was carry out that prove synchronized in time pulses of strain of measuring bars. Splitting test can be used to determine the tensile strength of brittle materials when the elastic behavior of the material and the state of equilibrium deformation of the sample are observed and its fracture occurs along the diametrical plane. These propositions were also carried out at testing.

According to the deformation diagrams at compression the values of the mechanical characteristics of the material were determined: the maximum stress and the strain before the beginning of fracture corresponding to the maximum stress at different strain rates. Integrating the curves obtained in the axes stress versus strain was calculated the value of the specific energy necessary for deformation and subsequent fracture of the sample. Increase of strength, strain before the beginning of fracture and fracture energy are observed with an increase of the strain rate in compression. The values of maximum stress and the time before the beginning of fracture corresponding to the maximum stress at different stress rates were determined on the basis of the time dependences of the tensile stress in each test on splitting. Increase of strength and a decrease of the time before the beginning of fracture are observed with an increase of the stress rate in tension.

Keywords: dynamics, Kolsky method, splitting, lime-sand brick, strain rate, stress rate.

MODIFIED STEPPED SCHEME FOR MODELLING THE DYNAMIC BEHAVIOUR OF 3D POROVISCOELASTIC SOLIDS

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ABSTRACT

The problem of the dynamic response of a soil medium under different kinds of loads is of significant importance in various areas of engineering, especially in connection with structures. Mechanics of advanced materials such as poro- visco- or poroviscoelastic materials is relevant to such disciplines as geophysics, geo- and biomechanics, seismology, constricting. The present paper is dedicated to the modification of the numerical approach for modelling the dynamic behaviour of three dimensional poroviscoelastic solids. The development of 3d boundary elements modelling of poroviscoelastic solids dynamics using stepping scheme is presented. The basic equations for fluid-saturated porous media proposed by Biot are modified by replacing the classical linear elastic model of the solid skeleton with the viscoelastic model. Thus, the new theory can take into account the viscoelastic effect of the solid skeleton. Classical models of viscoelasticity are employed, such as Kelvin-Voight model, standard linear solid model and model with weakly singular kernel. Boundary integral equations method is applied to solving three-dimensional boundary-value problems. Boundary-element method with mixed discretization, based on Green-Betty-Somigliana formulae, is used. The problem is treated in Laplace domain. The modified stepping scheme with variable integration step for quadrature coefficients calculation using the symmetry of integrand function and integral formulas of strongly oscillating functions is applied. Also modifications based on the linear and quadratic approximation of function are employed. A numerical example of poroviscoelastic rod under Heaviside type load is provided to illustrate the validity of the numerical solution by comparison with analytical one, and to investigate the influence of the viscosity coefficient on the transient response of poroviscoelastic medium. A problem of a poroviscoelastic cube with a cavity subjected to a normal internal pressure is considered. The comparison of dynamic responses when poroviscoelastic material is described by different viscoelastic models is presented. Viscosity parameter influence on dynamic responses of displacements and pore pressure is studied.

Keywords: poroviscoelasticity, boundary element method, boundary integral equation, Laplace transform, dynamics, stepped method.

TIME-FREQUENCY ANALYSIS OF ACOUSTIC EMISSION SIGNALS GENERATED BY CEMENT-FIBER BOARDS DURING BENDING TEST

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ABSTRACT

Fiber-cement construction products have been used in construction for over one hundred years. Contemporary fiber-cement boards are made of natural raw materials such as cement, cellulose fibers, PVA and water. Materials made of fiber-cement are used in construction as a building and finishing material for elevations, internal walls and roofs, hence are exposed to environmental conditions such as rainfall and temperature changes, in particular, frequent temperature transition through 0°C in a 24 hour cycle (cyclic freezing-thawing). In addition, fibrous cement materials, primarily used as cladding elements, are exposed to exceptional conditions, which include the high temperature caused by fire.

Fibre-cement boards available on the market are characterised by two main types of external surfaces. They may have the structure of raw fibre-cement or they may be covered with layers of acrylic coatings. However, even when additional protective coatings are used, there is risk of exposing the matrix and fibres to the influence of external conditions. In the case of incorrect instalment of the board on the framework, the boards are easily damaged, there are visible chips on their surface. However, attention to proper priming of uncovered places is rarely paid, so these places create trails for penetration of moisture and for damages caused by cyclical freezing-thawing. Although these are small areas, the unprotected surfaces may significantly decrease the general durability of the material, even when there is no extreme dampness or other harmful factors.

The article presents the results of experimental tests of bending strength of cement-fiber boards subjected to environmental factors and exceptional factors. The paper also presents a proposal to use a non-destructive method of acoustic emission based on time-frequency analysis for testing fiber-cement boards. Interesting research results were obtained, which allowed to trace the differences in the mechanisms of material destruction under the influence of various factors.

Obtained results that allowed to distinguish destruction processes in the material reinforced with fibers and in the fiber-free material. For this purpose analyzed graphs of total number of counts and the maximal energy of events of acoustic emission signals in time. The frequency spectrum of the signal for the samples was also determined, which allowed to trace the frequencies in which signals generated during the destruction of samples occur. The evaluation of the EA signals of the tested tapes was also performed in the time-frequency domain, determining the three-dimensional spectrum spectra of the power density.

Keywords: fiber-cement board, acoustic emission, non-destructive method, time-frequency analysis.

FRACTURE TOUGHNESS OF RC BEAMS WITH DIFFERENT SHEAR SPAN

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ABSTRACT

The bearing capacity of reinforced concrete beams on the shear is influenced by the following factors: shear distance to effective depth radio, the percentage of reinforcement by transverse and longitudinal rebar, concrete strength, and beam height. In general, under the influence of different combinations of factors mentioned above, distinguish three characteristic patterns of destruction of reinforced concrete beams on the shear: folding-bending destruction, destruction of the web, destruction owning to infraction anchoring of longitudinal reinforcement. Experimental research indicates when reinforced concrete beams loaded with concentrated forces, the key parameter is the distance from the support to the point of load application, when occurrence inclined crack and fracture (shear span). This article presents the research of the beams without transverse reinforcement. The testing program involves testing of each beam samples twice. Beams were tested by the static loading of applied force at two points. The variable parameter was relative span to effective depth ratio, which acquired the values a/d=2, 1.5 and 1. All samples were destroyed by shear. The bearing capacity of reinforced concrete beams on the shear strength (ULS) was for BO 1.1 – V_{Ed}=95 kN (shear span - a/d=2), BO 1.2 – V_{Ed}=140.5 kN (a/d=1/5), for BO 1.3 – V_{Ed}=198 kN (a/d=1). Experimental results were shown difference between the experiments of twin beams above 5 ... 9%. The obtained results indicate an increase of the bearing capacity with a decrease of span to effective depth ratio. For all samples, the following pattern of distribution of deformations in the section is characteristic: tensile deformation in the zone of distribution of an inclined crack, and deformation of compression around them. For beam BO 1.1, the largest tension deformations placed in the middle of the height of the cross section, whereas for beam BO 1.3, which was tested at span to effective depth ratio a/d = 1, the maximum deformations are located at the line of tensile reinforcement. In general, the contour drawing corresponds to the further spread of cracks. The first inclined crack disclosed in mid-height cross section, at the load 50 kN at an angle equal to 45°. As a result of tests, the sample BO 1.1 has reached the serviceability limit state (SLS) with the value of the transverse force of 80 kN. With a decrease shear span, the SLS of the RC beams increased and were for the BO 1.2 - 1.38 times and BO 1.3 - 1.88 times more. The SLS values by the crack's opening width are fixed at 71…84% of the load carrying capacity of the samples. The effect of increasing shear strength by SLS is similar to the increasing of the load bearing capacity and close by the value. It should be noted that in all samples, the limit crack occurs shortly before the exhaustion of the bearing capacity on the shear. However, the maximum values of inclined cracks width is fixed at the value of 0.55 ... 0.85 mm. This indicates a rapid increase cracking width after the samples loss their serviceability limit state. When the shear span decreases the width of the crack's opening decreases also.

Keywords: fracture toughness, shear span, inclined crack.

USE OF THE KOLSKY METHOD FOR DYNAMIC TESTS OF BRITTLE MEDIA

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ABSTRACT

The techniques for dynamic tests used to obtain the mechanical properties of brittle materials are described. The techniques are based on the fundamental Kolsky method using the Split-Hopkinson Pressure Bar (SHPB). Prerequisites and assumptions underlying these methods are described. Experimental results obtained during testing of ceramic bricks, fine-grain concrete and fiber-reinforced concrete are presented.
According to recommendations of scientific literature nowadays for testing brittle materials using the Kolsky method, the length/diameter ratio of the specimen should be in limits of 0.3 - 1. To reduce the effect of friction during the radial distribution of the specimen, it is necessary to use lubrication of contact surfaces of bars and the specimen. In this case, equality of the forces acting on the specimen during its deformation is evaluated on the basis of time-synchronized deformation pulses of the measuring bars. This technique allows to obtain dynamic deformation diagrams in stress strain or strain-time axes at different strain rates of experimental specimens.
In addition, by integrating the stress-strain curves obtained in the axes it is possible to calculate the value of specific energy necessary for deformation and subsequent failure of the specimen.
To determine the strength of brittle materials under tension, the splitting method or the «Brazilian test» and the indirect tension method, which is a modernized Nicholas scheme, are used. On the basis of conducted studies it was noted that the splitting test can be applied for determining tensile strength of brittle materials exhibiting elastic behavior and the equilibrium loading state of the specimen, and it fails along the diametric plane. Experiments with fine-grain concrete using the indirect tension method, in which the specimen is connected to the measuring bars by an adhesive joint, showed the fulfillment of the main assumption of the Kolsky method.
To determine the dynamic strength of shear brittle materials, a modification of the Kolsky method is used, in which the studied specimen is placed into a rigid jacket at a horizontal angle. In order to obtain the properties of brittle media under complex strain state, a modification of the Kolsky method was developed in which the test specimen is placed between the ends of the measuring bars in a rigid steel elastically deformable jacket, which prevents its radial distribution. The described techniques make it possible to obtain a wide range of properties of brittle materials at dynamic deformation rates.

Keywords: dynamics, Kolsky method, compression, splitting, indirect tension, shear, strain rate

Part III

Design of buildings, including reconstruction and renovation of antique buildings

MODELLING OF ELASTIC-PLASTIC BEHAVIOR OF CABLES

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ABSTRACT

The paper describes general calculation theory and the elastic-plastic behavior of cables – bearing elements of suspender structural systems. It is mentioned that this theory is based almost on the same assumptions as the theory of calculation of cables at behavior of material in the elastic range, excluding additional supposition in the part of idealization of real dependence between stresses and deformations on account of difficulties with using the latter in actual structures design. For that reason, this dependence is replaced with a model in the form of analytic curve or, as it is accepted to say in this case, a diagram, which is built according to some simple mathematic rule, reflecting element behavior conditions and characteristics of its material. It is stated that four main models of behavior of material are used in practice: elastic-plastic, elastic-plastic with linear hardening, rigid-plastic and rigid-plastic with linear hardening.

In the paper, the author sequentially considers behavior of cables using two idealized diagrams "stress-deformation" of cable material: elastic-plastic and elastic-plastic with linear hardening. Conditions of occurrence of plastic deformations in all behavior stages of the cable cross section are determined. Interrelations for geometrically and physically non-linear task of the cable at active loading are provided. Methods are given and limit values of loads acting on the cable are determined. Equations defining parameters of the cable deflected mode in all deformation phases and conditions of changing phases of the cable behavior are given.

The nature of the elastic-plastic behavior of cables is disclosed, which can be characterized by two moments. First, the appearance of plastic deformations in the cable cross section means the emergence of a limit state in it. And the second, the most important − the limit state realization in any random cross section of an elastic-plastic cable leads to extension of plastic deformations along its entire length. Hence, in turn, it follows that the process of the cable deformation is implemented in the following sequence: for $\sigma < \sigma_T$ (where σ_T is the material yield strength), all cross sections of the behavior of cable in the elastic range, and for $\sigma = \sigma_T$ all of them turn to the limit state. The latter also indicates that the calculation of a cable having an idealized elastic-plastic material stress-strain diagram makes it possible to find only the value of its ultimate load.

It is shown that, unlike the case of an elastic-plastic cable without taking into account material hardening, which leads to justification of the ultimate load value, the problem solution for a hardening elastic-plastic cable allows to watch the behavior of cable over the entire range of load variation.

Numerical solutions of the task are presented for a hardening elastic-plastic cable with different values of the modulus of a material linear hardening, loaded with a uniformly distributed load on the entire span.

Keywords: Flexible Elastic-Plastic Cable, Steel, Bridges.

MODELLING AND VERIFICATION OF BRIDGE BEHAVIOUR

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ABSTRACT

During design and analysis process, many simplified technical approaches are routinely used in the application of theories to practice. With the use of modern structural analysis computer programs, the reliable design alternative, providing the most probable response of a bridge structure due to a range of designed loads can be identified. Field measurements should be performed to determine the actual load effect and to verify the applied analytical models. Modelling principles and suggest some guidelines and consideration in finite element based structural analysis are illustrated in the paper on selected bridge structures. Measurements for monitoring structural response, collected data are shown using tests carried out on composite bridge superstructures. Also information significant for long term behaviour of structures can be collected. Especially material properties should be controlled, rheological effects checked and straining variation recorded. In the paper, quite uncommon bridge superstructures are presented. Firstly composite six spans bridge with roadway concrete deck supported on two steel girders is considered. The corresponding rather sophisticated numerical model has approximated these main structural members with shell finite elements. The cross trusses and bracing parts were meshed by member elements, including real eccentricities from bridge slab. As imposed criteria of comprehensive static testing were satisfied, conformity of the real behaviour with the design calculations could be stated. The fundamental frequency, mode of bending and torsional oscillation, damping, dynamic increment and corresponding critical bridge velocity were obtained from the registered signals in dynamic testing. The observed vibration properties were close to theoretically declared values.
The calculation model of cable-stayed foot bridge and its field testing offer details of the other structural study. Particularities of railway bridge modelling and real behaviour verification are illustrated at the slightly important one span truss overpass.
Long-term observations, as illustrated on segmental box-girder bridges, can examine time dependent material properties, effects of construction process and environmental impacts. The investigation can include obvious concrete compressive strength control, rheological processes, temperature gradients modification and stress variations in the main construction stages. The purpose is to identify real more correct behaviour especially of major structures.

Keywords: Bridge structure, numerical modelling, loading testing, field measurement.

ON THE ASSESSMENT OF EXISTING CIVIL ENGINEERING STRUCTURES

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ABSTRACT

This paper provides general requirements and procedures for the assessment of existing structures, such as buildings, bridges and industrial structures based on the standard ISO 13822/2009 “Bases for design of structures - Assessment of existing structures” and on the author’s experiences. The author of this paper is the co-author of the ISO standard.

During the use of civil engineering structures, their deterioration with time is observed. The reasons for that may be divided into: a) technical deterioration (aggressive environment, natural and man - made disasters, natural wear as a result of the long-term use, mining activities, human errors, improper use of structures), and b) moral deterioration (as a result of technical development because some structures may lose their societal functionality). The assessment of an existing structures can be initiated under the following circumstances: as it is required by the Building Law in every country, structural deterioration due to time-dependent action (e.g. corrosion, fatigue), an anticipated change in use or extension of working life, structural damage caused by accidental actions, a reliability check for special kind of loads, e.g. increased traffic loads, earthquakes. The assessment procedure is composed in general of some steps which are as follows: preliminary assessment (study of documents and other evidence, preliminary inspection and damage observation, preliminary checks, decisions on immediate actions, recommendations for detailed assessment), and detailed assessment (detailed documentary search and review, detailed inspection and damage documentation, data for the assessment, i.e. the material properties, structural properties, dimensions and actions, determination of properties of the structure, structural analysis, verification, and interventions. Responding to the requirements defined in the formulation of the objectives of the assessment of the structure (between the owner of the structure and assessing engineer) the assessment may result in several possible interventions including three aims: to recover original performance, to upgrade original performance, and to reduce response of the structure. These aims may be achieved by repair, stiffen and/or strengthen existing structure, improved irregularity and/or discontinuity, supplement energy dissipating system, reduce masses and isolate structure base from ground excitation. All the information obtained during the process of the structure assessment should be documented in a report for the owner upon the completion of the assessment. In the report the following should be included: the scope of the assessment, the description of the structure, investigation, analysis, verification, the discussion of evidence, the review of intervention options, conclusions with recommendations, and annexes.

Keywords: Existing Structure, Preliminary Assessment, Detailed assessment, Rehabilitation.

NUMERICAL ANALYSIS OF SUCTION INFLUENCE ON THE BEHAVIOUR OF UNSATURATED ELASTO-PLASTIC SOIL MEDIUM

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ABSTRACT

The paper presents a concept of numerical analysis of suction influence on behaviour of partially saturated soil medium.

Behaviour of soil is described by the elasto-plastic model of unsaturated soil [1] (using the extended incremental constitutive relationship in the following form "effective stress – strain and suction"). The model operates the equation of Wheeler and Sivakumar's plastic surface. The generalized hardening rule (for changing value of suction) connects the increment of plastic part of void ratio with stress and suction levels.

A numerical procedure of stress path simulation [2] is used for analysis in the triaxial test. Selected path stress in material point of partially saturated soil medium is modeled by the step-iterative calculation technique (using the author's concept of the modified Newton-Raphson algorithm). A modified Nayak-Zienkiewicz method is used for analysis of plastic state.

The analysis was limited to one non-standard shear path for a set of three different suction levels. The obtained results are presented in the form of conjugated graphical characteristics of changes of stress and strain, shear, and compressibility. Their detailed analysis and comparison with the results obtained for absence of suction show significant differences between them. It therefore indicates necessity to apply specific models taking into account suction in the partially saturated soil medium in the geotechnical practice.

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Keywords: Numerical analysis, Suction, Partially saturated soil medium, Stress path simulation, Elasto-plastic soil model, Triaxial test, Newton-Raphson technique, Nayak-Zienkiewicz method.

BUILDING DIAGNOSTICS VERSUS EFFECTIVENESS OF REPAIRS

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ABSTRACT

Building diagnostics before renovation is an important stage in the process of designing and making future repairs and modernization of buildings. Performed hastily, without careful analysis, it may be the cause of wrong decisions about the method of repair. The experience of the person performing the tests usually has an impact on the identification of existing hazards. Examples of damage described in the paper appeared in a residential multi-family building in use, the external walls of which were made using the three-layer bricked technology. The problem of cracking in the external elevation of the three-layer wall took place in the area between the passage under the building and the windows located near the passage.

On the part of designers, a frequent fault is neglecting essential details of the solutions being designed. The assumption that the worker would know what the minimum length of a support for the protective layer should be and how many connecting fittings should be used to connect layers in the triple-layer wall turned out to be incorrect.

The building was inspected, as it turned out later not precisely, and the causes of damage were wrongly identified. Results of the previous inspection included neglecting thermal loads. The designer recommended reinforcement of the external wall pillar between the windows. Construction of a huge support under the floor slab, consisting of two steel poles on both sides of the wall of the higher floor, perpendicular to the cracked wall, based on the monolithic bottom floor has been done. According to the calculations presented, the steel frame, 6,0 m long, stiffly anchored using expanding bolts with tie beam, at a temperature gain Δt = 17.0 °C changed its length by 1.2 mm. This caused pushing of the tie beam together with the wall in the direction of the outside of the building.

Such cases are presented in the study suggesting establishment of engineering supervision over the work being performed. The causes of errors have been found at the stage of identifying failure, recommendations and repair of a cavity curtain wall. In the summary it was emphasized, that expert experience gained on many examples of differently damaged buildings, under the supervision of a person with experience is necessary for theoretical knowledge to be verified, and the reports were prepared without any faults.

Keywords: Buildings, Cavity walls, Damages, Diagnostics, Repairs.

RENOVATION OF THE HISTORIC BUILDING AFTER DAMAGE CONNECTED WITH FOUNDATIONS SUBSIDENCE – CASE STUDY

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ABSTRACT

The following article outlines a method of saving a building belonging to the Medical University in Wroclaw. It was constructed nearby the Oder canal in the area of a flood retention basin of the river during the years 1891-1900 and concluded in the period of 1934-1939. In the preconstruction phase, the land was subject to irrigation works as well as substantial ground elevation by supplementing it with non-local soils. The building comprised several different facilities: the older part was a brick object located on deep, curved foundations and the newer part was a brick and reinforced concrete construction with shallow foundations. After serious floodings, the process of its destruction began. Cracks appeared in the walls whereas the ceilings and the roof under the extension of the building were hanging in the air. Such a process continued uninterruptedly for a few years which might have caused a construction collapse. Since the edifice housed valuable rooms and a lecture hall, it should have been re-established to its serviceability state. In the past, a few attempts of damage repair were made on the basis of the antecedent expertise analyses. However, they all failed due to a much superficial context of handling the issue as well as an false analogy that the conditions of foundations were the same both under the older and the newer parts of the property. Therefore, constructing wall anchoring and other reinforcements were unsuccessful. The major purpose of the following research was, then, to investigate into the actual causation factors of the damage and design an effective renovation method of the facility under question. It occurred obligatory to diagnose all the elements of the entire studied construction, mainly its old, underground section. Moreover, the type of soils together with their compaction degree at the level of the foundations were subject to the study. The undertaken analysis of the premise foundations settings, occurring damage and deformities enabled to delineate reasons and perform relevant renovation works. Main causes of the damage include: (i) placement of the building foundations on both low and unevenly compacted mounds formed from silt soils from soft plastic to liquid consistency, (ii) groundwater level volatility ranging to circa 6.0 m, (iii) lack of dilatation between the Extension of the property and its Connector resulting in the violation of the ceilings and roofs. Based on extensive studies, a concept of providing support to the walls of the building has been developed which guarantees trouble – free operation of constructions for years and it combines: (i) reinforcing the walls of the Extension on a stable surface with the use of piles, (ii) constructing anchoring for the Extension inside the roof at the stable part of the building, (iii) repairing the roof, its insulation as well as injecting gaps and cracks. The performed analysis on the damage reasons of the edifice reveals not only the damage description and the reconstruction method but also the impact of natural and anthropogenic forces which have earlier been neglected during a few, past, unsuccessful attempts of the building restoration. Thus, it should be obligatory to run a complex and thorough analysis of the reasons of damage to a property, particularly when it is a historical monument and when the construction process is carried out in stages during various historical periods.

Keywords: damage diagnostics, suffosion, reinforcement, reconstruction, historical facility.

OCTAHEDRON - BASED SPATIAL BAR STRUCTURES – THE FORM OF LARGE AREAS COVERS

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ABSTRACT

Increasing expectations for covers of large areas create opportunities for shaping innovative forms of structural systems. The main objectives of domes constructions are to aim to the weight of the structure optimization as well as to obtain a cover with huge possibilities of large area usage thanks to the lack of internal supports. The usage of steel in such kinds of construction systems is reflected in a relatively small own weight of the construction. The other advantages of the spatial bar structures are the usage of straight bars, high rigidity of the structure, ease of shaping, relatively easy assembly.

Among the variety of the domed construction solutions of the public facilities covers, such as planetariums, stadiums, fair halls, show halls, sports and recreational facilities, railway stations, there are domes where the basis of their shaping are regular polyhedra. Their grids can reach a span of more than 100 meters. However, the most common types of such structures that cover the public buildings have a diameter of 50 - 60 m.

The paper presents eight designed spatial bar structures as geodetic domes with a span of 50 m. The basis of their shaping is the regular octahedron, that is polyhedron which has not been recognized in detail as the basis for geodesic domes shaping. Using one of the procedure proposed by professor J.Fuliński, the original equilateral triangles of the regular octahedron were divided into smaller. Thanks to such a division, the new designed bar domes constituting the basis of the paper were obtained. These are domes shaped on the basis of 2904-hedron, 3456-hedron, 4056-hedron, 4704-hedron, 5400-hedron, 6144-hedron, 6936-hedron, 7776-hedron. The received bar structures were subjected to thorough geometric and static analysis.

The aim of the presented geometric analysis was to show the results of the adopted procedure of the division of newly designed structures, i.e. the number of nodes, bars, supports, groups of bars with different lengths, minimum and maximum bar lengths, the total bar lengths. Own formulas were developed to determine the number of nodes and bars of domes generated according to the analyzed division method. Structures were modelled in a computer program, dividing bar elements into 4 groups. Each group was dimensioned taking into account the use of the load capacity of the most stressed element at the level of 80-90%. The total weight of the developed bar domes was presented. The static analysis was carried out to introduce the behavior of the geodesic bar domes generated according to the presented in the paper method of the division of original face of regular octahedron. Considered: extreme axial forces occurring in bars, maximum vertical and horizontal displacements of nodes as well as maximum and minimum values of stresses.

The developed eight bar systems in the form of geodesic domes, which the basis of shaping is regular octahedron can be used as the covers of large areas without the necessity of the internal supports usage.

Keywords: one - layered bar structure, spatial bar structure, geodesic dome, structural morphology, shaping of dome, geometric and static analysis.

THE CONSTRUCTION HISTORY AND ASSESSMENT OF TWO HERITAGE INDUSTRIAL BUILDINGS IN WROCŁAW

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ABSTRACT

Industrial buildings from the beginning of the 20th century can still be found in Polish cities. Some of them have already been listed as heritage objects. Those structures where new technical solutions and materials were used, for example concrete, are especially interesting. Some of those objects are currently under a process of restoration with the aim to reconstruct and adapt them for completely new and different utility functions but without losing their important heritage value. In this paper, elements of the assessment procedure of the technical state regarding a historical survey, material examination and structural analysis, are presented on the example of two selected industrial buildings in which reinforced concrete was used as the main structural material. The main aim of the performed diagnostic procedure was verification of the load-bearing capacity of structures of the examined buildings. The calculation made confirmed that in case of not damaged concrete elements they have enough capacity to carry on newly designed loads. That confirmed that old concrete structures, especially in industrial buildings, sometimes have capacity reserves. On the other hand it allows to perform the design of less invasive renovation works or strengthening solutions with the aim to respect their industrial heritage value.

Figure 1 The current view of old the bakery building

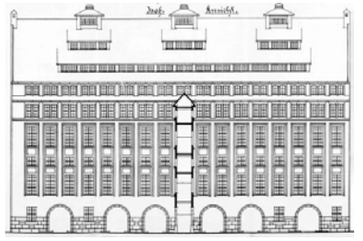

Figure 2 The archival drawing of the old bakery building

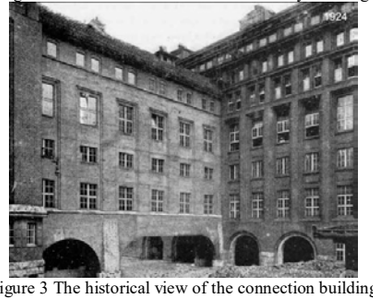

Figure 3 The historical view of the connection building

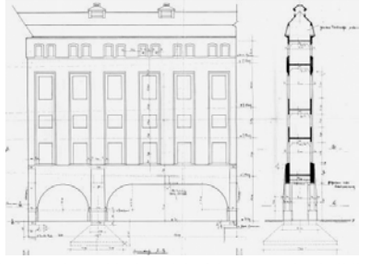

Figure 4 The archival model of the connection building

Keywords: Heritage Industrial Buildings, Concrete, Structural Analysis and Design.

NUMERICAL SIMULATION OF BEAM-TO-COLUMN JOINTS WITH FLANGE CLEATS

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ABSTRACT

Although the effect of semi-rigid steel beam-to-column connections on the behaviour of steel frames and their substantial economic benefits are recognized nowadays, many structural analyses still consider connections as either fixed or pinned. For that reasons, there is need to be able the generate moment-rotation responses of semi-rigid connections that can be used for analysis and design proposes. Characteristic of the joints can be found using FEM models.

The objective of the analysis was to find moment-rotation curves for beam-to-column joints with flange cleats and compare them to curves obtained from experimental studies. Numerical elastic-plastic 3D finite models was performed in order to establish a numerical analysis method for evaluating deformation of connections. The numerical tests were carried out by code ANSYS. Solid elements were used to mesh the beam, column, flange cleats and bolts. Contact surfaces between the flange of column and flange of cleats, the bolt shanks and flange of cleat and flange of column, and nuts and heads of bolts and flange of column and flange cleats are meshed by contact elements. The coefficient of friction of 0.2 is employed for contact surfaces.. Analysis was done for preloaded high strength bolts. The 3-D model uses the bilinear isotropic hardening option for plate elements of joints. The Huber - von Mises yield criteria was employed to define the plasticity. The large strain analyses were used.

For all joints there were obtained the FE results lightly underestimates results achieved from experiments.. Some differences in the initial value of stiffness and resistances indicate the need for further work on improving FEM models. The inclusion of dimensional deviations of the IPE nad HEB sections, variability in the values of the prestressing forces of the bolts and the not centric positions of the bolts in the holes in the FEM model may contribute to increasing the degree of compliance of the results from experimental and numerical analyzes.

These results have shown that the FE method was a powerful tool to improve the knowledge about connections design. They could be used in advanced structural analysis of frames.

Keywords: steel joints, flange cleats, FE modelling, nonlinear analysis

ANALYSIS OF RETAINING WALL STABILITY IN AREAS SPECIFIED IN REGISTER OF OBJECTS OF CULTURAL HERITAGE

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ABSTRACT

The case study of the assurance of retaining wall stability in densely urbanized conservation and cultural heritage areas are described in this paper. During The Second World War many of these historic buildings in Warsaw were completely or partially destroyed and until these days their remains constitute elements of the existing building development of the capital of Poland. The results of expert opinions and investigations are presented, regarding the operational and technical state of two retaining walls submitted to an expert before the repair works. The bad technical condition of these two retaining walls required the performance of temporary protection constructions. When designing the design concept, both the historic character of structures, the technical feasibility of performing construction works in the densely urbanized area, as well as determined water and ground conditions were considered.
The first of the analysed cases concerns the retaining wall localised in the vicinity of the Ordynacka Street and the Tamka street. Its role is to reduce the difference of the ground level between the Ordynacka Street and the multi-family residence situated near the Tamka Street. After analysing the historical aerial photographs, it was found that the retaining wall constitutes an underground part of the apartment house destroyed during the warfare. The solution proposed in the design concept is presented. The application of the relieving structure in the form of a reinforced concrete retaining construction supported on piles drilled in shrouded casing pipes is described in detail.
The second case study refers to Warsaw Old Town – the retaining wall ensuring the stability of the Vistula escarpment along Brzozowa Street in Warsaw. Also in this case, the construction of this wall was a remnant of the destroyed pre-war apartment house, but it was not the whole structure of the basement of the building, but only one of its walls. The additional difficulty was the very unfavourable water and ground conditions. Up to a depth of eight meters below the level of Brzozowa Street, there are poor soils in the form of soft-sand sandy dust with organic parts. In this case the solution was the designing the anchored sheet pile wall and concrete structure supported on the screw piles, which task is to support the wall..

Keywords: retaining walls, stability of the structure, technical state, historic apartment house

TECHNICAL DIAGNOSTICS OF THE HISTORIC APARTMENT HOUSE LOCATED AT NO. 31 IN DOBRA STREET IN WARSAW

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ABSTRACT

This paper presents a case study of investigating damages and assessing the current detailed technical state of the historic apartment house located at No. 31 in Dobra Street in Warsaw. The purpose of this assessment is to determine the possibility of the reconstruction of its last overground storey and the utility attic. Moreover, the impact of the 2nd underground line construction process and the influence of transport vibrations caused by both the street traffic and the underground on the damage of the supporting structure of the building is determined. The study was conducted in order to prepare the design for the planned last overground storey reconstruction considering the influence of the construction process on the adjacent buildings and the surrounding urbanized area.
The analysed building is a part of the terraced and the front row building development, in the plan drawing marked with the letter “C", with the main wing from the side of Dobra Street and the side wing from the side of Zajęcza Street with its outbuilding perpendicular to it in the yard. The building of the co called apartment house of Matysiak Family, was erected around 1920. During the Second World War the building was partially destroyed. After the warfare, the apartment house was rebuilt, reduced by one floor and it also lost the crowning of the corner in the form of a turret. Then it was operated as a municipal building. Currently, the building has five floors above the ground level and one underground floor. The supporting structure of the building is of a traditional brick type with a longwall construction system. The shape of the building and the variable layout make the building have a different spatial rigidity. Moreover, the cut-out of the recess at the interface between the walls of the front part and the annex adjacent to the yard cause the weakening of this rigidity.
The study of the building documentation, the field investigation on damage in the existing building and the results of the analysis of the accessible source papers on the impact of the construction of the 2nd underground line on the state of the apartment house, allow the authors to conclude that the current technical condition of this building does not exclude the possibility of making the superstructure of this building. Moreover, the conducted field tests of the traffic-caused noise and vibrations support that conclusion. The results of the carried out vibrations transmitted by the ground to the load-bearing structure of this building show that neither the transport-caused vibration nor the noise do not cause a harmful effect both on the damaged (scratched and cracked) masonry supporting structure of this building, as well as on its inhabitants. The conditions of reconstruction of this historic building are also specified in this paper, with particular emphasis on the impact of construction works on two neighbouring residential buildings.

Keywords: technical diagnostics, technical state, historic apartment house

SELECTED PROBLEMS OF PROTECTION OF HISTORIC BUILDINGS AGAINST THE RAINWATER AND THE GROUNDWATER

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ABSTRACT

The paper presents selected problems in the selection of the state of the art modern civil engineering solutions for drying moisture or wet, in particular parts of the underground structures of the brick historic buildings. The repair works of the immobile cultural heritage civil engineering objects require the appropriate choice of the design solution. These should be achieved by obtaining the assumed effects in the form of the effectiveness of repairs regarding all possible measures of protection of the cultural heritage buildings.
The selected results of own expert opinions, analysis and works are presented to determine the causes of the groundwater penetration into the interior of the underground parts of buildings, as well as the selection of the most suitable system solution for a specific case. Moisture is transferred from the outside of the building to the basement interior by four mechanisms liquid water flow, capillary suction, vapor diffusion and air movement. The variety of the different mechanisms of moisture, especially regarding buildings of cultural heritage implies that the selection of the most suitable system solution for solving moisture problem is the most crucial and a key issue in a specific case. The purpose of this selection is to perform the effective vertical and horizontal waterproofing of the basement walls together with the use of renovation plasters, as well as ensuring the evaporation of the existing moisture in these walls and floors. Additionally, due to the insufficient degree of natural ventilation of basement rooms, it is necessary to use the effective mechanical ventilation.
However in some cases the location of historic buildings, which requires the protection against the rainwater and the groundwater, particularly in densely urbanized area and in the vicinity of adjacent buildings or underground installations, excludes the application of the solution of making vertical insulation by digging out the entire basement walls. In such situations, the system solution needs to be selected that ensured tight hydro-insulation layer made. Based on authors' extensive experience case studies related with moisture observed in The Main Library of Mazovian Voivodeship and in Warsaw Citadel, along with several detailed approaches to solving these problems are presented in this paper.

Keywords: rainwater, groundwater, protection of historic apartment house, hydro-insulation, waterproofing.

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REINFORCEMENT OF BRICK HISTORIC BUILDINGS THREATENED BY STRUCTURAL DAMAGES OR BY FAILURE

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ABSTRACT

The paper presents the selected aspects of reinforcing the brick cultural heritage buildings, particularly load-carrying elements of those structures. In some cases the operational phase of many loadbearing elements of the historical buildings is shrinking or has used up. Moreover, significant damages, physical discontinuities in structural elements or building materials are leading to the loss of durability or the failure of these objects. The consequence of that occurrence is the necessity of strengthening, combined with the repair, of damaged elements of the masonry walls to ensure the safety of the whole structure. This safety should be assured regarding both the structure itself and its users. The design concept also needs to include recommendations and instructions of the conservator-inspector. The results of own expert opinions, analysis and works are presented in this paper to analyse the structural behaviour of the loadbearing elements of two selected historic buildings. Field measurements and in-situ inspections allowed to diagnose and to determine the use ratio of the structural elements and on its basis to design and to perform the repairs works of damaged or used elements of such structures.
The first of the analysed cases concerns the barracks facility near the Makowiecka Street in Przasnysz which was erected in 1912. Cracks in the brick walls have reached a width of up to 10 mm, have a cruising character and pose a real threat to the safety of the load-carrying elements of that historic building. The cause of the damage is the location of septic tanks in the close vicinity of gable walls of this object, which caused excessive settlement of its foundations. Cracks in sanitary rooms, located in the gable parts, were particularly propagated. Surface reinforcement of cracked loadbearing walls was applied on both sides. Additionally, cracked vaulted window lintels were reinforced with the use of steel sections.
Another case described in this paper is the brick dome of the church building of St. Anne in Wilanów district in Warsaw. At the beginning of the present century, the visible scratches on the elevation and inside the church began to appear. The largest number of scratches occurred in the outline of pillars supporting the dome, in arched windows and along the outer longitudinal walls. Design calculations for the dome reinforcement were carried out regarding both the performance characteristics of vaulted structures and the proper assembly of the existing structure with elements of the reinforcement system. The repair works programme included full protection of the dome considering the least possible interference in the historic church structure. The applied solution ensured a proper operation of the brick structure of the dome in the range of allowable compressive stresses.

Keywords: brick historic buildings, structure reinforcement, historic apartment house

UNCONSCIOUS DECISIONS CAUSING A FAILURE CONDITION OF THE 19th CENTURY BRICK CEILING

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ABSTRACT

The article describes a hazard caused by deformation of a brick vault located under the dungeons of the gate tower of Zamek Górny in Opole from the turn of the 13th and the 14th centuries, which was used as a school building until 2017.
The hazard, identified in 2013, was found on the ground level of the building in a communication route of the heavy traffic load. Visual inspections carried out in September 2013 revealed damage to the ceiling structure which made it necessary to expose the site in the days that followed. The examination demonstrated that the structure consisted only of a flat fragment of a ceramic brick board without any reinforcement and not connected with the remaining basement vaults. Probably, it was made in the 19th century using full ceramic bricks laid on the debris and sand base with gaps filled with mortar containing lime and cement. Visual inspections and tests have demonstrated that the existing situation was caused by civil works performed at the dungeon level nearly 6 years earlier due to an unconsidered decision on removing debris and a backfill which filled entirely the lower tower storeys. The above actions resulted in removal of the base of the floor 'laid on the ground' in the 19th century. Without reinforcement, this board could not have been a load-bearing component of a single-span ceiling, even at such a short span of ~1.25 m. This is a component subject to a variable load, since it is located in a place where students move between two educational buildings of the Mechanical School.
In this article, an analysis was carried out to verify possibilities of unbelievable strength of the artificially formed flat vault, which was previously a floor supported on a debris and sand base. A structure model (the ceiling of the intensively used passage between the educational building was created in Autodesk Structural Analysis Professional 2018. The dead load and operational load were taken for the analysis. Due to the condition of the basement (dungeon) ceiling, it was necessary to immediate exclude it out of use, i.e. to protect it from access by any persons and make a temporary reinforcement and finally to consult the problem with the Opole Province Monument Conservatory.
The condition of the ceiling, in particular 'vaults' intensively used by the students, indicated the necessity to prepare work for static and strength calculations and also propositions of temporary reinforcements. A technical assessment of the buildings relying merely on spot checks and visual inspections is extremely difficult. In the existing buildings, work of a construction engineer is not limited to the development of a project and acquisition of relevant decisions. The ceiling described in this article were secured in time, however, it is difficult to explain why they did not cause any problems for previous years.

Keywords: Ceiling, Traffic Load, Deformation.

RESEARCH OF POST-TENSIONED CONCRETE COMPOSITE SPANS WITH Π-BEAMS OF ROAD VIADUCT

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ABSTRACT

The paper is presented the results of research conducted on the posttensioned prestressed concrete spans made with precast Π-beams of part of seventh spans road viaduct under static field load test. Heavy trucks were used as static loads. Superstructure (main beams), deck slab, and fixed and moving bearings, and also supports (abutment and piers) in both roadways of viaduct were tested. Specification and range of conducted research are presented with analysis of results from the tests and calculation, which allowed to estimate span structures behavior and their actual load-capacity before allow them to normal service.
The viaduct was designed for the C (30 Mg) load class, in accordance with PN-85/S-10030 standard [2] with simply supported spans, and the construction started. Only the supports and main post-tensioned concrete channel beams located on them have been completed. After over 20 years, it was decided to complete the object, while increasing its load capacity to class B (40 Mg) [2]. Span structures were changed to continuous by RC deck slab.
A purpose of field load testing was to assess the behavior of spans structure of a part of viaduct under known load, to confirm if assumptions adopted in the load test design were correct, and to determine the current load-capacity of the structure. It mainly concerned evaluation of actual flexural rigidity of main pre-stressed beams of the load carrying structure, the deck and supports, as well as cross load distribution on individual main beams.
The aim of this study is to present a scope and a course of tests, as well as results of measurements and static strength calculations, with the known load.
Presented acceptance testing of this structure was performed based on relevant regulations for bridge industry, necessary for obtaining a decision on its handover to normal service, meeting at first load-capacity class C, and later class B, in accordance with PN-85/S-10030 standard [2]. Final conclusions presented mainly refer to the quality and load-capacity of the structure, as well as post-erection recommendations connected with its construction and operation [3], [4], [5], [6].

Keywords: Road Viaduct, Composite Span, Π-type Concrete Channel Beam, Field Load Test, Post-tensioned Prestressed Concrete Beam.

ASSESSMENT OF THE LOAD CAPACITY OF THE ANCHORAGE SYSTEM CONNECTING THE TEXTURED LAYER WITH THE STRUCTURAL WALL OF LARGE SLAB BUILDINGS IN THE LIGHTS OF EXPERIMENTAL RESEARCH AND FEM ANALYSIS

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ABSTRACT

The goal of article is to compare the results obtained from experimental tests of a new type of anchoring, combining a texture layer with a structural layer in external wall elements, used in large-panel slab buildings with the results from FEM analysis.
Two types of samples were subjected to experimental tests: single-layer uniform concrete and three-layer concrete with embedded point anchors and analogous samples with glued anchors. In the further stages of the research, three-layer samples with two concrete layers and styrofoam insulation with embedded concrete, as well as pasted and diagonal anchors and three-layer two-hole anchors with glued anchors and three-layer three-layered anchors with glued anchors will be tested. At this stage of the research, point anchors perpendicular to the surface of the sample were used.
An experimental study was carried out on the load-bearing capacity of the anchors for pulling with simultaneous shear of the texture layer. The research elements used C 12/15 and C 30/37 grade concrete, 12 mm diameter anchors, made of steel corresponding to the grade of 5.8 grade stainless steel bolts, Sika Anchorfix-1 resin and XPS polystyrene.
All attempts were planned according to one plan of the experiment. As for the three-layer samples, when testing, two forces were applied: pulling-out and shearing due to the detachment of the textured layer. The shear force was determined for the self-load of the surface area of 1 m^2 of the top texture layer, which was a force value equal to V = 1.4 kN. However, the increase of the pull-out force was determined according to the standard as the value of P = 0.5 kN/s.
In the tested systems of single horizontal anchors, perpendicular to the surface of the element, designed anchor fasteners were at different depths in the following anchorage variants of the construction layer thickness: 1/3, 1/2, 3/5, 2/3, 3/4, 5/6 thicknesses and throughout the entire construction layer, i.e. the entire cross section of the three-layer element. Anchors embedded in the elements achieved an effective anchorage depth of 8.5 cm to 17 cm, that is to the total thickness of the element.
The ANSYS program was used for numerical modeling of the analyzed samples. 3D models were created in which solid elements were used. For steel anchors, the material characteristic has been adopted as the bilinear isotropic hardening. The Drucker-Prager model was used in the concrete elements, the linear-elastic model was adopted for the resin, and the brittle model according to the linear-elastic fracture mechanics for the polystyrene.

Keywords: Numerical Modeling, Pull-Out, Shearing, Material Models, Adhesion.

RESTORATION OF THE INTERIOR OF THE SUMMER LUBOMIRSKI PALACE IN RZESZOW

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ABSTRACT

The Lubomirski Summer Palace is one of the most valuable not sacred monuments of Rzeszow architecture. It was erected in the late baroque style at the end of the 17th century by Hieronim Augustyn Lubomirski as part of a large garden complex around the Lubomirski castle. Times of his glory fall in the mid-18th century. At that time, palace with the surrounding park was extended by Jerzy Ignacy Lubomirski and became a residence willingly visited for recreational purposes. In 1906, it was destroyed in a fire. The palace changed its owners and was rebuilt several times. The last private owners of the Palace were Nieć family who were expropriated in the 70's of the 20th century. In 2012, after years of fighting, the Nieć family recovered the object and then sold it to the Regional Medical Chamber in Rzeszów. Since 2014, the palace and its surroundings have been renovated for the seat of the Chamber. In the first place the interiors were renovated, then the fence, facades and the nearest surroundings - stairs and terraces. Building the internal road and car park has been planned for the next period. At the last stage the garden in the western part of the estate (front) will be restored according to the original 18th century assumptions. The subject of this article is a detailed presentation of the scope and method of the palace interior renovation. This renovation was carried out between 2014 and 2016 on the basis of previously prepared architectural - building documentation and detailed renovation technology developed by the authors of the article (adapted to the technical condition of the object). The work was carried out under the strict supervision of the Provincial Office for the Preservation of Monuments. The article describes in detail the technical condition of the building before renovation, the scope of renovation works, problems encountered and the final effect - restored interiors of the building with few historic details of their décor. The current appearance and character of the Palace is the result of the realization of the idea of the owner of the object. This idea consists in referring to the times of splendor of the Lubomirski Summer Palace by finishing the representative part of the building (ground floor as a whole and part of basements, the 2nd and 3rd floors) in a high standard of use. Undoubtedly, this goal has been achieved. Huge involvement of the owner of the facility, the workload of many specialists and good cooperation between them were required to achieve the effect that we can admire today. It was also of great importance to obtain targeted subsidies for the implementation of this task from the President of the Rzeszów City and the Provincial Office for the Protection of Monuments in Przemyśl, as well as the involvement of the considerable funds of the Regional Medical Chamber.

Keywords: Monument, Palace, Renovation, Repair.

APPLICATION OF THE AGGREGATED CALCULATION ALGORITHM EA FAHP AND FUZZY TOPSIS METHODS IN THE EVALUATION OF RAILWAY CULVERTS SERVICEABILITY

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ABSTRACT

Culverts, which are extremely diversified with respect to static schemes and materials applied, constitute the largest group among engineering structures of land transport infrastructure. Moreover, quite a few of them were constructed as early as 19th century. Due to a large number of such structures, there occurs a necessity for maintenance services to efficiently manage culverts by making suitable decisions promptly with respect to their current and prospective serviceability.
The decision-making problem being analysed arises from the necessity to allocate limited financial resources to properly directed repair work of culverts. It is a multiple criteria issue consisting in the arrangement of such structures on the basis of their technical condition being decisive for their safety of use and, at the same time, providing the possibility to properly arrange the stages of the repair work to be carried out. The suggested calculation model as a combination of the modified EA FAHP method and the Fuzzy TOPSIS one fully reflects the specific character of the problem and allows to analyse any number of objects. It facilitates creation of a dynamic model to classify culverts.
Six conventional railway culverts of diversified structures ware the subject of conducted analysis as a numerical example (Fig. 1). All culverts under scrutiny were subjected to evaluation of their technical condition taking into consideration their load-bearing structures, piers, headwalls with the fittings and obstacles.

Fig. 1. View of considered three of six culverts.

What proved very helpful was the application of assessments in the form of linguistic variables, which facilitate quality description used most frequently in descriptions of technical condition, as well as representing the information obtained with the use of various methods and diagnostic techniques. The possibility to take into consideration the questionable character of assessments, incomplete data and group evaluation made by teams of experts, which are particularly significant in case of breakdowns, is yet another advantage of this method.
The proposed model is suitable for the monitoring and diagnostics (providing the possibility to evaluate technical condition of a given culvert etc.) and for the forecasting (collecting data evaluating the impact of the undertaken repair works on its use as a result).

Keywords: Railway culvert, serviceability, decision analysis, EA FAHP, Fuzzy TOPSIS.

ASSESSMENT OF TECHNICAL CONDITION OF HISTORIC PENNY BRIDGE IN OPOLE IN THE CONTEXT OF ITS RESTORATION

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ABSTRACT

Penny Bridge constructed at the beginning of the 20th century is an important element of Opole city landscape. This footbridge located within Mozart Street upon Młynówka canal is of a particularly decorative character and displays a series of interesting ornaments made both of steel and stone. The said double-span structure is over 39 m long and its useable width amounts to 2.7 m. Its truss girders have a non-typical structure, where bottom chords are horizontal and the upper ones curved and suspended to an additional parabolic tension member (chord) connected with the pylon (Fig. 1a). The footbridge, excluding the deck, has remained almost unchanged until the present day, serving the inhabitants of the city for over a hundred years proves its unquestionable durability. The last renovation of the structure was performed nearly 25 years ago and its steel structure has suffered certain degradation, mainly as far as the layers of paint and losses due to corrosion. Nevertheless, despite maintenance work occasionally performed by various administrators of the footbridge and modernisation of the deck, the recently carried out its technical inspection provides grounds to assume that at present the utilities are in the poorest condition (Fig. 1b).

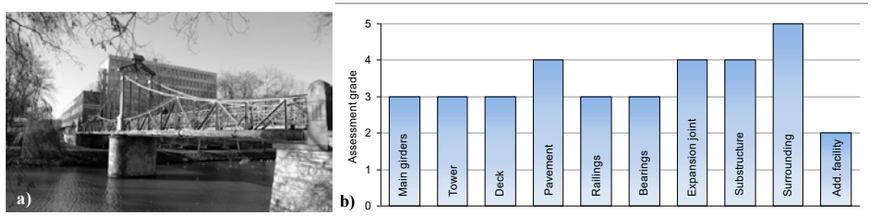

Fig. 1. View of Penny Bridge in Opole (a) and assessment of technical condition of the footbridge elements (b)

On the basis of the carried out technical inspection of the structure and the damage found, it was recommended to carry out many (listed in the paper) repair works as soon as possible. It shows that the footbridge should undergo urgent restoration. Particular attention was drawn to the manner of renovating the layers of paint on the footbridge, which was the subject of consultations carried out with the Province Monument Conservator in Opole. Their renovation is aimed at exposing aesthetic and architectural assets of the structure, whereas work must be done in a manner not posing threat to the original structure and fittings.
Moreover, characteristics of the bridge along with its historical background, as well as selected results of the analysis of bearing capacity of the girder has been presented in the paper.

Keywords: Footbridge, Monument, Technical Condition, Calculations, Restoration, Requirement.

BIONIC FORMS IN SEARCH OF STRUCTURAL MODELS IN ARCHITECTURE

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ABSTRACT

Bionics is an interdisciplinary field of science, the aim of which is to create models that map processes and principles of functioning of the living organisms that can be transferred to technology. The bionic design is an interesting trend in contemporary architecture, which is characterized by the search for spatial forms in analogy to living organisms. The analyses of the possibilities to describe natural patterns using mathematical models that enable the transfer of biological structures are of particular importance. The natural patterns open up new ways to look for effective structures and materials. The search for bionic patterns found in nature that can be transferred to technology is a new feature in the field of architecture modeling. Natural inspirations are possible to use in architecture e.g. by describing them using mathematical models mapping the natural form-shaping processes; an analysis in the interdisciplinary design team of building biological structures; the optimization of location conditions, and material optimization. Shaping the forms "adapted" to the conditions, the environment and the surroundings is an element of structural design optimized in terms of working loads, which exists in accordance with the idea of a sustainable development. The paper presents the results of the research on the possibility of using mathematical models in architecture that mimic the forms found in nature and the analysis of the efficiency of bionic and geometrical forms due to the minimum weight criterion. The main reason for the analysis was the research enabling the search for optimization due to the minimal material consumption along the lines of the structures designed by Richard Buckminster Fuller, which were moved to one of the currently undertaken architectural trends that enable shaping bionic architecture.
In conclusion, The comparative analysis of forms shaped by the transformations made it possible to unequivocally determine which of the rotational geometric and bionic solids constitute effective load-bearing structures as a result of taking into account the wind load. Searching for inspiration and understanding the rules governing the construction of structures found in the natural world can be an important element in shaping architecture.

Keywords: Bionic, Architecture, Structural optimization.

PROBLEMS CONCERNING RECONSTRUCTION OF OLD POST-INDUSTRIAL BUILDING OF A CLOSED COAL MINE AND ITS ADAPTATION TO A NEW UTILITY FUNCTION

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ABSTRACT

After liquidation of the former Gliwice Mine (in 2000), only two historical buildings have remained to date. One of them is the subject building, acting as a waiting room (pithead), together with a chain bath. This object was built in the first years of the 20th century according to the design of Emil and Georg Zillmann. In 2005, after five years of deterioration of the unused facilities, overhaul and modernization works were commenced. Currently, the building houses the Gliwice School of Entrepreneurship (GWSP), a college focusing on economic sciences, humanities and arts, and the House for Polish-German Cooperation (DWPN).
The main body of the building is divided into a lower two-floor encircling part and a higher inside part, which includes two big spaces, originally fulfilled the functions of a waiting room and a chain bath. Additionally, in the middle of the building a tower with a three intermediate ceilings is located.
The load-bearing system of the inside building is a wall structure with a system of ceramic load-bearing walls and a ceramic and steel infill floor Klein type. This part of building have a gable roof with a steel and wooden load-bearing structure. The tower has a mixed structure, that is, a wall structure made from full bricks with local steel sections. The tower roof is a pyramid and has a wooden rafter framing supported on the walls.
The introduction of the paper includes a historical outline of the building with a description of its function as a part of a now-defunct mine. Then, characterization of the building from material and structural point of view, in particular its unique load-bearing system and special construction of the tower is presented. Technical condition of individual structural elements, including foundations, load-bearing walls, floors, roof structure and skeleton structure of the tower are described. Observed damages (together with the causes of their arising) and their influence on the load-bearing capacity and stiffness of entire building is analysed and discussed. At the end, all repair and strengthening works undertaken to ensure the possibility of further and safe utilization of the building are described. In addition, complicated structural works related to the adaptation of the object to a new function are also presented.
The paper is illustrated with numerous photographs shown the state of the building in all phases, including situation after discontinuing its exploitation and prior to the renovation and modernization activities.

Keywords: post-industrial building, restoration overhaul, modernization, structure.

Part IV

Innovative construction technologies and exploitation of buildings and structures (including industrial, hydrotechnical, communal, transportation and geotechnical), BIM in civil engineering, legal and organizational issues of preparation and implementation of construction projects

EXPERIMENTAL AND THEORETICAL INVESTIGATION OF COMPOSITE TRUSS BEAMS

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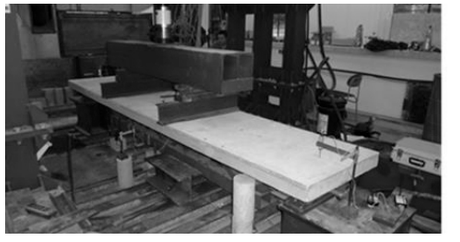
ABSTRACT

Composite steel-concrete trusses can be considered as one of the most economical systems for building and bridge structures. To create an interaction between steel parts and concrete, it is necessary to prevent the relative slip at the steel-concrete interface using shear connectors. But the local effects of a concentrated longitudinal force and the distribution of the shear force between steel section and concrete slab, as special task, should be appropriately examined. To analyse the global behaviour of steel-concrete composite trusses, experimental program was implemented. The similar steel-concrete composite truss beams of span 3.75 m were prepared.



Experimental testing using progressively static loading applied in the thirds of span above nodes. Strains were recorded in both chords and web members of the girders as well as concrete slab by system of strain gauges. The finite element analyses were used to investigate numerically shear connection of the truss structural system. Beside real shear headed studs connectors ϕ 10/50 mm used, the others connection models were developed. The alternative model 1 takes into account influence of surrounding concrete by tube-shaped envelope under stud head. The next stud connector model 2 considers slight larger concrete cylindrical stud cover. The in-between shape model 3 might simulate composite stud as a tapered concrete cone, surrounding steel shank. The comparison of experiment results and recommended theoretical curves confirm a good agreement in deflection development of the model 1 considering concrete tube-shaped envelope under stud head. However, model 3 simulating composite stud as a tapered concrete cone can provide higher accuracy in stresses. However the cylinder-shaped model 2 may be recommended for verification of deflections of common bridge trusses with discontinuous upper chord, supporting a concrete upper deck by means of short gusset plates at the joints where the members meet.

Keywords: Composite structure, Connection, Slip, Truss beam test.

THE EFFECT OF MINE INDUCED TREMORS ON SEISMIC RESPONSE OF SOIL-STEEL BRIDGES

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ABSTRACT

Rockburst are similar phenomena like low intensity natural earthquake. They can be observed in Upper and Lower Silesia regions. Analyses of soil-steel bridges under seismic excitation are so far limited. The rockburst is related to the mining exploitation. The influence of rockburst on the soil-steel bridges should be investigated, because this ground motions differ with many respects from natural earthquakes. The span of soil-steel bridges is typically ranging from 3 to 25 m, so they can be used as an effectives alternative for a short-span bridges. The soil-steel bridges can meet the design and safety requirements similar to traditional bridges, at lower costs. For these reasons, soil-steel bridges are more frequently used in road and railway projects in many parts of the World. This paper presents results of numerical study of soil-steel bridge under rockburst induced ground excitations. To conduct the seismic analysis two various records of rockbursts were used. Response characteristic of the soil-steel bridge caused by rockburts are analysed in detail. The obtained results are compared with the ones computed using under El Centro seismic benchmark record. Based on the conducted analysis of soil-steel bridge with the use of Time History analysis and finite element method with the application of a numerical programme DIANA, the following conclusions can be drawn:

- The duration of the mining rockburst is important for obtained values of internal forces in the analysed soil-steel bridge shell. The longer the rockburst, the higher the values of internal forces. In the analysis, the difference of internal forces in a steel shell between two applied mining rockbursts equalled about 12%.
- The direction of seismic load application (perpendicular or parallel to the bridge structure) is not relevant for non-destructive and low intensity loads.
- The highest values of displacements from mining rockbursts were obtained in the crown of shell structure and amounted to 0.16 m which is 68.75% of displacement value from El Centro excitation amounting 0.21 m,
- Maximum values of bending moments, axial forces and stresses were located in the middle part of shell, near the soil-steel bridge foundation. It should be noted that the stresses and axial forces had a compressive character. Applied paraseismic and seismic loads did not exceed steel yield strength which is 235 MPa for the analysed model.
- Maximum bending moments and axial forces obtained as a result of mining rockbursts are respectively 67.4% and 78.4%, compared to the case of El Centro seismic load.
- Ground acceleration affects the obtained values of internal forces and displacements in the steel shell. The greater ground acceleration, the higher values of internal forces and displacements.
- Acceleration and vibration velocity of bridge shell excited by mining rockburst are significantly lower than when using El Centro earthquake excitations.

Keywords: Soil-steel bridges, rockburst, seismic analysis

BEHAVIOUR OF CORRUGATED STEEL PLATE BRIDGE WITH HIGH SOIL COVER UNDER SEISMIC EXCITATION

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ABSTRACT

The design codes and calculation methods related to the corrugated steel plate (CSP) bridges and culverts say only on the minimum soil height. This value is connected with the bridge span and shell height. In the case of static and dynamic loads (like passing the vehicles), such approach seems to be reasonable. However, it is important to know how the CSP bridges with high the soil covers behave under the seismic loads. This paper is presented the result of numerical study of CSP bridge with different high soil cover under seismic excitation. The analysed CSP railway bridge in the cross section has two closed pipe-arches. The span of shells is 4.40 m and the height of shells is 2.80 m. In this study two heights of soil cover were analysed (2.40 m and 5.00 m). A linear model with El Centro records and Time History was used to analyse the problem. As a result of conducted numerical analysis of a CSP bridge under the seismic excitation with the use of DIANA FEA programme, the following conclusions can be drawn:

- Increased soil cover depth causes larger values of internal forces and displacements caused by an earthquake (El Centro excitation). It was observed that the direction of seismic excitation application does not influence the values of internal forces and displacements.
- Maximum bending moments and axial thrusts were achieved in a bridge model with the soil cover of 5.0 m and they were 124.41 kNm/m and –1763.04 kN/m, respectively. For a model with the soil cover height of 2.4 m, the bending moments and axial thrusts were lower by 21.5% and 34.9%, respectively. In case of stresses, the difference between maximum values in a steel shell for both considered soil cover heights was 23.5%. The maximum values were obtained for a bridge with the soil cover of 5.0 m. Maximum bending moments and stresses in a shell occurred in the same places – in a vicinity of a shell support (haunches). Whereas maximum axial thrusts also occurred near a steel shell foundation, whereby the area was stretching towards a shell crown.
- The largest vertical displacements were observed in a backfill and they amounted 0.099 m. They were higher by 26.9% than steel shell displacements. Maximum backfill and shell displacements were obtained for a model with the soil cover depth of 5.0 m.
- The increase of a soil cover depth over a shell causes lower accelerations, velocities and frequencies of structure vibrations caused by El Centro seismic excitation. The highest accelerations and velocities of vibrations were observed in case of the soil cover of 2.4 m and “Y” direction of excitation.
- The direction of seismic excitation is also important in case of accelerations and velocities of the structure vibration. It was observed that the highest acceleration and velocity of vibrations occurred on the (parallel) excitation direction “Y” (in a model with the soil cover depth of 2.4 m).

Keywords: Soil-steel bridges, numerical analysis, seismic analysis.

LEGAL BASES AND ECONOMIC CONDITIONS OF APPLYING RENEWABLE ENERGY RESOURCES IN CONSTRUCTION INDUSTRY

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ABSTRACT

European Union, including Poland, has not yet introduced full and complex legal regulations exclusively regarding energy-efficient construction. However, legal regulations do define the possibility of using renewable energy resources in the construction industry. In this article you can find a detailed overview of legal regulations concerning the bases of using renewable energy resources in the construction industry. They involve investors, designers and contractors. The article also indicates economic instruments supporting the energy-efficient construction in Poland. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (EU Official Journal L140 of 05.06.2009) creates opportunities for the development of the energy-efficient construction through implementation of renewable energy installations in the building sector. The possibilities are strongly supported by the strict requirements of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) (EU Official Journal L153 of 18.06.2010) regarding energy efficiency in the building sector. According to the regulations of the Directive, all new buildings will have to meet higher energy standards within a few years. The European Union imposes an obligation on Member States that: 1) by 31 December 2020, all new buildings will be nearly zero-energy buildings, and 2) by 31 December 2018, all new buildings occupied and owned by a public authority will be nearly zero-energy buildings. Implemented in 2012, Directive 2012/27/UE of the European Parliament and of the Council of 25 October 2012 on energy efficiency [...] (EU Official Journal L315 of 14.11.2012) creates an obligation for Member States to reduce energy consumption by 20% until 2020. Among others, renewable energy installations and energy efficiency technologies should be widespread to fulfil this requirement. The Act of 20 February 2015 on renewable energy sources (Journal of Laws of 2015, item No 478 as amended) transposes to Polish law Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (EU Official Journal L140 of 05.06.2009) and Directive 2012/27/UE of the European Parliament and of the Council of 25 October 2012 on energy efficiency (EU Official Journal L315 of 14.11.2012). The Act is complementary to the Act of 29 August 2014 on energy performance of buildings (Journal of Laws of 2014, item No 1200 as amended) and it creates attractive legal bases of implementation of renewable energy installations for investors in the construction industry. Legal and administrative regulations governing energy efficiency issues in the building sector in Poland are reinforced by financial instruments.

Keywords: Building Industry, Renewable Energy Sources, Legal Regulations, Economic Instruments.

ANALYSIS CONSTRUCTION INDUSTRY ON THE BASIS OF PRICE TRENDS OF LABOR COST ESTIMATES

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ABSTRACT

Records of the national, average pay rates in the construction industry, at quarterly intervals, allow cost – planning departments of contractors and investment services to assess current market conditions in the construction industry.
Price quarterly publications, such as Sekocenbud and Intercenbud, contain important information, enabling production preparation departments to prepare a comparison of the production in-house labor rates with the market production labor rates.
The article attempts to analyze the economic situation of domestic construction production in the years 2010-2016 based on the emerging price trends of the of labor cost estimates in this period, taking into account the impact of seasonal construction services.
In "Polish cost estimates standards", the labor cost estimate rate is present in one form: the net labor cost estimate rate, which fully corresponds to the rate defined in calculation formulas. The rates of labor cost estimates, in individual regions of Poland, are shaped according to the presented market situations.
This clearly is reflected in the periodic (quarterly) regional records of labor rates in the Sekocenbud system.
The Act on prices of July 5, 2001 does not contain any normative regulations regarding the methods of cost estimation of construction works.
The necessity to remain competitive forces large construction corporations to use a subcontracting system, involving several or even several dozen smaller, specialized in a narrow range of works, business entities in which labor costs are definitely lower, because they are reduced by a lower value of internal costs.
Summing up, labor costs, fueled by several-year market prosperity, have become a significant value on the pages of cost estimates for companies operating in this sector.
The collapse of the global economic situation that took place at the turn of 2008-2009 has made significant changes in this respect - global market prosperity, ended with the economic crisis of the American banking, favored investments of all kinds that fueled the construction industry. Construction, being the driving force of the economy, had to go into stagnation in its "post-crisis" form.
The price-creating components that build the cost price of the works were defined in the study by the Central Construction Information Center in Warsaw [3], the production labor costs in the total costs of general construction works range from 12% to 20% and constitute the second largest component. Methods for cost estimation of construction works also specify the methods for calculating the hourly labor cost estimate.

Keywords: production labor costs, situation of building production, cost estimates.

ENVIRONMENTAL INTERACTIONS TO COMPOSITE ELEMENTS OF ALL-GFRP KOLDING FOOTBRIDGE

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ABSTRACT

Structural integrity of a composite material embraces contributions from: materials science and engineering, processing science, design and fabrication technology. It combines a number of interacting factors: the criticality of the application, the accessibility for and ability to inspect vital parts and components, the intended use including load spectrum and time, the consequences of impact, fatigue, temperature and hostile environment, the nature of inherent flaws, the constituent properties of the material system utilized, and it takes into account human factors. Glass fibre-reinforced polymer GFRP pultruded profiles have great potential in the construction industry, presenting certain advantages when compared with traditional materials, including the potentially improved durability under fluctuating levels of environmental factors. The contribution presents analysis of GFRP composite, acquired from cable-stayed bridge exploited for 20 years in the fjord area of Kolding, Denmark. The cable-stayed Kolding Footbridge was constructed in 1997 using 12 different pultruded composite profiles all made of Fiberline Glass Fiber Reinforced Polymer. The bridge structure is crossing an overhead main railway line near a salt water fjord in Kolding city. In spite of these detrimental environmental conditions, the expected exploitation period of footbridge is minimum 100 years. Tensile and flexural tests let to observe the decomposition process and had taken information of basic stress parameters of GFRP material used in Kolding Footbridge. The differential scanning calorimetry (DSC) experiments were performed in the GFRP composite bridge material, in order to determine the mass variation and the energy changes suffered by the materials, as a function of temperature and time. Dynamic mechanical analysis (DMA) was allowed to detect thermal effects based on changes in the modulus or damping behavior. Fragment of composite material used in DMA and DSC tests was therefore subjected to natural aging as a result of temperature amplitudes, permanent solar radiation as well as aggressive impact of sea salt contained in the moisture in the air around coastal area. Aforementioned analyses of durability are necessary to examine and monitoring for environmentally aged composites bridge elements. Generally, the arrival of new materials at the area of civil construction such as FRP composites indicates the need for carrying out special, various estimation tests. It is valuable and important to observe, create monitoring for aging composite, especially after decades of exploitation in real environmental conditions.

Keywords: Bridges, GFRP composite, Tensile and flexural tests, DSC experiment, DMA analysis

CLASSIFICATION OF POLISH VOIVODESHIPS WITH REGARDS TO THE ACCIDENT RATE IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

The aim of the research was to classify Polish voivodeships into appropriate groups, which are characterized by a similar level of occupational safety in the construction industry. Based on a literature review of the subject, a number of factors that characterize the construction industry in Poland were identified. The basis for the adopted classification was statistical data published by the Central Statistical Office (CSO) regarding population, employment in the construction industry, the value of construction production and the number of occupational accidents. Due to the purpose and nature of the research, indicators were created on the basis of the selected factors and describe the voivodeships regarding:

- the frequency of accidents with regards to the number of people employed in the construction industry in a specific voivodeship,
- the value of construction and assembly production per one person employed in the construction industry,
- employment density in the construction industry.

These parameters were used to describe voivodeships in the applied cluster analysis. As a result of the calculations, a division of voivodeships into 5 groups was obtained:

1. Lubelskie, Podlaskie,
2. Warminsko-mazurskie, Lubuskie, Lodzkie, Podkarpackie,
3. Dolnośląskie, Opolskie, Slaskie,
4. Kujawsko-pomorskie, Swietokrzyskie, Zachodniopomorskie,
5. Mazowieckie, Pomorskie, Wielkopolskie, Malopolskie.

In the future, this classification will be used to create mathematical models for conducting comparative analyses between particular groups and also for predicting parameters characterizing various aspects that describe the accident rate in the construction industry.

Keywords: occupational accident, classification of voivodships, cluster analysis.

BICRITERIA PROBLEM OF DISCRETE OPTIMIZATION IN PLANNING A MULTIUNIT CONSTRUCTION PROJECT

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ABSTRACT

The paper describes the bicriteria discrete optimization problem that may occur during the scheduling of multiunit construction projects. A multiunit project involves the construction of many civil structures i.e. units (e.g. residential, commercial or industrial buildings, engineering structures: bridges, culverts, pipelines) with the same sets of required activities, but different in size. Relationships between the activities for all units in the project are expressed in a constant sequence for each unit e.g. earthworks, foundations, walls with slabs, rafter framings, etc. In the model of a multiunit project, the partial overlap in the sequence of the activities or the presence of intervals between them is allowed. The model also allows for additional time required for the movement of the working groups between units, depending on the nature of the working group and the sequencing of units. In the project the deadlines of activities in units are adopted. Exceeding or missing deadlines by the contractor of construction works causes the necessity to pay penalties for this reason. Accordingly, the earlier completion of construction works in the buildings is rewarded with additional income for the contractor. Changing the order of the execution of the units changes the value of the objective functions: the duration of the project and the cost (the sum of the disincentive penalties and incentive bonuses). The proposed model of the project is the bicriteria NP-hard flow shop problem with constraints that are characteristic for construction projects. The paper presents a full calculation example of the above-mentioned problem. The example presents a multiunit project, which involves the construction of 9 residential buildings (units) with 11 activities in each unit. The parameters are as follows: activity durations executed by working groups, couplings between units, times required due to the movement of working groups between units, a daily disincentive penalty and a daily incentive bonus. The goal of schedule optimization in the presented example is to find the set of Pareto-optimal solutions: the project costs and durations. In the case study presented in the paper, the total number of units in the multiunit project is small (only 9 units). Therefore, it was decided to use the exhaustive search algorithm to find the mentioned set of solutions. The model can be applied for scheduling large projects with a group of buildings or engineering structures that are distant from each other.

Keywords: Scheduling, Flow shop, Construction project, Bicriteria optimisation

PLANNING THE DEVELOPMENT OF SPATIAL MANAGEMENT AND TRANSPORT SYSTEM OF A CITY FROM THE POINT OF VIEW OF ENVIRONMENTAL IMPACT

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ABSTRACT

Spatial development of any area, and especially the urbanized one, has a significant impact on the size of transport demands of its inhabitants and the manner of meeting these needs. At the same time, transport systems to meet the transport demands of residents and individual sectors of the business and industry have a significant impact on the spatial planning. The increase in the degree of urbanization forces the development of transport systems. Well-developed transport systems are effective in the development of housing, trade and industry. Thus, there is a close relationship between spatial planning and transport systems. Transport systems, including, among others, the car transport system, have a significant impact on the residents' level of life comfort of residents. This level is expressed, inter alia, by air quality and noise from transport systems. The results of analyzes related to the impact of changes in spatial development, and thus accompanying changes in transport systems, changes in the emission of selected harmful chemicals for residents and noise from road traffic are presented in the paper. The analyzes were made on the basis of transport systems modeling results for various development scenarios: from a compact city, with dense development and a higher density of residence, to a diffused city (urban sprawl), in which residents live in a larger area, including suburban areas, with a good air quality, but where they are forced to travel longer to meet their transport demands, including trips to places of work and study. For each calculation scenarios, the sum of emissions of harmful chemical compounds, including carbon dioxide and sulfur dioxide, as well as noise and the number of vehicle kilometers on a typical week day and in the year were determined. Comparison of the above results allowed to determine the consequences of spatial planning policy on the standard of living of its inhabitants and the impact of this policy on the natural environment. The results of these calculations showed that as a result of spatial development policy promoting housing development in areas located on suburbia's, characterized by a lower level of urbanization, and thus theoretically more life-friendly, the number of private transport trips increases significantly, as well as the total number of kilometers traveled. As a consequence, the value of the harmful chemical substances emitted into the environment increased. The calculations carried out for scenario of a compact city have shown a decrease in interest in private cars trips for walking and cycling, as well as travel by public transport as an effect of shortening the length of daily trips. As a result, the value of emitted harmful chemical compounds dropped. The article is summarized by conclusions and recommendations in the area of urban spatial planning, indicating the need to promote the development of compact cities enabling reduction of private cars, substituted by zero emission ones: walking or cycling, as well as trips by public transport. At the same time, it was pointed out such spatial planning policy improve the living standards of the city's residents.

Keywords: Environmental protection, Urban planning, Transport Models.

FEASIBILITY STUDY OF CONSTRUCTION PROJECT IN COMPLIANCE WITH BANK INVESTMENT SUPERVISION REQUIREMENTS

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ABSTRACT

Technical, financial and organisational feasibility study methods in compliance with a Bank Investment Supervision requirements have been presented. Methodology of construction project appraisal for financing and execution professional preparation have been laid out – technical documentation, arrangements, realisation. Analysis and assessment of Bank Investment Supervision consisted of project execution plan PEP, geotechnical and environmental conditions, permit design, agreements and decision impacts of local authorities, engineering contract for construction works, project insurance and performance bonds, schedule of execution tasks and their costs, payment plan, investment budget and project economical effectiveness, scope of monthly construction works execution assessed by EVM approach, significant risks measurable assessment and handover procedure of construction project.
On the basis of the 12-year author's practice of Bank Investment Supervision developed methodology significant construction projects risks have been identified and measured: risks of the highest impact values and risks of the biggest likelihood appearance. The research has been recorded in 400 – 450 reports of 42 investment projects in advanced manufacturing, commercial, residential, hotels and apartment housing sectors. All identified risks appearing at entire life – cycle of construction projects have been precisely researched. At least one risk of the highest measured level of significance (around 0.3) is highlighted at each phase of investment process:

- Design Phase : Delayed agreements and environmental decisions
- Construction Phase: Not following Health & Safety requirements on site
- Maintenance Phase: Insufficient commercialisation of commercial investment

There are further conclusions drawn from deeper analysis of Bank Investment Supervision reports elaborated on 42 construction projects:

1. Identified above risks of investment process have a significant impact (on average 0.65) on success of a construction project
2. Majority of construction risks appear with likelihood not exceeding the value 0.4.
3. Risks of the highest impact values affect the monitored projects with pretty low level of likelihood and those of the lowest impact values are aligned with higher level of likelihood. Lack of correlation of risks impact and their likelihood at really high level determines reasonable level of risks significance, not higher than 1/3 of possible significance in "risks monitoring" strategy. Therefore, all professionally monitored construction risks are "manageable".
4. Engineering, Project and Construction Management (EPCM) approach to investment process and solid, consequent, regular construction projects monitoring executed by professional Banking Supervision Inspector (BSI) make possible to minimise any faults of inappropriate financing of construction projects.

Keywords: Feasibility Study, Bank Investment Supervision, Risks Significance

STRUCTURAL ENGINEERING BY WAY OF BIM

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ABSTRACT

Multinational software corporations responsible for CAD systems revved up their workings on Product Data Management (PDC) systems. Systems that create Product Data Base are named Product Data Sheet in Building Information Model/Modelling/ Management (BIM) formats now. To mention that BIM meaning is the environment of cooperation on any level with high-performance computing in real time. Building Information Modeling presents a new standard of data exchange between sides at every step of the investment. To verify all options designed for Structural Engineers offered by Autodesk Corporation, implementing BIM solutions, using Autodesk Robot 2018 as advanced structural analysis software and Revit 2018.2 as the intelligent software using model-based process to plan, design, construct, and manage buildings and infrastructure. It supports a multidiscipline design process for collaborative design.
To test and review the capabilities of the high-computing systems, there were made complex 3D models of a high-rise steel structure building with the different bracing systems. Models based on a steel interacting systems were compared with models with steel shell tubular systems. The influence of adopted structural solutions on building statics and deflections was analysed. A square 25.0/25.0 m object, 192.0 m high on a 3D plan was adopted to 48 floors with a height of 4.0 m. Every numerical model was based on bars and shell panel models, 3-, 4-node quadrilateral, finite elements with meshing size less than 0.5 m on Curtain Walls and slab floors. There were tested the abilities of generating dead and live loads, while wind pressure was simulated with Autodesk Robot Wind Load Simulation module. Eight 3D analytical models were compared, four interacting systems and four framed tube-in-tube systems, studying the impact of bracing system on internal forces and deflections in Autodesk Robot software. Shell tubular system structure consisted of 147 thousands of finite elements and more than 878 thousands of equations. The study of internal forces results in bars and global analysis of structure's deflections showed a quaint influence of designing slab floors using diaphragm calculation model (slab floor stiffening in nodes). The 3D graphics interface showing global deflections of the high-rise building visualized statics and schematic construction work. Model analysis unveiled that wind direction pressure on the edges of the high-rise building indicated turning forces caused by quarter winds.
The collaboration of Robot and Revit programmes was verified in terms of data exchange. Also, there was a spot on BIM model based schedules construction, cost estimates and visualisations. The trial of rendering photorealistic pictures and virtual interacting with the structure in a virtual reality was performed (VR, BIM Vision). In the high-rise building model was used V-Ray rendering technology in order to design photorealistic inside of a room with real-time, interactive and immersive walkthrough including catalogue products and finishing materials.

Keywords: high-rise steel structure, bracing systems, CAD, BIM, diaphragm model, shell, torsion.

ANALYTICAL MODELLING OF A THREE-LATER WALL SYSTEM OF STRENGTHENING FOR LARGE-PANEL SLAB BUILDINGS BY MEANS OF BONDED ANCHORS

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ABSTRACT

The goal of the article is to elaboration analytical models describing a new system of reinforcing three-layer walls of large-panel buildings with bonded anchors. The use of this type of fasteners that bond the façade texture layer to the structural slab is necessary due to the low durability of previously used suspension elements.
Various bonded anchorage systems were considered. The new anchorage systems were designed as two-anchors systems (horizontal anchor and diagonal anchors) and three-anchors systems (horizontal anchor and two diagonal anchors). The inclinations of these anchors are in the range of 30˚-60˚ with a jump of every 15˚ and additionally in the opposite direction with a jump of -15˚ in the case of three-anchors systems. Changing the settings of diagonal anchors was related not only to the thicknesses of three-layer walls, but also to the stress distribution during the tests of pull-out capacity of anchorages.
For the above types of reinforcements, analytical models have been developed that take into account the change of strength parameters of the resin and steel from which the anchors were made, the interaction of materials resin-steel and resin-concrete and the effect of simultaneous action of pull-out and shearing forces. Moreover, was assumed the simultaneous destruction of fasteners two- and three-anchors.
The presented of distribution of tangential stresses and normal adhesion of anchors bonded to concrete by means of binding material in the form of resin for the analyzed solutions.
Analytical models have been verified in the form of experimental research. All types of anchorages were simultaneously subjected to an axial load test for pulling-out. The tests were carried out in the laboratory hall of the Bialystok University of Technology with the use of the HYSDOZOK hydraulic load system. In the case of diagonal anchorages, it was helpful to design auxiliary equipment that works with the hydraulic cylinder of the machine.
In experimental studies, despite the inclusion of two classes of concrete in the tested elements in two series, it should be remembered that with regard to the actual structure, this parameter can not be maneuvered. We have an influence on the type of resin and the grade and grade of steel.
Out of the expected results it was possible to achieve in the case of pulling: destruction by pulling out the anchor, breaking off the cone of concrete, as well as destruction by splitting the concrete ground and in the case of shearing breakage of the concrete edge.
The elaborated analytical models will be used to determine the load-bearing capacity of the new connector system, which will allow the elaboration of guidelines for strengthening three-layer walls of large-panel slab buildings.

Keywords: Pull-Out, Shear, Bending, Bonded Anchors, Adhesion.

INFLUENCE OF STATIC LONG-TERM LOADS AND CYCLIC FREEZING/THAWING ON THE BEHAVIOR OF CONCRETE BEAMS REINFORCED WITH BFRP AND HFRP BARS

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ABSTRACT

The purpose of this study was to define the influence of static long-term loads and cyclic freezing/thawing on deformation characteristics of simple concrete elements reinforced with BFRP and HFRP bars.
The assumptions of the experiment were based on a comparison of the behavior of beams subjected to three point bending test under the influence of a long term static load and at the same time to cyclic freezing and thawing in the temperature range from -20 °C to + 20 C. In addition, reference beams loaded in the same way, were tested at constant temperature of +20 °C. The midspan deflections of beams, strains of concrete at the level of the top and bottom reinforcement as well as the spacing and the opening widths of cracks were measured.
Specially designed test stands were placed in a freezing chamber, the task of which was to simulate the above-mentioned temperature regime. The 150 cycles were accepted as the period of test, with each cycle lasting 8 hours. Thanks to 7:1 leverage, structure of the stand required a little number of weights in order to apply desired load. Inverted static scheme (beam bending upwards) allows full exposure of the tensile edges of tested elements, and thus the current registration of crack morphology.
Results of experimental tests and those obtained from theoretical calculations based on ACI 440:1R-06 standard, as well as material properties of concrete and FRP bars, were a base for their reciprocal consistency assessment.
BFRP and HFRP reinforced beams deflections values were respectively 180% and 210% larger, also they had 34% and 29% greater total cracks opening in comparison to those of reference specimens.
The insertion of additional rovings of coal fiber into the original basalt fiber bars significantly improved the mechanical properties of the reinforcing bars. It had also beneficial effect on deformation characteristics of beams subjected to cyclic freezing and thawing conditions.
Based on the tests conducted, it was found that in the aspect of long-term work, considering the atmospheric factors, simple beam elements reinforced with hybrid (HFRP) bars show the ability to carry 25% higher loads in comparison to those reinforced with basalt (BFRP) bars. Mainly, this is due to the higher modulus of elasticity of HFRP bars, and hence the higher stiffness of the elements.
The algorithms proposed in the design guidelines for structures reinforced with composite bars can be pre-applied for theoretical estimation in order to determine the behavior of beams reinforced with BFRP and HFRP.

Keywords: non-metallic reinforcement, freezing and thawing, long-term loads.

ANALYSIS OF THE DEPENDENCE BETWEEN THE NUMBER OF ACCIDENTS AT WORKPLACES THAT INVOLVE SCAFFOLDING AND CHANGES IN WORK EFFICIENCY

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ABSTRACT

The construction industry in Poland, as well as in the world, is characterized by a high level of hazard to the health and life of employees. The purpose of the article is to present the occupational characteristics of people injured in occupational accidents at workplaces that use construction scaffolding. The authors have attempted to establish a relation between selected factors that characterize injured employees who work on scaffolding and a human's physiological parameters, which change with age.
The results obtained from the analysis of occupational accidents involving construction scaffolding, which took place in five Polish voivodships: Dolnoslaskie, Lubelskie, Lubuskie, Mazowieckie and Wielkopolskie between 2010-2015, were presented. 177 occupational accidents were analysed. On the basis of post-accident protocols, the following occupational characteristics of employees who suffered from accidents were identified: the age of the victim, the time of day when the accident happened and the season of the year. In turn, on the basis of a review of the subject literature, the course of changes in an employee's performance during the day, week and calendar year was determined. The relation between efficiency and the identified occupational characteristics of the injured parties was determined.
Analysis of people injured in occupational accidents involving construction scaffolding allowed the following professional profile of an injured person to be formulated:

- parameters such as the age of a victim, the time of day of an accident and also the season when an accident occurred have a different impact on the number of accident events,
- the course of changes in the performance of employees is strongly influenced by age, as well as other factors such as the hour, time of day and quarter of the year,
- analysis of the age structure of injured people showed that the most common age group are people aged 46-50,
- people working in the afternoon between 2:01 p.m. and 3:00 p.m., at which time an employee achieves a local minimum of work productivity, are most often victims of accidents,
- analysis of the relation between the number of accidents and the time of year showed that the probability of an accident is the highest in the third quarter of the year.

Keywords: Construction industry, accident at work, scaffolding, work efficiency

ENVIRONMENTAL ENGINEERING ASPECTS BASED ON CONSTRUCTION OF 2 X 900 MW COAL FIRED UNITS IN OPOLE POWER PLANT

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ABSTRACT

New units 5 & 6 with the nominal power output of 2 x 900 MW are the extension of the existing Opole power plant. GE is supplying its efficient ultra-supercritical (USC) technology and air quality control systems as well as balance of plant which enables reducing the environmental impact and meeting regulatory requirements. This is particularly important in Poland, where around 84% of fuel for electricity generation is hard coal or lignite.

To protect the environment, various methods were used to reduce the impact of individual pollutants:

- Through the appropriate optimization of the process and usage of ultra-supercritical technology, high efficiency of unit is obtained, which in addition to improving the economic results of the plant has a significant impact on fuel consumption, individual utilities, and thus on emissions of pollutants into the atmosphere.
- Reduction of emissions of nitrogen oxides using primary methods in the boiler combustion chamber itself and secondary methods using the SCR system.
  NOx emissions below 80 mg/Nm3.
- Reduction of dust emission in the flue gases using high efficiency ESP plus additional effect of wet desulphurisation. Particulate emissions below 10 mg/Nm3.
  In addition, different means used to limit dust penetration into the atmosphere from ash removal system.
- Reduction of emissions of sulfur oxides using the WFGD system.
  SO2 emissions below 100 mg/Nm3 (with limestone) and below 30 mg/Nm3 (with limestone + formic acid)
- Reduction of emissions of heavy metals using FGD wastewater treatment plant.
- Increasing the dispersion of pollutants contained in the exhaust flue gases by introducing boiler exhaust flue gases into the cooling tower.
- Preventing water and soil pollution using oil separators, solid particle settlers and several additional solutions to reduce the risk of contamination.
- Noise reduction using covers, enclosures, acoustic screens, absorbent materials and noise attenuators. Far field noise level below 36/40 dB (A) (night/day) without background noise and only for units 5&6 to fulfil total plant noise level requirements below 44,5/54 dB (A) (night/day).
- Reduced raw water consumption from the river by optimizing the use of blowdown water from the cooling circuit and reusing it for process water for FGD and for washing purposes.

CONSCIOUS APPROACH TO URBAN AND EXTRA-URBAN SPACE RESTRUCTURING AS SEEN IN THE DESIGNS OF ARCHITECTURE STUDENTS

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ABSTRACT

In education of architects and urban planners, it is important to rely on interdisciplinary approach to many factors involved in the process. Especially in the built environment context, the awareness of the interaction of different components is of key importance. In their future work, architecture students need to have responsible and socially-oriented standpoint. It will be demonstrated in the creation of architectural objects in the natural landscape surroundings, and in the attitude to different type of architectural and urban spaces. Safety, the use of natural resources, the relations between architecture and the surrounds, the evaluation of the environmental components and their impact on the creative process are extremely important. The paper discusses examples of space solutions in the urban areas and those located outside cities. Those solutions involve daring architectural and urban forms that make use of the natural environment assets, and also quality architectural work and design. The presence of such objects is a response to the demand from the society, consequently it seems reasonable to explore the issues related to architectural education. The first example concerns architecture that is focused on searching for shapes and natural relations that are characteristic of the project site. In addition to accounting for the features that determine the architectonic and urban form, related, among others to the solar access, the design proposes a conversion of underinvested, wasteland urban area into green functional space. The newly designed area, intended for recreation, is well integrated with the complex of facilities available to users of different age. /The project received the main award in the field of architecture, in the competition for the best diploma thesis in 2017, organized by the Kielce University of Technology and Kielce Technology Park, specializing in the development of new technologies/. The second design is an attempt at incorporating a new architectural form having exhibition and research function into the site of historical value to the region, and also into body of the forest reserve. The design author's response to the site identity is an original architectural form, to which a sculptural touch was added. /The project received a distinction in the field of architecture, in the competition for the best diploma thesis in 2017, organized by Politechnika Świętokrzyska and Kielecki Park Technologiczny/.

Keywords: Architecture, Urban Space, Restructuring Space Urban, Restructuring Space Suburban.

RESEARCH OF RC COLUMNS STRENGTHENED BY CARBON FRP UNDER LOADING

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ABSTRACT

Typically, reconstruction or recovery existing buildings are more economical and effective way than to build new ones. One of strengthening methods is using of carbon fiber reinforced polymers (CFRP). Application of CFRP often has been used for strengthening existing reinforced concrete (RC) columns. The advantages of CFRP are the great corrosion resistance to environmental factors, no significant changes geometrical dimensions of the construction, little time to perform work, high stiffness and strength, low weight in comparison with other materials.But in comparing with other materials for strengthening of RC constructions the carbon-FRP more expensive material. So, it is important to research of strengthening effect from additional reinforcement value.
This paper presents experimental results of 6 reinforce concrete columns strengthened by CFRP strips Sika Carbodur S512 with 50 mm width. The comparative analysis was carried out and strengthened effectiveness was determined for 2 unstrengthen control specimens, 2 specimens strengthened without initial load and 2 specimens strengthened at 1/2 of experimentally determined destructive efforts of the unstrengthen column.
After experimental research of reinforced concrete columns strengthened by carbon FRP strip Sika CarboDur S512 there was determined that the strip starts working with the main reinforcement immediately after application.
The strengthening effect by reinforcement yield for specimens CSL-2.11 and CSL-2.12 was 56.6%, for specimens CSL-2.13-0.5 and CSL-2.14-0.5 – 42.0%. The strengthening effect by crushing of compressed concrete for specimens CSL-2.11 and CSL-2.12 was 59.1%, for specimens CSL-2.13-0.5 and CSL-2.14-0.5 – 43.8%. The strengthening effect has decreased from 56.6% to 42 % by ULS and from 59.1% to 43.8 % by crushing of compressed concrete when loading was 50% from ULS unstrengthen one.
The maximum deformation of the carbon FRP strip was achieved 96.4% from its limit value for specimens strengthened without loading and was achieved only 71.2% for specimens strengthened under loading. These obtained features should be taken into account when we design the system of strengthening by carbon FRP applied to real constructions

Keywords: Reinforced Concrete, Columns, Carbon FRP, strengthening.

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Górażdże Cement SA jest jednym z największych producentów cementu w Polsce i Europie. Firma prowadzi produkcję w dwóch zakładach: Cementowni Górażdże zlokalizowanej w miejscowości Chorula na Opolszczyźnie oraz Przemiałowni Ekocem w Dąbrowie Górniczej. Wychodząc naprzeciw oczekiwaniom klientów, Spółka oferuje produkty o stabilnych parametrach do zastosowania w wielu dziedzinach budownictwa. Oferta handlowa spółki obejmuje kilkanaście rodzajów cementu – są to: cementy portlandzkie (CEM I), cementy portlandzkie wieloskładnikowe (CEM II), cementy hutnicze (CEM III) oraz cement wieloskładnikowy (CEM V). Uzupełnieniem oferty handlowej są usługi doradztwa technologicznego w zakresie właściwości i zastosowania cementów i betonu.

Górażdże Cement SA jest spółką macierzystą i wiodącą linią biznesową grupy kapitałowej, która prowadzi działalność w trzech liniach produktowych: Górażdże Cement, Górażdże Beton i Górażdże Kruszywa. Właścicielem Grupy Górażdże jest międzynarodowy koncern HeidelbergCement, jeden z największych na świecie producentów materiałów budowlanych. Grupa Górażdże dysponuje obecnie siecią 58 wytwórni betonu towarowego zlokalizowanych na terenie całego kraju i eksploatuje złoża żwirów i piasków w 17 kopalniach surowców mineralnych na terenie południowo-zachodniej i północno-wschodniej Polski. Spółki Grupy zatrudniają około 1200 pracowników.

Górażdże to firma społecznie odpowiedzialna, która od lat umiejętnie łączy rozwój rynkowy i technologiczny z daleko wykraczającą poza standardy dbałością o pracowników, lokalne społeczności oraz ochronę środowiska. Górażdże aktywnie uczestniczą w życiu regionu. m.in. poprzez działania sponsoringowe i charytatywne. Z pomocy i wsparcia finansowego Górażdży korzystają dziesiątki instytucji i organizacji działających w obszarze kultury i ochrony zabytków, nauki, edukacji, sportu, ekologii oraz szeroko rozumianej działalności filantropijnej.

Grupa FAKRO to międzynarodowa korporacja działająca w branży budowlanej. Została założona w 1991 roku, w oparciu o całkowicie polski kapitał. Obecnie FAKRO to lider na polskim rynku oraz jeden z wiodących producentów okien dachowych na świecie. FAKRO zajmuje drugie miejsce z 15% udziałem w rynku. Od ponad 27 lat nieprzerwanie dostarcza innowacyjne, zaawansowane technicznie produkty stolarki otworowej do ponad 50-ciu krajów na całym świecie. Sprzedaż na eksport stanowi 70% produkcji.

W centrum badawczo-rozwojowym FAKRO ponad 100 inżynierów przekształca nowatorskie pomysły w innowacyjne rozwiązania i nowe produkty. Innowacyjność to DNA FAKRO i główny motor rozwoju. To filozofia nieszablonowego myślenia, które sprawia, że nowe rozwiązania rozszerzają funkcjonalność i podnoszą jakość produktu. FAKRO jest autorem ponad 160 zgłoszeń patentowych i wzorów użytkowych co czyni z niej jedną z najbardziej innowacyjnych firm. Do wielu krajów świata eksportuje nie tylko okna dachowe, ale także rozwiązania i myśl twórczą polskich inżynierów. W ten sposób polska firma wytycza nowe kierunki rozwoju dla branży okien dachowych na świecie.

Liczne certyfikaty przyznawane przez najbardziej prestiżowe instytuty Europy potwierdzają najwyższą jakość nie tylko produktów, ale także procesów produkcyjnych. Okna dachowe FAKRO jako pierwsze na rynku otrzymały niemiecki certyfikat TÜV.

Obecnie grupa FAKRO zatrudnia ponad 3300 osób pracujących w 12 spółkach produkcyjnych i 16 dystrybucyjnych, zlokalizowanych w Europie, Azji i Ameryce. W całej Polsce znajdują się magazyny regionalne FAKRO, które ułatwiają klientom dostęp do produktów, a rozbudowana sieć doradców technicznych koordynuje sprzedaż w kilku tysiącach składów materiałów budowlanych.

Firma FAKRO to ponad 8 milionów wyprodukowanych okien dachowych oraz 1000 oferowanych produktów. W ofercie FAKRO oprócz okien dachowych znajdują się schody strychowe, okna do dachów płaskich, świetliki rurowe, wyłazy. Firma oferuje również szeroką gamę akcesoriów do okien dachowych (markizy, rolety, żaluzje), a od 2016 r. do oferty FAKRO, pod marką INNOVIEW dołączyły aluminiowo-drewniane okna pionowe i wielkogabarytowe drzwi balkonowe HS. W kolejnym roku w ofercie pojawiły się drzwi wejściowe oraz bramy garażowe z serii INNOVIEW LINE posiadające możliwość sterowania za pomocą pilota lub aplikacji z urządzenia mobilnego w systemie FAKRO smartHome.

Strategiczne cele rozwoju FAKRO bazują na trendach i oczekiwaniach rynku, a firma konsekwentnie je realizuje, niejednokrotnie ustanawiając nowe standardy dla branży.

Grupa Kapitałowa ECO

ECO to nowoczesna, wiodąca na polskim rynku energetycznym grupa kapitałowa działająca na terenie 10 województw. Grupę tworzy spółka-matka ECO SA oraz 8 spółek zależnych, których celem jest oferowanie klientom niezawodnych dostaw energii i świadczenie usług wspierających rozwój biznesu.

Podstawowym przedmiotem działalności Grupy ECO jest wytwarzanie, przesył, dystrybucja i sprzedaż energii cieplnej oraz elektrycznej.

Proces wytwarzania ciepła w spółkach należących do Grupy ECO prowadzony jest w 160 kotłowniach o łącznej mocy zainstalowanej 905,4 MW, z czego:

- 850,1 MW to moc zainstalowana w 26 źródłach systemowych,
- 55,3 MW to moc zainstalowana w 134 kotłowniach lokalnych.

W 2017 roku łączna produkcja ciepła w Grupie ECO wyniosła 5.861,9 tys. GJ.

Część produkcji ciepła w spółkach Grupy ECO prowadzona jest w skojarzeniu z wytworzeniem energii elektrycznej. W tym celu Grupa ECO stosuje następujące urządzenia:

- Opole – gazowy układ kogeneracyjny oparty o turbinę gazową i kocioł odzysknicowy o mocy cieplnej 14,2 MWt i mocy elektrycznej 7,4 MWe
- Opole – węglowy układ kogeneracyjny oparty o kocioł parowy i turbinę parową przeciwprężną o mocy cieplnej 30 MWt (41 MWt przy pracy poza kogeneracją) i mocy elektrycznej 10,9 MWe
- Olesno – gazowy układ kogeneracyjny oparty o silnik spalinowy o mocy cieplnej 0,320 MWt i mocy elektrycznej 0,252 MWe
- Kutno – gazowy układ kogeneracyjny oparty o trzy silniki spalinowe o łącznej o mocy cieplnej 6,6 MWt i mocy elektrycznej 6,06 MWe
- Jelenia Góra – kogeneracja węglowa oparta o trzy kotły parowe o łącznej mocy zainstalowanej 75,1 MWt oraz trzy turbiny parowe przeciwprężne o łącznej mocy elektrycznej 14,4 MWe.

Od maja 2016 r. w Opolu eksploatowana jest instalacja OZE oparta na 105 kolektorach słonecznych o łącznej mocy 200 kW. Produkcja energii elektrycznej wyniosła w 2017 roku 159,4 tys. MWh. Swoim klientom firma oferuje również usługi w zakresie obsługi logistycznej i serwisu technicznego. Firma prowadzi swoją działalność w oparciu o nowoczesne systemy zarządzania i monitorowania, dbając przy tym o otoczenie i środowisko naturalne.

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- Różnorodność przekrojów dopasowanych do specyfiki przeznaczenia

W celu przedstawienia szczegółowej oferty cenowej prosimy o kontakt z biurem sprzedaży w Olszowej:

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ENERGOPOL TRADE OPOLE spółka z o.o.

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1997r. ***Nagroda II stopnia*** *za budowę zakładu produkcji dachówek "Braas" w Opolu*

2000r. ***Nagroda II stopnia*** *za rozbudowę i modernizację zaplecza Amfiteatru 1000-lecia w Opolu*

2001r. ***Nagroda II Stopnia*** *za odbudowę Ogrodu Zoologicznego w Opolu*

2008r. ***Nagroda III Stopnia*** *za realizację budynku administracyjnego w Muzeum Wsi Opolskiej w Opolu*

2011r. ***Nagroda III Stopnia*** *za przebudowę i rozbudowę budynku przy ul. Minorytów na siedzibę Miejskiej Biblioteki Publicznej w Opolu*

2014r. ***Tytuł „Budowa Roku 2013”*** *za realizację krytej pływalni* ***„WODNA NUTA”*** *przy ul. Prószkowskiej w Opolu.*

www.energopol.opole.pl

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Informacje o spółce:

Rejestracja spółki: ***KRS 0000021704***
Kapitał zakładowy: ***6.351.000 PLN***
NIP: ***937-10-30-253***
REGON: ***070661550***

Firma ThermoShield Poland jest częścią SICC GmbH – ThermoShield Europe, lidera w rozwoju i produkcji energooszczędnych farb termoceramicznych sprzedawanych pod nazwą ThermoShield.

Naszym celem jest produkcja i upowszechnianie termorefleksyjnych powłok malarskich opartych na mikrosferach ceramicznych, które przyczyniają się do poprawy komfortu cieplnego budynków, jak i ochrony zasobów naturalnych naszej planety. Innowacyjne działanie naszych produktów zostało potwierdzone przez wiele instytutów naukowych na całym świecie, z którymi stale współpracujemy.

To sprawia, że nasze produkty cieszą się uznaniem wśród klientów indywidualnych, jak i instytucjonalnych. Dzięki młodej, dynamicznej i doświadczonej kadrze pracowników potrafimy sprostać wszelkim wymaganiom naszych klientów.

Nasze produkty skierowane są do: osób prywatnych, firm wykonawczych, projektantów, architektów, zarządców nieruchomości i konserwatorów zabytków.

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Multipor firmy Xella Polska

Multipor to innowacyjny system ocieplenia od wewnątrz przeznaczony do termomodernizacji obiektów zabytkowych lub stropów w garażach podziemnych. Ponad 350 obiektów referencyjnych w całej Polsce świadczy o skuteczności tej technologii. Mineralne płyty izolacyjne Multipor stosowane są w termomodernizacji bardzo różnych obiektów historycznych: od starych fabryk adaptowanych na lofty, poprzez wielkie dworce, wieże wodne, pałace i kamienice, a nawet budynki z muru szachulcowego, jak również w obiektach współczesnych przy termomodernizacji stropów. Dzięki zastosowaniu płyt Multipor jako izolacji termicznej ścian od wewnątrz, przebudowywane obiekty zachowują wygląd i charakter pierwotnych fasad.

Oferta rynkowa i zakres stosowania

Multipor to mineralne płyty izolacyjne wykonane z bardzo lekkiej odmiany betonu komórkowego. Ich gęstość wynosi do 115 kg/m^3, przez co charakteryzują się wysoką izolacyjnością termiczną (współczynnik przewodzenia ciepła λ_D wynosi 0,043 W/mK) zachowując wszystkie najważniejsze zalety betonu komórkowego. Płyty Multipor to produkt zgodny z Europejską Aprobatą Techniczną ETA-05/0093. Materiał ten spełnia surowe wymagania, co uprawnia do znakowania go symbolem CE. Płyty te doskonale sprawdzają się jako izolacja termiczna ścian zewnętrznych od środka, stropów i dachów. Płyty Multipor aktywnie uczestniczą w procesie zmian wilgotności pomieszczeń w ciągu całego roku – ich zdolność do pochłaniania pary wodnej ogranicza zjawisko wykroplenia na wewnętrznej powierzchni ścian oraz ryzyko rozwoju grzybów pleśniowych. Dodatkowo niebagatelne znaczenie dla zdrowia i bezpieczeństwa ma też odporność ogniowa płyt Multipor – są one materiałem niepalnym o klasie reakcji na ogień A1.

Xella Polska Sp. z o.o., 02-146 Warszawa, ul. Komitetu Obrony Robotników 48
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