



REVIEW
OF RESEARCH
AND BUSINESS RESULTS
OF THE IMS INSTITUTE
IN 2013

**PREGLED
NAUČNIH I STRUČNIH
REZULTATA
INSTITUTA IMS
U 2013. GODINI**

Institut za ispitivanje materijala a.d.

Beograd, decembar 2013.

**PREGLED NAUČNIH I STRUČNIH REZULTATA
INSTITUTA IMS U 2013. GODINI**

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OF THE IMS INSTITUTE IN 2013

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1953 – 2013.

60 godina Instituta IMS



Osnivači Instituta za ispitivanje materijala

*Prof. dr Mirko Roš
(1879 – 1962.)*

*Prof. Branko Žeželj, redovni član SANU
(1910 – 1995.)*

Kao i svake godine, Institut IMS publikuje rezultate rada u nauci, kao i stručnog angažovanja na značajnijim projektima u 2013. godini. Iako je naučno-istraživački rad uglavnom multidisciplinaran, kao i sam Institut, pokušali smo da ovaj pregled rezultata učinimo lakšim za upotrebu primenom klasifikacije radova po CERIF (Common European Research Information Format), a ne samo po pravilniku resornog ministarstva.

Tokom godine, Institut za ispitivanje materijala je ostvario ozbiljne naučne i poslovne uspehe. U okviru tekućeg ciklusa naučnih projekata za period 2011-2014. godina, 22 istraživača Instituta IMS uključeni su u realizaciju sedam projekata iz tehnološkog razvoja, jedan integralni projekat i četiri projekta iz programa osnovnih istraživanja. Ono čime se Institut IMS može ponositi je 14 mladih istraživača upisanih na doktorske studije, čije školovanje finansiramo iz sopstvenih sredstava. Rezultati istraživačkog rada su u skladu sa dosadašnjim trendom rasta broja publikacija u međunarodnim časopisima i učešća istraživača na vodećim međunarodnim skupovima. U ovoj godini, Institut IMS je organizator četiri naučno-stručna skupa.

Odabrane stručne reference su, kao i svake godine, impresivne. Uz sve probleme sa kojima je suočena domaća privreda, a posebno građevinska industrija, Institut IMS je uspeo da obezbedi učešće u najznačajnijim projektima u zemlji i regionu. U skladu sa višedecenijskom tradicijom i ugledom, kao i širokim spektrom usluga koje pružamo, bili smo angažovani na projektovanju, ispitivanjima i istraživanjima građevinskih objekata, materijala i proizvoda, primeni tehnologija građenja i sistema prednaprezanja.

U 2013. godini Institut je učestvovao u projektima koji su u žiži struke i javnog mnjenja, kao što su most Zemun-Borča, magistralni gasovod Južni tok, koridori X i XI, bombardovani kompleks Generalštaba. Pored ovih projekata, nastavili smo rad na zaštiti graditeljskog nasleđa, obnovi i izgradnji putnih objekata duž autoputeva i magistralnih i regionalnih puteva u Srbiji, u Rafineriji nafte Pančevo, na revitalizaciji HE Đerdap 1, na drugim hidro i termo-elektranama u regionu, kao i primeni IMS tehnologije građenja i sistema prednaprezanja.

Ove godine se navršava 60 godina od formiranja Instituta za ispitivanje materijala NR Srbije. Za nas, ovaj jubilej je značajan kao podsećanje na izuzetne rezultate koje su u Institutu postigle brojne generacije – od prve, koju je predvodio akademik Branko Žeželj – sve do danas.

Urednici

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RESULTS
OF SCIENTIFIC RESEARCH
WORK

REZULTATI
NAUČNO-ISTRAŽIVAČKOG
RADA



T 150
MATERIAL
TECHNOLOGY

T 150
TEHNOLOGIJA
MATERIJALA

RAD U MEĐUNARODNOM ČASOPISU (M21)

M. Arsenović, L. Pezo, S. Stanković, Z. Radojević

SENSITIVITY ANALYSIS OF MATHEMATICAL MODELS FOR FINAL PRODUCT PROPERTIES: LINK TO DTG CURVE

Ceramics International, 2013, Vol. 39, No. 6, 6277-6285.

Compressive strength and water absorption of fired heavy clay products varies with firing temperatures, but not entirely according to linear function, as it is mostly reported in literature. Also, differential thermo-gravimetric curve shows many turnovers in all the samples tested, within observed temperature range (820–920 °C). The aim of this research was to find a cause for such behaviour. Except derivative weight (*DW*), compressive strength (*CS*) and water absorption (*WA*) are chosen as outputs that represent properties of the fired samples. These parameters can be calculated using second order polynomial models (SOPs), on the basis of content of major oxides and firing temperature, as shown in our previous research. Sensitivity analysis was used as the effective approach in testing changes observed in the SOP outputs, due to the variation of content of major oxides for +1% or –1% of their nominal value. This study reveals in more detail the most significant influence of inputs (SiO_2 , Al_2O_3 , Fe_2O_3 and CaO content) over the outputs (*DW*, *CS* and *WA*) in every observed firing temperature. Addition or lowering of content of major oxides can both increase and decrease all the observed outputs, as revealed using sensitivity analysis.

Keywords: heavy clay products, properties variation, differential thermo-gravimetry; second order polynomial model, sensitivity analysis.

M. Arsenović, S. Stanković, L. Pezo, L. Mančić, Z. Radojević

OPTIMIZATION OF THE PRODUCTION PROCESS THROUGH RESPONSE SURFACE METHOD: BRICKS MADE OF LOESS

Ceramics International, 2013, Vol. 39, No. 3, 3065-3075.

Loess clays are commonly used to produce bricks. Heavy clays, taken at location near Zrenjanin, Serbia, are used as a representative raw material in this

study. The sample, containing about 28% of clay sized particles, is enriched using two more plastic heavy clays from neighboring locations. Chemical and mineralogical content of clays is determined, as well as particle size distribution. Optimization of the processing parameters during the bricks production, i. e. temperature (900–1100 °C), and concentration of 2 clays combined addition (both in the range of 0–10%), is done based on the following independent parameters: compressive strength (CS), water absorption (WA), firing shrinkage (FS), weight loss during firing (WLF) and apparent density expressed as volume mass of cubes (VMC). Developed models showed r^2 values in the range of 0.822–0.998, and they were able to accurately predict CS, WA, FS, WLF and VMC in a wide range of processing parameters. The optimum conditions are determined by the response surface method (RSM), coupled with the fuzzy synthetic evaluation (FSE) algorithm, using membership trapezoidal function, with defined optimal interval values, depending on a final usage of the raw material in heavy clay brick industry.

Keywords: heavy clay brick, loess deposits, response surface method.

M. Arsenović, S. Stanković, Z. Radojević, L. Pezo

PREDICTION AND FUZZY SYNTHETIC OPTIMIZATION OF PROCESS PARAMETERS IN HEAVY CLAY BRICK PRODUCTION

Ceramics International, 2013, Vol. 39, No. 2, 2013-2022.

Many factors influence final clay brick properties, since the raw materials used are highly heterogeneous. Statistical analysis is rarely used, according to literature, but it would improve understanding of the overall system behavior and the quality of products.

In this study, analysis of variance (ANOVA) showed that the most important parameters influencing compressive strength (CS) were the quadratic terms of firing temperature, CaO and SiO₂ content in developed second order polynomial (SOP) models. Water absorption (WA) was mostly influenced by quadratic terms of CaO and SiO₂. The most influential interchange terms in all the models were SiO₂×CaO, SiO₂×Na₂O, Fe₂O₃×Na₂O, CaO×Na₂O and CaO×K₂O. Developed SOP models, which connected the influence of major oxides content and firing temperature on CS and WA, showed the highest r^2 values (0.926–0.967) obtained in the literature so far, for these naturally occurring heavy clay

raw materials. Developed models were able to predict CS and WA in a wide range of chemical composition and temperature treatment data. The implementation of the SOP model is simple using the set of equations in a spreadsheet.

The focus of this study was to determine the optimal composition and firing temperature, depending on final usage of the raw material in heavy clay brick industry. The study was conducted using fuzzy synthetic evaluation, through membership trapezoidal function, with pre-defined optimal interval values for every group of heavy clay products. The optimal samples chemical composition and firing temperature were chosen regarding the kind of the heavy clay product (I—solid bricks, II—hollow blocks and ceiling elements, and III—roof tiles).

Keywords: prediction, optimization, process parameters, clay brick.

M. Arsenović, Z. Radojević, S. Stanković, Ž. Lalić, L. Pezo

WHAT TO EXPECT FROM HEAVY CLAY?

Ceramics International, 2013, Vol 39, No 2, 1667-1675.

The need of testing the quality of brickclay arises in all brick factories, with the opening of new deposits. The analyses are both time and economically consuming, so the aim of this study was to shorten the procedure using the already known data. This study was focused on determining the usability of heavy clays, when only the raw material major elements chemical composition is determined. The effects of chemical composition, firing temperature, and several shape formats of laboratory samples on the final properties were investigated. Chemical composition of major elements was determined on the basis of classical silicate analysis. Firing was conducted in an oxidizing atmosphere, while maintaining all other experimental conditions constant, except the final temperature. Principal component analysis (PCA) was used to determinate groups of samples according to similarity of chemical composition. Prediction of compressive strength (CS) and water absorption (WA) was done by developing five artificial neural networks (ANN). The average regression coefficients r^2 were used to explore the confidence level of the models. Developed models were able to predict CS and WA in a wide range of chemical composition and temperature treatment data, and the highest average r^2 of 0.923 for CS was obtained, while r^2 for WA was 0.958. The wide range of

processing variables was considered in the model formulation, and its easy implementation in a spreadsheet using a set of equations makes it very useful and practical for CS and WA prediction. As it is known from literature, all the parameters entered this analysis are dependent on each other, but their mutual relationship was not quantified yet. Most importantly—the developed neural networks can be used on a global scale.

Keywords: heavy clay, neural networks, prediction

RAD U MEĐUNARODNOM ČASOPISU (M23)

A. Terzić, Lj. Pavlović, Lj. Miličić

EVALUATION OF LIGNITE FLY ASH FOR UTILIZATION AS COMPONENT IN CONSTRUCTION MATERIALS

International Journal of Coal Preparation and Utilization, 2013, Vol. 33, No. 4, 159-180.

Utilization potential of fly ash, as the main residue in the lignite coal combustion in Serbian power-plants, was investigated in present study. High production of fly ash represents extreme hazard for environment. Question of storage of this waste material is disclosed. Recycling and reapplication of fly ash in construction materials industry is only economic solution for on-going problem. Fly ash can be used as component in cement, mortar, concrete, bricks, and tiles. In this study, characterization of three different Serbian fly ash capacities was used as base for further fly ash utilization possibilities investigation. Investigation of fly ash mineralogical components as well as chemical composition analysis was emphasized. Macro-performance was correlated to the microstructure of fly ash studied by means of XRD and SEM analysis. Furthermore, thermal stability of crystalline phases, content of trace elements, physico-chemical characteristics and leaching toxicity were tested. Highlight was placed on determination of the influence of the fly ash grain-size and its microstructure on the performances of the fly ash based products. Comparison of Serbian fly ash properties with characteristics of foreign fly ashes lead to presumption that Serbian fly ash has equal if not better characteristics and that it can be reapplied in production of high value products manufacturing world-wide.

Keywords: fly ash, microstructure, potential reusing, physico-chemical characteristics, leaching, building materials.

A. Terzić, Z. Radojević, Lj. Miličić, Lj. Pavlović, J. Stojanović

HIGH-TEMPERATURE CONCRETE BINDERS BASED ON FLY ASH

Romanian Journal of Materials, 2013, Vol. 43, No. 3, 269-275.

High-temperature concrete binders in which fly ash, as environmentally harmful secondary raw material, is combined with masonry and refractory cement is a new option for reapplication of this coal combustion by-product. In this study, the design of the bonding agents was based on the fly ash from lignite coal combustion process and two types of cement: Portland cement and aluminated cement. Fly ash was applied without any further mechanical or thermal treatment. Mechanical properties of the binders were investigated and subsequently correlated with changes which occurred in the phase composition and microstructure of the agents. Scanning electron microscopy was used in investigation of microstructural changes caused by temperature. X-ray diffraction method was used in monitoring of the mineral phase changes also induced by increasing temperature. The investigations conducted on the bonding agents highlighted presence of good refractory properties and temperature-resistance, and also showed high values of compressive strength. The investigated bonding agents, thus, can be applied in refractory concretes, but also in various types of thermo-insulations.

Keywords: Portland cement, refractory cement, fly ash, microstructure, compressive strength.

M. Arsenović, L. Pezo, Z. Radojević, S. Stanković

SERBIAN HEAVY CLAYS BEHAVIOR: APPLICATION IN ROUGH CERAMICS

Hemijska industrija, 2013, DOI:10.2298/HEMIND121123006A

This study is focused on the behavior of five new deposits of heavy clays from Serbia, with the aim to evaluate their potential suitability as raw materials in rough ceramic applications. The Pfefferkorn plasticity coefficient (PC) and drying susceptibility using Bigot's curve were measured for each raw sample. Thermogravimetric analysis (TGA) showed the behaviour of dry products during firing. Samples groups were fired in the range of 850°C - 1000°C. Water absorption capacity (WAC) and compressive strength (CS) were done in order

to characterize clays after firing. Linear regression models were used to fit the results. Mathematical tools were used to determine statistical difference of major oxides content, shaping moist and compressive strength of dry laboratory products, using post-hoc Tukey`s HSD test. The chemical and mineralogical compositions of samples do not differ considerably, but their possible application does. All studied clays seem to be easily adaptable to a correct brick making process.

Keywords: heavy clay, technological characteristics, application.

RAD U MEĐUNARODNOM ČASOPISU (M24)

Z. Aćimović, A. Terzić, Lj. Andrić, Lj. Pavlović, M. Pavlović

APPLICATION OF CHROMITE IN THE PRODUCTION OF REFRACTORY COATINGS

Interceram – International Ceramic Review, 2013, Vol. 62, No. 4, 290-293.

This work investigated the possibility of developing new chromite-based refractory coatings for hot metal casting applications. The coating composition and rheological properties were optimized by careful choice of binding agents and addition of a suspension maintenance agent in the coating. Different solvents (water and isopropyl alcohol) and casting methods were used in the tests. Chromite was used as refractory filler in both the water- and alcohol-based coating compositions. The chromite was examined by X-ray diffraction analysis and scanning electron microscopy. The chromite shape and grain size were analysed visually with the aid of the OZARIA 2. 5 PC image analysis package. Test samples were cast using sand moulds and by the method of expandable patterns using a polymer model, also known as the “lost foam” casting process. The investigation demonstrated that water- and alcohol-based coatings have positive influence on the surface quality, structural and mechanical properties of alloy castings made with both casting processes.

Keywords: refractory coating, chromite, sand moulds, lost foam casting, image analysis.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

A. Terzić, Lj. Miličić, Z. Radojević, Lj. Pavlović, Lj. Andrić

PELLETIZED FLY ASH AS AGGREGATE FOR BUILDING MATERIALS

Third International Symposium on Natural Resources Management, Zaječar, Serbia, 2013, 19-26.

Although secondary waste material pelletization process is a world wide known technique in the production of artificial aggregates, it has not been widely used in construction sector. The cold-bonded fly ash aggregate was produced in semi-industrial pelletizing device. The fly ash particles were bonded with water-glass (Sodium silicate - Na_2SiO_3) and used as aggregate substitution in Portland cement based concrete. The performance characteristics of lightweight concretes and normal-weight concrete were investigated through compressive strength, modulus of elasticity and tensile strength representing the mechanical behavior. Utilizing fly ash to produce quality aggregates should yield significant environmental benefits.

Keywords: pelletization, fly ash, aggregate, concrete.

A. Terzić, Lj. Pavlović, Z. Radojević, Lj. Miličić

COMPARISON OF PROPERTIES OF BAUXITE BASED REFRACTORY CONCRETES WITH AND WITHOUT ADDITION OF FLY ASH

45th International October Conference on Mining and Metallurgy, Bor, Serbia, 2013, 41-44.

Analyses of refractory concrete properties were conducted by non-destructive methods. The goal of investigation was to establish correlation between sintering process and final performances of concretes based on bauxite aggregate. Two types of concrete were investigated: concrete (B1) based on high aluminate cement and bauxite, and concrete (B2) based on the same starting materials and addition of fly ash. The mechanical strength of concretes

was investigated at ambient and elevated temperatures by ultrasonic pulse velocity technique. The level of superficial porosity was investigated using program for image analysis. Non-destructive measurements were compared with results of the standard laboratory procedures. Non-destructive methods proved to be reliable means for characterization of micro-structural defects and optimization of refractory concrete design.

Keywords: concrete; bauxite; fly ash, ultrasonic pulse velocity, image analysis.

K. Janković, D. Bojović, LJ. Lončar, M. Stojanović

FROST RESISTANCE OF CONCRETE WITH DIFFERENT TYPES OF CEMENT

15th International Symposium of the Macedonian Association of Structural Engineers, Struga, Macedonia, 2013, BK-3, 1-6.

Adequate measures must be taken during the determination of the concrete composition for ensuring the durability of concrete exposed to an aggressive environment. The influence of the type of cement on the frost resistance of concrete was tested. That is the reason why the samples were made using two main types of cement (five types). The concrete mix design was done according to the recommendations of Serbian and European norms. Testing was done according to the SRPS U. M1.016. The total number of freeze-thaw cycles was 250. All types of concrete made according to the recommendations of the Serbian and European norms had the required frost resistance.

Keywords: concrete, durability, frost resistance.

M. Vasić, Z. Radojević

DRYING PROCESS MODELING FOR HEAVY CLAY PRODUCTS USING A NEW THIN LAYER DRYING MODEL

IMANE 2013 International conference, Iasi, Romania, 2013.

Applied Mechanics and Materials, Trans Tech Publication, Switzerland, 2013, Vol. 371, 323-327, DOI.10.4028 /www.scientific.net /AAM.371.323.

This paper represents the upgrade of our previous study in which we have presented a model for simulation of the drying kinetic and estimation of the

effective moisture diffusivity of clay tiles using a constant diffusivity model. The main objective of this study is to determine the time - dependent effective moisture diffusivity of shrinkable clay tiles. Experimental investigations were carried out, on clay tiles, in a laboratory recirculation dryer in which drying parameters (humidity, temperature, and velocity) could be programmed, controlled and monitored during drying. Results presented in this study have shown that the proposed drying model describes and correlates accurately drying kinetics and gives a reliable estimation of the time - dependent effective moisture diffusivity.

Keywords: drying process; variable diffusivity, clay tiles, convective drying, diffusion.

M. Vasić, Z. Radojević

DRYING SIMULATION OF SHRINKABLE CLAY TILES USING VARIABLE DIFFUSIVITY MODEL

MODTECH 2013 International conference, Sinaia, Romania, 2013.

Advanced Material Research, Trans Tech Publications, Switzerland, 2014, Vol. 873, 506-510, DOI.10.4028/ www.scientific.net/AMR.837.506

This paper represents the upgrade of our previous study in which we have presented a model for simulation of the drying kinetic and estimation of the effective moisture diffusivity of clay tiles using a constant diffusivity model. The main objective of this study is to determine the time - dependent effective moisture diffusivity of shrinkable clay tiles. Experimental investigations were carried out, on clay tiles, in a laboratory recirculation dryer in which drying parameters (humidity, temperature, and velocity) could be programmed, controlled and monitored during drying. Results presented in this study have shown that the proposed drying model describes and correlates accurately drying kinetics and gives a reliable estimation of the time - dependent effective moisture diffusivity.

Keywords: drying process; variable diffusivity, clay tiles, convective drying, diffusion.

O. Vušović, L. Kurešević, I. Delić-Nikolić

**STATE OF THE STONE ON THE SQUARE AROUND THE
MONUMENT TO VUK KARADŽIĆ IN BELGRADE**

Eight International Conference *Assessment, maintenance and rehabilitation of structures and settlements*, Borsko jezero, 2013, 439-446.

State of the stone slabs used for paving and cladding on the square around the monument to Vuk Karadžić in the centre of Belgrade varies depending on type of the stone used i.e. its genetic properties and on the stone finishing type. Among the predominant three stone types – Slavkovića dacite, Ravno Bučje granite and Africa red granite, only dacite slabs show severe deterioration. All deterioration types have been shown and described in this paper.

Keywords: Vuk Karadžić monument, Belgrade, stone slabs.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U IZVODU (M34)

A. Terzić, Z. Radojević, Lj. Miličić, N. Obradović, V. Pavlović, Lj. Pavlović

LIGHTWEIGHT CONSTRUCTION CERAMIC COMPOSITES BASED ON PELLETIZED FLY ASH AGGREGATE

Advanced Ceramic and Application II – New frontiers in multifunctional material science and procession, Belgrade, Serbia, 2013, 32.

As coal combustion byproduct fly ash represents a risk for environment: direct ash emission from open land-fills causes pollution of air, soil and water. The solution for this severe pollution problem is fly ash reapplication in various construction ceramic composite materials. Although pelletization of waste powdery material is a known technique in the production of artificial aggregates, it still has not been widely used in construction sector. Here investigated cold-bonded fly ash aggregate was produced in semi-industrial pelletizing device. The fly ash particles were bonded with water-glass (Sodium silicate - Na_2SiO_3) and used as substitution for aggregate in Portland cement based composite. Half of the produced lightweight aggregate was submitted to thermal treatment and afterwards applied in the construction composite in the same ration as in the case of cold-bonded pellets. The performance characteristics of two types of lightweight composites were mutually compared and afterwards correlated with characteristics of normal-weight concrete. Compressive strength, modulus of elasticity and tensile strength were used as represents of the composites mechanical behavior. Mineral constituents of fly ash pellets were analyzed by means of X-ray diffraction analysis, differential thermal analysis was applied in crystalline phase investigation, and scanning electron microscopy in microstructural analysis. The leaching behavior and environmental impact of hazardous elements were also analyzed. It was concluded that content of potentially toxic elements found in leachate of fly-ash based composites was far below tolerance limit proposed by actual standards for the building materials, characterizing the fly ash non-harmful secondary raw material and enabling its reapplication in building materials industry. Utilizing fly ash to produce quality aggregates should yield significant environmental benefits.

Keywords: coal ash, ceramics, composites, pollutants, fly ash reapplication, ecology.

M. Arsenović, L. Pezo, S. Stanković, Z. Radojević

OPTIMIZATION OF MAJOR OXIDES CONTENT AND FIRED BRICK PROPERTIES FOR VARIOUS APPLICATIONS

Advanced Ceramics and Applications II – New Frontiers in multifunctional Material Science and Processing, Belgrade, Serbia, 2013, 32.

The optimal samples content of major oxides (SiO_2 , Al_2O_3 , Fe_2O_3 , CaO , MgO , Na_2O , K_2O , MnO and TiO_2), firing temperature (800–1100 °C) and final properties of tiles, hollow blocks and solid cubes were chosen depending on a final usage of the raw material in heavy clay brick industry. Optimization procedure was performed using Fuzzy Synthetic Evaluation (FSE) algorithm on the basis of previously developed artificial neural networks models that predict compressive strength, water absorption, firing shrinkage, weight loss during firing and volume mass of laboratory products. Trapezoidal membership function is defined by experimentally obtained values and optimal ranges of tested properties. The objective function included all the fired products parameters with equal participation, and its maximum is determined the optimization results. Objective function gained values between 0.6 and 0.7. Solid bricks are proved to be producible of heavy clays containing the highest free SiO_2 and CaO content, by firing at high temperatures. Highly sinterable clays should be used for hollow bricks and the highest quality raw materials in roof tiles production, by firing at 900 °C at laboratory conditions.

Keywords: optimization, various brick products, chemical composition, brick properties.

Z. Radojević, A Terzić

FAÇADE CERAMIC TILES: MICROSTRUCTURAL ANALYSIS OF SUPERFICIAL DEFECTS

Advanced Ceramic and Application II – New frontiers in multifunctional material science and procession, Belgrade, Serbia, 2013, 53.

This investigation was conducted with an aim to determine nature and cause of defects appearing on the glazed facade ceramic tiles. The results of the investigation of incusions visible surface of ceramic tiles are presented in this paper. Glazed ceramic tiles, were previously in use, namely they were embedded on the exterior of a facility. Influenced by atmosphere, defects appeared on visible surface of glazed ceramic tiles. Defects were shaped as dark-brown dots surrounded by yellow halo. Investigation was conducted on the tiles previously embedded on the façade, as well as on new, previously not used ceramic tiles. With an aim to obtain answer on the question of defects origin, investigation was conducted in accordance with standard SRPS ISO 10545: determination of dimensions and surface quality; determination of moisture expansion; determination of chemical resistance; determination of resistance to stains. Microstructural analyses were conducted by means of optical microscope and scanning electron microscope coupled with energy dispersive spectrometer device. Analysis of obtained results highlighted possibility of defects cause being carbon and iron as impurity, both present in raw material used for glaze production.

Keywords: ceramic tiles, glaze, defects, impurities, microstructural analysis.

Z. Radojević, A. Terzić, I. Delić-Nikolić

INVESTIGATION OF CONSTRUCTION CERAMIC FROM OBJECTS OF CULTURAL AND HISTORICAL HERITAGE

Advanced Ceramic and Application II – New frontiers in multifunctional material science and procession, Belgrade, Serbia, 2013, 52.

Gothic-Romanic monastery on the location of Novi Rakovac, Gradina is significant site from aspect of historical and cultural heritage of the Republic of Serbia. Exact date of building of the monastery can not be clearly identified. Also, it is probable that during monastery “life” additional changes of building construction elements and, even, some reparation works have been performed. However, today, the monastery building is mostly in ruin. Thus, investigation has been carried out in order to make restoration and renovation plans. First step was to mark sampling locations on the building and its elements which would not make further harm or damage to the monument. Afterwards, sampling of stone, mortar and brick specimens has been performed. All specimens were well preserved and carefully stored for its continuity and compactness would be

maintained for further laboratory testing. Thus, results were utmost exact and precise and, furthermore, plans for restoration and renovation could be established. Namely, basing on the obtained results from investigations of given materials, new materials, which resemble old ones, could be designed and applied in restoration process. This paper presents results of investigation conducted on brick samples. Applied investigation is mostly engaged with textural characteristics of material in question. Reason for such choice of investigated properties is the fact that first task given to newly designed brick, which should replace old, original brick in the monument, is to aesthetically fit in the building conception. In relation to building functionality, other properties such are compressive strength; water absorption and adhesiveness were investigated. Thus, future durability of the renovated historical and cultural monument could be satisfied.

Keywords: ceramic, brick, properties, cultural heritage.

I. Delić-Nikolić, O. Vušović, L. Kurešević, Lj. Miličić

CONTRIBUTION TO THE RESEARCH OF HISTORICAL HERITAGE – LABORATORY EXAMINATION OF HISTORICAL MORTARS

Advanced Ceramic and Application II – New frontiers in multifunctional material science and procession, Belgrade, Serbia, 2013, 54-55.

Historical mortars represent the composite materials, consisting of the aggregates, binders or the mixture of binding materials and various admixtures. Knowing the original recipes and production methods, and the type and degree of their degradation yields a good basis for mending, conservation and restoration with the ultimate aim in preservation of the original, indigenous appearance and the identity of the reconstructed cultural or historical properties for the future generations. Good practice imposes cooperation of conservationists and experts in materials science, with mutual aim to understand the procedure used for production of these materials as well as possible. Characterisation of historic mortars demands a complex approach, starting with visual observation to laboratory examinations with various methods: mineralogical-petrographical, chemical, physico-mechanical etc. A particular problem is the integration of thus obtained data into a complete picture. Therefore, the cooperation of experts of various profiles is necessary: geologists, crystallographists, technologists, chemists, civil engineers,

historians, archaeologists, architects. One of the key questions is regarding the sampling procedure – first the choice of the sampling method, which must be as less invasive as possible, due to the nature of the material, then the size, number and the positions of the necessary samples. In the laboratories of the IMS Institute, we have examined the Roman mortars from the archaeological sites Viminacium and Sirmium, medieval mortars from the monasteries Gradac, Dombo, Peć patriarchy and from Smederevo fortress. Also, we have examined the modern times mortars – from the façade of the National museum. The results following these examinations point to the differences in recipes for mortars for different purposes, for mortars from different historical periods, and also differences due to the availability of certain ingredients.

Key words: historical mortars, laboratory examinations.

RAD U ČASOPISU NACIONALNOG ZNAČAJA (M51)

A. Terzić, Lj. Pavlović, Lj. Miličić, Z. Radojević, Z. Acimović Pavlović

PROPERTIES OF REFRACTORY BONDING AGENT BASED ON WASTE MATERIAL

Građevinski materijali i konstrukcije, 2012, Vol. 55, No. 2, 47-57.

The fly ash disposal on open landfills poses significant risk to the environment. Sustainable solution for the pollution-prevention is reuse of fly ash in building materials. Building composites – high temperature bonding agents, in which fly ash is combined with refractory components is new option for realication of this waste material. In this study, investigated bonding agent was based on fly ash mixed with high-aluminate cement. Fly ash previously underwent mechanical activation. Mineral phase analysis of the composite by means of XRD was accented due to the changes occurring with increasing temperature. Processes taking place during composite thermal treatment from 20 up to 1100 °C were identified by means of DTA method. The leaching behavior and potential environmental impact of hazardous elements were analyzed. Investigated fly ash-cement composite proved to have high physico-mechanical performances, but also good thermo-insulation characteristics. The overall results showed that alication of the fly ash in high-temperature bonding agents is sustainable solution for managing this environmentally hazardous waste material.

Keywords: building composites fly ash, thermo-insulation, toxic elements, realication, building composites.

J. Dragaš, S. Marinković, Lj. Miličić, S. Marković, N. Tošić, I. Ignjatović,

GEOPOLIMERI NA BAZI ALKALNO AKTIVIRANOG ELEKTROFILTERSKOG PEPELA KAO NOVO VEZIVO U BETONU

Izgradnja, 2013, Vol. 67, No. 9-10, 359-366.

As the concern for the environment and need for sustainable construction practice continues to grow, research in the field of new materials made with waste materials which have a lower impact on the environment is gaining wide

interest. This paper analyzes the characteristics of fly ash from power plant Nikola Tesla B, and its applications in alkali activated fly ash geopolymers as a new binder in concrete. Testing of the particle size distribution and chemical composition of fly ash has been done, as well as the testing of workability and compressive strength of geopolymer pastes under different ratios of water glass and sodium hydroxide. The results show that fly ash from power plant Nikola Tesla B can be used as a binder in alkali activated fly ash geopolymers made with water glass and sodium hydroxide as alkali activators cured on 80oC.

Keywords: fly ash, alkali activation, geopolymers, paste, compressive strength.

RAD U ČASOPISU NACIONALNOG ZNAČAJA (M52)

A. Terzić, Lj. Pavlović

COMPARISON OF PROPERTIES OF CORUNDUM BASED CONCRETES WITH AND WITHOUT ADDITION OF FLY ASH DETERMINED BY MEANS OF NON-DESTRUCTIVE METHODS

Tehnika: Novi Materijali, 2012, Vol. 21, No. 6, 873-878.

The analyses of the concrete properties performed in this study were conducted by means of the non-destructive methods: ultrasonic pulse velocity technique and image analysis. The goal of the investigation was to establish mutual correlation between the sintering process and the final performances of the concretes based on corundum aggregate. Two types of high-temperature resistant concrete were investigated: concrete (C1) based on high aluminate cement and corundum, and concrete (C2) based on the same starting materials and the addition of fly ash, which can be considered as potentially harmful waste material for the environment but at the other side as useful secondary raw material. The mechanical strength of concretes was investigated at ambient temperature and at elevated temperatures (110, 300, 500, 800, 1000, 1300 and 1500 °C) by means of ultrasonic pulse velocity technique. The level of the superficial porosity, present at ambient temperature as well as after thermal treatments, was investigated using Image Pro Plus - program for image analysis. Non-destructive measurements were afterwards compared with results of the standard laboratory procedures. Non-destructive methods proved to be reliable means for the characterization of micro-structural defects and the optimization of high-temperature concrete design for an application.

Keywords: concrete; high-temperature; fly ash, ultrasonic pulse velocity, image analysis.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

D. Nikolić, G. Ćirović, K. Janković, M. Stojanović

ANALIZA POJAVE PRSLINA U AB KONSTRUKCIJAMA PRIMENOM GRUBIH SKUPOVA

VIII Međunarodno naučno-stručno savetovanje *Ocena stanja, održavanje i sanacija građevinskih objekata i naselja*, Borsko jezero, 2013, 77-84.

Teorija grubih skupova predstavlja jedan od relativno novijih matematičkih pristupa u definisanju i analizi nepreciznosti, neodređenosti i neizvesnosti i pogodan je alat za sisteme podrške u odlučivanju. U radu je predstavljen model definisanja pravila odlučivanja u neizvesnom okruženju pri klasifikaciji i analizi uzroka pojave prslina u armirano-betonskim konstrukcijama u odnosu na vreme (u svežem ili očvrslom betonu) i uzrok (fizički, hemijski, termički i statički) pojave prslina. Tabela odlučivanja je dobijena na osnovu razmatranja karakteristika prslina kao atributa uslova, a sam model je baziran na stohastičkom pristupu. Pokazano je da se primenom teorije grubih skupova objektivno mogu formulisati pravila odlučivanja za date parametre koji se odnose na kategorizaciju prslina.

Ključne reči: prslina, kategorizacija, podrška pri odlučivanju, teorija grubih skupova.

G. Ćirović, D. Nikolić, S. Mitrović

PREDVIĐANJE ČVRSTOĆE PRI PRITISKU CEMENTNIH KOMPOZITA SA VRLO VISOKIM MEHANIČKIM SVOJSTVIMA PRIMENOM POTPORNIH VEKTORA

XXXX Simpozijum o operacionim istraživanjima *SYM-OP-IS 2013*, Zlatibor, Srbija, 2013, 250-255.

U radu je prikazana primena jedne od savremenih metoda veštačke inteligencije, metode potpornih vektora (Support Vector Machine - SVM) kojom je moguće izvršiti klasifikaciju uzoraka i regresionu analizu. Za eksperimentalno dobijene podatke ispitivanja čvrstoće pri pritisku betona ultra

visokih čvrstoća (Ultra High Performance Concrete - UHPC) je odabran skup podataka kojim se definiše zavisnost čvrstoće pri pritisku u odnosu na sadržaj silikatne prašine, čeličnih vlakana i primenjeni režim nege uzoraka. Pokazano je da se primenom ove metode mogu predvideti mehanička svojstva kompozita na osnovu navedenih parametara.

Keywords: Support vector machine, Regression, Ultra high performance concrete

I. Delić-Nikolić, O. Vušović, L. Kurešević, B. Ivočić

PRILOG REKONSTRUKCIJI ZGRADE NARODNOG MUZEJA U BEOGRADU – ISPITIVANJE MALTERA SA FASADE

Osmo naučno-stručno međunarodno savetovanje *Ocena stanja, održavanje i sanacija građevinskih objekata i naselja*, Borsko jezero, 2013, 427-432.

Poštujući pravila rekonstrukcije i sanacije značajnih istorijskih objekata, prilikom rada na obnovi zgrade Narodnog muzeja u Beogradu izvršena su ispitivanja maltera koji je korišćen za izradu fasade. Zbog prirode uzoraka i u želji da se ne načine oštećenja fasade uzeta su i ispitana dva uzorka maltera, jedan sa atike, a drugi sa levog bočnog rikalita strane okrenute ka Trgu republike. U radu su prikazani rezultati ispitivanja i izvedeni zaključci.

Ključne reči: narodni muzej, fasada, malter.

O. Vušović, I. Delić-Nikolić, L. Kurešević

PRILOG ISTRAŽIVANJU I ISPITIVANJU ISTORIJSKIH MALTERA - ISPITIVANJE MALTERA SA CARSKO PALATE U SIRMIJUMU

Laboratorijska ispitivanja istorijskih maltera imaju veliki značaj u procesu restauracije značajnih istorijskih građevina. U radu je dat prikaz laboratorijskih ispitivanja mineraloško-petroloških karakteristika i hemijskog sastava maltera koji potiče sa unutrašnjeg zida Carske palate Sirmium u Sremskoj Mitrovici. Rezultati ovih ispitivanja su pokazali da se malter sastoji od agregata i veziva sa različitim aditivima. Agregat je predstavljen zrnima stena i monomineralnim zrnima, kao i sitnim komadima zdrobljene opeke. Vezivo je predstavljeno

gašenim krečom. Aditivi su predstavljeni komadima slame i prahom izmrvljene opeke.

Ključne reči: istorijski malter, spomenici kulture, Sirmium.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U IZVODU (M64)

M. Vasić, Z. Radojević

ESTABLISHING THE MODEL FOR PREDICTING THE MOISTURE AND VELOCITY IN THE CRITICAL POINT DURING DRYING OF GREEN MASONRY PRODUCTS

Advanced Ceramic and Application II – New frontiers in multifunctional material science and procession, Belgrade, Serbia, 2013, 33.

The aim of this study was to establish the model for predicting the moisture and velocity in the critical point during drying of green masonry products. The raw material was first dried at a temperature of 60⁰C, and then after cooling to room temperature, was milled down using perforated rolls mill. Milled material was identified and subject to further classical preparation, which precedes the formation on the vacuum presses. Thus prepared sample carried the name - sample A. The starting raw material was mechanically activated for 30 minutes. Thus prepared sample carried the name - sample B. Laboratory samples 120x50x14 mm were formed in a laboratory extruder under a vacuum of 0.8 bar. These samples were used in further experimental work. Drying process was monitored and all process parameters such as: temperature, relative humidity of the drying air, weight changes, linear shrinkage, temperature of the surface and in the centre of test samples were recorded continually. Two mathematical models, based on multi factorial experimental design technique, were set up. The first describes the moisture and the second one the velocity value of the samples B in the critical point as a function of temperature, relative humidity and the velocity of the drying medium.

Keywords: drying, mechanical activation, experimental design technique, masonry product.

DOKTORSKA DISERTACIJA (M71)

M. Arsenović

OPTIMIZACIJA I PREDVIĐANJE KVALITETA MATERIJALA, PROCESA I KRAJNJIH OSOBINA OPEKARSKIH PROIZVODA MATEMATIČKIM MODELOVANJEM KARAKTERISTIČNIH PARAMETARA

Doktorska disertacija odbranjena 14.10.2013. na Tehnološko-metalurškom fakultetu Univerziteta u Beogradu.

Kvalitet opekarskih sirovina u Srbiji varira u širokom opsegu u pogledu hemijskih, mineraloških, granulometrijskih i keramičko-tehnoloških karakteristika. Različitost sastava i heterogena priroda sirovina uzrokuje varijacije osobina pečenih proizvoda. Da bi se utvrdile matematičke zakonitosti u ponašanju analizirano je 139 uzoraka opekarskih sirovina iz Srbije. Određivan je hemijski i mineraloški sastav polaznih sirovina, kao i ukupni sadržaj karbonata, ostatak na situ od 0,063 mm, a zatim je vršena adekvatna priprema i oblikovanje laboratorijskih proizvoda, sušenje i pečenje na deset temperatura u intervalu 800 - 1100 °C. Ponašanje sirovina pri oblikovanju i sušenju ispitano je na osnovu određivanja vlage oblikovanja, koeficijenta plastičnosti prema Feferkornu, osetljivosti u sušenju prema Bigou, linearnog skupljanja u sušenju i čvrstoće na pritisak suvih oblikovanih tela. Kvalitet uzoraka nakon termičkog tretmana ispitivan je na osnovu: čvrstoće pri pritisku, upijanja vode, gubitka mase žarenjem, skupljanja u pečenju i zapreminske mase. Ponašanje sirovina u toku procesa pečenja proučavano je metodama termičke analize. Takođe su opisane i reakcije koje se odigravaju tokom pečenja na osnovu termalne analize (DSC, TGA i DTG dijagrama) lesnih sirovina. Zbog izuzetno velikog broja podataka, rezultati su obrađeni i prikazani deskriptivnom statistikom (minimum, maksimum, srednja vrednost, standardna devijacija i varijansa). Korelacionom i analizom glavnih komponenti (PCA) su testirani dobijeni podaci radi utvrđivanja međusobne zavisnosti. Rezultati hemijske i mineraloške analize korišćeni su kao polazni podaci za predviđanje osobina pečenih proizvoda, te su prvobitno ispitani post-hoc Tukey-evim testom koji je pokazao statistički značajne razlike između uzoraka i pogodnost rezultata za dalju analizu i modelovanje proučavanih parametara: čvrstoće pri pritisku, upijanja vode, gubitka mase žarenjem, skupljanja u pečenju i zapreminske mase. Utvrđeno je

da najbolje rezultate daju matematički modeli u obliku polinoma drugog reda i veštačkih neuronskih mreža. Takođe su prikazane analize nivoa uticaja određenih ulaznih promenljivih na izlazne (analiza varijanse - ANOVA i *sensitivity* analiza).

Poseban deo je posvećen uočenom nelinearnom variranju osobina proizvoda sa porastom temperature pečenja, s obzirom na to da je ova pojava vrlo retko prikazivana u literaturi, a svi ispitivani uzorci iz Srbije su pokazali ovakvo ponašanje, koje je testirano pomoću *sensitivity* analize.

Optimizacija proizvoda i procesa na osnovu hemijskog sastava polaznih sirovina (kao i obrnuto) urađena je pomoću *fuzzy* logike na osnovu trapezoidne funkcije i funkcije pripadnosti. Takođe je testirana adekvatna mešavina tri sirovine i optimalna temperatura pečenja da bi se dobili određeni oblici pekerskih proizvoda, pri čemu je korišćena metoda odzivne funkcije (RSM).

Definisanje odnosa karakteristika polaznih sirovina i krajnjih proizvoda u odnosu na temperaturu pečenja je tema koja od davnina pokreće raznovrsna istraživanja. Uprkos tome, korišćenje hemometrijskih alata sa ciljem da se sveobuhvatno razume ponašanje pomenutih sistema je tek od nedavno postalo praksa. Istraživanje prikazano u ovoj disertaciji već ima svoj doprinos u ovoj oblasti, s obzirom na broj radova objavljenih u međunarodnim časopisima, u kojima su po prvi put prikazane matematičke metode koje omogućuju određivanje najznačajnijih uticaja na osobine proizvoda, modele kojima se može skratiti postupak istraživanja novootvorenih ležišta, i optimizovati proizvodnja. Istraživanja obuhvaćena ovom doktorskom disertacijom su izvedena prateći najsavremenije svetske trendove, a postignuti rezultati mogu se koristiti kao osnova za dalje usavršavanje dobijenih matematičkih modela proširenjem baze podataka. Takođe, ovakva metodologija može se koristiti i u industrijskoj praksi, što predstavlja jedan deo planiranih budućih istraživanja.

Ključne reči: pekerske sirovine, hemijski i mineraloški sastav, osobine suvih i pečenih proizvoda, predviđanje, optimizacija.



T 152
COMPOSITE
MATERIALS

T 152
KOMPOZITNI
MATERIJALI

RAD U MEĐUNARODNOM ČASOPISU (M23)

A. Mitrović, D. Nikolić, Lj. Miličić, D. Bojović

PROPERTIES OF COMPOSITE CEMENT WITH COMMERCIAL AND MANUFACTURED METAKAOLIN

Technical Gazette, 2013, 20 (4), 683-687.

Metakaolin composite cements were prepared with 5 to 35 % replacement of ordinary Portland cement with metakaolin (MK), manufactured by thermal activation/calcination of domestic kaolin clay, and commercial metakaolin (CMK). Performance of the composite cements was evaluated through the setting time (initial and final), compressive strengths (for ages 2, 7, 28, 90 and 180 days) and soundness, and compared with control cement (Portland cement – CEM I). After 28 days, compressive strength was higher than that for control cement for cements prepared with addition of CMK, and with addition of up to 25 % MK.

Keywords: composite cement, compressive strength, metakaolin, setting time, soundness.

A. Mitrović, M. Zdujić

MECHANOCHEMICAL TREATMENT OF SERBIAN KAOLIN CLAY TO OBTAIN HIGH REACTIVE POZZOLANA

J. Serb. Chem. Soc., 2013, 78 (4), 579-590.

Mechanochemical treatment of Serbian kaolin clay was performed in a planetary ball mill using two different milling media, hardened steel or zirconia vials and balls. The samples obtained after various milling times were characterized by particle size laser diffraction (PSLD), X-ray diffraction (XRD), differential scanning calorimetry/thermogravimetry (DTA/TGA) and Fouriertransform infrared (FTIR) analyses. The mechanochemical treatment induced amorphization of the kaolinite phase accompanied by dehydroxylation. It was found that for given milling parameters, amorphization mainly occurred in the milling period up to 15 min, and was completed after about 30 min of milling for both employed milling media. The pozzolanic activities were

determined by the Chappelle method. Milling in the hardened steel milling medium had no significant influence on pozzolanic activity, even though there was accumulated iron contamination. For both milling media, a pozzolanic activity of 0.79

was obtained for the samples milled for 15 min and it remained almost unchanged with prolonged milling. The determined pozzolanic activity values were similar to those of commercial metakaolinite or metakaolinite obtained by calcination of the same clay, thereby, indicating that highly reactive pozzolana could be obtained by mechanochemical treatment of Serbian kaoline clay.

Keywords: kaolin clay, kaolinite, metakaolinite, mechanochemical treatment, pozzolana.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

D. Jevtić, A. Mitrović, A. Savić, A. Radević

CEMENT COMPOSITES MODELING USING AMORPHOUS KAOLIN

45th International October Conference on Mining and Metallurgy, Borsko jezero, Serbia, 2013, 592-595.

Cement based composites (concrete and mortar) are widely used in building industry, owing their popularity to huge production rate of cement. Nevertheless, cement production was found to have several negative environmental impacts. This is the reason why more and more alternative binders, like amorphous kaolin, are investigated and whenever possible implemented, with respect to the rules of energy efficiency. Three series of mortars were made, with and without amorphous kaolin, and then investigated both in fresh and in hardened state, as well. Positive impact of substitution of cement with amorphous kaolin was detected, especially in fresh state (improvement of consistence).

Keywords: cement, amorphous kaolin, mortar, physical and mech. properties.

D. Nikolić, K. Janković, A. Mitrović, Lj. Miličić

BOND BEHAVIOUR OF CONCRETE AND SILICA FUME MORTAR

15th International Symposium of the Macedonian Association of Structural Engineers, Struga, Macedonia, 2013, BK-7, 18-21.

The quality of the bonded silica fume mortar overlay depends on the bonding at the layer's interface, which is affected by water to cement (w/c) ratio of applied mortar and moisture condition of old concrete surface at different curing regimes. The aim of research presented in this paper is to evaluate these factors affecting the interfacial bond strength of old concrete and new layer of silica fume mortar. The pull-off tests were measured on samples prepared with overlay mortar and three different moisture conditions for old concrete (air dry, wet and saturated surface dry).

Keywords: silica fume mortar, bond behaviour, pull-off test.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

D. Jevtić, A. Mitrović, A. Savić, A. Radević

UTICAJ DODATKA AMORFNOG KAOLINA NA SVOJSTVA MALTERA

8. Simpozijum *Reciklažne tehnologije i održivi razvoj*, Borsko jezero, Srbija, 2013, 163-168.

U radu je prikazana mogućnost primene amorfnog kaolina, dobijenog mehanohemijom, kao dela zamene cementa kod cementnih kompozita, kao i ekološki aspekti njegove primene. Projektovane su četiri malterske mešavine, etalon sa čistim cementom (sa oznakom "1"), mešavina oznake "2" sa 5% amorfnog kaolina, mešavina oznake "3" sa 10% amorfnog kaolina i mešavina "4" sa 20% amorfnog kaolina u odnosu na ukupnu masu cementa. Na malterima u svežem stanju ispitivana je zapreminska masa, a na očvrslim kompozitima ispitivana su mehanička svojstva (čvrstoća pri pritisku i čvrstoća pri savijanju) i skupljanje. Na osnovu rezultata dobijenih tokom eksperimentalnih ispitivanja može se izvesti opšti zaključak da se primenom amorfnog kaolina u svojstvu pucolana mogu dobiti novi kompoziti povoljnih fizičko-mehaničkih svojstava, koji su takođe u skladu sa principima održivog razvoja.

Ključne reči: cement, amorfni kaolin, malter, fizičko-mehanička svojstva.



T 220
CIVIL ENGINEERING,
HYDRAULIC ENGINEERING,
OFFSHORE TECHNOLOGY,
SOIL MECHANICS

T 220
GRAĐEVINARSTVO,
HIDRAULIKA,
PRIOBALNA
TEHNOLOGIJA,
MEHANIKA TLA

PREDAVANJE PO POZIVU SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M31)

D. Berisavljevic, N. Šušić

STATIC LOAD TESTING OF LARGE DIAMETER PILES

Contemporary Civil Engineering Practice 2013, Andrevlje, Serbia, 2013, 159–166.

This work considers the effect of vertical compressive force on three piles in a static load test. The piles have the lengths 23-46 m and diameters Ø800-200 mm. As the ultimate load was not used in the test, the ultimate bearing capacities are determined on the criteria from published literature. The Davisson criterion was found to be conservative. The method proposed by Decourtand Chin gave highest values of the ultimate bearing capacity. Difference between the minimum and maximum interpreted bearing capacities can be even 100%. In addition to the test results, this work describes the performance of a pile and the loading procedure. The standard loading procedure (ASTM D1143, point 5.1) is recommended to be substituted by the quick loading procedure (ASTM D1143, point 5.6).

Keywords: pile, static load test, bearing capacity.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

D. Berisavljevic, N. Šušić

ANALYSIS OF STATIC LOAD TEST RESULTS

Eight International Conference *Assessment, Maintenance and Rehabilitation of Structures and Settlements*, Borsko jezero, Serbia, 2013, 585–594.

Paper presents static load test results of piles under vertical compressive load. Length of all piles tested is between 14.0 to 46 m. Piles diameter is $\varnothing 520$ to 2000 mm. No pile were tested to failure, but when possible, ultimate resistance was determined based on criterions from literature. Decourt and Chin method produce highest value of failure load. Definition of failure by various methods can result in different failure loads for the same static load test. This difference can be as much as 40 %. At one site in Novi Beograd eight “Franki” piles with variable lengths from 14.0 to 15.0 m were tested. Settlements for the working load ranged between 2.0 to 3.8 mm. Based on those results question can be raised, if piles are oversized? Along with results procedure for pile (test) preparation and methods for applying load are shown. It is suggested to replace standard loading procedure (described in ASTM D1143, point 5.1) with quick load test method (ASTM D1143, point 5.6).

Keywords: pile, static load test, capacity.

D. Berisavljevic, N. Šušić, D. Rakić

A NOTE ON CPT-DMT CORRELATIONS IN SAND

Conference of the Geotechnical Society of Bosnia and Herzegovina *GEO-EXPO 2013*, Jahorina, Bosnia and Herzegovina, 2013, 267-273.

Relations between cone resistance (q_c) obtained from cone penetration test and dilatometer modulus (ED) and constrained modulus (M) obtained from flat dilatometer test are presented. It was found that in order to penetrate dilatometer blade approximately 1.3 times larger total force is needed than for standard 10 cm² cone penetrometer. ED- q_c correlations are possible but should be restricted to local site conditions. q_c should not be directly related to M due to large

scatter of results. The main reason for this impossibility lies in the fact that M is obtained from KD , which is parameter that is related to stress history of the deposit, while on the other hand q_c is known to be less sensitive to stress history.

Keywords: DMT, CPT, sand, correlations.

D. Rakić, I. Basarić, N. Šušić

GEOTECHNICAL ASPECTS IN SUSTAINABILITY – ENERGY GEO-STRUCTURES

5th International Conference *Geotechnics in Civil Engineering*, Sokobanja, Serbia, 2013, 455-462.

This paper presents general overview of the geotechnical aspects in sustainable development, which includes the use of renewable energy sources (wind, solar, geothermal energy and bioenergy), the application of alternative ecological and reuse of waste materials, the role in storage of CO₂ emission, geo-diversity conservation, etc. Emphasis is placed on the so-called energy geo-structures, which represent the modern technology of using the geothermal energy through systems which are integrated into the underground construction of the structures (shallow foundations, foundations on piles, diaphragms, tunnel lining, anchors, etc.). They provide significant energy savings over conventional heating and cooling systems, reduce the use of non-renewable energy sources and thus significantly contribute to environmental protection issues.

Keywords: sustainability, geothermal energy, energy geo-structures, energy piles.

J. Ćirilovic, N. Vajdić, G. Mladenović, C. Queiroz

DEVELOPING COST ESTIMATION MODELS FOR ROAD REHABILITATION AND RECONSTRUCTION

TRB 2013 Annual Meeting, TRB Paper 13-2037.

The average unit costs of road works vary substantially between countries, and even between projects in the same country, due to a number of factors. In this paper an effort is made to develop prediction models for the unit costs of road

works that could be applied for a wide range of conditions in different countries.

A specialized dataset was used, which was generated under a World Bank study that included road works contracts from 14 countries in Europe and Central Asia (ECA). Two techniques were used for model development: multiple regression analysis and artificial neural networks. As the major problem found with the data set was missing or incomplete data, classification trees were used as an intermediate step to evaluate the correctness of the selected parameters. Three models were developed using regression analysis, two for the unit cost of asphalt concrete and one for the cost per km of rehabilitation and reconstruction works. The models include as independent variables the price of diesel fuel or oil, country Gross National Income per capita, World Governance Index, Transparency International Corruption Perception Index, percent of local bidders participating in the tender, and climate conditions. The analysis using classification trees confirmed the appropriateness of the variables selected in the regression analysis. The models developed using artificial neural networks were superior compared to the regression models, using mostly the same parameters. The resulting models could be particularly useful at the strategic level, for planning and optimization of works on road networks in ECA countries.

Keywords: Construction costs; Maintenance costs; Reconstruction; Rehabilitation; Neural networks.

K. Đoković, L. Čaki, N. Šušić

PRELIMINARY TESTS FOR DETERMINING DISPERSION OF FINE - GRAINED SOILS

8th International Conference *Assessment, Maintenance and Rehabilitation of Structures and Settlements*, Borsko jezero, Serbia, 2013, 361–368.

Using of dispersive fine - grained soil to construction of earth structures (embankments, core earth dams etc.) can cause serious engineering problems, if the dispersive soils are not identified. Dispersive soils can not be determined by the visual classification or standard identification - classification tests such as grain size analysis, Atterberg limits etc. The paper presents the results of investigations of dispersion fine - grained soils by preliminary tests: the crumb test and the double hydrometer test.

Keywords: dispersive soils, identification, the crumb test, the double hydrometer test.

K. Đoković, L. Čaki, N. Šušić

ASSESSING SOIL DISPERSIVITY BASED ON CLASSIFICATION TESTS

5th International Conference *Geotechnics in Civil Engineering*, Sokobanja, Serbia, 2013, 197-204.

Dispersive clay soils represent a specific type of fine-grained soils, with clay particles dispersing (deflocculating) in the presence of water forming a colloidal dispersion system. Such soils are inconvenient for the construction of earth embankments: dikes, made up dam cores, etc. Using a fine-grained dispersive soil to build up embankments may cause serious engineering problems, in case the dispersive soil has not been identified as such. Dispersive soils can not be determined using standard identification – classification tests such as granulometric (particle size) analysis, plasticity tests and similar. The paper gives an overview of the results of testing dispersivity of fine-grained soil using other classification tests: the crumb test and the double hydrometer test.

Keywords: dispersive soils, identification, crumb test, double hydrometer.

K. Đoković, N. Šušić, L. Čaki, G. Hadži-Niković

CORRELATION BETWEEN PARAMETERS OF COMPACTION AND GRAIN SIZE DISTRIBUTION OF THE COARSE SOILS

15th International Symposium of the Macedonian Association of Structural Engineers, Struga, Macedonia, 2013, CT-5, 1-6.

The paper describes the relationship between grain size distribution (C_u , C_c) and parameters compaction of soils (ρ_{dmax} , ρ_{dmin} , I_d). Relationship between the coefficient of uniformity C_u , coefficient of curvature C_c and maximum dry density ρ_{dmax} , minimum dry density ρ_{dmin} and index of relative density I_d , were obtained from laboratory tests conducted on a large number of samples of sand and fine-grained gravel. On the basis of the relationship, knowing grain size

distribution soil can be evaluated potential compaction parameters: the maximum dry density, minimum dry density and the density index of the soil.

Keywords: parameters of compaction, coefficient of uniformity, coefficient of curvature.

M. Orešković, J. Ćirilović, G. Mladenović

PERFORMANCE OF ASPHALT MIXTURES WITH HIGH CONTENT OF RECYCLED ASPHALT MATERIAL

14. kolokvij o asfaltih in bitumnih, Bled 2013.

The addition of reclaimed asphalt pavement (RAP) to asphalt mixtures, although widely used in many countries, is still in the beginning stage in Serbia. According to many studies, RAP rates between 10% and 20% are commonly used in asphalt mixes and they perform similarly to conventional mixtures. The use of higher RAP rates, up to 50 %, would lead to more sustainable pavement structures with lower energy and natural resources consumption, having also positive effects from the economic point of view.

The paper presents the properties of RAP and influence of RAP on the volumetric and mechanical characteristics and laboratory performance of the 22 mm base course mix. The mix designs included a control mix with 0% RAP and two asphalt mixes with 15% and 30% RAP, all prepared with the B 50/70 bitumen. The tests conducted on the HMAs include moisture susceptibility, resistance to permanent deformation (wheel tracking and flow number), and mixture stiffness (complex and dynamic modulus).

The testing performed so far indicates that addition of higher percentage of RAP improves the rutting resistance and stiffness without compromising the moisture susceptibility. The addition of 15% of RAP resulted in relatively small increase of stiffness, while addition of 30% RAP increased the stiffness substantially, relative to the control mix.

Keywords: RAP, asphalt.

M. Prica, K. Doković, N. Šušić, D. Berisavljević

IN SITU TESTING OF SOILS BY SCREW PLATE LOAD TEST (SPLT)

5th International Conference *Geotechnics in Civil Engineering*, Sokobanja, Serbia, 2013, 191-196.

The screw plate load test is a field test for determining deformation properties of soils. Unlike the “classical” tests using a circular plate which can be performed on terrain surfaces only, the screw plate load test can be successfully carried out in the test boreholes over 2 m deep. This paper presents an overview of our experience in conducting screw plate load tests. To our knowledge, no such tests have been carried out in our region before.

Keywords: screw plate, in situ tests, modulus of deformation.

N. Milovanović, Ž. Flajs

TRIAL LOAD TESTING OF STEEL TRUSS ROOF STRUCTURE AT FACILITY OF AQUATIC PARK IN BIJELJINA

Eight International Conference *Assessment, Maintenance and Rehabilitation of Structures and Settlements*, Borsko jezero, Serbia, 2013, 265-270.

In order to test the capacity derived steel truss roof structure on the facility of Aquatic park in Bijeljina, a trial load testing was conducted at one of its segments. Trial testing was performed in accordance with SRPS U. M1.047:1987. Required load according to design calculations, was 380 kN. In addition to measurement of vertical and horizontal displacements of structure, stress/strain state was also monitored. Structure static system is a continuous truss girder over two spans of 35.0 +17. 5 m.

Keywords: Steel truss structure, trial load testing, stress and strain.

N. Šušić, Đ. Đuričić, D. Arsović

INFLUENCE OF THE VEGETATION REMOVAL ON LANDSLIDE FORMATION

6th International Conference *Science and Higher Education in Function of Sustainable Development*, Užice, Serbia, 2013, 3/23-25.

In this paper we shall show the results of analysis of the influence of the vegetation removal on landslide formation. The stability analysis was performed on the soil slope before any intervention was made and after the removal of natural vegetation cover. Decrease in slope stability is due to much easier infiltration of the surface water and subsequent lowering of the effective stresses in the soil.

Keywords: landslide, natural vegetation cover, effective stresses.

SAOPSTENJE SA NACIONALNOG SKUPA STAMPANO U CELINI (M63)

J. Ćirilović, A. Dorđević, V. Jokić

APPLICATION OF GENETIC ALGORITHMS FOR PAVEMENT MAINTENANCE OPTIMIZATION

Ocena stanja, održavanje i sanacija građevinskih objekata i naselja, Zlatibor, 2013.

Finding the optimal pavement maintenance strategies, defined by the frequency and intensity of the rehabilitation works, is one of the key problems in the field of Road Infrastructure Management. In this paper is given an example of the methodology for solving the above-mentioned optimization problem using genetic algorithms (GA). The paper compares the solutions obtained using the GAs and using software RONET. In this paper, four models were calibrated: (i) the model estimating the effects of maintenance treatments; (ii) pavement deterioration model; (iii) model estimating the maintenance cost; and (iv) road users cost estimation model. Comparison of methods in the case study provides a sensitivity analysis of obtained solutions regarding the choice of method and comparison of "optimal" solutions obtained by different methods. Also, the advantages and disadvantages of the use of both methods are highlighted.

Keywords: optimal pavement maintenance strategy, genetic algorithms, RONET.

REALIZOVAN PATENT (M92)

N. Šušić, D. Rakić

BETONSKI ELEMENTI SA ISPUNOM ZA OJAČANJE ZONE KLIZANJA TERENA

Registar malih patenata Zavoda za intelektualnu svojinu po br. 1320 (prijava br. MP-2012/0075 od 30.11.2012.).

Da bi se sprečilo dalje klizanje terena potrebno je nekim merama povećati otpor tla, tj. ojačati zonu klizne površi. Ugradnjom novih betonskih elemenata sa ispunom postiže se ovaj efekat.

Betonski elementi sa ispunom je novi geo-konstruktivni element koga čine dva dela: valjkasti prstenovi i ispuna prstenova. Betonski elementi se ugrađuju tako što se tehnikom bušenja postavljaju kontinualni valjkasti betonski prstenovi u zonu iznad i ispod klizne površi. Zatim se šupljina prstenova popunjava sa betonom, drobljenim agregatom ili šljunkom.

Suština ugradnje betonskih elemenata sa ispunom je da oni prihvate sile klizanja i prenesu ih na stabilno tlo ispod klizne površi i na taj način ojačaju zonu klizne površi. Za razliku od standardnih načina sanacije klizišta gde ojačanje tla i konstrukcija se radi za celo tlo, od klizne površi pa do površine terena, betonski elementi sa ispunom su konstrukcije i ojačanja tla samo u zoni klizne površi. Na taj način troši se mnogo manje materijala i rada pri izvođenju sanacionih mera, pa samim tim su i troškovi mnogo manji.



T 230
BUILDING CONSTRUCTION

T 230
Visoka gradnja

RAD U VRHUNSKOM MEĐUNARODNOM ČASOPISU (M21)

G. Ćirović, V. Radonjanin, M. Trivunić, D. Nikolić

OPTIMIZATION OF UHPFRC BEAMS SUBJECTED TO BENDING USING GENETIC ALGORITHMS

Journal of Civil Engineering and Management, 2013,

DOI:10.3846/13923730.2013.801908

Ultra high performance fiber reinforced concrete (UHPFRC) is cementitious composite with very high strength, and when compared with ordinary concrete it is a more superior material both in terms of its mechanical properties and its durability. In order to predict the behaviour of UHPFRC beams, first of all, experiments were carried out to investigate the mechanical properties of composites containing 2% and 4% of steel fibers. Following this, four beams of 2m in length were tested by subjecting to four point bending. Two beams contained only micro steel fibers, while the remaining two contained conventional steel bar reinforcement. On the basis of experimental studies and recommendations by the AFGC for UHPC, the behaviour of the beams was modeled and optimization was carried out using genetic algorithms (GA) according to the criterium of minimum price. In this paper, the prices of individual UHPFRC beams are also shown in comparison with beams which contain steel bars or prestressed reinforcement.

Keywords: ultra high performance fiber reinforced concrete, optimization, beams, genetic algorithms.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U IZVODU (M34)

G. Petrović, N. Milovanović

RECENT RESEARCH WORK RESULTING IN IMS BUILDING TECHNOLOGY IMPROVEMENTS

Sixth edition of the research conference on civil engineering, economy of constructions, architecture, urban planning and territorial development, Bucharest, 2013, 88.

IMS Building Technology is based on prefabricated concrete elements of the skeleton, assembled on-site and joined using prestressing. This construction method, developed in 1950s and implemented Worldwide, is still in use. This paper describes recent improvements and the research work that initiated and enabled them, as well as on-site experiences from the process of implementation.

Keywords: industrialization of building, IMS Building Technology, prestressing, prefabrication.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

G. Ćirović, S. Mitrović, D. Nikolić

NEKE METODE VEŠTAČKE INTELIGENCIJE SA PRIMENOM U GRAĐEVINARSTVU

XXXX Simpozijum o operacionim istraživanjima *SYM-OP-IS 2013*, Zlatibor, Srbija, 2013, 239-244.

Algoritmi za optimizaciju konstrukcija su način da se odredi optimalna topologija, geometrija i dimenzije poprečnih preseka uz ograničenja vezana za opterećenje koje deluje na konstrukcije, ali svakako i cenu i rok izgradnje. U inženjerskoj praksi česte su i optimizacije vezane za samu dinamiku izgradnje, određivanje najpovoljnije lokacije za izgradnju nekog objekta i sl. Tradicionalne metode modelovanja i određivanja rešenja u procesu optimizacije zahtevaju glomazne matematičke proračune, dok se uvođenjem metoda i tehnika veštačke inteligencije otvara čitav spektar mogućnosti za efikasan način pronalaženja adekvatnih i za praksu prihvatljivih rešenja. U radu su prikazane pojedine metode koji se intenzivno primenjuju u prethodnih nekoliko godina, sa osvrtom na njihove prednosti i mane.

Ključne reči: Veštačka inteligencija, metaheurističke metode, optimizacija konstrukcija.



T 450
METAL TECHNOLOGY,
METALLURGY,
METAL PRODUCTS

T450
TEHNOLOGIJA METALA,
METALURGIJA,
PROIZVODI OD METALA

RAD U ISTAKNUTOM MEĐUNARODNOM ČASOPISU (M22)

M. Đurđević, G. Huber, Z. Odanović

SYNERGY BETWEEN THERMAL ANALYSIS AND SIMULATION

Journal of Thermal Analysis and Calorimetry, 2013, Vol. 111, No. 2, 1365-1373.

Available databases presently used by commercial simulation software packages for the aluminum casting industry usually come with material properties for only a few selected standard alloys. In the case of other alloys with different chemical compositions and refinement or modification treatment, thermal analysis could be an invaluable tool in order to gain necessary properties. The aim of this paper is to demonstrate the potential application of the cooling curve analysis in the existing simulation software in order to improve their accuracy.

Keywords: Simulation, thermal analysis, aluminum alloys.

M. Đurđević, S. Manasijević, Z. Odanović, R. Radisa

INFLUENCE OF DIFFERENT CONTENTS OF SILICON AND COPPER ON THE SOLIDIFICATION PATHWAYS OF CAST HYPOEUTECTIC ALSI (5–9 WT. %) CU (1–4 WT. %) ALLOYS

Int. Journ. Material Res., 2013, Vol. 104, No. 9, 865-873.

A comprehensive understanding of solidification process is of paramount importance for the control and prediction of actual casting characteristics. The present work presented the potential of cooling curve analysis to characterize the solidification path of cast hypoeutectic series of Al–Si–Cu alloys. The aim of this work was to examine how variation in chemical composition of Si (from 5 wt. % to 9 wt. %) and Cu (from 1 wt. % to 4 wt. %) may affect characteristic solidification temperatures, their corresponding fraction solid, and thermal freezing ranges of investigated alloys. All solidification parameters that have been calculated using cooling curve analyses show good correlation with the corresponding parameters calculated using commercial Pandat software. These

parameters either collected from the cooling curve analysis or calculated using Pandat software can be easily incorporate into existing simulation software packages in order to improve their accuracy. In addition, cooling curve analysis can be used to estimate the effect of cooling rate on above mentioned solidification parameters and used as additional input data for simulation.

Keywords: aluminum alloys; thermal analysis; cooling curve analyses; fraction solid analysis; thermal freezing range.

Srđan M. Bošnjak, , Dejan B. Momčilović, Zoran D. Petković, Milorad P. Pantelić, Nebojša B. Gnjatović

FAILURE INVESTIGATION OF THE BUCKET WHEEL EXCAVATOR CRAWLER CHAIN LINK

Engineering Failure Analysis, 2013, Vol. 35, 462–469.

The high mobility of open pit machines in heavy duty conditions provides fertile ground for the occurrence of various failures of the traveling mechanisms' vital parts such as chain links. The goal of the study presented in this paper was to diagnose the cause of the damage of the bucket wheel excavator crawler chain links. In order to identify the reasons behind chain link failures, stress state calculations were performed as well as experimental investigations which, given the nature of the failure, included visual and metallographic examinations, chemical composition analysis and tests of mechanical properties. Based on the results of the numerical–experimental analyses, it was concluded that the chain link breakdowns are caused by ‘manufacturing-in’ defects. The results of the presented analyses also emphasize the importance of a comprehensive quality control of chain links.

Keywords: Bucket wheel excavator, Chain links, Damage diagnostics, Stress-analysis, Experimental investigations.

RAD U MEĐUNARODNOM ČASOPISU (M23)

I. Dimić, M. Arsić, B. Međo, A. Stefanović, V. Grabulov, M. Rakin

EFFECT OF WELDED JOINT IMPERFECTION ON THE INTEGRITY OF PIPE ELBOWS SUBJECTED TO INTERNAL PRESSURE

Tehnički vjesnik, 2013, Vol. 20, No. 2, 285-290.

Since local defects reduce the load-carrying capacity and deformation ability of a piping system, an analysis is undertaken to quantify the influence of weld defects on integrity of the pipe elbows subjected to internal pressure. Incompletely filled groove is examined, because this type of defect was previously detected by ultrasonic measurement on the inner surface of the pipeline from a hydro-power plant. Three-dimensional finite element analysis is conducted using Abaqus software package. The influence of weld defect geometry (its depth, length and location) on the elbow integrity is determined. Additionally, decrease of load carrying capacity is determined for the case when a crack has initiated at the bottom of the defect. The influence of finite element type (hexahedral or tetrahedral) is examined.

Keywords: elbow, finite element method, incompletely filled groove, pipe, structural integrity, welded joint.

M. Đurđević, S. Manasijević, Z. Odanović, N. Dolić

CALCULATION OF LIQUIDUS TEMPERATURE FOR ALUMINUM AND MAGNESIUM ALLOYS APPLYING METHOD OF EQUIVALENCY

Advances in Materials Science and Engineering, 2013, Article ID 170527, 8, <http://dx.doi.org/10.1155/2013/170527>

The purpose of this paper is to develop a mathematical equation, which will be able to accurately predict the liquidus temperature of various aluminum and magnesium cast alloys on the basis of their known chemical compositions. An accurate knowledge of liquidus temperature permits a researcher to predict a variety of physical parameters pertaining to a given alloy. The analytical expressions presented in this paper are based on the “method of equivalency.”

According to this concept, the influence of any alloying element on the liquidus temperature of an aluminum and/or magnesium alloy can be translated into the equivalent influence of a reference element. Silicon as a reference element has been chosen for aluminum alloys and aluminum for magnesium alloys. The sum of the equivalent concentrations for other elements, when added to the influence of the actual reference element is used to calculate the liquidus temperature of the alloy. The calculated liquidus temperatures for wide ranges of alloy chemical compositions show a good correlation with corresponding measured liquidus temperatures.

Keywords: Al alloys; Mg alloys, liquidus temperature, phase diagrams.

M. Rakin, M. Arsić, S. Bošnjak, N. Gnjatović, B. Međo

INTEGRITY ASSESSMENT OF BUCKET WHEEL EXCAVATOR WELDED STRUCTURES BY USING THE SINGLE SELECTION METHOD

Tehnički vjesnik, 2013, Vol. 20, No. 5, 811-816.

In order to reduce the testing costs for structural welded joints and production losses due to excavator standstill, a new method for integrity and reliability assessment of welded joints during exploitation of bucket wheel excavators has been developed. In this paper, a part of non-destructive testing results for the butt welded joints on bucket wheel boom, counterweight boom and discharging boom is presented, prior to the repair of the collapsed bucket wheel excavator SchRs 1760×32/5. It has been in operational mode for 17 years prior to the collapse, in other words it has been subjected to approximately 2.125.000 cycles of variable loading. Hypergeometric distribution has been used for calculation of probability that x welded joints, which comprise n welded joints with defects, would be selected for testing out of overall number of joints Q . The integrity assessment for welded structures of bucket wheel excavators has been performed on the basis of defect analysis and probabilistic assessment of the fatigue crack growth in welded joints. By using this method, the testing costs have been reduced by 70 % through optimized scope of the inspections and time periods between them.

Keywords: elbow, finite element method, incompletely filled groove, pipe, structural integrity, welded joint.

M. Rakin, N. Bajić, M. . Mrdak, D. Veljić, M. Arsić

ANALYSIS OF MECHANICAL AND STRUCTURAL PROPERTIES OF MICRO ALLOYED STEEL WELDED JOINTS DEPENDING ON QUALITY OF CORED WIRE

Tehnički vjesnik, 2013, Vol. 20, No. 4, 635-640.

The aim of this study was to master new quality cored wires made of steel strips and the cores filled with metal powders and low molecular hydrophobic compounds. For experimental research, the specimens were made of micro alloyed steel type NIOMOL 490K intended for making welded structures subjected to dynamic loads and effects of low temperature. Welding of test specimens was done using the MAG method in CO₂ shielding with two new quality cored wires. The testing included the determination of mechanical properties of the base metal (BM) and the weld metal (WM), which apart from having sufficient strength must also have good toughness. The microstructures of BM, WM and heat affected zone (HAZ) were analysed, due to possible formation of a heterogeneous microstructure, which can reduce toughness. Results of testing of welded joints should define a new quality of cored wires in view of welding-technological characteristics. The results indicate that the new quality cored wires can produce good mechanical-structural properties of welded joints.

Keywords: cored wire, mechanical properties of welded joints, micro alloyed steel welding, microstructure.

S. Marković, Lj. Milović, M. Vrhovac, T. Lazović, A. Marinković, V. Aleksić

LIFE EXTENSION OF GEARS FLANK SURFACES REGENERATED BY HARD FACING

Metalurgia International, 2013, Vol. XVIII, No. 2, 81–85.

This paper contains the results of experimental analysis of fatigue endurance of used steel teeth regenerated by hard facing. The cylindrical spur gears were tested and compared with the newly made ones, after being regenerated by hard facing with subsequent cementation and quenching. The fatigue testing under variable amplitude loading was used to determine the duration of operational life through measurement of wear. The obtained results demonstrated the

impact of hard facing methods on gear endurance in operation. In the test on regenerated gears it was discovered that initial pits appeared almost simultaneously for different facing materials and a bit earlier than in tests on newly made ones, despite their considerably higher pitting rate. Apart from that, the tested operational lives of regenerated and newly-made gears were approximately equal and much longer than predicted.

Keywords: tribological characteristics, reparatory hard facing, gears working life.

RAD U ČASOPISU MEĐUNARODNOG ZNAČAJA (M24)

M. Arsić, Z. Odanović, S. Bošnjak, M. Mladenović, Z. Savić

STATE ANALYSIS AND INTEGRITY OF WELDED STRUCTURES OF THE UPPER RING OF THE TURBINE RUNNER GUIDE VANE APPARATUS OF HYDROELECTRIC GENERATING SET A6 ON HYDRO POWER PLANT ĐERDAP 1

Advanced Materials Research, Trans Tech Publications, Switzerland, 2013,
Vol. 814, 7-18.

During the refurbishment of the hydroelectric generating set A6 on HPP "Đerdap 1", for the state analysis and assessment of the level and causes of degradation of the structure of the vertical Kaplan turbine runner guide vane apparatus non-destructive tests and inspections, as well as destructive tests of base material and welded joints, have been carried out after 40 years of service. Results of non-destructive tests performed on welded joints are presented in this paper (magnetic particle and ultrasonic inspection), as well as results of destructive tests of the base material and welded joints (testing of tensile properties, impact testing, metallographic analyses of the structure). A large number of crack type line indications were detected by magnetic particle inspections, while the occurrence of partial penetration in roots of welded joints was detected by ultrasonic inspections, as well as lamellar tearing of the base material. Tensile properties of tested samples taken in longitudinal and transverse direction fulfilled the requirements of the standard with certain deviations, which does not stand for samples taken in z-direction with significantly lower values of contraction of the cross-section than minimum prescribed values, which proves that base material is not resistant to the occurrence of lamellar cracks. Metallographic tests performed on specimens taken from the base material in longitudinal and transverse direction showed that the microstructure is stripe-shaped and ferrite-pearlite with non-metallic inclusions of oxide, sulphide, silicate and aluminate type, while

metallographic tests performed on specimens taken from welded joints showed that their microstructure is stripe-shaped and ferrite-pearlite with non-metallic inclusions of oxide type. A large number of micro- and macro-cracks were detected in the microstructure as well. Experimental tests enabled the determination of the causes of occurrence of lamellar tearing in base material and crack type defects in welded joints, while analytical calculation that refers to the stress state enabled integrity of welded structure of the upper ring of the turbine runner guide vane apparatus.

Keywords: hydro turbine, welded structure, degradation of material, crack, integrity assessment.

Z. Odanović, M. Arsić, V. Grabulov, M. Đurđević

INVESTIGATION OF THE REPAIR WELDING TECHNOLOGY USING NI BASE ELECTRODE

Advanced Materials Research, Trans Tech Publications, Switzerland, 2013, Vol. 814, 25-32.

Metal materials are subjected to innumerable time-dependent degradation mechanisms when operate in power, petrochemical and refinery plant. These materials are subjected to multiaxial stresses, creep, fatigue, corrosion and abrasion. As a result of service especially at high temperatures and high pressures, can lead to forming cracks, damages or failures. In situation of breakdown in such systems there is a need for weld repair on plant components and repair work can be expensive and time-consuming. Most weld repairs of low alloy steels require high-temperature post weld heat treatment (PWHT); but in certain repairs, however, this is not always possible. Expenses of the repair work could be reduced if the weld repairing is performed on site. Also, application of the nickel based filler metal can be alternative to performing PWHT. These repair welding procedures with Ni based filler metal could be categorized as cold repair welding. Purpose of presented investigation was to compare a repair welding technology with filler austenite material

based on Ni and without application of the PWHT, with a classical repair welding procedure with preheating and PWHT and using a filler metal with chemical composition similar to parent metal. Properties comparison of the welded joints obtained by these two repair welding technologies was performed for the Cr-Mo steel (13CrMo4-5) by the metal arc welding procedure with covered electrode (MMA - 111). Weldability analysis by the analytical equations and technological tests for determination of the sensitivity to crack forming for cold and hot cracks by the CTS and Y tests, were performed for both repair welding technologies. Tensile tests, absorbed energies tests, bending tests and hardness measurements were performed on trial joints. Light optical microscopy (LOM) was applied for microstructure analysis. The fracture toughness of welded joints obtained by both investigated technologies, were estimated by the calculated stress intensity factor K_{Ic} and dynamic stress intensity factor K_{Id} for weld metal and heat affected zone. All of the obtained results were analyzed and discussed. It was concluded that repair welding technology with Ni base filler material without PWHT, enables welded joints without the appearance of cracks, with a good mechanical properties, slightly higher hardness in the HAZ, but with lower expenses compared to standard repair welding technology. In applying this technology in emergency welding repairing on-site, on the equipment and industrial facilities with high security requirements, inspection using non destructive technique has to be frequently applied compared to standard procedures.

Keywords: repair welding; cold welding; Cr-Mo steel; Ni based filler material.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

V. Aleksić, B. Vistić, Lj. Milović

METHODOLOGICAL APPROACH TO RECOVERY OF THE CRACKS ON THE TURBINE-SHAFT AT HYDROELECTRIC POWER PLANT ĐERDAP II

Power Transmissions, 4th International Conference, Sinaia, Romania, 2012.

Mechanisms and Machine Science, Springer, 2013, Vol. 13, 573-584.

In present paper, the methodological approach to analysis of the causes of failures and recovery of the damages has been presented using the example of the damage of the turbine-shafts construction. This approach can be applied to various types of similar constructions, and its application in preventive maintenance would contribute to extension of the operating life of the turbine shafts.

Keywords: turbine shaft, testing, crack, analysis, recovery.

V. Aleksić, Lj. Milović, S. Bulatović

TESTING OF METALS IN THE FUNCTION OF DETERMINING THE FAILURE OF TURBINE SHAFT – METHODOLOGICAL APPROACH

11th International Conference on Accomplishments in Electrical and Mechanical Engineering and Information Technology DEMI 2013, Banja Luka, Bosnia and Herzegovina, 2013, 1153-1158.

This paper presents a methodological approach of testing of metals in the function of determining the cause of failure and failure analysis of turbine shaft. The analysis was conducted on the example of damage of the turbine shaft in hydropower plants. This approach may be applied to similar types of turbine shaft, and its application in preventive maintenance would help extend the life of turbine shaft.

Keywords: turbine shaft, testing, crack, analysis.

V. Aleksić, R. Simić, Z. Stojanović, Lj. Milović

METODOLOŠKI PRISTUP SANACIJI OŠTEĆENJA PAROVODA U TERMOELEKTRANAMA I TOPLANAMA

III Međunarodni kongres *Inženjerstvo, ekologija i materijali u procesnoj industriji*, Jahorina, Bosna i Hercegovina, 2013, 382-392.

Na primeru procurivanja i oštećenja parovoda sveže pare u termoelektranama i toplanama prikazan je metodološki pristup utvrđivanja uzroka otkaza i saniranja oštećenja. Dati pristup se može primeniti za slične konstrukcije, a njegova primena u preventivnom održavanju doprinosi produženju radnog veka parovoda.

Keywords: parovod, oštećenje, sanacija, metodološki pristup.

V. Aleksić, S. Bulatović, Lj. Milović

CONTROL OF HAZARDOUS WASTE IN THE LABORATORY FOR METAL TESTING – CURRENT PROBLEMS

15th International conference *Meeting point of the science and practice in the fields of corrosion, materials and environmental protection*, Yucorr, Tara, Serbia, 2013, 153-161.

This paper presents a controlled process of collecting, identification, classification and labeling of waste and hazardous materials in laboratory for testing materials of the Institute of testing materials (Institute IMS). Waste management and hazardous materials are carried out by applying appropriate protective measures, in order not to endanger the lives and health of people and does not pollute the environment. This paper highlights the problems related to the disposal, storage and retrieval of small quantities of hazardous waste, as is the case in the laboratory for material testing. It should not be ignored, because small amounts of generated hardly degradable waste, if left without any care, can harm the environment and impact on quality of life.

Keywords: control, hazardous waste, laboratory, metal testing.

V. Aleksić, S. Bulatović, Lj. Milović

**NDT IN FUNCTION PREVENTION OF LOSS INTEGRITY
OF STRUCTURES LARGE DIMENSIONS**

5th Jubilee Balkan Mining Congress, Ohrid, Macedonia, 2013, 8, 21.

The paper presents examples of the loss of structural integrity due to large induced defects in welded joints occurred during the time of preparation of construction or during operation, which are not detected in time or not at the time repaired, and can be attributed to inadequate prevention in system maintenance. Daily visual inspection should be provided in order to monitor the behavior of structures in exploitation, and if necessary, NTD method of testing the most loaded parts of the structure should be applied. This approach may be applied to other types of similar construction, and its application in preventive maintenance would help extend the life of structures of large dimensions.

Keywords: NTD, prevention, integrity loss, large-scale structures.

RAD U NAUČNOM ČASOPISU (M53)

S. Bulatović, V. Aleksić, Lj. Milović

FAILURE OF STEAM LINE CAUSES DETERMINED BY NDT TESTING IN POWER AND HEATING PLANTS

Frattura ed integrità strutturale, The International Journal of the Italian Group of Fracture, 2013, Anno VI, No. 26, 41-48.

This paper examines leakage and damages of steam and provides an overview of NDT testing in order to determine the cause of steam lines failure in power plants and heating plants. This approach may be applied to similar structures and its application in preventive maintenance would help extend the life of steam pipes.

Keywords: steam line, failure, NDT testing.



B 003
ECOLOGY

B 003
EKOLOGIJA

RAD U ČASOPISU NACIONALNOG ZNAČAJA (M51)

D. Perović, T. Spasojević-Šantić

UZROCI I POSLEDICE GLOBALNOG ZAGREVANJA

ECOLOGICA, 2013, No. 71, 527-530.

Globalno zagrevanje je jedan od najsloženijih problema sadašnjice koji se manifestuje povećanjem prosečne temperature zemljine atmosfere od početka dvadesetog veka. Smatra se da je uzrok nastanka usled povećanih emisija CO₂ i CH₄ koji dovode do efekta staklene bašte. Globalno zagrevanje je nastalo nizom prirodnih uzroka poput: oslobađanje metana iz arktičkih tundri i močvara; promene u Zemljinoj orbiti; varijacije u emisiji energije Sunca i sunčeve pege; vulkanske aktivnosti i emisije aerosola koji oštećuju ozonski omotač. Međutim, uzroci nastali ljudskim delovanjem su ubrzali ovaj proces i kao neke od bitnijih možemo da navedemo: prenaseljenost i veliki broj stanovnika; pojačana industrijalizacija; sagorevanje fosilnog goriva kao osnovnog izvora energije; nestanak šuma; rupa u ozonskom omotaču, kao i sam način života ljudi u urbanom ekosistemu.

Keywords: globalno zagrevanje, gasovi staklene bašte, degradacija životne sredine, ozonski omotač, kisele kiše.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

T. Spasojević-Šantić, D. Perović, G. Dražić

FITOREMEDIJACIONI PLAN U TRETMANU ZEMLJIŠTA ZAGAĐENOG TEŠKIM METALIMA PRIMENOM INDIJSKE SLAČICE (BRASSICA JUNCEA)

Naučno-stručna konferencija *Zaštita životne sredine između nauke i prakse- stanje i perspektive*, Banja Luka, Bosna i Hercegovina, 2013.

Kao posledica naglog industrijskog razvoja i povećane poljoprivredne proizvodnje dolazi do stalnog porasta količina i vrsta štetnih i opasnih materija, što prouzrokuje sve izraženije zauzimanje i zagađivanje prostora i životne sredine. Teški metali se ubrajaju u najrasprostranjenije zagađivače zemljišta i šire životne sredine. Istraživanja ukazuju na njihovu toksičnost, ponašanje u zemljištu i ulaženje u lanac ishrane preko biljaka. Fitoremedijacija je biotehnologija koja podrazumeva upotrebu biljaka za ekstrakciju, sekvencijaciju i/ili detoksikaciju polutanata koji su prisutni u zemljištu. Biljne vrste i genotipovi značajno se razlikuju u sposobnosti distribucije teških metala. Indijska slačica (*Brassica juncea*) je najpoznatija vrsta koja je sposobna da akumulira olovo i da ga translocira iz korena u izdanak. Brojni su primeri testiranja *Brassica juncea* i sposobnosti ove biljke da akumulira olovo i druge teške metale u nadzemnom izdanku. Shodno tome, u radu će biti predstavljen fitoremedijacioni plan u tretmanu zemljišta zagađenog teškim metalima in situ primenom indijske slačice (*Brassica juncea*) kako bi se izvršila revitalizacija degradiranih lokaliteta.

Ključne reči: fitoremedijacija, indijska slačica, zemljište, teški metali.



P 420
PETROLOGY,
MINERALOGY,
GEOCHEMISTRY

T 150
**PETROLOGIJA,
MINERALOGIJA,
GEOHEMIJA**

RAD U MEĐUNARODNOM ČASOPISU (M23)

S. Dević, M. Cocić, M. Logar, S. Erić, N. Matejević

MINERALOGICAL CHARACTERIZATION OF PREMIX USED IN THE MANUFACTURE OF FOOD FOR POULTRY AND LIVESTOCK

Journal of Agricultural Science, 2013, Vol. 5, No. 11, 110–117.

One of the basic requirements that must be met in the production of livestock and poultry is a good food for their diet. Premix is an integral part in the food production for poultry and livestock. It is a mixture of organic and inorganic components. Our study has been conducted with a goal to identify minerals in foreign premix for the production of domestic premix and substitution of premix imported. Food with foreign premix has shown good results while raising poultry and livestock. Production of domestic premix with minerals from our area would enable better utilization of domestic resources. Using different methods (DTA, IR, XRD, SEM and EDS) mineralogical characterization of foreign premix has been made. Based on results of mineralogical characterization, minerals in mineral part of foreign producers' premix have been clearly identified. They are *Clinoptilolite* (Ca, K,) $_{2-3}Al_3$ (Al, Si) $_2Si_{13}O_{36} \cdot 12 (H_2O)$, as primary and minerals *Quartz* (SiO₂) and *Calcite* (CaCO₃) as secondary. The Clinoptilolite is mineral from zeolite group.

Keywords: premix, mineralogical characterization, feed, poultry, livestock, clinoptilolite,

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U IZVODU (M34)

S. Dević, M. Cocić, M. Logar

DTA AND IR METHOD SUPPORT THE MINERALOGICAL CHARACTERIZATION OF CLAY

2nd International Conference *Clays, Clay Minerals and Layered Materials CMLM 2013*, Sankt Petersburg, Russia, 2013, 55.

Clays belong to a complex group of minerals and their mineralogical characterization demands the use as many methods as possible. The paper presents the results of clay testing by DTA and infrared method as a contribution to mineralogical characterization of clay. These results confirm the results of other, previously used methods. The clays from two deposits in Serbia have been examined. Both clays were previously examined by XRF, XRD and EM method. The results of this method confirmed that the clay is of kaoline type (Dević et al. , 2011a). Both examined clays contain minerals kaolinite and halloysite. Clay 1 also contains quartz. SEM micrographs show the layered structure and platy forms (Fig. 1) (Dević et al. , 2011b). On the DTA curves are registered endothermic peaks in the temperature range 500-600°C which corresponds to kaolinite (Fig. 2). The endothermic effect of dehydration of kaolinite occurs in the range 550-650°C (Kulikov et al. , 1985). IR curves of both clays have shown characteristic peaks for kaolinite, but the clay 2 curve shows higher kaolinite content. These results are consistent with the chemical compositions of the examined clays. Clay 1 has a higher SiO₂ content, and clay 2 has a higher content of Al₂O₃ (Dević et al. , 2011a). DTA and IR methods are very important as a support to quality of mineralogical characterization.

Keywords: clay, mineralogical characterization, method

RAD U VODEĆEM ČASOPISU NACIONALNOG ZNAČAJA (M51)

S. Dević, M. Cocić, M. Logar,

OPTICAL MICROSCOPY AND ITS CONTRIBUTION TO THE CONTROL OF APPLIED SUBMERGED ENTRY NOZZLE (SEN) IN CONTINUOUS CASTING OF STEEL

Zaštita materijala, Materials protection, 2013, 54, (3), 275-279.

The aim of this paper is to represent results of optical microscopy in control of Submerged Entry Nozzle (SEN) that will show the contribution of this method in the process of continuous casting of steel. A large number of SEN have been monitored and tested in the long period. This paper shows the most interesting results. SEN are formed parts of refractory materials based on alumina-graphite. They are produced with isostatic pressing process and used in all kinds of steel casting. A polarizing microscope Neophot 32 was used for examination with optical microscopy (reflected light) method. In the process of continuous casting of steel, SEN is in contact with steel and casting powder that can act destructively on SEN. Thus, SEN erosion is the result of that destruction. Steel effects on the inner wall of SEN, while casting powder effects on the outside of the wall. The destructive effect of steel and casting powder reduces the durability and resistance of SEN. Micrographs in this paper present the appearance and structure formed at the contact of steel - wall of SEN and casting powder - wall of SEN. Appearance, structure and minerals as a result of optical microscopy examination indicate the influence of various factors on the process of continuous steel casting. These factors are the quality of casting powder, the quality of SEN, technological parameters (speed of steel casting, casting temperature, composition of the steel) and others. Depending on the obtained SEN results, if necessary, the correction of technology parameters and other influencing factors could be performed. The correction depends on the causes for SEN resistance reduction. Thus, if external SEN erosion is large, a less aggressive casting powder will be used in the process. The results of optical microscopy in control SEN indirectly contribute to improving processes, increasing quality of the final products and reduce costs.

Keywords: optical microscopy, SEN, casting powder, steel, continuous casting.

L. Kurešević, I. Delić-Nikolić, O. Vušović

VULKANITI STOLOVA KAO GRAĐEVINSKI KAMEN

Tehnika, 2013, Vol. 4, Rudarstvo, geologija i metalurgija 64, 640-645.

Vulkaniti Stolova južno od Kraljeva predstavljani su dajkovima dacito-andezita. Ovi vulkaniti su od otvaranja kamenoloma Kamenica pored reke Ribnice korišćeni za dobijanje kocke, agregata i ploča za oblaganje. Fizičko-mehanička svojstva ovog kamena, kao i njegov mineraloško-petrološki sastav ispitivani su u Institutu IMS iz Beograda dugi niz godina, i prikazani u ovom radu. Iako su fizičko-mehanička svojstva svežijih delova stenske mase dobra, zbog nedostatka monolitnosti, intenzivne ispucalosti, heterogenog izgleda i nepovoljnog lučenja, ovi vulkaniti nisu interesantni sa aspekta arhitektonskog građevinskog kamena, ali ispunjavaju uslove za primenu kao tehnički građevinski kamen, i upravo navedena svojstva olakšavaju njihovu eksploataciju.

Ključne reči: Stolovi, Kamenica, građevinski kamen.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U IZVODU (M64)

M. Cocić, M. Logar, B. Matović, S. Dević

MIKROSTRUKTURA I FAZNI SASTAV STAKLOKERAMIKE DOBIJENE OD DEFINITIVNE FLOTACIJSKE JALOVINE IZ RTB-A BOR

Šesti Simpozijum o termodinamici i faznim dijagramima, Borsko jezero, Srbija, 2013, 15-16.

U ekstrakciji bakra, posebno u procesu flotacijskog obogaćivanja i pirometalurške prerade nastaju otpadni materijali koji predstavljaju velike zagađivače životne sredine. Deponije definitivne flotacijske jalovine i odbačena šljaka iz peći za topljenje pretvaraju velike površine u degradirano zemljište i permanentni su izvor širenja zagađenja zemljišta, vode i vazduha.

Shodno činjenici da su to materijali ferosilikatnog sastava, mogućnost iskorišćenja ima izuzetan značaj, ne samo zbog smanjenja količine industrijskog otpada, već i kao potencijalna sirovina za obrazovanje sinterovane staklokeramike. Promenom uslova toplotne obrade kao i režima hlađenja može se kontrolisati mikrostruktura i osobine proizvoda, odnosno može se proizvesti staklokeramički materijal sa predodređenim osobinama [1]. Na sl. 1 date su dve staklokeramičke mikrostrukture izgrađene od stakla i kristala hematita na različitim temperaturnim režimima. Na $t = 1150^{\circ}\text{C}$ sadržaj hematita je 32 %. Kristali su anhedralni, retko subhedralni, prečnika uglavnom ispod $10\ \mu\text{m}$. Na 1480°C dolazi do pada viskoznosti i razlivanja stakla. Tada je površina u najvećoj meri izložena oksidaciji i razvoj hematita kulminira u velikom broju euhedralnih kristala čiji sadržaj dostiže 44 %. Između ove dve mikrostrukture, sintetizovan je niz staklokeramičkih materijala pod različitim temperaturnim režimima sa dodatkom bazalta i tufa. Težnja je da se pronađe optimalan sastav i uslovi kristalizacije za dobijanje primenljivog staklokeramičkog materijala.

Ključne reči: staklokeramika, kristali, staklo.



ORGANIZATION
OF CONFERENCES

ORGANIZACIJA
STRUČNIH SKUPOVA

Konferencija

**FASADE I KROVOVI U ZGRADARSTVU – SAVREMENI I
TRADICIONALNI MATERIJALI I SISTEMI U FUNKCIJI
ENERGETSKE EFIKASNOSTI, TRAJNOSTI I ESTETIKE**

Inženjerska komora Srbije, Beograd, 25.10.2013.

Organizatori

Društvo za ispitivanje i istraživanje materijala i konstrukcija Srbije;

Institut za ispitivanje materijala;

Inženjerska komora Srbije.

Izgradnja stambenih objekata, zgrada i porodičnih kuća, njihov kvalitet i estetski izgled su bitan element života u njima. Danas se susrećemo sa raznim načinima izgradnje gde se vrlo često ugrađuju nekvalitetni materijali koji narušavaju kako funkcionalnost objekta, tako i njegovu trajnost. Sa druge strane na tržištu su se pojavili kvalitetni materijali čijom primenom su se stvorili preduslovi za izgradnju kvalitetnih objekata, no njihovom nestručnom ugradnjom dobijaju se nefunkcionalni objekti, a u mnogome se i narušava njihov estetski izgled.

Konferencija prevashodno ima za cilj da se projektantima, ugrađivačima, kao i proizvođačima materijala ukaže na negativne pojave koje se dešavaju na već izgrađenim zgradama u toku njihove eksploatacije i koje negativno utiču na njihov vek i koje narušavaju estetski izgled samog objekta.

Takođe na konferenciji će se prikazati kako kvalitetnom primenom savremenih i tradicionalnih materijala u izgradnji zgrada, može da se dobije kvalitetan, energetski efikasan, siguran i trajan objekat sa aspekta življenja, a da istovremeno bude zadovoljena njegova estetika.

II International Conference of the Serbian Ceramic Society

**ADVANCED CERAMICS AND APPLICATIONS II: NEW FRONTIERS
IN MULTIFUNCTIONAL MATERIAL SCIENCE AND PROCESSING**

The Serbian Academy of Sciences and Arts, Belgrade, 30.9 - 1.10.2013.

Organization

Serbian Academy of Sciences and Arts;

Institute of Chemistry, Technology and Metallurgy;

Institute for Technology of Nuclear and Other Raw Mineral Materials;

IMS Institute;

Archaeological Institute of SASA;

Institute of Technical Sciences of SASA;

Ministry of Education, Science and Technological Development
of the Republic of Serbia.

The opening ceremony and welcome speeches given by prof. dr Vojislav Mitić, President of the Serbian Ceramic Society; prof. dr Olivera Milošević, president of the Serbian Ceramic Society Committee, and dr Radomir Žikić, assistant minister at the Ministry of Education, Science and Technological Development of the Republic of Serbia, were followed by plenary lectures. The second day of the conference proceeded with plenary sessions, invited lectures and work in sections.

The general conference topics included: Basic Ceramics Science, Science of Sintering, Multifunctional Ceramics, Nano, Bio and Opto Ceramics, Constructional and Eco ceramics, Magnetic and Amorphous Materials, Composites Catalysis and Electrocatalysis, Ceramic Art and Design, Archaeological Heritage and Young Researchers, and they were met with great interest among the wide scientific community, as reflected in the statement at Ceramic Tech Today.

Osmo naučno-stručno međunarodno savetovanje

**OCENA STANJA, ODRŽAVANJE I SANACIJA GRAĐEVINSKIH
OBJEKATA I NASELJA**

Borsko jezero, 14-17.5.2013.

Organizatori

Savez građevinskih inženjera Srbije;

Insitut za ispitivanje materijala;

Rudarsko-topioničarski basen Bor.

Specifični geotehnički i seizmološki problemi naše zemlje i Balkana, socio-ekonomski odnosi i drugi faktori doveli su do zaostajanja za razvijenim zemljama u oblasti tretmana postojećeg graditeljskog fonda. To je nametnulo potrebu razvoja metodologija za procenu stanja postojećih objekata i naselja, za izbor adekvatnog pristupa održavanju, sanaciji i rekonstrukciji građevinskih objekata i naselja uz uključivanje optimizacionih i informacionih sistema u ove oblasti. Uočavajući složenost i aktuelnost navedene problematike, Savez građevinskih inženjera Srbije (SGIS) organizovao je osmo po redu savetovanje, posvećeno oceni stanja, održavanju i sanaciji građevinskih objekata i naselja. Ciljevi savetovanja su široka razmena iskustava stručnjaka različitih profila: građevinskih inženjera različitih smerova, geotehničara, arhitekata, urbanista, prostornih planera, ekonomista, pravnika i ostalih stručnjaka koji rade u graditeljstvu na pregledu, ispitivanju i proceni stanja objekata i na projektovanju i izvođenju radova u oblasti održavanja i sanacija objekata i naselja.

Stručni seminar

**PRIMENA NOVIH STANDARDA U OBLASTI TEHNOLOGIJE
BETONA**

Institut za ispitivanje materijala, Beograd, 15.11.2013.

Organizatori:

Društvo za ispitivanje materijala i konstrukcija Srbije (DIMKS);

Institutom za ispitivanje materijala;

Građevinski fakultetom Univerziteta u Beogradu;

Fakultet tehničkih nauka Univerziteta u Novom Sadu, Departman za građevinarstvo i geodeziju;

Građevinsko-arhitektonski fakultet Univerziteta u Nišu;

Udruženje Cementne industrije Srbije.

Cilj seminara je bio inoviranje i unapređenje znanja putem upoznavanja sa najnovijim standardima iz te oblasti. Polaznicima je izdato uverenje o stečenom znanju iz oblasti obuhvaćene seminarom, koje se kasnije može upotrebiti kao dokaz o kompetentnosti kandidata za rad na poslovima na fabrikama betona, laboratorijama, građevinskim preduzećima koja izvide betonske radove itd.



AWARDS
AND RECOGNITIONS

NAGRADE
I PRIZNANJA

M. Gunjača, Z. Hiberšek, Ž. Ličina, Z. Luković

**NAGRADA ZA IZUZETNO DOSTIGNUĆE U STRUCI
IZ DELATNOSTI ČLANOVA INŽENJERSKE KOMORE SRBIJE
ZA PROJEKAT DRUMSKOG MOSTA SA KOSIM KABLOVIMA
PREKO REKE TISE U ADI**

Drumski most preko reke Tise u Adi je sastavni deo novoprojektovanog puta koji povezuje Adu u Bačkoj, na desnoj obali reke Tise i Padej u Banatu, na levoj obali. Konstruktivno rešenje mostovske konstrukcije je sistema grede sa kosim zategama. Most se sastoji od dva raspona, dužine $L = 77,4 \text{ m} + 167,7 \text{ m} = 245,10 \text{ m}$. Ukupna širina mosta iznosi 11 m. Širina kolovoza je konstantna i iznosi 7,50 m, a širina pešačkih staza je 1,50 m. Niveleta mosta je u vertikalnoj krivini u nagibu od 3%. Kao osnova za izradu grede iskorišćena konstrukcija demontiranog mosta, dobijena donacijom Vlade SR Nemačke 2002 godine.

Rekonstruisana čelični nosač starog mosta je otvorenog poprečnog preseka, ali sa povećanom visinom limenih nosača na 2 m i izvedenim ojačanjima na mestima ankerovanja kablova u konstrukciju i novododatim podužnim i poprečnim spregovima u okviru poprečnog odnosno podužnog preseka mosta. Kolovozna ploča je izvedena u obliku orto ploče sa trapeznim ukrućenjima. Greda je pridržana sa po tri para kosih kablova u svakom rasponu u rasporedu lepeze. Piloni stub mosta je „A“ oblika, visine 60 m u odnosu na kotu nivelete grede. Pilon je armirano betonski, punog pravougaonog poprečnog preseka, uklješteni u masivni rečni stub.



N. Šušić, D. Rakić

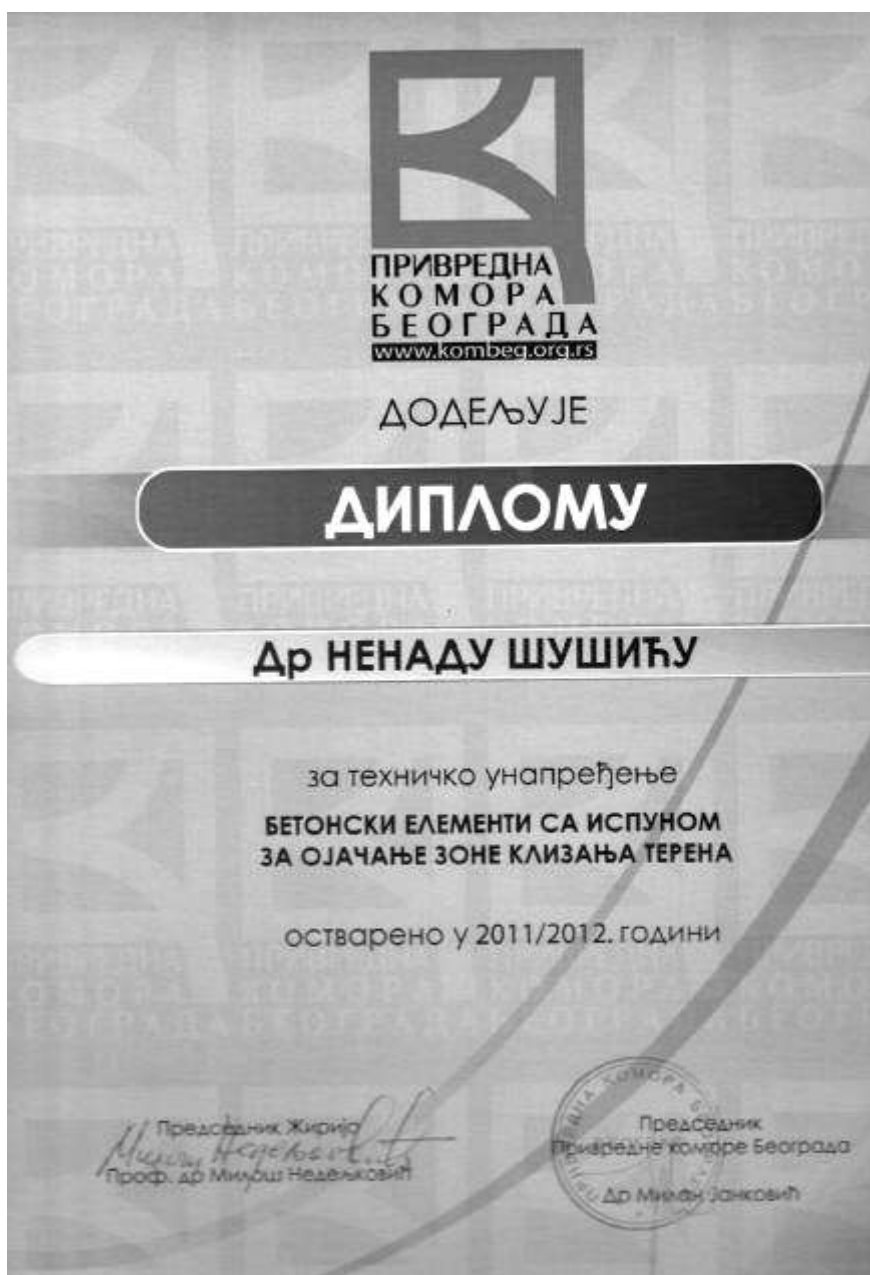
**NAGRADA PRIVREDNE KOMORE BEOGRADA ZA TEHNIČKO
UNAPREĐENJE ZA 2013. GODINU**

**ZA PATENT BETONSKI ELEMENTI SA ISPUNOM ZA OJAČANJE
ZONE KLIZANJA TERENA**

Da bi se sprečilo dalje klizanje terena potrebno je nekim merama povećati otpor tla, tj. ojačati zonu klizne površi. Ugradnjom novih betonskih elemenata sa ispunom postiže se ovaj efekat.

Betonski elementi sa ispunom je novi geo-konstruktivni element koga čine dva dela: valjkasti prstenovi i ispuna prstenova. Betonski elementi se ugradjuju tako što se tehnikom bušenja postavljaju kontinualni valjkasti betonski prstenovi u zonu iznad i ispod klizne površi. Zatim se šupljina prstenova popunjava sa betonom, drobljenim agregatom ili šljunkom.

Suština ugradnje betonskih elemenata sa ispunom je da oni prihvate sile klizanja i prenesu ih na stabilno tlo ispod klizne površi i na taj način ojačaju zonu klizne površi. Za razliku od standardnih načina sanacije klizišta gde ojačanje tla i konstrukcija se radi za celo tlo, od klizne površi pa do površine terena, betonski elementi sa ispunom su konstrukcije i ojačanja tla samo u zoni klizne površi. Na taj način troši se mnogo manje materijala i rada pri izvodjenju sanacionih mera, pa samim tim su i troškovi mnogo manji.





RESEARCH PROJECTS
FINANCED BY THE
MINISTRY OF EDUCATION,
SCIENCE AND
TECHNOLOGICAL
DEVELOPMENT

NAUČNI PROJEKTI
FINANSIRANI OD STRANE
MINISTARSTVA
PROSVETE, NAUKE
I TEHNOLOŠKOG
RAZVOJA

**NAUČNI PROJEKTI
FINANSIRANI OD STRANE MINISTARSTVA PROSVETE, NAUKE I
TEHNOLOŠKOG RAZVOJA**

TEHNOLOŠKI RAZVOJ

Ev. broj	Naziv projekta	
35002	Razvoj novih metodologija revitalizacije turbinske i hidromehaničke opreme hidroelektrana u zavisnosti od uzroka degradacije materijala	Dr Miodrag Arsić, rukovodilac projekta Dr Vencislav Grabulov Dr Zoran Odanović Nebojša Milovanović
36014	Geotehnički aspekti istraživanja i razvoja savremenih tehnologija građenja i sanacija deponija komunalnog otpada	Dr Nenad Šušić, rukovodilac projekta Mr Ksenija Đoković Dušan Berisavljević
36017	Istraživanje mogućnosti primene otpadnih i recikliranih materijala u betonskim kompozitima, sa ocenom uticaja na životnu sredinu, u cilju promocije održivog građevinarstva u Srbiji	Dr Aleksandra Mitrović Dr Ksenija Janković Dr Dragan Nikolić Mr Dragan Bojović Ljiljana Lončar
35011	Integritet opreme pod pritiskom pri istovremenom delovanju zamarajućeg opterećenja i temperature	Mr Dejan Momčilović Mr Vujadin Aleksić

35006	Održivost i unapređenje mašinskih sistema u energetici i transportu primenom forenzičkog inženjerstva, eko i robust dizajna	Dr Miodrag Arsić
35029	Razvoj metodologija za povećanje radne sposobnosti, pouzdanosti i energetske efikasnosti mašinskih sistema u energetici	Mr Dejan Momčilović
35040	Razvoj savremenih metoda dijagnostike i ispitivanja mašinskih struktura	Željko Flajs

INTEGRALNI PROJEKTI

Ev. broj	Naziv projekta	
45008	Razvoj i primena multifunkcionalnih materijala na bazi domaćih sirovina modernizacijom tradicionalnih tehnologija	Dr Zagorka Radojević Dr Anja Terzić Dr Milica Arsenović Mr Miloš Vasić Ljiljana Miličić Ivana Delić

OSNOVNA ISTRAŽIVANJA

Ev. broj **Naziv projekta**

186010 Minerali Srbije: sastav, struktura, geneza, primena i doprinos održanju životne sredine Dr Snežana Dević

172005 Uticaj nano i mikrostrukturnih konstituenata na sintezu i karakteristike savremenih kompozitnih materijala sa metalnom osnovom Dr Zoran Odanović

174004 Mikromehanički kriterijumi oštećenja i loma Dr Vencislav Grabulov

172057 Usmerena sinteza, struktura i svojstva multifunkcionalnih materijala Dr Anja Terzić



SELECTED
BUSINESS REFERENCES

ODABRANE
STRUČNE REFERENCE

U ovom odeljku dat je pregled ključnih usluga koje je Institut IMS izvršio u 2013. godini.

U skladu sa multidisciplinarnom organizacijom Instituta, usluge obuhvataju izradu investiciono-tehničke dokumentacije, ispitivanja na terenu i u laboratorijama, stručni nadzor nad izvođenjem radova, studije, ekspertize i drugo u praktično svim oblastima građevinarstva i energetike.

Pregled referenci dat je po organizacionim celinama.



THE CENTRE
FOR MATERIALS

CENTAR
ZA MATERIJALE

CENTAR ZA MATERIJALE

Laboratorija za kamen i agregat

R.b. Referenca

1. Laboratorijsko ispitivanje u cilju realizacije geoloških istraživanja ležišta kamena

2. Brojne analize kamena i kamenih agregata

3. Ispitivanje maltera sa kulturno-istorijskih spomenika (Sirmijum, Karadorđev konak, tvrđava Virpazar, kulturno dobro Suvača)

4. Ispitivanje kamena sa kulturno-istorijskih spomenika (manastir Arača, spomen kosturnica na Mačkovom kamenu, spomenik dobrovoljcima Prvog svetskog rata u Novom Miloševu)

Laboratorija za građevinsku keramiku		
R.b.	Referenca	Investitor
1.	Elaborat o oceni kvaliteta opekarske sirovine sa ležišta Čekmin	IGM Mladost Leskovac
2.	Elaborat o oceni kvaliteta sirovine iz bušotina izvedenih u Rađevskom ugljenom basenu kod Bele Crkve	Farmakom Šabac
3.	Elaborat o oceni kvaliteta opekarske sirovine sa ležišta	Univerzum Kubršnica Arandelovac
4.	Ispitivanje uzoraka crepova od gline proizvođača Potisje Kanjiža u cilju produžetka eko-znaka propisanog odlukom Evropske Komisije od 9. jula 2009. godine (C(2009) 5613)	Potisje Kanjiža
5.	Studija o oceni kvaliteta opekarske sirovine, definisanje parametara procesa proizvodnje opekarskih proizvoda za zidanje i crepa	Cigłana Podujevo
6.	Studija o utvrđivanju prirode i uzroka defekata na površini braon fasadne opeke	Zorka opeka Donje Crniljevo
7.	Veštačenje za Viši sud u Somboru: Nalaz sa mišljenjem o količini proizvedenih opekarskih proizvoda po vrsti proizvoda/asortimanu u 2006. godini u jednoj domaćoj cigłani	
8.	Studija o optimizaciji svojstava teniske šljake i aditiva	CAPITOL.W.B.C.PLC Ukrajina

Laboratorija za beton		
R.b.	Referenca	Investitor
1.	Kontrola kvaliteta betona na RTB Bor	Energoprojekt Visokogradnja
2.	Ispitivanja sastavnih delova betona i betona za betonsku bazu u Preševu, na deonici Autoputa Levosoje-granica BRJ Makedonija	Putevi Užice
3.	Projektovanje betonske mešavine za ledenu ab ploču za otvoreno klizalište SRC Tašmajdan	MBA Miljković
4.	Naknadno utvrđivanje kvaliteta betona u konstrukciji za most u Šljivovici, na putu Užice – Višegrad	Putevi Užice
5.	Naknadno utvrđivanje kvaliteta betona u konstrukciji za stambeno – poslovni centar Park, Kostolac	PD TE – KO Kostolac
6.	Proizvodna sposobnost fabrike betona	Put inženjering, Niš
7.	Završne ocene kvaliteta betona za objekte izvedene u Srbiji	GMT Konstrukcije Gračanica, BiH
8.	Kontrola kvaliteta betona na projektu: Most Zemun-Borča	China Road and Bridge Corporation – Serbia
9.	Kontrola kvaliteta ugrađenih materijala tokom izvođenja radova na autoputu E-80, deonica Čiflik-Staničenje	Construcciones Rubau Niš
10.	Rukovođenje laboratorijom za beton, stručna kontrola i pružanje instrukcija kod proizvodnje i ugrađivanja betona	Integral – Inženjering Banja Luka, BIH
11.	Pod-konsultant za nadzor građevinskih radova na autoputu E 75 (Grabovnica – Lovosoje)	Louis Berger



Laboratorija za veziva, hemiju i maltere

R.b. Referenca

1. Uvođenje i primena novog Pravilnika o kvalitetu cementa (Službeni Glasnik Br 34/2013)

Podneta kompletna dokumentacija za imenovanje Instituta IMS kao imenovanog tela za sertifikaciju cementa (prvo imenovanje iz oblasti građevinskih materijala)

 2. Prethodne probe i optimizacija sastava maltera za restauraciju tvrđave u Virpazaru , Koto

 3. Veštačenje u tužbi Prvi maj Čačak protiv Kribone Čačak, radi utvrđivanja istovetnosti tehnološkog postupka u proizvodnji gotovih maltera
-

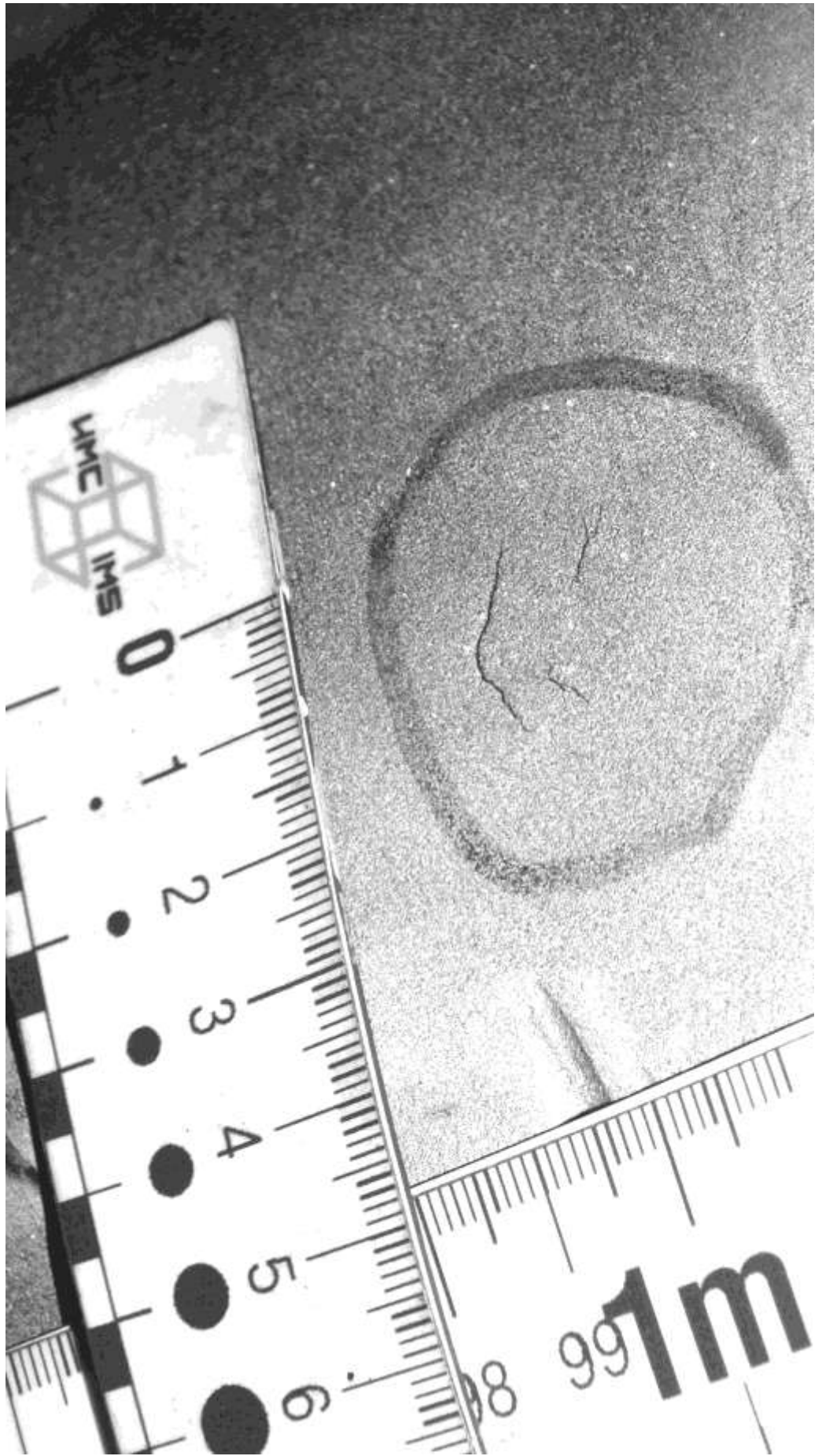


THE CENTRE
FOR METALS
AND ENERGETICS

CENTAR
ZA METALE
I ENERGETIKU

CENTAR ZA METALE I ENERGETIKU

R.b.	Referenca	Investitor
1.	<p>Ispitivanje i ocena stanja turbinske i hidromehaničke opreme agregata A4 i A5 (IBR (VT, VTδ, MT, PT UT, RT, HT, Replika)</p> <p>IR (mehaničko-tehnološke osobine, hemijski sastav, metalografija)</p> <p>Prijem opreme i kontrola tehničke dokumentacije hidroagregata i generatora u fabrikama u Srbiji i inostranstvu</p> <p>Izrada tehnologije zavarivanja, izbor elektrode i ispitivanje metala šava, ispitivanje za WPS</p> <p>procena preostalog veka</p> <p>konsalting usluge</p>	<p>PD HE Đerdap</p> <p>HE Đerdap 1,</p> <p>Kladovo</p>
2.	<p>Ispitivanje i ocena stanja turbinske i hidromehaničke opreme agregata A1 i A2 (IBR (VT, VTδ, MT, PT UT, RT, HT, Replika), procena preostalog veka.</p> <p>Ispitivanje i ocena stanja dovodnog cevovoda</p>	<p>PD HE Đerdap</p> <p>HE Pirot</p>
3.	<p>Ispitivanje metala metodama sa i bez razaranja opreme i parovoda (IBR (VT, VTδ, MT, PT, UT, RT, HT, Replika)</p> <p>IR (mehaničko tehnološke osobine, hemijski sastav, metalografija)</p> <p>Prijem opreme i kontrola tehničke dokumentacije</p>	<p>PD TE Nikola Tesla</p> <p>TE Kolubara A,</p> <p>Veliki Crljeni</p>



4.	Usluge ispitivanja metala sa i bez razaranja Panpnske termoelektrane i toplane Novi Sad	Kontrol Inspekt, Beograd
5.	Ispitivanje metala bez razaranja na terenu i ispitivanje metala sa razaranjem za potrebe TERMOELEKTRANE „B“ i KOPA DRMNO u 2013 god. Parovodi B1 i B2 (RA, RB, RC), napojna voda (RL), međupovezni parovodi (MP1-MP2 i P2-P3) IBR (VT, VT δ , MT, PT, UT, RT, HT, Replika) IR (mehaničko tehnološke osobine, hemijski sastav, metalografija)	PD TE KO Kostolac TE Kostolac B, Kopovi, Drmno
6.	IBR (VT,MT,PT, UT) i nadzor pri zavarivanju pri izradi gornjeg prstena usmernog aparata agregata A5 za HE Đerdap 1	DSD Noell – Virzburg, Nemačka
7.	Kontrolisanje metodama IBR (VT,MT,PT,UT) i IR (mehaničko-tehnološke osobine) pri izradi lopatica radnog kola i lopatica usmernog aparata agregata A4 u Litostroju, Ljubljana, Slovenija	PD HE Đerdap HE Đerdap 1, Kladovo
8.	Kontrolisanje metodama IBR (VT,MT,PT,UT) i IR (mehaničko-tehnološke osobine) pri izradi turbinskog poklopca agregata A5 u GOŠA FOM, Smederevska Palanka	PD HE Đerdap HE Đerdap 1, Kladovo
9.	Utvrđivanje stanja račve A6 cevovoda na HE Perućica IBR (VT, MT, PT, UT, RT), IR (mehaničko-tehnološke osobine) procena preostalog veka	EP CG, HE Perućica, Nikšić, Crna Gora



THE CENTRE
FOR ROADS
AND GEOTECHNICS

CENTAR
ZA PUTEVE
I GEOTEHNIKU

CENTAR ZA PUTEVE I GEOTEHNIKU

Odeljenje za geotehniku

R.b. Referenca

1. Ispitivanje šipova

Izveštaj o ispitivanju AB bušenih šipova Š5 i Š35 Ø1000 mm, statičkim probnim opterećenjem na vertikalnu silu pritiska za objekat "Silosi" u TE Kostolac

Izveštaj o ispitivanju AB šipa Š2 Ø1200 mm statičkim probnim opterećenjem na vertikalnu silu pritiska, Zrenjeninska petlja

Izveštaj o ispitivanju šipova sistema franki Ø600 mm-probni šipovi van konstrukcije Š1 i Š2, opitom statičkog probnog opterećenja vertikalnom silom pritiska za objekat 290 u okviru postrojenja za prečišćavanje otpadnih voda u Šapcu

Izveštaj o ispitivanju šipova sistema franki Ø600 mm- šipovi unutar konstrukcije Š67,Š131,Š251,Š349 i Š378, opitom statičkog probnog opterećenja vertikalnom silom pritiska za Nano centar, Novi Beograd

Izveštaj o ispitivanju bušenih šipova Ø900 mm šipovi Š56D i Š89D statičkim probnim opterećenjem hor. silom pritiska na kranskoj stazi za kombinovanu mašinu treće deponijske linije PK Drmno

2. Geotehnički elaborati

Geotehnički elaborat o rezultatima geotehničkih istraživanja terena za potrebe izrade projektne dokumentacije za objekat Magacin mehanizacije na trasi magistralnog gasovoda JUŽNI TOK u okviru kompresione stanice 2 u Bačkom dobrom Polju

Izvršenje dela istražnih radova - istraživanje geotehničkih uslova na deonici 3 i na lokacijama kompresorskih stanica 1 i 2, i laboratorijska ispitivanja uzoraka tla, za potrebe izrade Idejnog i Glavnog projekta Magistralnog gasovoda „Južni tok“ na teritoriji Republike Srbije

Elaborat o geološkim istraživanjima za potrebe stabilnosti padine u sklopu razrade projekta izgradnje Plaza centra, Beograd

Geotehnički elaborat o rezultatima ispitivanja terena za potrebe rekonstrukcije TS 220/110kV "KRUŠEVAC 1" i "BISTRICA"



Geotehnički elaborat o rezultatima ispitivanja terena za izgradnju objekata za odsumporavanje dimnih gasova u TENT A u Obrenovcu

Dokumentacioni elaborati o rezultatima geotehničkih ispitivanja terena za potrebe izgradnje propusta i mosta na pristupnom putu ka gasovodu JUŽNI TOK, lokalna stacionaža km: 0+104, na lokaciji Bačevica, Šalinac, Lugavčina, Kušiljevo-Porodin 1

Elaborat o potrebnim merama sa predlogom obezbeđenja kosina duž državnog puta IA-4 (M-21) deonica Užice-Kamenolom Surduk, na km:0+000-1+975 i Tunel Šargan-drž. granica, na km:0+000-12+669

Izveštaj o rezultatima dilatometarskih ispitivanja na odlagalištu PK Tamnava-Istočno polje u zoni izmeštanja korita reke Kolubare-II faza i novog bloka B-3 na lokaciji TE Kostolac B

Geotehnički izveštaj o dozvoljenom opterećenju asfaltnog betonskog platoa za potrebe montaže bagera tipa SCHRS 740/6*25 na mestima oslonaca montažnih podupirača

3. **Projekti sanacije klizišta**

Glavni projekat poboljšanja državnog puta II-156 (R-118a), Dojeviće-Pazarište, od km: 0+242.60 do km: 0+289.00 u zoni oštećenja trupa puta, sa geotehničkim elaboratom

Glavni projekat poboljšanja državnog puta II-130 (R-103), Aleksandrovac-Žabari, izlaz iz Oreovice sa sanacijom aktivnog klizišta na km:33+437, sa geotehničkim elaboratom

Glavni projekat poboljšanja državnog puta IB-115 (M-23.1), Kragujevac (Ravni gaj)-Kraljevo, na km:49+550 u zoni klizišta BALOSAVA 4, sa geotehničkim elaboratom

Glavni projekat poboljšanja državnog puta IB-15 (M-23.1), deonica Kragujevac (Ravni gaj)-Kraljevo, na km:48+970, u zoni klizišta BALOSAVA 3, sa geotehničkim elaboratom

Projekat izvedenog stanja poboljšanja puta u zoni klizišta JEZGROVIĆE 2 na magistralnom putu M-2, deonica Ribariće-Vitković, na km:1185+100

Glavni projekat poboljšanja puta II-158 (R-102), Kragujevac-Kruševac, od km:9+480 do km:9+500 u zoni klizišta u selu Donja Sabanta sa geotehničkim elaboratom



Odeljenje za projektovanje saobraćajnica

R.b.	Referenca	Investitor
1.	Glavni projekat kolovozne konstrukcije pristupnih puteva sa geotehničkim istražnim radovima do tehnoloških objekata magistralnog gasovoda Južni tok, na lokacijama: Zaječar / Prlita, Zaječar /Grište, Boljevac / Bačevica, Boljevac / Krivi Vir, Paraćin / Bošnjane, Despotovac / Brestovo, Svilajnac / Kušiljevo, Žabari/ Porodin.	South Stream Novi Sad
2.	Glavni projekat poboljšanja autoputa E-75, Beograd-Niš deonica: Mali Požarevac - Ralja, (desna traka) od km 615+598 do km 641+479, L= 25.881 km	JP Putevi Srbije



THE CENTRE FOR
STRUCTURES
AND PRESTRESSING

CENTAR ZA
KONSTRUKCIJE
I PREDNAPREZANJE

CENTAR ZA KONSTRUKCIJE I PREDNAPREZANJE

Odeljenje za prednaprezanje		
R.b.	Referenca	Investitor
	Primena sistema prednaprezanja SPB SUPER	
1.	Koridor XI, deonica Ub-Lajkovac	Putevi Užice
2.	Sanacija Kačkog mosta u Novom Sadu	Mostogradnja Beograd
	Primena sistema prednaprezanja SPB i SPB SUPER i utezački radovi	
3.	Nadvožnjak preko pruge i Privrednikove ulice na bulevaru Evrope u Novom Sadu	West Gradnja Šabac
4.	Most preko Ibra u Kraljevu	GP Nikolić Kraljevo
5.	Nadvožnjak preko pruge na deonici Gilje-Paraćin	BAUWESEN Vreoci



Odeljenje za sanacije, projektovanje i nadzor

R.b.	Referenca	Investitor
1.	Tehnički izveštaj o izvršenim istražnim radovima na lokaciji porušenog hangara u sklopu vojnog aereodroma Batajnica	Ministarstvo odbrane
2.	Tehnički izveštaj o izvršenim istražnim radovima na objektu upravne zgrade Beogradskog sajma	DP Beogradski sajam
3.	Tehnička kontrola glavnog projekta sanacije stambenog objekta u Beogradu	Građevinska direkcija Srbije
4.	Projekat sanacije armiranobetonske konstrukcije na serijama S-1700, S-2700, S-200 i S-2100 u sklopu rafinerije nafte u Pančevu	Rafinerija nafte Pančevo
5.	Projekat sanacije plivačkog bazena u Rači	Opština Rača
6.	Glavni projekat građevinske konstrukcije stambeno-poslovne zgrade u Vukovarskoj ulici u Osijeku, Hrvatska	Gradnja Osijek



Laboratorija za ispitivanje konstrukcija

R.b.	Referenca	Investitor
1.	Ispitivanje konstrukcije mostova probnim opterećenjem: NAR - LOT2 – Severne pristupne saobraćajnice prilazu mostu preko Ade u Beogradu (18 konstrukcija)	MBA Miljković
2.	Ispitivanje probnim opterećenjem konstrukcije tribina na stadionu FK Voždovac	FK Voždovac
3.	Ispitivanje stenskih ankera probnim opterećenjem na HE Trebinje 1	HE Trebinje 1 Grančarevo



CERTIFICATION BODY

SERTIFIKACIONO TELO

SERTIFIKACIONO TELO

R.b.	Referenca
	Sertifikacija proizvoda prema harmonizovanim evropskim standardima – Redovni nadzor fabrike i fabričke kontrole proizvodnje (FPC)
1.	ROCKWOOL ADRIATIC, Potpićan, Hrvatska
2.	URSA SLOVENIJA, Novo Mesto, Slovenija
3.	TRIMO INŽENJERING, Beograd
