REVIEW
OF RESEARCH
AND BUSINESS RESULTS
OF THE IMS INSTITUTE
IN 2021

PREGLED
NAUČNIH I STRUČNIH
REZULTATA
INSTITUTA IMS
U 2021. GODINI

Institut za ispitivanje materijala a.d.

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PREGLED NAUČNIH I STRUČNIH REZULTATA INSTITUTA IMS U 2021. GODINI

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U 2021. godini Institut IMS je, u saradnji sa svojim dugogodišnjim partnerima iz javnog sektora, građevinske industrije i energetike, nastavio da niže poslovne uspehe.

Stručni timovi Instituta i ove godine su učestvovali u najznačajnijim građevinskim poduhvatima, i to u svim fazama - od istražnih radova i projekata, preko ispitivanja, nadzora i kontrole kvaliteta, do izvođenja specijalističkih radova. Pored rada na geotehničkim konstrukcijama i objektima putne privrede, nastavljen je rad i na remontima hidro i termo-energetskih postrojenja, sanaciji konstrukcija i zaštićenog graditeljskog nasleđa, primeni sistema prednaprezanja. Akreditovane laboratorije Instituta IMS punim kapacitetom su ispitivale brojne građevinske proizvode, kao i građevinske i mašinske konstrukcije, buku i drugo, prema obimu svoje akreditacije. Puštena je u rad oprema za ispitivanja reakcije na požar. Nastavljen je projekat akustičkog zoniranja Beograda. Ispitani su probnim opterećenjem železnički mostovi duž brze pruge Beograd - Subotica. Realizovana je sertifikacija osoba u oblasti zavarivanja. Institut IMS je prva institucija u Republici Srbiji koja je formirala Telo za tehničko ocenjivanje, čime je otvorena mogućnost za sprovođenje tehničkog ocenjivanja širokog spektra nestandardizovanih građevinskih proizvoda.

Naučno-istraživački rad nastavljen je kroz realizaciju ugovora sa Ministarstvom za nauku i tehnološki razvoj Republike Srbije, u koji je uključeno dvadeset istraživača Instituta IMS. U ovoj godini, možemo se pohvaliti i učešćem naših stručnjaka u Programu za izvrsne projekte mladih istraživača Fonda za nauku Republike Srbije, kao i u programu bilateralne naučne i tehničke saradnje Ministarstva za nauku i tehnološki razvoj Republike Srbije i Saveta za naučno-tehnološka istraživanja Turske.

Apstrakti publikovanih radova su deo Pregleda rezultata na koji smo, po običaju, posebno ponosni. Uprkos različitim ograničenjima, u saradnji sa dugogodišnjim partnerskim akademskim i naučno-istraživačkim organizacijama učestvovali smo u organizaciji dva naučna skupa. Angažovanje Instituta IMS u izgradnji i održavanju objekata Beogradskog sajma prikazano je na izložbi u Galeriji nauke i tehnike Srpske akademije nauka i umetnosti.

U narednoj godini obeležavamo 70 godina od osnivanja Instituta za ispitivanje materijala Srpske akademije nauka za industriju i građevinarstvo, od koga je ubrzo potom nastao naš Institut kao samostalna ustanova. Ovaj jubilej nam imponuje, ali nas i obavezuje da održimo intenzitet i kvalitet rada po kome smo prepoznatljivi već sedam decenija.

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RAD U MEĐUNARODNOM ČASOPISU IZUZETNIH VREDNOSTI (M21A)

G. Goel, M. V. Vasić, N. K. Katyar, S. K. Kirthika, M. Pezo, P. Dinakar

POTENTIAL PATHWAY FOR RECYCLING OF THE PAPER MILL SLUDGE COMPOST FOR BRICK MAKING

Construction and Building Materials, 2021, Vol. 278, 122384.

This study's focus was to develop a potential pathway for recycling of the paper mill sludge compost (PMSC) in brick making. Composting reduces the paper mill sludge (PMS) moisture content considerably and shredding becomes easier. The addition of PMSC leads to an increase of porosities in bricks and makes them lighter, besides delivering energy to the firing process from burning organics. Lighter construction materials help minimize construction outlay by reducing labour and transportation costs and lesser expense on foundation construction. The variability in the experimental data and the brick properties were investigated for two types of soils, typical in the brick industry of India (alluvial and laterite soil), blended with PMSC in five mix ratios (0%, 5%, 10%, 15% and 20%). The samples of oven-dried bricks were fired at two different temperatures (850 and 900°C) in an electrically operated muffle furnace representing typical conditions of a brick kiln. Various properties of bricks were analyzed which included linear shrinkage, bulk density, water absorption and compressive strength. Conclusions were drawn based on these properties. It was found that the addition of PMSC to the alluvial and laterite soil by up to 10% weight yield mechanical properties of fired bricks compliant with the relevant Indian and ASTM codes. Toxicity characteristic leaching procedure (TCLP) tests showed that PMSC incorporated fired bricks are safe to use in regular applications as non-load-bearing and infill walls. This study is timely in light of the European Green Deal putting focus on circular economy. Besides, it fulfills the objective of UN sustainable development goals (SDG).

Keywords: paper mill sludge compost, fired bricks, recycling, sustainability, waste-to-brick, laterite soil, alluvial soil.

RAD U VRHUNSKOM MEĐUNARODNOM ČASOPISU (M21)

G. Veselinović, D. Životić, K. Penezić, M. Kašanin-Grubina, N. Mijatović, J. Malbašić, A. Šajnović

GEOCHEMICAL CHARACTERIZATION OF SEDIMENTS FROM THE ARCHAEOLOGICAL SITE VINČA – BELO BRDO, SERBIA,

Catena, 2021, Vol. 196, 104914.

In this study, a multidisciplinary approach was used for a detailed characterization of sediments from the archaeological site Vinča – Belo Brdo, Serbia, one of the most important Neolithic settlements in Europe. This research aimed to determine the paleoenvironmental conditions during Pleistocene and Early Holocene sedimentation prior to Early Neolithic settlement (~5800 cal BC) and provide novel insight into the interaction between humans and the environment during the Middle and Late Neolithic (5300–4550 cal BC). For the first time, organic geochemical characterization, combined with organic petrography, grain size, mineralogy, and inorganic analysis were done on sediment samples from geological and archaeological sections of the Vinča – Belo Brdo site. In the archaeological section, the layer with remains of the burned house and the overlaying leveling layer were particularly interesting. The samples from the oldest geological layers were characterized by the relatively high content of carbonates, the largest amount of soluble organic matter (OM), predominance of liptinite macerals, along with the prevalence of short and mid-chain n-alkanes indicating a marsh-lake depositional environment. The sedimentation of overlaying geological layers continued in an oxbow lake, followed by a shallow depositional environment with stronger input of vascular plants. This was indicated by an increase of the terrigenous component, a high amount of huminite maceral, especially textinite, the predominance of odd long-chain n-alkanes, as well as the presence of diterpanes, pimarane, and 16α(H)-phyllocladane. Quartz was the most abundant mineral in paleosol, while the OM had a mixed origin with a major input of microorganism in the precursor biomass. Estimated average paleosol temperature around 12–16 °C and mean annual precipitation of 938 mm/yr were favorable for ancient civilization settlement. In archaeological samples, the OM was predominantly formed by microorganisms, with a certain contribution of terrestrial plants. Their occurrence was substantiated by the

presence of telohuminite, detrohuminite, resinite, and sporinite. The prevalence of n-alkane C18, along with the occurrence of inertinite macerals, semifusinite and fusinite, in the layer with the burned house remains confirmed the incomplete combustion of woody biomass at temperatures <500 °C. Organic and inorganic geochemical parameters for the leveling layer covering the destroyed buildings showed analogous composition as the lowest geological layers. This proved that Vinča inhabitants excavated material for leveling at a site in their vicinity, and used it for covering the burnt debris, clearing the areas for a new settlement. In this context, the decades long archaeological dilemma of the origin of the leveling material was resolved.

Keywords: archaeological site Vinča, neolithic, paleosol, geochemistry, biomarkers.

M. V. Vasić, L. Pezo, M. Vasić, N. Mijatović, M. Mitrić, Z. Radjović

WHAT IS THE MOST RELEVANT METHOD FOR WATER ABSORPTION DETERMINATION IN CERAMIC TILES PRODUCED BY ILLITIC-KAOLINITIC CLAYS? THE MYSTERY BEHIND THE GRESIFICATION DIAGRAM

Boletín de la Sociedad Española de Cerámica y Vidrio, accepted 23.11.2020, https://doi.org/10.1016/j.bsecv.2020.11.006

This study presents the 51 mixtures of ceramic clays characterized by using XRF, XRD, granulometry, and dilatometry analyses. After firing in a 1000–1250 °C range, water absorption (WA) according to EN standards by boiling in water, under vacuum, and by 24 h soaking is determined. The results indicated that there was a high and statistically significant correlation between the standard methods, but the testing under vacuum gave the highest saturation of the samples fired at 1200 C and 1250°C. It is determined that these illitic-kaolinitic clays can be used to produce floor ceramic tiles belonging to the BIIa group (water absorption between 3% and 6%). The study also aimed to reveal which method of WA determination is suitable to read the sintering interval from the gresification diagrams, which is compared to the beginning of sintering as read from dilatometry curves.

Keywords: illitic-kaolinitic clays, ceramic tiles, water absorption, gresification diagram, sintering range.

M. V. Vasić, G. Goel, M. Vasić, Z. Radojević

RECYCLING OF WASTE COAL DUST FOR THE ENERGY-EFFICIENT FABRICATION OF BRICKS: A LABORATORY TO INDUSTRIAL-SCALE

Environmental Technology & Innovation, 2021, Vol. 21, 101350.

In this study, an optimal mixture of loess brick clays and waste coal dust in laboratory hollow blocks production is determined with the aim of promoting sustainable development in terms of saving resources and energy. The novelty of the work lies in the first-time utilization of waste coal dust in combination with loess soil brick-making thus bolstering European effort on waste utilization. The mentioned is also in line with UN sustainable development goals, SDG 12 and 9. The chemical and mineralogical contents of the clays were obtained using various chemical characterization methods, and thermal behavior by using dilatometry and simultaneous DSC/TG analysis. The important ceramic and technological characteristics of the extruded brick clay and waste coal dust composite samples during molding, drying, and firing were obtained. The chosen mixture of 70 % calcareous clay and 30 % plastic clay to 3 % of high-calorie waste coal dust is found optimal. Industrial-scale optimal blocks (250x190x190 mm^3) with 60 % of vertical voids were fired in a tunnel kiln, and the firing regime was recorded. It is determined that the regime must be corrected in the firing and cooling zone since the differences measured by thermo-couples were up to 180 C. The industrial prototype was found to be of satisfactory quality meeting the requirements of water absorption and compressive strength as per European and other international standards. The study was first of a kind detailed characterization of the industrial size bricks encompassing waste coal dust and loess brick clays, with the emphasis on the usability in the industry, and additionally recording and correcting of the firing regime in a tunnel kiln. The product is recyclable and can be disposed of safely after the end of life.

Keywords: loess brick clay, coal dust, optimal mixture, tunnel kiln, firing regime, optimization.

RAD U ISTAKNUTNOM MEĐUNARODNOM ČASOPISU (M22)

Lj. Miličić, A. Terzić, L. Pezo, N. Mijatović, I. Brčeski, N. Vukelić

ASSESSMENT OF EFFICIENCY OF RARE EARTH ELEMENTS RECOVERY FROM LIGNITE COAL COMBUSTION ASH VIA FIVE-STAGE EXTRACTION

Science of Sintering, 2021, Vol. 53, No. 1, 169–185.

Rare earth elements (REE) are frequently referred to as ingredients for enhancements in modern industry, as they are extensively applied in many industrial branches due to their accented electro-magnetic and optical properties. REE have end-utilizations as catalysts, magnets, and as dopants for ceramic materials. Rare earth minerals are scarce therefore the unconventional REE-containing resources such as waste materials and industrial byproducts are continuously being investigated. Coal combustion products comprise REE concentrations varying between 200 ppm and 1500 ppm. This quantity can be isolated though the extraction procedure. In this study, the five stages extraction was conducted on the coal combustion ash from the selected landfill site. The extractions of 32 elements (As, Ga, Ce, Be, Ge, Nd, Cr, Zr, Eu, Cu, Nb, Gd, Co, Mo, Dy, Li, Ag, W, Mn, Cd, Au, Ni, In, Hg, Pb, Sn, Tl, V, Sb, Th, Zn, and La) were conveyed. Chemical analyses were conducted via XRF, ICP-OES, ICP-MS, and AAS techniques. The complexity of the obtained data was examined by Principal component analysis and Cluster analysis in order to derive interconnections between quantity of elements and landfill characteristics, as well as mutual relationships among the elements of interest, and to assess the accomplishment of REE recovery from the coal ash.

Keywords: powdery materials, Industrial byproduct, recycling, chemical extraction, analytical modeling, dopants for ceramic materials.

M. Radomirović, N. Mijatović, M. Vasić, B. Tanaskovski, M. Mandić, L. Pezo, A. Onjia

THE CHARACTERIZATION AND POLLUTION STATUS OF THE SURFACE SEDIMENTIN THE BOKA KOTORSKA BAY, MONTENEGRO

Environmental Science and Pollution Research, 2021, Vol. 28, 53629–53652.

Surface sediments collected from twelve stations in the Boka Kotorska Bay were analyzed for the level and distribution of twenty-six elements and ten oxides, grain sizes, organicmatter, and carbonate content. Potentially toxic elements (Al, Fe,Mn, Cr, Zn, Ni, Cu, Pb, As, Co, U) were determined to assess the contamination status and potential environmental risk according to the single-element indices (enrichment factor (EF), geoaccumulation index (Igeo), contamination factor (CF)), and combined index (pollution load index (PLI)). The single-element indices EF and CF revealed that the surface marine sediment was moderately polluted with Pb, Cu, and Cr, while Igeo indicated moderate pollution with Ni > Cr > Zn > Cu > As and moderate to heavy pollution with Pb, as a result of the anthropogenic factors. The method of the combined effect of toxic elements, PLI, showed the highest pollution rate at the shipyard location in the Bay of Tivat. Pearson's correlation coefficient (r), principal component analysis (PCA), and cluster analysis (CA) were applied to highlight similarities and differences in the distribution of the investigated elements in the Bay, confirming the claim obtained by the pollution indices. The sediment contamination with most heavy metals, such as Cr, Zn, Ni, Cu, Pb, and As, has been identified in the Tivat Bay area.

Keywords: marine sediment quality, ED-XRF analysis, contamination indices, multivariate statistical analysis, Southeastern Adriatic Sea.

M. V. Vasić, L. Pezo, J. V. Gupta, S. Chaudhary, Z. Radojević

AN ARTIFICIAL NEURAL NETWORK-BASED PREDICTION MODEL FOR UTILIZATION OF COAL ASH IN PRODUCTION OF FIRED CLAY BRICKS: A REVIEW

Science of Sintering, 2021, Vol. 53, 37–53.

This study analyzed the last 20 years` data available on power plant coal ashes used in clay brick production. The statistical analysis has been carried out for a total of 302 cases based on the relevant parameters reported in the literature. The chemical composition of the clays and coal ashes, percentage incorporation and maximum particle size of ash, size of fired samples, peak firing temperature, and the corresponding soaking time were selected as inputs for modeling. The product characteristics i.e. open porosity, water absorption, and compressive strength was taken as output parameters. An artificial neural network model has been developed and showed a satisfactory fit to experimental data and predicted the observed output variables with the overall coefficient of determination (r^2) of 0.972 during the training period. Besides, the reduced chi-square, mean bias error, root mean square error, and mean percentage error were utilized to check the correctness of the obtained model, which proved the network generalization capability. The sensitivity analysis of the model suggested that the quantity of Na_2O coming from brick clays, the percentages of SiO_2 and K_2O coming from ashes, and MgO coming from clays were the most influential parameters in descending order for the ash-clay composite bricks` quality, mostly owing to the influence of fluxes during firing.

Keywords: clays, coal ash, traditional ceramics, mechanical properties, modeling.

RAD U MEĐUNARODNOM ČASOPISU (M23)

N. Mijatović, A. Terzić, L. Pezo, Lj. Miličić, D. Živojinović

IMPROVEMENT AND MODIFICATION OF ENERGY-DISPERSIVE X-RAY FLUORESCENCE METHOD FOR DETERMINATION OF METAL ELEMENTS IN CEMENT LEACHATES - CHEMOMETRIC APPROACH

Journal of the Serbian Chemical Society,
https://doi.org/10.2298/JSC200501067M

A modification of analytical procedure for energy-dispersive X-ray fluorescence (EDXRF) quantification of ten chemical elements (As, Ba, Cd, Co, Cr, Cu, Mo, Ni, Pb, Zn) in the leachates obtained from cement binders was developed. Twenty-nine testing samples were used in the experiment. All samples were based on Portland cement. Fly ash of different origin, zeolite and bentonite were employed as mineral additives in the cement binders. Distilled water was used as leachate. Validation of the modified EDXRF procedure was conducted in terms of limits of detection and quantification, working range, linearity, selectivity, precision, trueness, and robustness. Traceability of the procedure was established using certified reference materials. Uncertainty of measurement was confirmed via "in-house" laboratory validation approach. The expanded uncertainties for ten analysed elements were obtained for entire working range of EDXRF method. Robustness of the modified EDXRF procedure was assessed by means of chemometric in-house approach. The results obtained by modified X-ray fluorescence method were additionally correlated to those acquired by inductively coupled plasma optical emission spectrometry to confirm that EDXRF can be used as an effective and reliable alternative method for analysis of cement leachates.

Keywords: in-house validation; mineral additives, cluster analysis; ICP-OES, EDXRF, building materials.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

B. Ilić, V. Radonjanin, M. Malešev, M. Laban

CHALLENGES IN STANDARDIZATION OF 3D PRINTED CONCRETE

15th International Scientific Conference *Planning, Design, Construction and Building Renewal (iNDIS)*, Novi Sad, Serbia, 2021.

3D concrete printing (3DCP) is a promising new building technique in construction. There are a huge number of advantages of 3DCP that should be highlighted, such as reducing material use, improving safety and working conditions, creating less waste, simplifying the building logistics, savings in labor requirements and finally reducing building time. Despite all the benefits, to achieve a full 3DCP potential, a set of widely accepted, comprehensive standards should be developed. This paper will present information on the 3DCP standardization process in the world and various roadmaps for standard development.

Keywords: 3D concrete printing, standards, standardization, roadmaps.

K. Janković, D. Bojović, M. Stojanović, I. Despotović, L. Antić

PROPERTIES OF CONCRETE KERBS WITH RECYCLED AGGREGATE FROM PRECAST ELEMENT

2nd International Conference *CoMS 2020/21*, Slovenia, 2021, Vol. 1, 148–153.

The paper presents the possibility of using recycled aggregate from precast concrete paving elements and kerbs in the production of concrete kerb units. Experimental work included several types of concrete consistency class S1, made with different amounts of cement and coarse recycled concrete aggregate. The influence of percentage and grain size of recycled concrete aggregate on concrete compressive strength at different ages was observed. Based on the experimental results, it can be concluded that the use of recycled concrete as an aggregate creates a new composite material that can be used for the production of precast elements. The results show that the replacement of the coarse natural aggregate

with aggregate from crushed concrete is possible to produce concrete curbs that meet the requirements of EN 1340, but the class depends on the replacement percentage of the natural aggregate with recycled ones. In this way, the production waste is turned back to process, and the newly created concrete is certainly ecological material.

Keywords: recycled concrete aggregate, concrete, kerbs, precast elements.

K. Janković, M. Stojanović, D. Bojović, L. Antić, Lj. Lončar

THE INFLUENCE OF STEEL FIBERS AND CURING REGIMES ON MECHANICAL PROPERTIES OF UHPC

ASES International Symposium, Aranđelovac, Serbia, 2021, 246–254.

The most cement based composites with steel fibers have very high compressive strength, flexural strength and abrasion resistance. Micro steel fibers are usually used in ultra-high performance concrete (UHPC). It is important to determine its optimal dosage that improves the concrete properties and does not reduce the UHPC workability. Silica fume, as supplementary cementitious materials improving microstructure and strength of the interfacial transition zone (ITZ), which result in increase in strength of UHPC. Further, curing on high temperature have positive effect on the pozzolanic reactions between CH formed during hydration and silica fume. The aim of this study was to examine the effects of curing regimes on mechanical properties of UHPC with different content of steel fibers (1, 2 and 3%). Standard curing regime in water, steam curing and autoclaving were applied. Comparative test results of concrete in fresh and hardened state are shown.

Keywords: UHPC, steel fibers, compressive strength, flexural strength, curing regime.

M. Stojanović, K. Janković, D. Bojović, L. Antić, Lj. Lončar

INFLUENCE OF DIFFERENT TYPES ON THE ULTIMATE AND RESIDUAL FLEXURAL STRENGTH OF SPRAYED CONCRETE

2nd International Conference *CoMS 2020/21*, Slovenia, 2021, Vol. 2, 145–150.

The influence of the application of different types of fibres on the flexural strength of beams cut from slabs of sprayed concrete is presented in the paper. Fibres of different materials, shapes and dimensions were used. All types of concrete were made of the same component materials and composition, except the amount of fibres that is varied. Slabs of dimensions 60x60x10 cm were made using a concrete spraying machine. After curing, the beams of 75x125x500 mm were cut from the beams. Flexural strength of the beams was tested according to SRPS EN 14488-3 at the age of 28 days. Based on the test results, depending on the type, shape, amount and distribution of fibres, values of ultimate and residual strengths were analysed. The highest values of ultimate and residual strength at deformations of 0.5-1, 0.5-2 and 0.5-4 mm had sprayed concrete (or shotcrete) with the addition of 40 mm polypropylene fibres.

Keywords: shotcrete, fibres, flexural strength, ultimate and residual strength.

M. Stojanović, K. Janković, D. Bojović, L. Antić Aranđelović, Lj. Lončar

POSSIBILITY OF USING AERO SOLID AS A REPLACEMENT FOR AIR ENTRAINING ADMIXTURE

15th International Scientific Conference *Planning, Design, Construction and Building Renewal (iNDIS)*, Novi Sad, Serbia, 2021, 438–445.

Increasingly, there is a problem with infrastructure projects when using concrete with air entraining admixture. Such problems can occur due to many factors: incompatibility of applied materials, variability in the quality of component materials, concrete production in extreme conditions of elevated temperature, etc. It was investigated whether there is any other additive that does not have these shortcomings, but protects concrete from various influences. In this paper, the possibility of using Aero Solid powder additive as a substitute for air entraining admixture was shown. Three mixtures: without frost protection additive, with Aero Solid and with air entraining admixture were designed. The properties of fresh and hardened concrete were examined. The obtained results of compressive

strength, resistance to freezing / thawing and depth of penetration of water under pressure indicate that it is possible to use Aero Solid as a substitute for air entraining admixture.

Keywords: Aero Solid, air entraining admixture, freezing / thawing, compressive strength.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U IZVODU (M34)

A. Terzić, L. Pezo, M. Pezo, N. Mijatović, Lj. Miličić

APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN PERFORMANCE PREDICTION OF CEMENT MORTARS WITH VARIOUS MINERAL ADDITIVES

Serbian Ceramic Society Conference *Advanced Ceramic and Application IX – New frontiers in multifunctional material science and processing*, Belgrade, Serbia, 2021, 88.

Prediction of physico-mechanical and thermo-mechanical properties of cement mortars with different mineral additives based on materials' starting compositions by means of machine learning models is an essential feature in contemporary civil engineering. In this study, the prediction of performances of seventeen mortar mixtures based on Portland cement (CEM I 42.5R) with mineral additives and subsequent comparison with properties of mortars in which various cement types were used as binders was conducted using artificial neural network (ANN) modeling. Analytical model comprised discrimination based on similarities and differences between composite mortars and mortars based on 6 different cement types (without additives). The employed cements were: ordinary Portland cement, moderate heat hydration cement, high early strength cement, low heath hydration cement, high sulphate resistant cement, calcium aluminate cement, and high alumina cement. The mineral additives used were: fly ash, bottom ash, zeolite, bentonite, perlite, vermiculite, pyrophyllite, micro silica, silica fume, spinel, chamotte, calcinated clay, kaoline clay, alumina, limestone, talc, and copper slag. This investigation designates the impacts of various process parameters, such as the concentration of SiO2, Al2O3, Fe2O3, CaO, MgO, K2O, Na2O, TiO2, SO3, and LoI, and their effects on the quality of mortars with additives. The characteristics of mortars were evaluated regarding the dependent parameters such as: pozzolanic activity, heath of hydration, setting time, compressive strength, split tensile strength, compressive and split tensile strength under various temperatures up to 1000 □C, refractoriness, and sulphate resistence. Cluster Analysis and Principal Component Analysis were used for estimating the effect of ascertained process parameters on the quality of cements

and additives. Artificial neural network model was employed to foresee the quality of cement mortars with additives of discovered outputs and its results show the high suitability level of anticipation: 0.999 during the training period, which can be regarded appropriately enough to correctly predict the observed outputs in a wide range of processing parameters. The developed ANN model displayed high predictive accuracy and it can be used in civil engineering for prediction of properties of novel mineral additives if their chemical composition is known.

Keywords: Construction materials; Chemical analysis; Sintering, Physico-mechanical properties; Analytical modeling.

N. Mijatović, A. Terzić, Lj. Miličić, M. Vasić, Z. Radojević

CLAY SAMPLE PREPARATION BY MICROWAVE DIGESTION FOR FE DETERMINATION USING INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROMETRY

Serbian Ceramic Society Conference *Advanced Ceramic and Application IX – New frontiers in multifunctional material science and processing*, Belgrade, Serbia, 2021, 86–87.

This paper presents the optimization of clay sample preparation using microwave digestion for the determination of Fe using inductively coupled plasma optical emission spectrometry (ICP OES). The optimization of the method was performed using following factors: mass of the investigated sample, volume of acids - nitric (HNO3), hydrofluoric (HF), and phosphoric (H3PO4), and microwave digestion temperature. Iron concentrations were used as responses. Twenty seven samples and two certificated reference materials (CRM) were destroyed using different combinations of conditioning (i.e. variations of the mass of samples, volumes of acids, and temperatures). The following optimized conditions were established after full factorial design: digestion time of 20 min, sample amount of 0.1 g, 8 ml H3PO4, 2 ml HNO3, 1 ml HF, and digestion temperature of 230 °C. The efficiency in decomposing clays with concentrated acids was higher than 80 %. This condition allowed final digests in total concentration of Fe. The method was validated and applied for the determination of Fe in aluminosilicate samples. The optimized method allows the determination of iron with quantification limit of 0.01 mg/kg. The precision (expressed as relative standard deviations) was determined using five replicates of two samples

of clays and the results obtained were 1.68 % and 2.07 % for iron. The accuracy was confirmed by the analysis of two certified reference material (NCS DC CRM 60106 and NCS DC CRM 60102). The proposed method was applied for the determination of iron in clays from Serbia. The metal concentrations found varied from 1.86 % to 5 % for iron.

Keywords: chemical analysis, analytical modeling, statistical verification of methodology, ceramics, building materials.

M. V. Vasić, A. Terzić, Z. Radojević

GEOPOLYMERS TO REPLACE TRADITIONAL CERAMICS: A PRELIMINARY INVESTIGATION

Serbian Ceramic Society Conference *Advanced Ceramic and Application IX – New frontiers in multifunctional material science and processing*, Belgrade, Serbia, 2021, 87.

In an attempt to conduct the geopolimerization of raw clay and waste clay brick mixture, several experimental sets are conducted. Commercial water glass and 10 M KOH in a mass ratio of 2.5:1 were used as an activator. Samples are made in the form of 5×5×5 cm3 cubes and 12×2.5 cm2 tiles. The important results characterizing non-activated and activated samples after 14, 21, and 28 days are followed. Instrumental analyses were employed to determine the chemical and mineralogical content of the studied materials and to follow the changes introduced by the chemical alkaline activation (XRF, XRD, FT-IR, DSC/TGA, and dilatometry). The microstructure of the materials is recorded by microscopic technique (FESEM). The tile-shaped specimens behaved better than the cubes during the onset of drying, were more stable, and had fewer cracks. Besides, longer drying times induced better mechanical characteristics to the products, and also pre-curing in steam conditions is concluded to be beneficial. This was the first detailed study to show that, after a detailed study and optimization, it is possible to replace traditional ceramic with new materials, while avoiding thermal treatment and meeting the needs of the circular economy and sustainable development.

Keywords: geopolymer ceramics, waste brick, calcareous clay, alkali activation.

M. Aškrabić, D. Zakić, A. Savić, Lj. Miličić, I. Delić-Nikolić, Z.Ilić

COMPARISON BETWEEN DAMAGE DEVELOPMENT ON COMPOSITE AND STANDARDIZED MORTAR SPECIMENS EXPOSED TO SOLUBLE SALTS

5th International Conference on Salt Weathering of Buildings and Stone Sculptures, Delft, Netherlands, 2021, 129-139.

Salt crystallization of lime-based rendering mortars is one of the most common reasons for their deterioration. Still, testing of the resistance to soluble salt action has not yet been standardized for this type of material. Lime-based renders are usually placed in several layers, each of them having a specific role and composition. Nevertheless, tests used in the literature are commonly performed on standardized prismatic or cylindrical mortar specimens. This paper presents a comparison between damage development on the composite samples, prepared on porous stone substrate with two types of rendering mortars, and standardized prismatic mortar specimens. Samples were prepared with pure putty lime mortars and lime-putty based mortars with the addition of natural zeolite. Two types of composite samples and four types of prismatic samples were used during the test. The testing was conducted at the age of 90 days using two types of salt solutions (NaCl and Na2SO4). Damage development was followed visually during five cycles of wetting and drying. Salt distribution using XRF analysis was measured at the end of the test on composite samples. It was shown that damage development greatly depends both on sample and mortar types.

Keywords: rendering mortars, salt crystallization, salt distribution, lime based mortars.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

D. Ivanišević, S. Ilić, B. Ilić, M. Laban, A. Kijanović

KLASIFIKACIJA GRAĐEVINSKIH PROIZVODA U VEZI SA BITNIM KARAKTERISTIKAMA: REAKCIJA NA POŽAR I OTPORNOST PREMA POŽARU

Građevinski materijali i konstrukcije sa aspekta nove tehničke regulative u Republici Srbiji, Beograd, Srbija, 2021, 71–80.

Države sve veću pažnju poklanjaju poboljšanju građevinskih proizvoda koji se koriste prilikom izgradnje objekata. To značajno doprinosi zaštiti zgrada od požara, a samim tim i bezbednijoj evakuaciji osoba koje se nalaze unutar objekta. Kako bi način gradnje i izbor građevinskih proizvoda bio adekvatan, prilikom projektovanja, neophodno je da država napravi adekvatne zakone i pravilnike koji će imati sve potrebne smernice i ograničenja kojih projektanti i izvođači moraju da se pridržavaju. U radu je prikazana komparativna analiza Pravilnika o obaveznom atestiranju elemenata tipskih građevinskih konstrukcija na otpornost prema požaru i novog pravilnika koji je u pripremi.

Ključne reči: reakcija na požar, otpornost prema požaru, ponašanje prema spoljašnjem požaru, pravilnik, klasifikacija.

D. Jevtić, A. Savić, M. Aškrabić, Lj. Miličić

OSNOVNI ASPEKTI NOVOG PRAVILNIKA O TEHNIČKIM I DRUGIM ZAHTEVIMA ZA HEMIJSKE DODATKE BETONU

Građevinski materijali i konstrukcije sa aspekta nove tehničke regulative u Republici Srbiji, Beograd, Srbija, 2021, 21–33.

Pravilnikom o tehničkim zahtevima za hemijske dodatke betonu, mlaznom betonu, malteru i injekcionoj masi za kablove za prethodno naprezanje, definisan je kako postupak za stavljanje ovih proizvoda na tržište, tako i osnovni i specifični zahtevi koje svaki od ovih proizvoda treba da ispuni. U radu su bliže objašnjeni ovi zahtevi i procedure, kao i veza sa pratećim standardima za ispitivanje hemijskih dodataka.

Ključne reči: hemijski dodaci, sertifikacija proizvoda, specifični zahtevi.

D. Milinković, Lj. Miličić, B. Ilić, D. Pršić, N. Vukosavljević

NOVE MOGUĆNOSTI ZA OCENJIVANJE PERFORMANSI GRAĐEVINSKIH PROIZVODA KOJI NISU OBUHVAĆENI HARMONIZOVANIM STANDARDOM, TEHNIČKIM PROPISOM ILI SRPSKIM STANDARDOM I IZDAVANJE SRPSKE TEHNIČKE OCENE

Građevinski materijali i konstrukcije sa aspekta nove tehničke regulative u Republici Srbiji, Beograd, Srbija, 2021, 81–88.

Setom podzakonskih akata donetim na osnovu Zakona o građevinskim proizvodima („Službeni glasnik RS“, broj 83/18) uređuje se mogućnost ocenjivanja performansi građevinskih proizvoda koji ne potpadaju u oblast primene nekog postojećeg harmonizovanog standarda, tehničkog propisa ili srpskog standarda. Srpska tehnička ocena nudi proizvođačima građevinskih proizvoda put do srpskog znaka usaglašenosti odnosno dozvoljava ocenjivanje performansi građevinskog proizvoda i sačinjavanje deklaracije o performansama u slučaju nepostojanja harmonizovanog standarda, tehničkog propisa ili srpskog standarda ili za koje metoda ocenjivanja definisana u harmonizovanom standardu nije odgovarajuća za ocenjivanje performansi nijedne bitne karakteristike. Ovim radom predstavljene su ključne odredbe nacionalnih propisa kojima se utvrđuju uslovi i postupak sprovođenja tehničkog ocenjivanja građevinskih proizvoda.

Ključne reči: srpska tehnička ocena, srpski dokument za ocenjivanje, telo za tehničko ocenjivanje.

I. Delić Nikolić, B. Ilić, N. Matović

OSNOVNI ASPEKTI NOVOG PRAVILNIKA O TEHNIČKIM ZAHTEVIMA ZA FRAKCIONISANI AGREGAT ZA BETON I ASFALT

Građevinski materijali i konstrukcije sa aspekta nove tehničke regulative u Republici Srbiji, Beograd, Srbija, 2021, 11–20.

Pravilnikom o tehničkim zahtevima za frakcionisani agregat za beton i asfalt, koji se primenjuje na frakcionisane agregate dobijene obradom prirodnih,

proizvedenih ili recikliranih materijala i mešavine ovih agregata, propisani su tehnički zahtevi, postupci ocenjivanja i verifikacije stalnosti performansi i isti je usaglašen sa odredbama Zakona o građevinskim proizvodima. U ovim radu predstavljeni su ključni aspekti koje donosi novi Pravilnik, a odnose se prvenstveno na obaveze i odgovornosti proizvođača, kao i radnje koje sprovodi imenovano sertifikaciono telo za proizvod u postupku ocenjivanja i verifikacije stalnosti performansi.

Ključne reči: frakcionisani kameni agregat, ocenjivanje i verifikacija stalnosti performansi.

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

T 220
GRAĐEVINARSTVO,
HIDRAULIKA,
PRIOBALNA
TEHNOLOGIJA,
MEHANIKA TLA

RAD U MEĐUNARODNOM ČASOPISU (M23)

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

APPLICATION OF FLY ASH TO REDUCE SOIL DISPERSIVITY IN EMBANKMENTS

Comptes rendus de l'Académie Bulgare des Sciences, 2021, Vol. 74, No. 6, 890–898.

Due to rapid development of modern highways and railroad in Serbia, the need for embankment materials has increased. Deposits of natural materials used for this purpose often contain dispersive soils. On the other hand, thermal power plants in Serbia annually generate several million tons of fly ash, which could be used to reduce the dispersion of material embedded in embankments. The paper presents the results of tests conducted for the first time in Serbia to assess the improvement in natural soil dispersivity with fly ash from a thermal power plant. The dispersivity of mixtures of fly ash and natural soil was tested according to ASTM and BS standards. To determine the optimal ash content, 10, 30 or 50% of fly ash was added to the soil samples. The results show that 30 – 50% of fly ash reduces the dispersivity of natural soil for one to two dispersion classes.

Keywords: fly ash, dispersivity soils, loess, fly ash – soil mixture, soil stabilization, crumb test, double hydrometer test, pinhole test.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

M. Ćosić, N. Božović, M. Krstić

ANALYSIS OF REDISTRIBUTION OF THE PILE SHAFT-BASE LOAD USING THE DYNAMIC LOAD TEST (DLT)

Earthquake Engineering and Geotechnical Aspects of Civil Engineering, Vrnjačka Banja, Serbia, 2021, 308–316.

The paper analyses transmission and redistribution of the load from the pile on the soil, with a special focus on these effects regarding the shaft and base of the pile. The test was conducted using the dynamic load test (DLT) by incrementally increasing the kinetic energy of the drop weight impact in several drops. The results of in–situ DLTs are presented and after the performed signal matching for every impact of the drop weight. The testing and appropriate numerical analyses determined the mechanism of redistribution of the shaft-base load of the pile up to the ultimate bearing capacity, whereby there occurs a reduction in the transmission of the load via the shaft and an increase in the transmission of the load via the base.

Keywords: pile, shaft, base–toe, bearing capacity, testing, DLT.

M. Ćosić, N. Šušić, M. Prica

SOME ASPECTS OF PILE TESTING USING STATIC LOAD TEST (SLT)

Earthquake Engineering and Geotechnical Aspects of Civil Engineering, Vrnjačka Banja, Serbia, 2021, 317–327.

The paper presents typical examples of pile load tests with a specific analysis of results, whereby the test methodology relies on existing ASTM standards, own knowledge and experience. The pile tests were conducted using own equipment with licensed hardware and software for the Static Load Test (SLT). The tests have shown some situations that arise when analyzing the bearing capacity of piles. Aspects of application of different equipment and testing methodologies in different situations are indicated. Also, the need to develop a plan for testing the

load capacity of piles when it comes to large and significant structures was pointed out.

Keywords: pile, tests, bearing capacity, SLT, counterweight, reactive system.

M. Ćosić, N. Šušić, M. Prica, N. Božović

SOME ASPECTS OF PILE TESTING USING DYNAMIC LOAD TEST (DLT)

Earthquake Engineering and Geotechnical Aspects of Civil Engineering, Vrnjačka Banja, Serbia, 2021, 289–299.

The paper presents typical examples of pile load tests with a specific analysis of results, whereby the test methodology relies on existing ASTM standards, own knowledge and experience. The pile tests were conducted using own equipment with licensed hardware and software for the Dynamic Load Test (DLT). The tests have shown the correct and problematic situations that arise when analyzing the bearing capacity of piles. Aspects of application of different equipment and testing methodologies in different situations are indicated. Also, the need to develop a plan for testing the load capacity of piles when it comes to large and significant structures was pointed out.

Keywords: pile, tests, bearing capacity, DLT, signal matching.


НИКОЛА ТЕСЛА
1856-1943

REGISTROVAN PATENT NA NACIONALNOM NIVOU (M92)

M. Ćosić, N. Šušić, M. Prica

SISTEM SA OPRUGOM ZA POBOLJŠANJE DINAMIČKOG ISPITIVANJA ŠIPA – SPRING FOR IMPROVING THE DYNAMIC TESTING OF PILES

Broj 2021/8345 – MP – 2021/0065, od 7.7.2021.

Pronalazak se odnosi na sistem sa oprugom za poboljšanje dinamičkog ispitivanja šipa. Opruga se ugrađuje u sistem za dinamičko ispitivanje šipa. Elastičnom deformacijom (sabijanjem) opruge povećava se potencijalna energija sistema. Ukupna kinetička energija koja se realizuje prilikom udara tega o glavu šipa povećana je usled dodatnog dejstva opruge na slobodni pad tega sa odgovarajuće visine.

Ključne reči: opruga, šip, teg, udar.

T 230
BUILDING CONSTRUCTION

T 230
VISOKA GRADNJA

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

M. Ćosić, R. Folić

MODELING OF DAMPING EFFECTS IN SOIL – STRUCTURE INTERACTION IN THE PUSHOVER ANALYSIS

1st Croatian Conference on Earthquake Engineering, Zagreb, Croatia, 2021, 1333–1344.

The paper shows aspects of damping modelling in nonlinear static pushover analysis (NSPA) of structures through systematization of damping types and formed flow diagram, depending on the type of applied target displacement analysis. By applying the developed flow diagram, in the process of creating and analysing numerical models of structures, it is possible to very efficiently consider which type of damping should be selected and how to introduce damping in nonlinear static pushover analysis. Generally speaking, in nonlinear static pushover analysis (NSPA) damping is introduced indirectly by reducing the response spectrum. The problem of introducing damping is considered taking into account the soil-structure interaction, modelling the kinematic effects and the damping effects of the foundation, i.e., the ground. Parametric analysis was performed by varying the parameters: the effect of foundation depth, i.e., the impact of the existence of underground floors and the impact of damping. Based on the developed pushover curves, the levels of target displacements for each individual condition were determined, and then these discrete values were classified according to soil categories. By connecting such discrete values of the target displacement, a cumulative curve was constructed, i.e., an envelope of possible states of drifts and forces. By applying the proposed procedure, it is possible to consider the possible level of nonlinear deformations of the system, taking into account the effect of interaction with the soil and damping. The research established that the introduction of the soil-structure interaction can significantly affect the values of global drift, and thus partially the correction of the relevant total lateral seismic force. The sensitivity of the change in the relevant total lateral seismic force is much lower than the displacement, because in the nonlinear domain the system has much less stiffness, even in certain situations the stiffness is zero, so a small increase in load can produce much

greater deformation. Also, the research found that for different types of soil and different damping values, the fragments of the pushover curves, obtained by interpolating the target displacements for the same soil types, overlap at certain intervals.

Keywords: damping, flowchart, NSPA, pushover curve, drift, seismic.

RAD U ISTAKNUTOM NACIONALNOM ČASOPISU (M52)

M.Vasić, Z. Radojević

ODREĐIVANJE OTPORNOSTI NA PROKLIZAVANJE PODNIH OBLOGA I PEŠAČKIH STAZA – METODE VREDNOVANJA

Građevinski Kalendar 2020, 2021, Vol. 52, 2021, 34–49.

Jedan od uslova na koji treba obratiti posebnu pažnju prilikom projektovanja podnih objekata i pešačkih staza predstavlja odabir materijala koji moraju da uvaže i zahteve protivkliznosti, kako bi se predupredile neželjenene povrede i skupi sudski sporovi. Nedovoljno razvijena zakonska regulativa u našoj zemlji, koja prati i definiše uslove kvaliteta koje podne i pešačke podloge trebaju da poseduju po pitanju otpornosti na proklizavanje dodatno otežava posao pravilnog odabira materijala. Proces usaglašavanja domaće regulative i one koja važi u EU je poslednjih godina uzeo zamaha. Zahtevi za građevinske proizvode i objekte iz zakona o građeviskim proizvodima usvojenog 2018 godine prevashodno zahtevaju da objekti kao celine i njihovi sastavni delovi (podne obloge, pešače staze itd...) moraju da odgovaraju svojoj predviđenoj nameni, uzimajući u obzir zdravlje i bezbednost ljudi tokom čitavog životnog veka. Ovaj rad ima za cilj da približi domaćoj javnosti problematiku određivanja otpornosti na proklizavanje podnih obloga i pešačkih staza kao i ocenu istih. Nakon upoznavanja sa metodama vrednovanja protiv kliznosti, koje se uobičajeno koriste u EU, u radu su dati primeri ispitivanja i predlog kako da projektanti, zavisno od tipa podne obloge / pešačke staze i njihove pozicije u objektu odnosno buduće namene, definišu zahteve materijala koje se odnose na kvalitet po pitanju otpornosti na proklizavanje u trenutku njihove ugradnje odnosno nakon određenog perioda eksploatacije. Obzirom na činjenicu da će u EU krajem 2021 standardi opisani u radu biti objedinjeni u jedinstven EN 16165 standard, poslednji deo rada će se odnositi na kratak opis razlika u postupku uvežbavanja osoblja koje učestvuje u ispitivanju po metodi A – EU 16165 u dnosu na metodu DIN 51097.

Ključne reči: otpornost na proklizavanje, podne obloge.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

Z. Radojević, B. Ilić, M.Vasić,

TEHNIČKI I DRUGI ZAHTEVI ZA ELEMENTE ZA ZIDANJE PREMA NOVOM PRAVILNIKU I SERIJI STANDARDA SRPS EN 771

Građevinski materijali i konstrukcije sa aspekta nove tehničke regulative u Republici srbiji, Beograd, Srbija, 2021, 63–70.

Nakon usvajanja zakona o građevinskim proizvodima 2018 godine, kojim su uređeni uslovi za stavljanje na tržište elemenata za zidanje, kao i obaveze privrednih subjekata, usledio je period tranzicije. Tokom 2019 i 2020 doneti su novi pravilnici za elemente za zidanje čime je proces povlačenja stare tehničke regulative zasnovane nizu pravilnka i seriji SRPS (JUS) standarda otpočeo. Upravo to nas je navelo da u ovom radu akcenat bude na prikazu novih tehničkih i drugih zahteva (postupka ocenjivanja i verifikacije stalnosti performansi, obeležavanja i znaka usglašenosti) utvrđenih u seriji standarda EN 771 i novom pravilniku, koje elementi za zidanje treba da ispune. Serija standarda EN 771 (1–6) se odnosi na elemente za zidanje od gline, kalcijum silikata, od betona (obični i laki agregati) odnosno autoklaviranog ćelijastog betona, veštačkog i prirodnog kamena.

Ključne reči: elementi za zidanje, harmonizovani standardi serije EN 771., verifikacija stalnosti performansi, nadzor.

T 270
ENVIRONMENTAL
TECHNOLOGY,
POLLUTION CONTROL

T 270
TEHNOLOGIJA
ŽIVOTNE SREDINE,
KONTROLA ZAGAĐIVANJA

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

A. Drpić, T. Spasojević-Šantić, Z. Radojević

ENVIRONMENTAL PRODUCT DECLARATION (EPD) FOR CLAY ROOF TILES – CASE STUDY: PRODUCTION PLANT OF CLAY ROOF TILES IN REPUBLIC OF SERBIA

International Conference on Resource Sustainability, *icRS 2021,* University College Dublin, Ireland, 2021. doi:10.1088/1757-899X/1196/1/012031

The Environmental Product Declaration (EPD) is a standardized way of quantifying the impact of a product or system on the environment. This study evaluates the environmental impact of 1 tone of clay roof tiles, produced in production plant in Serbia, defined and grouped by use of Product Category Rules (PCR). The purpose of this study is to determine: (1) life cycle stages of the product which have the major impact on the environment expressed as environmental impact categories; (2) the processes of clay roof tile production which have the most important effects on the environment also expressed as environmental impact categories. The LCA analysis has been conducted with the One Click LCA software, developed by Bionova Ltd, Finland. All processes have been modelled based on the inventory data given in the Ecoinvent database (v3.6). According to the results in this study and observed from the aspect of the product life cycle, the production process has the major impact on the environment, and from the aspect of the resources used, the major impact on the environment has the consumption of energy and the use of raw materials.

Keywords: LCA, EPD, PCR, roof tiles.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U IZVODU (M34)

T. Spasojević-Šantić, A. Drpić, Z. Radojević

ENVIRONMENTAL PRODUCT DECLARATION (EPD) FOR CLAY CONSTRUCTION PRODUCT

9th Serbian Ceramic Society Conference *Advanced ceramics and application*, Belgrade, Serbia, 2021, 74–75.

Environmental Product Declarations (EPD) for clay construction products provide important information about those products and their use. The professional and technical foundations of the EPD must be verifiable and must meet the requirements of ISO 14025 for ecolabels, the ISO 21930 for EPD for building products, and the more specific EN 15804 for Product Category Rules (PCR) for construction products EPD. Each EPD needs to cover all life cycle stages of a product (module A-D). Life Cycle Assessment (LCA) analyses all phases of the life cycle of a construction product, takes into account the different impacts of these phases on the environment, evaluates, analyses and interprets the results. In this study, LCA analysis for clay construction products has been conducted with the One Click LCA software, developed by Bionova Ltd, Finland. All processes have been modelled based on the inventory data given in the Ecoinvent database (v3.6). Based on the results, the production phase (modules A1-A3) contributes the most to the environmental impact. Taken as a whole, most impact categories are dominated by energy processes and consumption of raw materials.

Keywords: EPD, LCA, PCR, construction products.

T 350
CHEMICAL TECHNOLOGY
AND ENGINEERING

T 350
HEMIJSKA TEHNOLOGIJA
I INŽENJERING

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

M. Vasić, R. Rekecki, Z. Radojević

NOVEL METHOD SUITABLE FOR DECREASING THE ROOFING TILE FAILURES GENERATED DURING RAPID DRYING

9th International Conference on Modern Technologies in Industrial Engineering *ModTech 2021*, Iasi, Romania, 2021.

Eventhough the literature related with the principles for setting up the rapid drying regime of porouse shrinking materials for example roofing tiles is rather limited it can be found that one of the restraing factors is related with the "nature" of the raw material. Beside it is practically impossible to achieve the 90 or 95% of the humidity in the industrial drying chambers or tunel during the heating step, in which products are heated to the much higher temperatures than in the traditional drying regimes. These effects will enevitabely cause the formation of cracks. In order to prevent the formation of cracks during intensive drying the nonionic surfactant Triton X-100 was added in the raw material during forming process. Various amouts of surfacants around the the critical micelle concentration (CMC) were used. The possibility to track all moisture transport mechanisms during isothermal experiments, in accordance with the comprehensive drying theory, on the Deff – MR curves was used. The material strength us moisture content (MS curve) were recorded experimentally using the Bazak procedure. Characteristic spots registered on Deff – MR curves were then transposed on the MS curves. Registered material strength and crack time positions helped us to monitor the development of the cracs during drying, to determin the moust suitable concentration of the sulfacant as well as to propose the explanaition how the interaction of the sulfacants with clay helps the water molecules to easier move up to the surface. The application of surfactant in a recomanded amount will significantly reduce the drying induced fractures in roofing tiles during its intensive drying and consequently good quality products can be produced by high drying rates.

Keywords: rapid drying, Deff – MR curves, effective diffusivity, moisture transport, clay tiles, nonionic surfactant, Triton X-100.

RAD U ISTAKNUTOM NACIONALNOM ČASOPISU (M52)

M.Vasić, Z. Radojević,

DESIGN AND CHARACTERIZATION OF TENNIS SLAG PRODUCED FROM GROUND BRICK SCARP WASTE AND ADDITIVES

Građevinski Kalendar 2020, Vol. 52, 2021, 1–15.

This paper presents the results of designing tennis slag with improved properties using grouded brick scrap waste and additives. Brick scarp was taken from three factories. The obtained waste from each factory was graunded at different granulation. Graunded scarp waste was firstly characterized. The additive was then added to each of the samples in different concentrations. After determining the initial humidity, the mixtures were exposed to various external influences (drying and freezing), during which the equilibrium humidity of the mixtures was determined. Process parameters and changes in the properties of mixtures that have an impact on the production process of a new final product – mixing, drying and packaging were monitored. It was stated that the treated samples of tennis slags were more consistent in humid conditions, that they did not freeze, and that the level of dust was reduced during exploitation.

Keywords: tennis slag, brick scarp waste, aditives.

T 450
METAL TECHNOLOGY,
METALLURGY,
METAL PRODUCTS

T450
TEHNOLOGIJA METALA,
METALURGIJA,
PROIZVODI OD METALA

RAD U MEĐUNARODNOM ČASOPISU (M23)

B. Zečević, Lj. Milovic , Z. Burzić, A. Maksimović, V. Aleksić

J-INTEGRAL ANALYSIS OF THE SIMULATED HEAT-AFFECTED ZONE OF THE ELEVATED-TEMPERATURE MARTENSITIC STEEL

Experimental Techniques, 2021, https://doi.org/10.1007/s40799-021-00487-9.

Due to its superior strength at high temperatures P/T91 steel is often applied in the chemical, petrochemical and fossil-fired power generation industries. The high strength is achieved by a suitable martensitic microstructure after appropriate heat treatment procedure. Welding is the most important process of joining the components in such plants, and the heat-affected zone is often the weakest part of these structures. Having in mind that the welded joint is the weakest area, it is necessary to know its properties and assess the level of its degradation. It was found that the life-limiting factor in case of P/T91 steel welded structures are the cracks located in the heat affected zones, more precisely in its intercritical region. In present paper the results of the fracture toughness measurement carried out on simulated P91 steel ICHAZ specimens produced using a weld simulator has been presented. The tests were done on two types of simulated specimens, those subjected to the subsequent PWHT and with those left untreated (without PWHT), at room temperature and 600 °C. For the J-integral estimation pin-loaded SEN(T) specimens were tested in plane stress conditions using the unloading compliance method of deriving a single specimen resistance curve and the η-method.

Keywords: resistance curves, elevated temperature, J-integral, SEN(T) specimen, simulated ICHAZ.

M. Dramicanin, S. Balos, P. Janjatovic, I. Zabunov, V. Grabulov

ACTIVATED FLUX TIG WELDING OF STAINLESS STEEL PIPES

Chemical Industry & Chemical Engineering Quarterly, 2021, Vol. 25, No. 4, 353–360.

In this work, the presence of TiO2 nano particle based activated flux combined with orbital welding of seamless thick-walled pipes of stainless steel and low-

cycle pulse current was done, representing a novel combination of welding processes parameters. Control specimens were welded without flux and consumable material and without flux with the consumable material. Experimental welding with different welding parameters was done. A special attention was done to characterize the flux by zeta sizer method, representing a new approach versus the conventional approach where nominal oxide particle size is reported. The obtained welds were visually tested, macro analyzed, their microstructures were examined, and their tensile and bending properties were determined. The results show that the flux influences a significant increase in penetration depth, up to the full penetration, which has a positive effect on the increase in the tensile and bending properties of the weld metal. Material beahviour model was developed, based on microstructural features of the near weld-line. Without the flux, grain enlargement occurred near the surface, while with flux, it occurred under the weld, which can be attributed to recrystallization and a reversed Marangoni convection.

Keywords: orbital welding, oxide coating, mechanical properties, depth of welding.

S. Bulatović, V. Aleksić , Lj. Milović , B. Zečević

AN ANALYSIS OF IMPACT TESTING OF HIGH STRENGTH LOW-ALLOY STEELS USED IN SHIP CONSTRUCTION

Brodogradnja/Shipbuilding, 2021, Vol. 72, No. 3, 1–12.

Brittle damages have been examined widely since welding became common practice when it comes to carrying out robust structures. Welded structure of the ship hull has to be continuous. Brittle damages that occur on hull structures have always been examined thoroughly. Cracks are most commonly initiated at locations where stress concentrators exist. These concentrators can originate due to flaws that occur during the design phase or due to mistakes that occur during the assembly of the structure. When it comes to failures and damages that occur at ship structures, it has been noticed that damages due to brittleness practically always happen at low temperatures. Impact test analysis is significant due to the fact that it replicates the ductile to brittle transition of steel in practically identical range of temperatures for all ship structures. Impact of ductile-brittle transition temperature is an important factor especially because there have been many ship failures and damages in history. In ship structures made of welded joints of high

strength low-alloy (HSLA) steels with their segments (parent metal, weld metal and heat-affected-zone), the toughness test determines the tendency of steel to brittle fracture, respectively the tendency to increase brittleness during exploitation. Parameters obtained by testing the properties of plasticity are the fundamental for the composition of ship structures with the aim of realize strengths under tested load. The test results of high strength low-alloy steel toughness assessment at different test temperatures show that temperature significantly affects the impact toughness of steels and their alloys.

Keywords: impact toughness, ship construction, high strength low-alloy steel, transition temperature.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

M. Arsić, N. Zdravković, V. Grabulov, S. Bulatović, M. Mladenović

STRENGTH OF THE WELDED JOINT WITH IMPROVED MECHANICAL PROPERTIES OF WELD METAL AND HEAT AFFECTED ZONE

X International Conference *Heavy Machinery – HM 2021*, Vrnjačka Banja, Serbia, 2021, A.43–A.46.

Selection of steel, dimensions and fabrication technology for the welded structure are all parts of the design process, because they are in close connection with the function of the structural whole under certain conditions of exploitation for the predicted service life. Quality of welded joints in the process of production of the welded structure is being defined by properties that the structure has to possess in order to fulfill certain requirements, which is being accomplished by the selection of the adequate welding procedure and welding parameters, implementation of inspection programs for all technological operations, as well as by performing mechanical and technological tests in order to determine the magnitude of strength and deformation of base material and welded joints. Constituent parts of a welded joint are base material, heat affected zone and weld metal. Heat affected zone of structural steels is being characterized by the fusion zone, overheating zone, zone of complete normalization and zone of incomplete normalization. In this paper the effect of change in hardness of weld metal and heat-affected zone on mechanical properties of welded joints when base material is quenched and tempered steel C45 is being considered. Test results showed that the application of welded structures made of quenched and tempered steels with hardness HV10 > 400 and tensile strength UTS > 600 MPa is useful only when the stress concentration is low ($\alpha_s \leq 2$) and when there are no residual stresses due to welding.

Keywords: supply quenched and tempered steel, mechanical properties, hardeness of the welded joint, heat affected zone.

M. Arsić, V. Grabulov, S. Bulatović, M. Mladenović, Z. Savić

WELDED JOINTS INTEGRITY OF THE PRESSURE VESSELS PIPES MADE OF HOT ROLLED FINE-GRAINED STEEL

Međunarodno savetovanje *Energetika 2021, Energija, ekonomija, ekologija*, Zlatibor, Serbia, 2021, 346–350.

Vertical Kaplan turbines, manufactured in Russia, are installed in 6 hydroelectric generating units at Đerdap 1, with nominal power of 176 MW each. Because of the structural solution and inability of performing periodic inspections and state analyses, 40 years long service life of the turbine and upper ring of guide vane apparatus was predicted. Welded structures of the turbine cover and upper ring of guide vane apparatus consist of 4 segments made of steel St 3, in accordance with GOST 380-94. Flux-cored arc welding was used in order to merge the segments. Non-destructive and destructive tests were performed on parent material and welded joints during the rehabilitation of the hydroelectric generating set A4, in order to carry out the condition analysis and assessment of the level and cause of eventual degradation of structures of the turbine cover and upper ring of guide vane apparatus at hydro power plant Đjerdap 1. In this paper the analyses that refer to determination of the cause of lamellar tearing of parent material in the area of welded joints based on results of magnetic particle testing and ultrasonic testing are presented.

Keywords: welded joint, specimens, micro specimens, mechanical properties, integrity.

M. Arsić, V. Grabulov, S. Bulatović, M. Mladenović, Z. Savić

LAMELLAR TEARING OF PARENT MATERIAL AND DEGRADATION OF WELDED JOINTS AT VITAL WELDED STRUCTURES

Međunarodno savetovanje *Energetika 2021, Energija, ekonomija, ekologija*, Zlatibor, Serbia, 2021, 351–354.

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Keywords: welded structure, non-destructive test, lamellar tearing of parent material, degradation of the welded joint.

S. Bulatović, V. Aleksić , Lj. Milovic , B. Zečević

HIGH STRENGTH LOW ALLOY STEELS IMPACT TOUGHNESSASSESSMENT AT DIFFERENT TEST TEMPERATURES

15th International Conference on Accomplishments in Mechanical and Industrial Engineering *DEMI 2021*, Banja Luka, BIH, 2021, 375–378.

In many production processes, as well as in the exploitation of machine components and structures, materials are exposed to impact loads. In structures made of welded joints of high strength low alloy steels with their constituents (parent metal, weld metal and heat affected zone), the toughness test determines the tendency of steel to brittle fracture, respectively the tendency to increase brittleness during exploitation. The strain rate is high and the material manifests much more brittle behavior than is shown by tensile testing. Toughness as a mechanical property is an important factor that is defined as the energy that needs to be spent in order to achieve fracture. Parameters obtained by testing the properties of plasticity are the basis for the design of structures in order to achieve strengths under applied load. The test results of high strength low alloy steel toughness assessment at different test temperatures show that temperature significantly affects the impact toughness of steels and their alloys. At higher temperatures the impact energy on fracture is high (the material shows the properties of plasticity) while at lower temperatures the impact energy is small (the material is brittle).

Keywords: impact toughness, high strength low alloy steel, welded joint.

S. Bulatović, V. Aleksić, B.Zečević

CORROSION PROTECTION OF SHIP

XXII YuCorr: Stecište nauke i prakse u oblastima korozije, zaštite materijala i životne sredine, Tara, Srbija, 2021, 177–182.

Hull maintenance is one of the most important aspect in ships lifetime. Ship maintenance represents prevention of ship system failures, dealing with them and extending ships lifetime. Corrosion has been a common cause of damage in ships for years. The most widely used method for protecting ship structures is application of coatings. Ships age, size and navigation area all influence in choosing the right protective coating system. Hull protective coating can be applied either during navigation or during ship repair works in shipyard.

Keywords: corrosion protection, protective coatings, ship's hull.

V. Aleksić, B. Zečević, S. Bulatović, A. Maksimović, Lj. Milović

3D MODELING IN THE FUNCTION OF CAVITATION DEMAGE TESTING AT HYDROPOWER PLANTS

U susret zelenom oporavku, ENERGETIKA 2021, Zlatibor, Serbia, 2021, 360–363.

Very little attention is being paid to conditions of surface preparation prior to the execution of non-destructive testing. The quality of the performed test also depends on the preparation, as well as the quality of the test report, which must include traceability and repeatability, which is not often the case. One of the aspects of preparation is making of a sketch, 2D or axonometric, of the object of examination with a defined orientation in space and certain benchmarks in order to define the identified defect and imperfections. Damage caused by cavitation erosion is a current problem in parts of hydropower plants which elements are exposed to the effects of rapid water flow. Analysis of the cavitation effect and an adequate approach to solving the problem requires a comprehensive picture of the places that are most exposed to cavitation, and this is achieved by controlling and testing parts of hydropower plants by nondestructive methods. The paper

shows the usage of a parametric drawing and modeling program, SolidWorks, on the example of testing parts of large hydropower equipment exposed to cavitation, in order to prepare for non-destructive testing and report on the performed test.

Keywords: nondestructive testing (NDT), cavitation damage, 3D modeling.

V. Aleksić, M. Dojčinović, Lj. Milović, B. Aleksić, A. Prodanović

MECHANISMS AND MORPHOLOGIES OF CAVITATION DEMAGE OF NN 70 STEEL

XXII YuCorr: Stecište nauke i prakse u oblastima korozije, zaštite materijala i životne sredine, Tara, Srbija, 2021, 237–247.

Broken test tubes for low-cycle fatigue testing of Nionicral 70 (NN-70) parent material (PM) steel and simulated heat-affected zones (SHAZ) were used to produce samples for cavitation resistance testing. Ultrasonic vibrational cavitation method (stationary sample method) was applied for testing in laboratory conditions. The test conditions and procedure, sample preparation and interpretation of results are defined by ASTM G32. The surfaces of the NN-70 PM and SHAZ steel samples were exposed to cavitation and damage monitoring over time. Measuring the weight loss of samples on the analytical balance after a certain time allowed us to determine the cavitation velocity as a measure of the material's resistance to the effect of cavitation. Scanning electron microscopy (SEM) was applied to monitor variations in surface morphology with changing test time. On the basis of the results of the cavitation resistance test, the morphologies of the surface damage for different exposure times of the cavitation of PM and SHAZ steel NN-70 samples were analyzed, as well as the mechanisms that led to the damage of the sample surfaces.

Keywords: cavitation, steel NN-70, PM, SHAZ, mechanisms and morphologies of damage.

V. Grabulov, Z. Burzić, Dž. Gačo, M. Burzić, S. Perković

EXPERIMENTAL DETERMINATION OF HIGH-CYCLIC FATIGUE PARAMETERS OF WELDED JOINT OF HIGH-ALLOY STEEL X20

11th International Scientific – Professional Conference *Engineering Technologies in Manufacturing of Welded Constructions and Products, SBW 2021*, Slavonski Brod, Croatia, 2021, (USB) 8 p.

Experimental research in this paper included the influence of exploitation time and temperature on the behavior of the welded joint of high-alloy steel X20 CrMoV 12 1 (X20) under conditions of variable load. The influence of exploitation conditions was analyzed by determining the permanent dynamic strength, construction of the Weller diagrams (S-N diagrams) of the base material and components of the welded joint.

Keywords: High alloy steel X20, high cycle fatigue, permanent dynamic strength, Weller diagrams.

Z. Burzić, S. Perković, M. Lisov, V. Grabulov, M. Burzić

CRACK INITIATION AND GROWTH IN WELDED JOINT OF STEEL FOR OPERATION AT ELEVATED TEMPERATURE

31st International Conference *WELDING 2020*, Kladovo, Serbia, 2021, (USB) 8 p.

In a paper given, experimental investigations have included the analysis of crack initiation and growth in welded joint of steel for operation at elevated temperatures. For better understanding of the phenomenon of crack initiation and propagation in welded joints of A-204 Gr. A steel designed for high-temperature and high-pressure application, it is necessary to determine the effect of heterogeneity of microstructural and mechanical properties on fracture toughness and fatigue crack initiation and propagation in welded joint components. Based on the tests conducted with pre-cracked CT and Charpy size specimens, the effect of heterogeneity of microstructural and mechanical properties of welded joints on fracture toughness and fatigue-crack growth parameters was determined.

Keywords: weld joint, fracture toughness, fatigue crack initiation, fatigue crack growth, fatigue threshold.

RAD U VRHUNSKOM ČASOPISU NACIONALNOG ZNAČAJA (M51)

V. Aleksić, M. Dojčinović, Lj. Milović, B. Zečević, A. Maksimović

MEHANIZMI I MORFOLOGIJE KAVITACIONOG OŠTEĆENJA ČELIKA NIONIKRAL 70

Zaštita Materijala, 2021, Vol. 62, No. 2, 95–105.

Polomljene epruvete za ispitivanje niskocikličnim zamorom čelika Nionikral 70 (NN-70) osnovnog materijala (OM) i simulirane zone pod uticajem toplote (SZUT) poslužile su nam za izradu uzoraka za ispitivanje otpornosti na kavitaciju. Za ispitivanje u laboratorijskim uslovima primenjena je ultrazvučna vibraciona metoda kavitacije (metoda stacionarnog uzorka). Uslovi i procedura ispitivanja, priprema uzoraka kao i interpretacija rezultata definisani su standardom ASTM G32. Površine uzoraka čelika NN-70 OM i SZUT bile su izložene dejstvu kavitacije i praćenju oštećenja kroz određeno vreme. Merenje gubitka mase uzoraka na analitičkoj vagi posle određenog vremena omogućilo nam je određivanje kavitacione brzine kao mere procene otpornosti materijala na dejstvo kavitacije. Za praćenje varijacija u morfologiji površine s promenom vremena ispitivanja primenjena je skenirajuća elektronska mikroskopija (SEM). Na osnovu rezultata ispitivanja otpornosti na kavitaciju u radu su analizirane morfologije oštećenja površina za različita vremena izlaganja dejstvu kavitacije uzoraka OM i SZUT čelika NN-70 kao i mehanizmi koji su doveli do oštećenja površina uzoraka.

Ključne reči: kavitacija; čelik NN-70; OM; SZUT; mehanizmi i morfologije oštećenja.

ORGANIZATION
OF CONFERENCES

ORGANIZACIJA
STRUČNIH SKUPOVA

STRUČNI SKUP

ZEMLJOTRESNO INŽENJERSTVO I GEOTEHNIČKI ASPEKTI GRAĐEVINARSTVA

Vrnjačka Banja, 3–5.11.2021.

Organizatori

Savez građevinskih inženjera Srbije – Društvo za zemljotresno inženjerstvo Srbije i Srpsko društvo za mehaniku tla i geotehničko inženjerstvo

Institut IMS, Beograd

Ograničene mogućnosti nametnute aktuelnom pandemijskom situacijom su razlog koji je uslovio istovremeno održavanje dva savetovanja. Raznolikost geotehničkih uslova, složeni geotehnički zahvati prilikom izgradnje objekata u urbanim područjima i objekata saobraćajne insfrastrukture, česte pojave klizišta, nove tehnologije i materijali, kao i činjenica da Srbija i zemlje regiona spadaju u seizmički aktivna područja nameću potrebu i interes za teme koje Savetovanje obuhvata.

Razmenjena su iskustva stručnjaka različitih profila i specijalnosti koji se bave geotehnikom. Važna pitanja su pregled dosadašnjih rezultata i dostignuća u ovim važnim oblastima kao što su: metoda primenjenih geotehničkih terenskih istražnih radova, laboratorijskih ispitivanja, seizmoloških istraživanja, primene savremenih teorijskih i numeričkih postupaka, metodologije analize i projektovanja, kao i oblast praktične građevinske operative.

STRUČNI SKUP

GRAĐEVINSKI MATERIJALI I KONSTRUKCIJE SA ASPEKTA NOVE TEHNIČKE REGULATIVE U REPUBLICI SRBIJI

Institut IMS, Beograd, 8.10.2021.

Organizatori

Institut IMS, Beograd

Društvo za ispitivanje i istraživanje materijala i konstrukcija (DIMK) Srbije

Društvo za ispitivanje i istraživanje materijala i konstrukcija (DIMK) Srbije i Institut za ispitivanje materijala u sklopu svojih aktivnosti, između ostalog, permanentno organizuju susrete naučnika, stručnjaka i predstavnika privrede koji se bave problematikom materijala i konstrukcija. Ograničene mogućnosti nametnute aktuelnom pandemiskom situacijom su uslovile pauzu u organizaciji ovakvih skupova a u međuvremenu izrađeni su i stupili na snagu propisi, set pravilnika, koji su od suštinskog značaja za građevinarstvo.

Cilj Skupa je bio da se stručnoj javnosti i predstavnicima građevinske industrije prikažu najznačajnije odredbe i aspekti primene novih pravilnika koji su doneti u poslednjih par godina ili su u postupku donošenja. Tehnički zahtevi koje moraju da ispune građevinski materijali, postupak ocenjivanja i verifikacije stalnosti performansi, vrsta tela za ocenjivanje, deklaracija i sertifikat o performansama kao i znak usaglašenosti su osnovne teme Skupa. Dužna pažnja je posvećena građevinskim konstrukcijama, zahtevima za projektovanje, izvođenje, održavanje, rušenje kao i zahtevi za građevinske proizvode namenjene ugradnji u građevinske konstrukcije.

IZLOŽBA

BEOGRADSKI SAJAM: INOVATIVNOST TEHNOLOGIJE, ARHITEKTURE I KULTURE

Galerija nauke i tehnike SANU, Beograd, 8–26.11.2021.

Organizatori

Kolektiv arhitekata, Beograd

Beogradski sajam d.o.o. Beograd

Institut IMS, Beograd

Izložba *Beogradski sajam: Inovativnost tehnologije, arhitekture i kulture* arhitekturu Beogradskog sajma posmatra i analizira kroz prizmu tehnologije, pri čemu autonomiju dela stavlja ispred autorskih namera, tumačenja kulturološkog konteksta i, u najširem smislu – izvan ideologije.

Beogradski sajam je važno mesto primene tehnoloških patenata IMS-ovog koncepta prednapregnutog betona, tehnologija konstrukcije velikih raspona sa minimalnim debljinama betonskih ljuski i prefabrikovanih betonskih elemenata. Realizacija ovih inovacija imala je i ima veliki uticaj na razvoj građevinarstva i arhitekture kako javnih, tako i stambenih objekata. Paralelno sa razvojem tehnologije, iako u okviru socijalističke ekonomije, vidimo razvoj izvozne industrije, razvoj konzorcijuma, kao i razvoj finansijskih okvira u kojima nastaju veliki državni projekti.

Stambeni blokovi nastali na osnovama tehnologije IMS-a produkt su racionalne arhitekture koja se bazira na detaljno razvijenim individualnim stambenim jedinicama sa jedne, i razvijenom kolektivnom gradskom strukturom sa druge strane. Sistematizovana rešenja koja su kataloški prikazana u publikacijama IMS-a nedvosmisleno ukazuju na ovaj postupak i odnos dva ekstrema razmere arhitekture grada – prostorne jedinice i urbanog sistema.

Beogradski sajam je jedna od velikih celina koje još uvek nose i žive duh arhitekture metropole i svojim halama i svojim događajima, te su njegov budući razvoj i opstanak pitanja opstanka jednog od identiteta našeg društva. Vrednost ovih građevina treba sagledati nezavisno od ideološke pozadine njihovog nastanka.

SCIENTIFIC RESEARCH PROJECTS | **NAUČNO-ISTRAŽIVAČKI PROJEKTI**

NAUČNO-ISTRAŽIVAČKI RAD FINANSIRAN OD STRANE MINISTARSTVA PROSVETE, NAUKE I TEHNOLOŠKOG RAZVOJA

Institut IMS sklopio je sa Ministarstvom prosvete, nauke i tehnološkog razvoja Republike Srbije ugovor o realizaciji i finansiranju naučnoistraživačkog rada NIO u 2021. godini, evidencioni broj: 451-03-9/2021-14/ 200012.

Ovim ugovorom obezbeđeno je projektno finansiranje za sledeće istraživače Instituta IMS:

Broj	Ime i Prezime	Naučno ili stručno zvanje
1	Dr Zagorka Radojević	Naučni savetnik
2	Dr Nenad Šušić	Naučni savetnik
3	Dr Ksenija Janković	Naučni savetnik
4	Dr Anja Terzić	Naučni savetnik
5	Dr Milica Vasić	Viši naučni saradnik
6	Dr Miloš Vasić	Naučni saradnik
7	Dr Dragan Bojović	Naučni saradnik
8	Dr Dejan Momčilović	Naučni saradnik
9	Dr Biljana Ilić	Naučni saradnik
10	Dr Ksenija Đoković	Naučni saradnik
11	Dr Mladen Ćosić	Naučni saradnik
12	Dr Jelena Ćirilović	Naučni saradnik
13	Dr Vujadin Aleksić	Naučni saradnik
14	Dr Srđan Bulatović	Naučni saradnik

15	Ljiljana Miličić	Istraživač saradnik
16	Ivana Delić-Nikolić	Istraživač saradnik
17	Marko Stojanović	Istraživač saradnik
18	Ljiljana Lončar	Stručni savetnik
19	Željko Flajs	Viši stručni saradnik
20	Nikola Božović	Istraživač pripravnik

NAUČNO-ISTRAŽIVAČKI PROJEKAT

U OKVIRU PROGRAMA ZA IZVRSNE PROJEKTE MLADIH ISTRAŽIVAČA – PROMIS FONDA ZA NAUKU REPUBLIKE SRBIJE

MORTAR DESIGN FOR CONSERVATION – DANUBE ROMAN FRONTIER 2000 YEARS AFTER

Institut IMS učestvuje u projektu *MORTAR DESIGN FOR CONSERVATION – DANUBE ROMAN FRONTIER 2000 YEARS AFTER (MoDeCo2000)* u saradnji sa Tehnološkim fakultetom Univerziteta u Novom Sadu i Arheološkim institutom iz Beograda. Ovaj projekat, u kome učestvuju istraživači Instituta IMS Ljiljana Miličić i Ivana Delić-Nikolić, se realizuje u okviru Programa za izvrsne projekte mladih istraživača – Promis Fonda za nauku Republike Srbije, pod evidencionim brojem 6067004.

Tokom prvog projektnog perioda sprovođenja aktivnosti planiranih u okviru projekta *MoDeCo2000* , a nakon kabinetskog istraživanja vezanih za arheološke, arhitektonske, geološke i tehnološke aspekte arheoloških nalazišta, lokaliteta i pojedinačnih spomenika na nekadašnjoj rimskoj dunavskoj granici – limesu, uz prikupljanje obimne kolekcije literature, tim projekta *MoDeCo2000* je posetio 23 istorijske lokacije.

Reka Dunav kroz Srbiju protiče u ukupnoj dužini od 588 km, a projektna ekspedicija je ispitala rimske ostatke duž njenih 484 km. Tim koji čine arhitekta, arheolog, inženjeri materijala, geolog i hemičar posetio je 32 građevine i tom prilikom prikupio uzorke 99 različitih maltera koji potiču iz dve jedine legionarske tvrđave na teritoriji današnje Srbije, Singidunuma i Viminaciuma, drugih rimskih utvrđenja i osmatračnica, nekropola, manjih naselja i gradova, kao i usamljenih građevina.

Proces uzorkovanja je detaljno dokumentovan (fotografije, pozicioniranje i tekstualni opis uzoraka). Laboratorije učesnika projekta, Tehnološkog fakulteta u Novom Sadu i Instituta IMS, su uzorke za dalje ispitivanje odabrale uz podršku članova tima iz Arheološkog instituta, a prema dosadašnjem iskustvu svakog pojedinačnog člana tima, kao i dogovorima tokom projektnih sastanaka. Uzorci su foto dokumentovani uz kreiranje njhovih dosijea preko noformirane baze koju danas čini preko 8.000 snimaka iz laboratorije i preko 3.500 fotografija sa terena.

Digitalna optička mikroskopija je urađena na 73 uzorka, mineraloško-petrografske analize do sada sprovedene na 40 uzoraka, dok su na 6 odabranih uzoraka sprovedenja ispitivanja hemijskog sastava I fizičko – mehaničkig svojstava. Analize su projektnom timu pružile dobar uvid u kolekciju uzoraka maltera i ponudile relevatne ulazne podatke za dalje laboratorijske analize koje su već započete (analize odnosa agregata i veziva, fazna analiza – XRD i dr.), za koje se procenjuje da će biti sprovedene na ukupno 35 uzoraka do kraja ispitivanja.

Uzorkovani malteri pripadaju građevinama čije vremensko određenje pokriva dugačak period od I do VI veka, tako pružajući mogućnost analize razvoja tehnologije izrade maltera tokom celokupne rimske dominacije na našoj teritoriji, dok će malteri tvrđava na Dunavu iz XII i XV veka dati važne podatke o daljim građevinskim aktivnostima nakon pada rimskog limesa. Za Limes kao serijsko kulturno dobro se trenutno priprema nominacioni dosije za upis na Uneskovu Listu svetskog nasleđa, a njegov važan segment će biti upravo rezultati istraživanja maltera u okviru projekta *MoDeCo2000*.

Do sada sprovedene laboratorijske analize su pokazale međusobnu raznolikost uzoraka, izdvojile one koje je projektni tim ocenio kao važne za buduću pripremu maltera za konzervaciju spomenika na limesu, i navele na prve zaključke o antičkom graditeljstvu uz reku Dunav, ali i drugim aspektima života na granici tokom rimskog i ranovizantijskog perioda.

Aktivnosti na diseminaciji projekta su sprovedene kroz medije (tv, radio, štampa, internet, društvene mreže), komunikaciju sa nadležnim institucijama i profesionalcima koji se bave zaštitom graditeljskog nasleđa, ali i studentima iz relvantnih oblasti projekta, kao i preko predavanja na nacionalnom naučno-stručnom skupu o očuvanju kulutrnog nasleđa.

NAUČNO-ISTRAŽIVAČKI PROJEKAT

U OKVIRU PROGRAMA NAUČNO-TEHNOLOŠKE SARADNJE MINISTARSTVA PROSVETE, NAUKE I TEHNOLOŠKOG RAZVOJA REPUBLIKE SRBIJE I SAVETA ZA NAUČNOTEHNOLOŠKA ISTRAŽIVANJA TURSKE

TAILOR MADE SELF-COMPACTING HEAVYWEIGHT CONCRETE WITH WASTE MATERIALS

Na osnovu Protokola o saradnji u oblasti nauke i tehnologije između Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije (MPNTR) i Saveta za naučnotehnološka istraživanja Turske (TUBITAK), potpisanog u Beogradu, 7. oktobra 2019. i na osnovu Konkursa za podnošenje zajedničkih predloga projekata, usaglašena je i 5. maja 2021. potpisana Odluka o odobrenim projektima naučno-tehnološke saradnje (2021–2023).

Nakon razmatranja 79 administrativno korektnih predloga projekata sa obe strane, a u skladu sa prioritetima definisanim u tekstu Konkursa i na osnovu sprovedenih procedura ocene projekata u obe države, odobreno je za finansiranje 10 predloga projekata.

Među odobrenim projektima je i *Tailor made self-compacting heavyweight concrete with waste materials*, kojim rukovode dr Ksenija Janković iz Instituta IMS i dr Kambiz Ramyar, Ege University, Engineering Faculty, Izmir. Na projektu učestvuju i sledeći istraživaći iz Instituta IMS: dr Anja Terzić, dr Dragan Bojović, dr Miloš Vasić i Marko Stojanović.

SELECTED
BUSINESS REFERENCES

ODABRANE
STRUČNE REFERENCE

U ovom odeljku dat je pregled ključnih usluga koje je Institut IMS izvršio u 2021. 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, mašinske industrije i energetike.

Pregled referenci je dat po organizacionim celinama.

THE CENTRE
FOR MATERIALS

CENTAR
ZA MATERIJALE

CENTAR ZA MATERIJALE

	Laboratorija za građevinsku keramiku	
R.b.	**Referenca**	**Investitor**
1.	Elaborat o rezultatima ispitivanja uzorka grusificiranog granita iz ležišta Tomića Majdan u Darosavi i preporukama za primenu u proizvodnji keramičkih pločica i vatrostalnih materijala	Evro-Venet d.o.o. Pančevo
2.	Elaborat o rezultatima ispitivanja uzoraka keramičkih glina sa lokaliteta Damnjanovića Brdo u Donjem Crniljevu	Zorka-keramika d.o.o. Beograd
3.	Elaborat o rezultatima ispitivanja uzoraka glina sa glinokopa fabrike	Dilj d.o.o. Vinkovci
4.	Elaborat o rezultatima ispitivanja reprezentativnih uzoraka opekarskih sirovina sa deponije ciglane, sa preporukama kriterijuma za prihvatanje sirovina za proizvodnju opekarskih proizvoda	Neimar d.o.o. Zrenjanin
5.	Elaborat o rezultatima ispitivanja reprezentativnih uzoraka opekarskih sirovina sa deponije ciglane, sa preporukama kriterijuma za prihvatanje sirovina za proizvodnju opekarskih proizvoda	Univerzum ciglana d.o.o. Aranđelovac

6.	Elaborat o rezultatima ispitivanja reprezentativnih uzoraka opekarskih sirovina sa deponije ciglane, sa preporukama kriterijuma za prihvatanje sirovina za proizvodnju opekarskih proizvoda	CR Srđan Nikolić Guberevac
7.	Elaborat o rezultatima ispitivanja glina sa ležišta ciglane i mešavina sa ugljem sa preporukama za proizvodnju energetskih blokova	Mašinac NM84 d.o.o. Svilajnac
8.	EPD – Deklaracija proizvoda o zaštiti životne sredine prema SRPS ISO 14025:2007 i SRPS EN 15804:2020 za crepove i fazonske komade od gline	A.D. POLET IGK Novi Bečej
9.	EPD – Deklaracija proizvoda o zaštiti životne sredine prema SRPS ISO 14025:2007 i SRPS EN 15804:2020 za elememte za zidanje od gline – grupa proizvoda blokovi od gline	A.D. POLET IGK Novi Bečej Proizvodni pogon u Stražilovu

	Laboratorija za akustiku i vibracije	
R.b.	**Referenca**	**Investitor**
1.	Akustično zoniranje Beograda	Grad Beograd Sekretarijat za zaštitu životne sredine
2.	Studija o uslovima koji moraju ispunjavati ugostiteljski objekti radi zaštite od buke na teritoriji grada Beograda	Grad Beograd Sekretarijat za zaštitu životne sredine
3.	Kontrolna merenja buke po nalogu inspektora	Grad d Beograd Sekretarijat za inspekcijske poslove

	Laboratorija za toplotnu tehniku i zaštitu od požara	
R.b.	**Referenca**	**Investitor**
1.	Preko 130 protivpožarnih ispitivanja na gotovo svim kapitalnim projektima značajnim za R. Srbiju i grad Beograd.	Belgrade Waterfront Aerodrom Nikola Tesla Kula 2 Ušće Klinički centar Srbije Sky Line
2.	Oko 140 testova iz oblasti reakcije na požar u svrhu određivanje klase gorivosti materijala za domaće i inostrane proizvođače termoizolacionih materijala. Puštena u rad oprema za sva ispitivanja reakcije na požar.	Saint-Gobain Knauf Rockwool Ursa Fibran Baumit
3.	Oko 120 ispitivanja toplotne provodljivosti za termoizolacione materijale.	Maxima Bekament Austrotherm Fima Masterplast
4.	Oko 50 ispitivanja u cilju određivanja koeficijenta prolaženja toplote za građevinsku stolariju na gotovo svim kapitalnim projektima značajnim za Republiku Srbiju (poslovni i stambeni objekti, škole, bolnice, vrtići...).	Tehnomarket d.o.o. ASC Aluminium Systems and Constructions d.o.o. GAT d.o.o. Novi Sad DUNAV d.o.o. Vranje

	Laboratorija za beton	
R.b.	**Referenca**	**Investitor**
1.	Završne ocene kvaliteta betona za objekte izvedene u Srbiji za Širbegović grupa – GMT Konstrukcije, Gračanica, BiH	Širbegović Inženjering, Gračanica, BIH
2.	Tekuća kontrola kvaliteta betona na gradilištu: E-763 od Preljine do Požege, na izgradnji mostova i saobraćajnice, za China Communications Construction Company LTD. Ogranak Beograd Savski venac	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Putevi Srbije
3.	Tekuća kontrola kvaliteta betona na gradilištu: E-763 od Preljine do Požege, na izgradnji tunela Munjino brdo i Laz, ukupne dužine preko 6k m, za China Communications Construction Company LTD. Ogranak Beograd Savski venac	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Putevi Srbije
4.	Tekuća kontrola kvaliteta betona na gradilištu: Brza saobraćajnica na deonici od Iverka do Lajkovca, za China Shandong International Economic & Technical, Ogranak Beograd	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Putevi Srbije
5.	LOT B3.2 Izgradnja Ostružničkog mosta u konzorcijumu sa kompanijeom UTIBER iz Mađarske	JP Putevi Srbije
6.	Završne ocene kvaliteta betona za objekte izvedene u Srbiji za firmu Baupartner	Baupartner, Lukavac, BIH

7.	Nezavisna laboratorijska kontrola kvaliteta betona prilokom izvođenja građevinskih radova na izgradnji Autoputa E-75, LOT 1- Put i mostovi od Grdelice do tunela Predejane za INTEGRAL INŽENJERING, Niš	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Koridori Srbije d.o.o.
8.	Kontrola kvaliteta na izvođenju radova na izgradnji brane i akumulacije Arilje – profil Svračkovo za HIDROTEHNIKA – HIDROENERGETIKA, Beograd	Ministarstvo građevinarstva, saobraćaja i infrastrukture
9.	Vršenje stručnog nadzora za kontrolu projekata i izvođenje građevinskih radova na izgradnji auto-puta od Kuzmina do Sremske Rače u dužini od 17 km	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Putevi Srbije
10.	Tekuća kontrola kvaliteta betona na gradilištu: Most preko reke Save kod Šapca na putu Ruma – Šabac – Loznica, dužine 2 km	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Koridori Srbije a.d.
11.	Tekuća kontrola kvaliteta betona na gradilištu: izgradnja autoputa E-763 deonica od Surčina do Novog Beograda za China Communications Construction Company LTD. Ogranak Beograd Savski venac	Ministarstvo građevinarstva, saobraćaja i infrastrukture JP Putevi Srbije a.d.

12.	Tekuća kontrola kvaliteta betona na gradilištu: Rekonstrukcija i proširenje Aerodroma Nikola Tesla Beograd za konzorcijum Vinci –Terna	Vinci Airports
13.	Tekuća kontrola kvaliteta betona na gradilištu: izgradnja stambeno-poslovnih kompleksa Simfonia i Metropoliten za Roberts Millennium d.o.o. Beograd	Belgrade Waterfront d.o.o.

THE CENTRE
FOR METALS
AND ENERGETICS

CENTAR
ZA METALE
I ENERGETIKU

CENTAR ZA METALE I ENERGETIKU

Laboratorija za ispitivanje metala,
Kontrolno telo,
Sertifikaciono telo za sertifikaciju osoba
Laboratorija za etaloniranje mehaničkih veličina

R.b.	Referenca	Investitor
1.	Ispitivanje materijala i zavarenih spojeva u toku projekta Zamena isparivača od kote 4 m do kote 72,5 m, DeNox gorionici sa kavezima, rekonstrukcija kanala. Zamena parovoda RA linije – 220 t bloka B, Zamena ovešenja cevovoda RL linije	JP EPS BEOGRAD Ogranak TE Nikola Tesla B Obrenovac Ušće
2.	Kontrola tehničke dokumentacije za prijem i ispitivanje mašinske opreme za potrebe sanacije RHE BB	JP EPS BEOGRAD Ogranak Drinsko-Limske HE RHE Bajina Bašta
3.	Superkontrola nad izvođenjem radova na transmisionom gasovodu (interkonektor) granica Bugarske – granica Mađarske na teritoriji Republike Srbije	BUREAU VERITAS DOO, Beograd
4.	Fabrički prijem opreme od strane Instituta pri izradi i sanaciji delova hidroagregata u fabrikama LMZ, Silovie Mašini, Rusija	JP EPS BEOGRAD Ogranak HE Đerdap HE ĐERDAP 1 Kladovo

5.	Ispitivanje mašinske opreme	JP EPS BEOGRAD Ogranak HE Đerdap HE ĐERDAP 1 Kladovo
6.	Kontrola HM opreme HE Đerdap 2	JP EPS BEOGRAD Ogranak HE Đerdap Kladovo
7.	Ispitivanje opreme bez razaranja HMO – HE PIROT	JP EPS BEOGRAD Ogranak HE Đerdap Kladovo
8.	Ispitivanje glavnih parovodnih linija RA, RB i RC i ispitivanje prestrujnih parovoda metodama bez razaranja za 2021. blokovi A1i A2	JP EPS BEOGRAD Ogranak TE Nikola Tesla A Obrenovac
9.	Ispitivanje turbinske opreme Ispitivanje NDT metodama (lopatice, vretena, ležajevi...) za remont 2021. blokovi A1 i A2	JP EPS BEOGRAD Ogranak TE Nikola Tesla A Obrenovac

10.	Ispitivanje hemijskog sastava i mehaničkih osobina materijala	GP Nikolić DOO, Kraljevo STRABAG DOO, Beograd ASAIBELIK DOO, Beograd INSTITUT GOŠA DOO, Beograd PROLETER AD, METALSKA INDUSTRIJA, Arilje METALING DOO, Beograd TANKMONT DOO, Beograd RUDNIK OLOVA I CINKA VELIKI MAJDAN DOO, Ljubovija JP EPS BEOGRAD, OGRANAK RB KOLUBARA, Lazarevac MONTESINO DOO, Beograd NBA – COMMERCE, Beograd MARKANT, Valjevo TVIK DIV, Valjevo

11.	Sertifikacija betonskog čelika	KÜRÜM International Sh.A.Ish-Kombinati Metalurgjik Elbasan/Albania
		TRGOVIR DOO, Gračanica, BiH
		ARCELOR MITTAL, Zenica
		ALSIKO DOO, Beograd
		FERRIERE NORD, Udine
		METALFER STEEL MILL, Sremska Mitrovica
		ARMAKO, Prnjavor
		KOMERC - MALI, Prnjavor
		SIDENOR STEEL INDUSTRY S.A. Thessaloniki, Greece
		SOVEL SA HELLENIC STEEL PROCESSING COMPANY, Athens, Greece
		DUCTIL STEEL SA, Buzau, Romania
		DOJRAN STEEL DOOEL, Nov Dojran, Makedonia
		COLAKOGLU METALURJI A.S., Beykoz, Turska
		MAKSTIL AD, Skopje, Makedonija
12.	Sertifikacija osoba u oblasti zavarivanja	Đerdap usluge a.d., Kladovo
		Sanacija i ispitivanje metala d.o.o. Beograd
		Srbija Kargo a.d. Beograd
		Silos – Tech d.o.o. Senta
		Energetika d.o.o. Kragujevac

13.	Etaloniranje uređaja za merenje mehaničkih veličina	AG Institut Novi Sad Avia Tehnics Beograd Bekament Banja Komerc BET Beograd Comex Sabac GAF Nis Global Maitenance Beograd Gorenje GTI Beograd Gosa Institut Smederevska Palanka Hemofarm Vršac Hemomet Metalfer Sremska Mitrovica Hidrotehnika-Hidroenergetika IMW Institut Siemens Kragujevac Institut Mihajlo Pupin Institut za puteve Beograd JAT Tehnika Kompressor ING Valjevo Livnica Banja Luka MC-Bauchemie Sremska Mitrovica Mostogradnja Beograd Prva Petoletka Trstenik TOSCELIK Niksic Univerzum Arandjelovac Xella Srbija Vreoci Yanfeng Kragujevac Zavod za zavarivanje Beograd Zorka Keramika Šabac

THE CENTRE
FOR ROADS
AND GEOTECHNICS

CENTAR
ZA PUTEVE
I GEOTEHNIKU

CENTAR ZA PUTEVE I GEOTEHNIKU

Težište angažovanja Centra za puteve i geotehniku su aktivnosti na projektima vezanim za izgradnju putne mreže u Republici Srbiji. Za razliku od ranijih godina i pretežnog angažovanja na praćenju izvođača pri izgradnji, u 2021. godini znatno je učešće u kontroli i nadzoru na održavanju puteva. Institut IMS je vodeći partner Puteva Srbije i Koridora Srbije.

Pored puteva i putnih objekata, Centar za puteve i geotehniku Instituta IMS učestvuje u realizaciji projekata brojnih drugih infrastrukturnih objekata, kao što je modernizacija pruge Beograd – Subotica.

I u ovoj godini nastavljeno je učešće u izgradnji magistralnog gasovoda kroz Srbiju (Turski tok).

Od terenskih istražnih radova izdvajamo izvođenje istražnih bušotina (dubina do 300 m), standardnih penetracionih opita (SPT), statičkih penetracionih opita (CPT i CPTU), opita dilatometarskom sondom (DMT i SDMT), ispitivanja vodopropustljivosti tla različitim terenskim metodama (VDP), ugradnju pijezometarskih konstrukcija sa osmatranjem i praćenjem režima podzemnih voda i dr. Terenske metode ispitivanja šipova zauzimaju značajno mesto u našoj delatnosti, a na tržištu se izdvajamo kao lideri u toj oblasti u protekloj deceniji.

Redovne aktivnosti Centra za puteve i geotehniku obuhvataju dinamičko ispitivanje šipova metodom DLT, ispitivanje integriteta šipova metodom PIT (SIT), statičko ispitivanje šipova - SLT metoda, PDA metoda za praćenje i optimizaciju procesa pobijanja prefabrikovanih betonskih i čeličnih šipova.

Laboratorija za puteve i geotehniku akreditovana je kod Akreditacionog tela Srbije prema SRPS ISO/IEC 17025:2006. U njoj se vrše ispitivanja tla (identifikaciono–klasifikaciona ispitivanja, fizičko–mehanička modelska ispitivanja), kamenog agregata i brašna, bitumena i bitumenskih emulzija, asfaltnih mešavina. U okviru laboratorijskih ispitivanja na terenu vrši se kontrola kvaliteta ugrađenog materijala i izvedenih radova (prethodna, tekuća, kontrolna ispitivanja i izvođenja opita in situ).

U okviru projektovanja značajno mesto u radu zauzimaju geotehnička istraživanja terena i projekti sanacije klizišta - nestabilnih kosina useka i nasipa puteva i prirodno nestabilnih padina . Značajna su i projekovanja svih vrsta fundiranja, rekonstrukcija i sanacija objekata različitih namena. Ističe se i iskustvo u oblasti putarstva, na projektovanju novih, rehabilitacija i rekonstrukcija postojećih puteva svih rangova sa pratećim objektima i dimenzionisanjem kolovoznih konstrukcija.

Naši inženjeri imaju veliko iskustvo u kontroli i proveri kvaliteta izvođenja svih vrsta radova, kontroli građevinske dokumentacije i praćenju radova u skladu sa njom, kao i rešavanju novonastalih situacija tokom izvođenja radova.

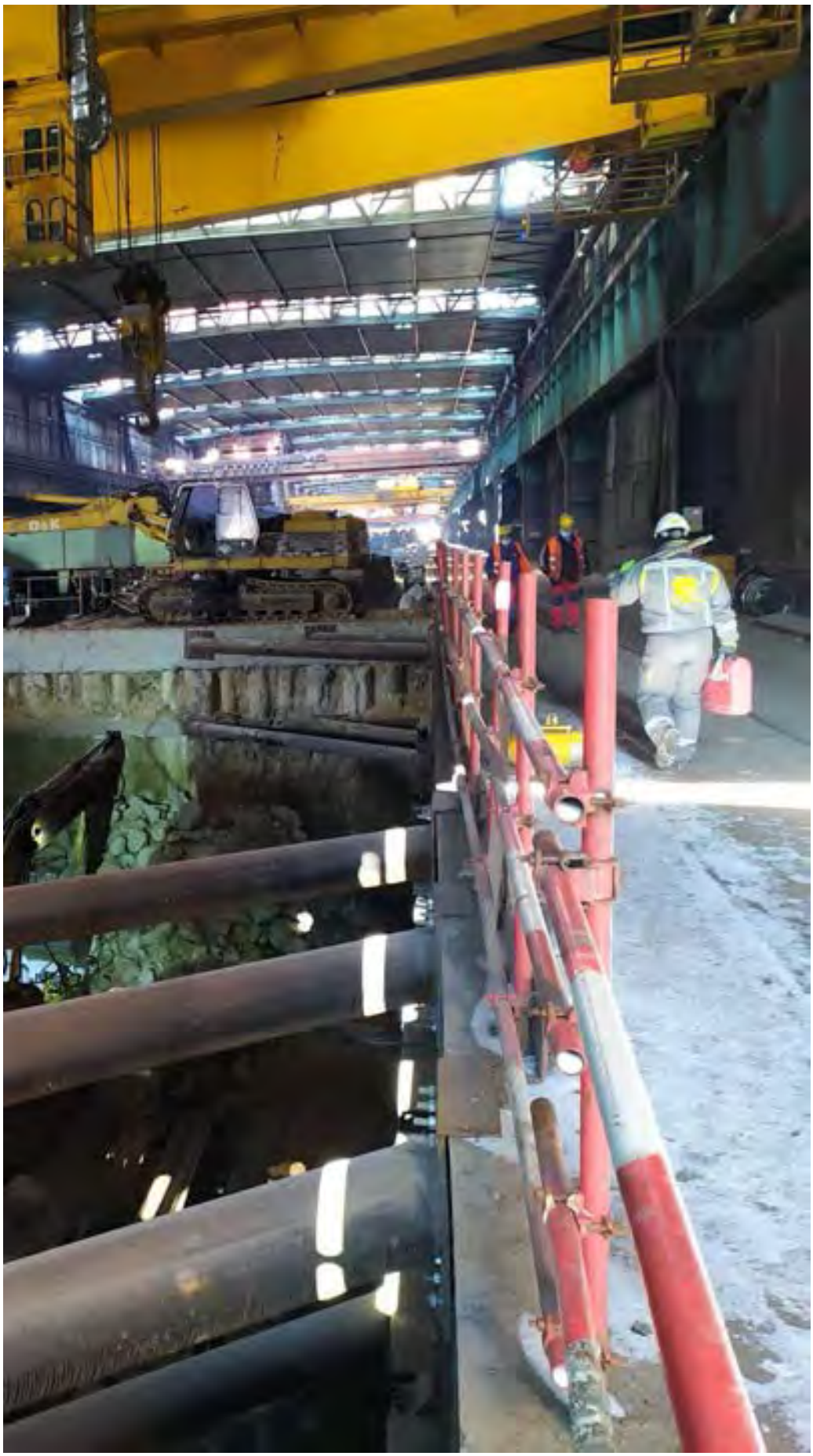
THE CENTRE FOR
STRUCTURES
AND PRESTRESSING

CENTAR ZA
KONSTRUKCIJE
I PREDNAPREZANJE

CENTAR ZA KONSTRUKCIJE I PREDNAPREZANJE

	Odeljenje za prednaprezanje	
R.b.	**Referenca**	**Investitor**
1.	Inženjerig usluge prilikom bušenja, ugradnje, injektiranja i prednaprezanja geotehničkih sidara i testiranje nosivosti geotehničkih sidara za potrebe stabilizacije kosine, na autoputu E-75, deonica Gornje polje – Tunel Predejane, LOT 1, usek 2, usek 4	Integral Inženjering Ogranak Niš
2.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju mosta preko reke Klisure, projekta pojačanog održavanja državnog puta IB-35, deonica Zaječar - Knjaževac	Integral Inženjering, Ogranak Niš Fortis Niskogradnja d.o.o. Beograd
3.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi prednaprezanja za potrebe sanacije mosta preko reke Tise kod Titela	MOST-NS d.o.o. Novi Sad RINCOP d.o.o. Veternik
4.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju greda za potrebe sanacije ramovskoh konstrukcija hangara na aerodromu Batajnica	Dijamant Inženjering d.o.o Beograd
5.	Primena sistema prednaprezanja BBR i radovi na prednaprezanju nadvožnjaka na km 26+392 pruge Beograd – Subotica, deonica Beograd – Stara Pazova	China Railway International Co. Ltd. Serbia Ogranak Beograd Kruševac Put a.d. Kruševac

6.	Primena sistema prednaprezanja OVM i radovi na prednaprezanju mosta br. 16, na km 590+981 –, na autoputu E70 / E75 – obilaznica oko Beograda – deonica Dobanovci – Bubanj Potok	Power Construction Corporation Of China Limited Ogranak Beograd Diorit d.o.o Beograd
7.	Primena sistema prednaprezanja OVM i radovi na prednaprezanju nadvožnjaka na km 13+288 pruge Beograd – Subotica, deonica Beograd – Stara Pazova	China Railway International Co, Ltd Serbia Ogranak Beograd Diorit d.o.o Beograd
8.	Testiranje nosivosti geotehničkih sidara na potpornom zidu izlaznog i ulaznog portala tunela Beli Potok, na obilaznici oko Beograda	Power Construction Corporation Of China Limited Ogranak Beograd Ferbild d.o.o. Beograd
9.	Testiranje nosivosti geotehničkih sidara u sklopu konstrukcije obezbeđenja temeljne jame za potrebe izvođenja objekta nove koračne peći u okviru HBIS Železara Smederevo	PIN konsalting centar d.o.o Beograd



	Odeljenje za projektovanje, nadzor i sanacije	
R.b.	**Referenca**	**Investitor**
1.	Pregled i istražni radovi sa stručnim mišljenjem o opštem stanju kejske konstrukcije u prahovu	Eliksir Prahovo
2.	Izveštaj o pregledu mosta na putu Sremska Kamenica – Petrovaradin u okviru petlje Mišeluk	Gradska uprava za građevinsko zemljište i investicije Novi Sad
3.	Idejni projekat i Projekat za izvođenje sanacije drumskog mosta preko reke Ibar u Kraljevu (L = 3 x 60 m = 180 m)	Grad Kraljevo JP za uređivanje građevinskog zemljišta Kraljevo
4.	Ekspertiza međuspratne konstrukcije u okviru stambeno-poslovnog objekta Sakura Park u Beogradu	Sakura Park d.o.o.
5.	Projekat sanacije temelja var-mašine u okviru željezare HIBIS Smederevo	Industial Automation d.o.o.
6.	Stručno mišljenje o mogućnosti izvršenja vangabaritnog prevoza teškog tereta na relaciji nova luka železare HBIS Smederevo – Državni put IB 14 – TE Kostolac B	Bora Kečić Specijalni transport d.o.o.
7.	Elaborat o stanju konstrukcije objekta O.Š. Dragan Kovačević u Beogradu	O.Š. Dragan Kovačević
8.	Stručno mišljenje o razlogu nastanka prslina na objektu galerije na deonici Beograd centar – Stara Pazova na km 23+762	China Railway 21st Bureau Group Co. Ltd. Ogranak Beograd

9.	Projektno – tehnička dokumentacija za rekonstrukciju objekta O.Š. Julijana Ćatić u Stragarima, odeljenje u Ramaći	O.Š. Julijana Ćatić
10.	Stručno mišljenje o stanju objekata Predškolske ustanove Poletarac u Novoj Pazovi	P.U. Poletarac Stara Pazova
11.	Elaborat o stanju konstrukcije garaže SMUP ispod mosta u Brankovoj ulici	Muzej automobila
12.	Elaborat o stanju konstrukcije objekta BIGZ	MPP BIGZ d.o.o.

	Laboratorija za ispitivanje konstrukcija	
R.b.	**Referenca**	**Investitor**
1.	Ispitivanje probnim opterećenjem železničkih mostova železničke pruge E-85, projekat brze pruge Beograd - Subotica, deonica: Stara Pazova - Novi Sad. Ukupan broj mostova iznosi 36, od kojih se po kompleksnosti same mostovske konstrukcije ističu vijadukti na km 59+159 (ukupne dužine 5.800 m), na km 51+ 423 (ukupne dužine 493 m) i na km 55+689 (ukupne dužine 329 m).	Železnice Srbije a.d.
2.	Istražne usluge na nosećim čeličnim i betonskim konstrukcijama GPO i zajedničkim objektima sa projektom sanacije	JP EPS BEOGRAD, Ogranak TE Nikola Tesla B, Obrenovac
3.	Ispitivanje stenskih ankera probnim opterećenjem na izgradnji autoputa E-763, deonica: Preljina - Požega, tunel Laz i tunel Munjino brdo	China Communications Construction Company Ltd.
4.	Ispitivanje mosta probnim opterećenjem: Most preko reke Lim u Prijepolju, Most Batajnička petlja, Nadvožnjak preko pruge Ruma - Šabac, Most preko reke Ub u selu Gola glava, Most preko pruge u Mladenovcu.	

CERTIFICATION BODY | **SERTIFIKACIONO TELO**

SERTIFIKACIONO TELO

Institut IMS je akreditovan kod Akreditacionog tela Srbije kao sertifikaciono telo za obavljanje poslova sertifikacije građevinskih proizvoda prema standardu SRPS ISO/IEC 17065:2016, Opšti zahtevi za tela koja sprovode sisteme sertifikacije proizvoda, rešenje broj 04-003.

Na osnovu Rešenja Ministarstva građevinarstva, saobraćaja i infrastrukture, Institut IMS ad je imenovan kao telo za sprovođenje ocenjivanja usaglašenosti cementa opšte namene i cementa za specijalnu namenu u skladu sa zahtevima Pravilnika o kvalitetu cementa (Sl. glasnik RS, br. 34/13 i 44/14), čelika za armiranje betona u skladu sa zahtevima Uredbe o tehničkim i drugim zahtevima za čelik za armiranje betona (Sl. glasnik RS, br. 35/2015 i 44/2016), cenjivanja i verifikacije stalnosti performansi hemijskih dodataka betonu, mlaznom betonu, malteru i injekcionoj masi za kablove za prethodno naprezanje u skladu sa zahtevima Pravilnika o tehničkim zahtevima za hemijske dodatke betonu, mlaznom betonu, malteru i injekcionoj masi za kablove za prethodno naprezanje ("Sl. glasnik RS", br. 39/2019), ocenjivanja i verifikacije stalnosti performansi elemenata za zidanje od gline, elemenata za zidanje od kalcijum-silikata i blokova od gline za polumontažne sitnorebraste tavanice u skladu sa zahtevima Pravilnika o o tehničkim zahtevima za elemente za zidanje od gline, elemente za zidanje od kalcijum-silikata i blokove od gline za polumontažne sitnorebraste tavanice (Sl. glasnik RS, br. 90/2019), ocenjivanja i verifikacije stalnosti performansi elemenata sistema cevovoda od plastičnih masa za snabdevanje vodom namenjenom za ljudsku upotrebu, transport zaprljane i kanalizacione vode, transport gasovitih goriva i instalacije za grejanje u skladu sa zahtevima Pravilnika o tehničkim zahtevima za elemente sistema cevovoda od plastičnih masa za snabdevanje vodom namenjenom za ljudsku upotrebu, transport zaprljane i kanalizacione vode, transport gasovitih goriva i instalacije za grejanje (Sl. glasnik RS, br. 6/2020). Institut IMS ad je upisan u registar imenovanih tela za ocenjivanje usaglašenosti pod jedinstvenim registarskim brojem И 030.

Registar izdatih sertifikata: http://www.institutims.rs/sertifikacija/registar.html.

R.b.	Referenca	Investitor
1.	Sertifikacija cementa	Lafarge BFC d.o.o. Beočin
		Moravacem d.o.o. Popovac
		Titan cementara Kosjerić d.o.o. Kosjerić
		NEXE d.d. Našice
		CEMEX Hrvatska d.d. Kaštel Sućurac
		Fushe Kruje Cement Factory SH.P.K. Albanija
		Fabrika Cementa Lukavac d.d. Lukavac
		Tvornica cementa Kakanj d.d. Kakanj
		TRAÇIM Çimento Sanayi Ve Ticaret A.Ş. Turska
		OYAK Çimento Fabrikaları A.Ş. Turska
2.	Sertifikacija hemijskih dodataka	SIKA Srbija d.o.o. Šimanovci
		ADING a.d. Skoplje
		TKK Proizvodnja kemičnih izdelkov d.o.o. Srpenica, Slovenija
		Master Builders Solutions Spa, Treviso, Italija
		BT3 Betontechnik GmbH, Theresienfeld, Austrija
		MC-Bauchemie Kft. Mađarska
		ISOMAT d.o.o. Šimanovci, Srbija
		KUTRILIN d.o.o. Zagreb, Hrvatska

3.	Sertifikacija čelika za armiranje betona	ALSIKO d.o.o. Beograd ArcelorMittal Zenica d.o.o. Zenica, BIH Armako d.o.o. Prnjavor, BIH DOJRAN STEEL DOOEL, Dojran, Severna Makedonija KOMERC MALI d.o.o. Prnjavor, BIH KURUM, Albanija METALFER STEEL MILL d.o.o. Sremska Mitrovica Sidenor Steel Indystry S.A. Thessaloniki, Grčka Sovel Hellenic Steel Processing Company S.A, Almyros, Greece Trgovir d.o.o. Gračanica, BIH Ferriere Nord S.p.A. Udine, Italija Çolakoğlu Metalurji A.Ş, Istanbul, Turska
4.	Sertifikacija elemenata za zidanje	IGM Mladost Leskovac, Ogranak Stalać IGM Mladost Leskovac, Ogranak Vlasotince IGM Mladost Leskovac, Ogranak Mala Plana AD Polet IGK, Novi Bečej Zorka Opeka d.o.o. Šabac PGP Rapid a.d. Apatin Univerzum ciglana d.o.o. Aranđelovac Univerzum export-import d.o.o. Aranđelovac DOO Neimar, Zrenjanin IGM Opeka d.o.o. Smederevska Palanka Gold Ceramics LLC, Prokeram, Ukrajina

CERTIFICATION BODY
FOR THE CERTIFICATION
OF PERSONS

**SERTIFIKACIONO TELO
ZA SERTIFIKACIJU
OSOBA**

SERTIFIKACIONO TELO ZA SERTIFIKACIJU OSOBA

Sertifikacija osoba je bazirana na sertifikaciji zavarivača i usklađena je sa zahtevima standarda SRPS ISO/IEC 17024:2012 – Ocenjivanje usaglašenosti – Opšti zahtevi za tela koja obavljaju sertifikaciju osoba.

Obim akreditacije Sertifikacionog tela za sertifikaciju osoba obuhvata:

Zavarivanje čelika topljenjem prema šemi sertifikacije IMS-01, koja je usklađena sa standardom SRPS EN ISO 9606-1:2017.

Aluminotermijsko zavarivanje šina prema šemi sertifikacije IMS-02, koja je usklađena sa standardom SRPS EN 14730-2:2012.

R.b.	Referenca	Investitor
1.	Sertifikacija osoba u oblasti zavarivanja	Đerdap usluge a.d. Kladovo
		Sanacija i ispitivanje metala d.o.o. Beograd
		Srbija Kargo a.d. Beograd
		Silos – Tech d.o.o. Senta
		Energetika d.o.o. Kragujevac

CONTROL BODY | **KONTROLNO TELO**

KONTROLNO TELO INSTITUTA IMS

Akreditacija kontrolnog tela Instituta IMS obuhvata oblasti kontrolisanja koje se sprovode u Centru za metale i energetiku.

Kontrolisanje delova postrojenja i objekata pri izgradnji, rekonstrukciji, revitalizaciji i remontu – procesnih, hidroenergetskih, hidromašinske opreme, hidromehaničke opreme, termoenergetskih, turboenergetskih). Kontrolisanje tehnologija zavarivanja metalnih materijala (elektrolučno zavarivanje, gasno zavarivanje, navarivanje). Kontrolisanje proizvoda od gvožđa i čelika – pljosnati proizvodi, limovi, trake, profili, cevi, šipke, žice, odlivci, otkovci, liveno gvožđe. Kontrolisanje metalnih konstrukcija – čeličnih i aluminijumskih. Kontrolisanje nove opreme pod pritiskom. Ocenjivanje usaglašenosti nove opreme pod pritiskom primenom modula B i F prema odredbama Pravilnika o tehničkim zahtevima za projektovanje, izradu i ocenjivanje usaglašenosti opreme pod pritiskom (Sl. Glasnik RS br. 87/2011) i relevantnih harmon izovanih standarda. Najznačajniji poslovi u 2021. godini dati su u tabeli.

Kontrolno telo		
R.b.	**Referenca**	**Investitor**
1.	Superkontrola nad izvođenjem radova na transmisionom gasovodu (interkonektor) granica Bugarske – granica Mađarske na teritoriji republike Srbije	Bureau Veritas d.o.o. Beograd
2.	Fabrički prijem opreme od strane Instituta pri izradi i sanaciji delova hidroagregata u fabrici LMZ, Silovie Mašini, Rusija	JP EPS Beograd Ogranak HE Đerdap HE Đerdap 1 Kladovo
3.	Kontrola tehničke dokumentacije za prijem i ispitivanje mašinske opreme za potrebe sanacije RHE BB	JP EPS Beograd Ogranak Drinsko-Limske HE RHE Bajina Bašta

PT PROVIDER | **PT PROVAJDER**

PIMS - PROVAJDER ZA ISPITIVANJE OSPOSOBLJENOSTI INSTITUT IMS

Provajder za ispitivanje osposobljenosti Institut IMS (PIMS) tokom 2021. godine realizuje 10 šema ispitivanja osposobljenosti ispitnih laboratorija (ocenu njihove kompetentnosti), sa predmetima ispitivanja prikazanih tabelom. Učešće u realizaciji ovih šema uzelo je 124 učesnika iz 33 zemlje Evrope, Azije i Afrike.

Od 11.1.2018. godine PIMS se nalazi na EPTIS kalendaru i bazi podataka svetskih PT Provajdera.

Provajder Institut IMS je od 5.12.2018. godine akreditovan od strane Akreditacionog tela Srbije u skladu sa referentnim standardom SRPS ISO 17043:2011, pod brojem 09-001.

R.b.	Predmet ispitivanja osposobljenosti	Broj učesnika
1.	Cement	
	ciklus hemijskih svojstava	12
	ciklus fizičko-mehaničkih svojstava	18
2.	Kameni agregat	
	ciklus fizičkih i mehaničkih svojstava	12
	ciklus fizičkih svojstava	20
3.	Bitumen	
	ciklus fizičkih svojstava	13
4.	Buka	
	ciklus u zatvorenom prostoru	9
	ciklus na otvorenom prostoru	12
	ciklus u radnoj sredini	5
5.	Čvrsti otpad	
	ciklus hemijskih svojstava	3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