REVIEW
OF RESEARCH
AND BUSINESS RESULTS
OF THE IMS INSTITUTE
IN 2018

PREGLED
NAUČNIH I STRUČNIH
REZULTATA
INSTITUTA IMS
U 2018. GODINI

Institut za ispitivanje materijala a.d.

Beograd, decembar 2018.

PREGLED NAUČNIH I STRUČNIH REZULTATA INSTITUTA IMS U 2018. GODINI

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Tiraž

300 primeraka

ISBN 978-86-82081-28-9

U ovoj godini navršava se 65 godina od kako je Institut za ispitivanje materijala izdvojen iz okvira tadašnje Srpske akademije nauka i postao ustanova sa samostalnim finansiranjem. Od tog trenutka, pa sve do danas, Institut IMS gradi svoju reputaciju nezavisne istraživačke organizacije nacionalnog značaja.

Institut za ispitivanje materijala je i ove, veoma uspešne godine, učestvovao u najznačajnijim projektima u zemlji i regionu. U skladu sa višedecenijskom tradicijom i ugledom, kao i širokim spektrom usluga koje pružamo, bili smo angažovani na kontroli i nadzoru, projektovanju, ispitivanjima i istraživanjima građevinskih i mašinskih objekata i konstrukcija, materijala i proizvoda, na geotehničkim istražnim radovima, kao i primeni različitih tehnologija i sistema razvijenih u Institutu IMS.

Kao najznačajnije, izdvajamo nastavak rada na koridorima X i XI, na obnovi i izgradnji putnih objekata duž autoputeva i magistralnih i regionalnih puteva u Srbiji, na revitalizaciji HE Đerdap 1 u Kostolcu i na drugim hidro i termo-elektranama, sanaciju brojnih klizišta, primenu sistema prednaprezanja i druge specijalističke inženjerske usluge.

Nastavljeno je učešće naših saradnika na realizaciji sedam projekata tehnološkog razvoja, jednog projekta integralnih i interdisciplinarnih istraživanja i četiri projekta iz programa osnovnih istraživanja.

I ove godine Institut IMS može da se pohvali priloženim pregledom apstrakata, koji svedoči o održanom kontinuitetu objavljivanja naučnih radova na uglednim skupovima i u istaknutim publikacijama.

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RAD U VRHUNSKOM MEĐUNARODNOM ČASOPISU IZUZETNIH VREDNOSTI (M21A)

A. Terzić, L. Pezo, N. Mijatović, J. Stojanović, M. Kragović, Lj. Miličić, Lj. Andrić

THE EFFECT OF ALTERNATIONS IN MINERAL ADDITIVES (ZEOLITE, BENTONITE, FLY ASH) ON PHYSICO-CHEMICAL BEHAVIOR OF PORTLAND CEMENT BASED BINDERS

Construction and building materials, 2018, Vol. 180, 199-210.

Instrumental analyses accompanied by analytical modeling tools were employed to assess physico-chemical changes induced by variations in chemical composition of cementitious composites, i.e. mortar binders. Coal combustion ash was utilized as pozzolanic mineral additive. The binders' mix-design was supplemented with sorptive clays to prevent migration of toxic elements from fly ash. The experiment was established on the premise of clay's ion-exchanging ability. Ten binders comprising cement CEM I 42.5 and fly ash, zeolite and/or bentonite additions were prepared in accordance with chemometric experimental design rules. Chemical composition was determined via XRF method. The changes in mineral phases and crystallinity were traced by X-ray diffraction. Hydration mechanisms and thermal behavior were investigated via DTA/TGA. The chemical bonds were identified by FTIR. Morphology of hardened samples was detected by SEM. Mathematical tools employed data sets of instrumental analyses to form a clear differentiation between binders and to assess changes caused by adoption of mineral additives in the mix designs. Sorptive clays showed pozzolanic behavior, thereby causing no incapacitation to the cement hydration mechanism, and classifying as a possible economical resources which can be used in production technology of construction materials to redeem environmental pollution issues of building industry.

Keywords: recycling, chemical properties, analytical modeling, electron microscopy, thermal analysis, binders, structural applications.

B. Ilić, A. Mitrović, Lj. Miličić, M. Zdujić

COMPRESSIVE STRENGTH AND MICROSTRUCTURE OF ORDINARY CURED AND AUTOCLAVED CEMENT-BASED COMPOSITES WITH MECHANICALLY ACTIVATED KAOLINS

Construction and Building Materials, 2018, 178, 92-101.

The effects of two different mechanically activated kaolins, AKV (61% kaolinite, 14% quartz and 16% mica) and AKG (51.6% kaolinite and 40.6% quartz) on the compressive strength of cement composites and microstructure of pastes were investigated. Composite mixtures, in which 10, 20, 30, 40 and 50% of ordinary Portland cement (OPC) was replaced by AKV or AKG, were prepared with w/b of 0.5, and exposed to different curing conditions (ordinary curing for 28 days and autoclaving). Factors affecting microstructure were investigated on pastes by X-ray diffraction (XRD), Differential thermal analysis/thermal gravimetry (DTA/TG) analyses, Mercury intrusion porosimetry (MIP) and Scanning electron microscopy with Energydispersive spectroscopy (SEM-EDS).

AKG composites exhibited higher compressive strengths under both curing conditions. Positive autoclaving effects on strengths were predominantly pronounced at the higher cement replacement levels. Comparison of the autoclaved and ordinary cured paste microstructure, revealed more intensive pozzolanic reaction during autoclaving conditions (CH content near zero) and higher total porosity. The negative effect of hydrogarnet on the strength was compensated by the formation of the crystalline tobermorite.

Obtained results revealed that mechanically activated kaolin, with high content of quartz, could be a promising pozzolanic addition, even at high cement replacement levels (30–50%), especially when autoclaving curing conditions were applied.

Keywords: Mechanically activated kaolin, Cement-based composites, Microstructure, Ordinary curing, Autoclave curing.

RAD U VRHUNSKOM MEĐUNARODNOM ČASOPISU (M21)

M. Pezo, L. Pezo, A. Jovanović, A. Terzić, Lj. Andrić, B. Lončar, P. Kojić

DISCRETE ELEMENT MODEL OF PARTICLE TRANSPORT AND PREMIXING ACTION IN MODIFIED SCREW CONVEYORS

Powder Technology, 2018, Vol. 336, 255-264.

Screw conveyors are widely used in various industries, mostly for transporting and/or lifting bulk materials over short to medium distances. In this paper, five types of horizontal single-pitch screw conveyors with modified geometry with three different lengths (400, 600 and 800 mm) were investigated for mixing action of natural zeolite and quartz aggregate (sand) with particle sizes 3, 4 and 5mm, during the transport. The proper mixing of these materials provides an adequate disposition of zeolite particles within the composite and prevents agglomeration and interference with cement hydration. Zeolite application as a binder in a building material is a possible solution to environmental pollution problems caused by cement production. The geometry of the screw transporter is changed by including three additional helices oriented in the same or the opposite direction from screw cutting edges, and the auxiliary mixing action (used to enhance the blending procedure) was accomplished. The influences of screw length, particle diameter, the studied geometry variations of screw design, on the mixing performances of the screw conveyor-mixer during material transport were explored by ANOVA. The artificial neural network model was developed in order to predict the mixing action within the modified screw conveyor. All investigations were performed experimentally and numerically, by using Discrete Element Method (DEM). The results of the DEM investigation showed that the initial particle path could be lengthened with the certain modifications in the geometry of the screw conveyor, or by expanding its length.

Keywords: Zeolite, Composite building materials, DEM, Modified screw conveyor, Premixing, Mixing quality.

RAD U ISTAKNUTOM MEĐUNARODNOM ČASOPISU (M22)

A. Terzić, N. Obradović, V. Pouchly, J. Stojanović, K. Maca, V. Pavlović

MICROSTRUCTURE AND PHASE COMPOSITION OF STEATITE CERAMICS SINTERED BY TRADITIONAL AND SPARK PLASMA SINTERING

Science of Sintering, 2018, Vol. 50, 299-312.

The influence of the sintering method on the mineral phase transformations and development of the crystalline microstructure of steatite ceramics was investigated. The steatite samples were fabricated from talc and bentonite as low-cost raw materials. Feldspar and barium carbonate, as fluxing agents, were altered in the steatite composition. Dilatometric analysis was applied in the monitoring of the dimensional changes and thereby densification of steatite during the traditional sintering (TS) procedure up to 1200 °C. Spark plasma sintering (SPS) method was used under the following sintering conditions: 100 °C/min heating rate, uniaxial pressure of 50 MPa; sintering temperature 800 °C/1 min or 1000 °C/2 min. Crystallinity changes and mineral phase transition during sintering were observed by X-ray diffraction technique. Microstructural visualization of the samples and the spatial arrangements of individual chemical elements were achieved via scanning electron microscopy equipped with the EDS mapping. It was found that SPS sintering facilitated all microstructural changes during high temperature treatment and shifted them to lower temperatures. SPS treatment conducted at 1000 °C resulted in maximum densification of the steatite powder compacts and the formation stabilized protoenstatite structure.

Keywords: Dilatometry, Spark Plasma Sintering, Electron microscopy, X-ray analysis, Microstructure-final, Magnesium silicate.

M. V. Vasić, L. Pezo, J.D. Zdravković, M. Vrebalov, Z. Radojević

THERMAL, CERAMIC AND TECHNOLOGICAL PROPERTIES OF CLAYS USED IN PRODUCTION OF ROOFING TILES – PRINCIPAL COMPONENT ANALYSIS

Science of Sintering, 2018, Vol. 50.

This research describes a study of 11 selected samples of brick clays applied in roofing tile production, by using simultaneous thermal analysis. Additionally, the laboratorysized samples were prepared and fired (850-950 °C) and technological properties were determined. Mathematical analysis was applied to sum all the experimental results and help discriminate the samples by their behavior during firing. The samples, very similar according to mineralogical and chemical content, as well as granulometry tests, were successfully grouped using principal component analysis (PCA). The PCA was used to explore and easily visualize the differences between samples. The PCA performed for differential thermal analysis (DTA), differential scanning calorimetry (DSC) and differential thermogravimetry (DTG) curves clearly showed that the heat flow was mainly influenced by carbonate content and its grain size, while DTG discriminated samples according to the contents of clay minerals and carbonates. In addition, dilatometry analysis revealed which samples underwent the highest densification during the firing process. The PCA analysis of fired products properties showed that the highest correlations were between water absorption with firing shrinkage and compressive strength.

Keywords: Brick clay, Thermal analyses, Principal component analysis, Dilatometry.

M.R. Vasić, R. Rekecki, Z. Radojević

A PROCEDURE FOR SETTING UP THE DRYING REGIME THAT IS CONSISTENT WITH THE NATURE AND PROPERTIES OF CLAY RAW MATERIAL

Drying technology, 2018, Vol. 36 (3), 267-282.

Over the past three decades, traditional ceramic facilities: chamber and tunnel dryers are improved. Better thermo-technical equipment, operational strategies as well as reliable scale - up methodologies have lead to higher quality of the dried

clay roofing tiles. Although there has been a progress, up to this study, there is no universally or even widely applicable criterion, which could be used to precisely define the change of drying air parameters (humidity, temperature, and velocity) during the drying process. The objective of this study was to specify the variable air parameters that should be used during the drying process in order to approach as much as possible to the theoretically defined optimal drying process.

Keywords: drying process, drying regime, effective diffusion coefficient, clay roofing tile, clay raw material.

RAD U MEĐUNARODNOM ČASOPISU (M23)

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

THE POSSIBILITY OF THE USE OF BOTTOM ASH IN CONCRETE PRECAST PRODUCTS

Građevinar, 2018, Vol. 70, No. 5, 413-419.

Chemical, physical and mechanical properties of bottom ash from two thermal power plants were analysed in order to evaluate the quality of bottom ash and to determine the possibility of its use in composite materials. It was found that the bottom ash samples from both power plants show good properties enabling their practical use, and that they also meet most of the criteria specified for fly ash. Samples in which 4, 8, 12 and 16% of fine aggregate was replaced with bottom ash were tested. The results meet criteria of applicable regulations for concrete, which justifies the use of bottom ash in construction industry.

Keywords: bottom ash, thermal power plant, concrete, durability, sustainable development.

RAD U ČASOPISU MEĐUNARODNOG ZNAČAJA VERIFIKOVANOG POSEBNOM ODLUKOM (M24)

N. Mijatović, L. Pezo, A. Terzić, S. Šerbula, R. Kovačević

THE BIOMETRICS TECHNIQUES FOR THE ASSESSMENT OF THE DEGREE OF ADOPTION OF TOXIC AND ESSENTIAL ELEMENTS

Zaštita materijala, 2018, Vol. 59, 56-66.

The focus of this study is on the biometric classification of plants, plant organs, sampling sites and sampling time, in terms of toxic (As, Cd, Hg and Pb) and essential elements (Cu and Zn) monitoring, and possible the application in phyto-remediation. The degree of adoption of elements depends on the plant species and its morphological and physiological properties, therefore the adoption of toxic and essential elements in three plant species (coltsfoot, dandelion and nettles) was investigated. Vegetation experiments were carried out in the coastal region of river Kriveljska, Serbia. Principal component analysis and analysis of variance were used for assessing the effect of plant types, plant organs (root, shoot and leaves), and sampling sites and sampling time (April, May, June) on toxic and essential elements uptake. Obtained results showed that a difference in toxic and essential elements uptake depends mostly upon the cultivar and the plant organ types. Biometric techniques provided a good opportunity for a better understanding the behaviour of plants and obtaining much more useful information from the original data.

Keywords: coltsfoot, dandelion, nettles, toxic elements, essential elements, biometrics monitoring.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

I. Despotović, K. Janković

INFLUENCE OF TAILINGS AND FLY ASH ON THE SRENGTH OF SELF-COMPACTING CONCRETE

10th International Scientific Conference *Contemporary Materials 2017*, Banja Luka, BIH, 2018, 163-170.

Concept of sustainable development, which beside sociological and economic aspects, includes saving of energy, environment protection and preservation of restorable natural resources, presents strategic determination of various economic sectors. In that way great contribution is expected from construction industry. Self-compacting concrete has significant environmental advantages in comparison to the vibrated concrete: absence of noise and vibrations during installing provides a healthier working environment. Unlike vibrated concrete, self-compacting concrete contains significant amounts of fine particles, i.e. a mineral additive that greatly affects its performance, where potential use of fly ash is very important ecological aim. Tailing test results showed no pozzolanic activity and so its application in concrete can be only a partial replacement of aggregate.This paper presents the possibility of using tailings and fly ash, which are waste products, in Self – Compacting Concrete. The obtained results indicate that these materials can successfully be used.

Keywords: Self – Compacting Concrete, Tailings, Fly ash, Compressive strength.

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

SELF-COMPACTING CONCRETE WITH RECYCLED CONCRETE AGGREGATE AS ECOLOGICAL MATERIAL

RILEM Proceedings PRO 121, Vol. 1, 2nd International RILEM/COST Conference *SynerCrete'18: Interdisciplinary Approaches for Cement-based Materials and Structural Concrete: Synergizing Expertise and Bridging Scales of Space and Time*, Funchal, Portugal, 2018, 315-320.

The concept of sustainable development, which in addition to social and economic aspects, includes energy saving, environmental protection and the conservation of exhaustible natural resources, is a strategic goal of many economic sectors including the particular contribution expected from the construction. Self-compacting concrete contains a certain amount of powdered materials – fillers. There are various possibilities of selecting this component. If we used any of the industrial by-products, such as fly ash or silica fume, we would solve the problem of depositing these materials, and thus made concrete ecological material. The research subject presented in this paper are the properties and technology of self-compacting concrete in the fresh and hardened state, made with various mineral additives: lime, fly ash, and silica fume, wherein the aggregates used, are both natural and recycled aggregates.

Keywords: self-compacting concrete, recycled concrete aggregate, fly ash, limestone.

K. Janković, D. Bojović, M. Stojanović , I. Despotović, Lj. Lončar

CONCRETE PAVING BLOCKS AND FLAGS MADE WITH RECYCLED AGGREGATE FROM PRECAST ELEMENTS

ASES International Congress, Zlatibor, 2018, 212-217.

The possibility of using recycled aggregate from precast paving blocks and curbs in the production of concrete elements for the pedestrian areas is shown in this paper. Experimental work has included few types of concrete made with different amounts of cement and recycled concrete aggregate. Based on the testing results it was assumed that it is possible to produce the concrete paving blocks and flags comply with European standards. The results show that replacing natural aggregate with crushed concrete aggregate produces concrete elements which meet the requirements of EN 1338 and EN 1339, but class depends of percent of replacement natural aggregate by recycled.

Keywords: recycled concrete aggregate, paving blocks, paving flags.

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

THE EFFECT OF NANO SIO2 ON THE STRENGTH OF UHPC

6th International Conference *Contemporary Achievements in Civil Engineering 2018*, Subotica, 2018, 265-272.

Research on the application of nano materials in cement composites in the world began in the early 21st century. When preparing UHPC, nano SiO2 was used. The aim of the research is to determine the influence of nano-silica, as partial substitution for cement on the mechanical properties of UHPC. The results of the comparative testing of concrete in fresh and hardned state are presented without any substitution of up to 2% of cement with nano SiO_2. In order to determine the effect of the nano-silica on the increase in compressive strength and flexural strength, the specimens which were curing in water were tested at the age of 2, 7 and 28 days.

Keywords: nanosilica, UHPC, compressive strength, flexural strength.

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

THE INFLUENCE OF POLYPROPYLENE FIBERS ON THE MECHANICAL PROPERTIES OF SHORCRETE FOR SLOPES

ASES International Congress, Zlatibor, 2018, 237-244.

This paper presents the possibility of the use of polypropylene fibers in shotcrete which would be used for coating slopes. Shotcrete mixes with different content of polypropylene fibers were tested and compared with referent shotcrete without fibers. Puncture testing was performed on shotcrete slabs, while compressive and tensile splitting strength were testing on cubes at 28 days of age. Obtained results for shotcrete containing 5 kg/m^3 polypropylene fibers show the best mechanical properties.

Keywords: shotcrete, polypropylene fiber, reinforcement, energy absorption, strength.

M.R. Vasić, Z. Radojević

COMPARISION AND EVALUATION OF RECENTLY REPORTED METHODS FOR OPTIMIZATION OF INDUSTRIAL DRYING REGIMES

International Conference on Modern Technologies in Industrial Engineering *ModTech 2018*, Constanta, Romania, published in IOP Conf. Series: Materials Science and Engineering 400 (2018) 062030.

doi:10.1088/1757-899X/400/6/062030

In our previous studies we have presented the calculation method along with the procedure for setting up the non isothermal drying regime. Even though this method is harmonized, with the theory of moisture migration during drying and can be used to predict the optimal industrial drying regime and proper drying air parameters, up till now it was not compared with other models. The main goal of this paper, was to compare and evaluate our model with the one reported by the German group of authors in 2008. The first task was to create criteria for model evaluation. Five parameters were chosen: non-existence of cracks, total drying time, twist coefficient, chamber coefficient and flexural strength. The second task was to create a software tool, for modeling the first and second drying section of green clay masonry element, using the instructions provided within the published articles. The third task was to apply German and our procedure on the same clay raw material. Results have shown the absence of cracks on dried and fired samples. In the case of German method total drying time, as well as twist and camber coefficients were higher while the physico - mechanical properties were lower. Presented results have additionally validated that our dying model can be used for the accurate prediction of industrial drying kinetics and a reliable estimation of moisture transport during drying.

Keywords: drying process, drying regime, effective diffusion coefficient, clay roofing tile, clay raw material.

N. Mijatović, A. Terzić, N. Jović-Jovičić, A. Milutinović Nikolić, D. Jovanović, D. Živojinović

ADSORPTION STUDY ON NATURAL CLAYS AS CEMENT MINERAL ADDITIVES: POSSIBILITY OF TOXIC METALLIC CATIONS IMMOBILIZATION

Serbian Ceramic Society Conference *Advanced Ceramic and Application VII – New frontiers in multifunctional material science and processing*, Belgrade, 2018, 70-71.

Evironmetally safe mortars in which part of the cement binder was replaced by mineral additives (i.e. zeolite, bentonite and fly ash) were designed. Fly ash, as fine powdery byproduct of coal combustion, comprises heavy metals in its composition. Bentonite and zeolite are natural adsorbents with ability to immobilize certain toxic elements and prevent their migration from the mortar structure. In this study the ability of bentonite and zeolite to adsorb toxic cations present in fly ash leachate was investigated. Metallic cations were detected in quantities not higher than 52.6, 15.5, 52.4 and 22.7 mg/kg for Zn, Pb, Cu and Ni respectively. Adsorption kinetic was monitored using 0.1 mol/dm^3 solutions of each of investigated cations (Zn^{2+}, Pb^{2+}, Cu^{2+} and Ni^{2+}) as well as multicomponent solution of all these cations during predefined time intervals in the range from 10-1440 minutes. Adsorption isotherms were obtained in concentration range for each cation of single and multicomponent solution in the range from 0.10-0.30 mol/dm^3. The obtained results of this investigation indicate that bentonite and zeolite are efficient adsorbents and, therefore, they can be applied in combination with fly ash in environmentally-safe construction materials.

Keywords: Zeolite, Bentonite, Environmentally safe materials; Structural applications; Construction composites.

RAD U VODEĆEM ČASOPISU NACIONALNOG ZNAČAJA (M51)

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

SVOJSTVA I PERFORMANSE MALTERA SA DODATKOM PRIMARNIH I SEKUNDARNIH MINERALNIH SIROVINA U CILJU ZAMENE CEMETNOG VEZIVA

Tehnika: Novi Materijali, 2018, Vol. 27, 470-476.

Mineralni dodaci se ekstenzivno koriste kao zamena za cement u građevinskim betonima i malterima. Leteći pepeo je jedan od najčešće primenjivanih dodataka koji unapređuje reološka, mehanička i termička svojstva materijala. Međutim, ovaj industrijski nusprodukat sadrži teške metale zbog čega je neophodna optimizacija njegove dozaže pri dizajnu maltera. Glineni materiali kao što su zeolit i bentonit svojim sorpcionim mehanizmima mogu da preduprede migraciju toksičnih elemenata iz pepela imobilišući ih unutar strukture. U ovom radu eksperimentalno su ispitana tri različita maltera pripremljena na bazi Portland cementa, rečnog peska i kombinacije mineralnih dodataka – letećeg pepela, zeolita i bentonita. Malter M_1 sadržao je sva tri dodatka u odnosu 1:1:1, malter M_2 je sadržao zeolit i bentonit u odnosu 1:2, dok je odnos zeolita i bentonita u malteru M_3 bio 2:1. Cilj istraživanja je bio da se ispita uticaj mineralnih dodataka na fizičko-hemijska, termička i mehanička svojstva maltera. Primenjene su instrumentalne metode - X-ray difrakcija, diferencijalno termijska i dilatometrijska analiza i FTIR spektroskopija. Rezultati istraživanja su ukazali da se primenom ovih mineralnih dodataka mogu dobiti ekonomični malteri sa dovoljno dobrim performansama.

Ključne reči: građevniski materijali, mehanička svojstva, termička svojstva, sorpcija, reciklaža.

PREDAVANJE PO POZIVU SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M61)

B. Ilić, V. Radonjanin, A. Mitrović

THERMALLY AND MECHANICALLY ACTIVATED KAOLIN AS SUPPLEMENTARY CEMENTITIOUS MATERIALS

Savremena građevinska praksa 2018, Andrevlje, 2018, 77-98,.

The effects of thermally (MK) and mechanically activated kaolin (AK) on the compressive strength of cement-based composites and microstructure of pastes were investigated. Composites, in which from 10% to 50% of ordinary Portland cement (OPC) was replaced by either MK or AK, were prepared and cured under different conditions (ordinary and autoclave). Hydration products were determined by XRD analyses on cement pastes, while porosity and pore size distribution was investigated by mercury intrusion porosimetry (MIP).

Positive effects on the compressive strength of ordinary cured composites could be achieved by application up to 30% of MK. AK composites showed lower strengths, for all ages, compared to both MK composites and reference. In comparison to the reference, autoclaved MK and AK composites, exhibited lower compressive strength, as a consequence of increasing the hydrogarnet formation. AK could be applied in ordinary and autoclaved composites with cement replacement level up to 10%.

Keywords: metakaolin, mechanically activated kaolin, cement-based composites, compressive strength, microstructure.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

M. Vasić, Z. Radojević, L. Pezo, J. Zdravković, A. Terzić

ANALIZA TERMIČKOG PONAŠANJA MONTMORILONITSKIH I ILITSKIH OPEKARSKIH GLINA SA CILJEM PREDVIĐANJA KRIVIH PEČENJA U INDUSTRIJI

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, 2018, 65-75.

Cilj ovog istraživanja bio je da se ispitaju montmorilonitske i ilitske opekarske gline koristeći diferencijalnu termičku, termogravimetrijsku i dilatometrijsku analizu radi procene pogodnosti za proizvodnju građevinskih elemenata. Kod ispitivanih sirovina određeni su koeficijent plastičnosti i osetljivost u sušenju. Karakteristike pečenih proizvoda su utvrđene na osnovu upijanja vode i čvrstoće pri pritisku. Sve korišćene metode su upotrebljene za predviđanje i definisanje određenih tehnoloških parametara u proizvodnji i formiranju krivih pečenja. Dobijeni rezultati mogu povećati stepen sigurnosti u vođenju proizvodnog procesa ka dobijanju opekarskih elemenata željenih karakteristika.

Keywords: Opekarske gline, termička analiza, krive pečenja, optimizacija procesa.

Z. Radojević, A.Terzić, Lj. Vasić, Lj. Santo

OPTIMIZACIJA SASTAVA I SVOJSTAVA GLINENIH KOMPOZITA U CILJU DOBIJANJA OPEKARSKIH PROIZVODA NAPREDNIH PERFORMANSI

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, 2018, 37-46.

U cilju unapređena postupka proizvodnje opekarskih blokova razmatrana je mogućnost reciklaže ugljene prašine umešavanjem u osnovnu sirovinsku smešu. Osnovna sirovinska smeša je optimizovana od glina različitih svojstava i peska. Definisan je obim ispitivanja novih sirovinskih mešavina, kao i parametara tehnološkog procesa proizvodnje energetskih blokova. Polazna osnova za

istraživanja je upravo bila aktuelnost teme energetske efikasnosti, a u daljoj instanci konstantno otvoreno pitanje energetske i ekonomske održivosti građevinskih objekata.

Ključne reči: opekarske gline, ugljena prašina, energetski blokovi, pečenje, reciklaža .

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MECHANICAL
ENGINEERING,
HYDRAULICS,
VACUUM TECHNOLOGY,
VIBRATION AND ACOUSTIC
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TEHNOLOGIJA
I AKUSTIČKI
INŽENJERING

RAD U VRHUNSKOM MEĐUNARODNOM ČASOPISU (M21)

S. Bošnjak, M. Arsić, N. Gnjatović, I. Milenović, D. Arsić

FAILURE OF THE BUCKET WHEEL EXCAVATOR BUCKETS

Engineering Failure Analysis, 2018, Vol. 84, 247-261.

https://doi.org/10.1016/j.engfailanal.2017.11.017

Buckets present the vital substructure of all digging machines, and are intended for the realisation of the fundamental machine function: soil excavation. This paper presents the results of the experimental-numerical investigation of the cause of the bucket wheel excavator SRs 470 buckets failure. The chemical composition and mechanical properties, the impact toughness, hardness, tendency to cracks and the microstructure are determined by using appropriate tests. Experimental examinations of working and residual stresses were done by using strain gauges. The superposition of the experimentally determined working and residual stresses and the calculation of the total principle stresses were conducted using the originally developed procedure presented in this paper. The bucket working stress state was calculated by applying the linear finite element method. Conclusions based on the investigation results show that the main reasons for the buckets failure were the 'design-in defects': oversights made during the procedures of geometrical shaping and material selection. Furthermore, high values of residual stresses as well as the cold cracking observed on the welded joint of the knife and the bucket body, are suggesting that the 'manufacturing-in defects' have a significant role in the failure as well. The fact that buckets failure appeared due to oversights made during geometrical shaping, material selection and manufacturing, emphasizes the importance of the critical approach implementation during the design phase of the earthmoving machines working devices.

Keywords: bucket wheel excavator, bucket; failure, experimental investigation, linear finite element analysis.

RAD U ČASOPISU MEĐUNARODNOG ZNAČAJA VERIFIKOVANOG POSEBNOM ODLUKOM (M24)

B. Međo, M. Arsić, M. Rakin, S. A. Sedmak, Z. Savić

INTEGRITY ASSESSMENT OF VITAL BEAM COMPONENTS THAT ENABLE CONJOINT OPERATION OF TWO BRIDGE CRANES

Structural Integrity and Life, 2018, Vol. 18, No. 1, 53-55.

Vital components of the beam that enable conjoint operation of two bridge cranes are braces and the threaded spindle. The beam connects two bridge cranes with the overall lifting capacity of 500 t (2x250 t) and enables their simultaneous conjoint operation during the rehabilitation or major overhaul of hydroelectric generating set equipment at the hydro power plant "Djerdap 2". Two braces are being installed instead of two hooks when that situation occurs. Threaded spindle is loaded with 500 t (5 MN), while braces are loaded with 250 t (2.5 MN) each. Integrity of structures is a relatively new scientific and engineering discipline which in a broader sense comprises condition analysis, behaviour diagnostics, service life evaluation and rehabilitation of structures, which means that, beside the usual situation in which it is necessary to evaluate the integrity of structure when a flaw is detected by means of non-destructive tests, this discipline also comprises stress condition analysis for the crackless structure, most often through the use of the finite element method. That's the way to obtain the precise and detailed distribution of displacements, deformations and stresses, which enables determination of weak spots at the structure, even before the initiation of the crack. Non-destructive tests were performed in order to analyze the current condition of braces and of the threaded spindle. On the basis of performed analytical calculations it was determined that their integrity is not threatened, although some internal non-homogeneities were detected by ultrasonic testing.

Keywords: cranes, ultrasonic testing, braces, threaded spindle, integrity of structures.

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

USE OF NON-DESTRUCTIVE TESTS FOR THE ASSESSMENT OF INTEGRITY AND SERVICE LIFE OF HYDRO-MECHANICAL EQUIPMENT

Advanced Materials Research, 2018, Vol. 1146, 9-16.

https://doi: 10.4028/www.scientific.net/AMR.1146.9

Technical diagnostics, concerning the turbine and hydromechanical equipment, should rely on certain testing procedures, history of use of turbine and hydromechanical equipment with expert knowledge regarding the structures and operating conditions, as well as on the analysis of results performed by experts with appropriate experience and knowledge in design, exploitation, maintenance, reliability, fracture mechanics etc. Degradation of properties of the material and/or welded joints at structures and components of turbine and hydro-mechanical equipment is being caused by the simultaneous influence of a large number of technological, metallurgical, structural and exploitational factors. In this paper some examples where non-destructive tests enabled the determination of causes of degradation of base material or welded joints, as well as identification of elements necessary for expert decisions regarding the methodology that is supposed to be used for the rehabilitation of components of turbine and hydro-mechanical equipment (repair welding, repair of damaged surfaces by cold metallization, use of new technologies and materials, corrections of existing structural solutions) in order to improve their technical characteristics and extend the service life of the hydroelectric generating set are presented.

Keywords: hydro turbine, non-destructive testing, degradation of material, structural integrity.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

M. Arsić, S. Bošnjak, V. Grabulov, B. Vistać, Z. Savić

REPAIR OF DAMAGED SURFACES AT THE VITAL SECTION OF THE REGULATORY MECHANISM OF THE HYDRO TURBINE GUIDE VANE APPARATUS

VIIIth International Metallurgical Congress, Ohrid, Macedonia, 2018, CD, 1-6.

Vertical Kaplan turbines were installed in 6 hydroelectric generating sets at "Djerdap 1", nominal power 178 MW, made in Russia. During the refurbishment of the hydroelectric generating set A1 at the hydro power plant Djerdap 1, experimental non-destructive tests on all of its components were performed in order to determine the state of the turbine as a whole. During the testing the damages and cracks were detected on internal surfaces of cranks and sleeves of guide vane apparatus vanes, which were caused by turbine shaft vibrations. Cranks and sleeves were made of cast steel 25L, in accordance with the standard GOST 977. The repair methodology for damaged internal surfaces of cranks of guide vane apparatus vanes is presented in this paper. It was necessary, due to the structural solution used for the design of cranks and sleeves and their function during exploitation, to define a large number of details, carefully reconsider them and carry out all activities with extreme care in order to enable the safe operation and continuous use of cranks. Overlooking, underestimation or incorrect perception of important details could cause significant problems during turbine operation.

Keywords: hydro turbine, crank, sleeve, damages, repair tehnology.

M. Arsić, S. Bošnjak, V. Grabulov, M. Mladenović, B. Međo, Z. Savić

MECHANICAL PROPERTIES OF STEEL API X60 USED FOR WELDED JOINTS CREATED BY ARC WELDING

4th International Conference *Mechanical Engineering in XXI Century*, Niš, 2018, 193-196.

This paper contains results of tests performed in order to determine mechanical properties of steel API 5L X60, used as filler material during the execution of welded joints. Arc welding of samples from which the specimens were taken was carried out through the application of welding process 111, because it is one of the processes for the execution of pipelines for the transport of oil or gas. Microspecimens with diameter of 1,5 mm were tested in order to determine tensile properties of material taken from the heat-affected zone and weld metal, while specimens with diameter of 6 mm were tested in order to determine tensile properties of parent material. Standard Charpy V-notch specimens were used in order to determine impact energy. On the basis of results of tensile tests carried out on specimens taken from parent material, heat-affected zone and weld metal it was determined that mean values of yield strength and tensile strength of parent material and weld metal are practically equal, while these values for heat-affected zone are more than 20% lower. There is a similar situation when it comes to the value of elongation. Mean values of overall impact energy for parent material and weld metal are practically equal, while in comparison with results obtained for material taken from the heat-affected zone they are more than 2 times lower. Through the analysis of energy necessary for initiation and propagation of cracks it was determined that the ratio of those energies is very good when it comes to parent material and weld metal, while it was also determined that the critical location for crack initiation is the heat-affected zone.

Keywords: steel API 5L X60, welded joint, specimens, microspecimens, mechanical properties.

M. Arsić, S. Bošnjak, V. Grabulov, M. Mrdak, Z. Savić

WELDING TECHNOLOGY FOR AREAS OF THE GENERATOR ROTOR HUB WHERE CRACKS WERE DETECTED AT HYDRO POWER PLANT ĐERDAP 1

4th IIW South-East European Welding Congress, Belgrade, 2018, CD, 1-6.

During the revitalization of the hydroelectric generating set A4 at the hydro power plant ''Djerdap 1'', all of its parts were subjected to experimental non-destructive tests. Cracks were detected at the casted part of the generator rotor hub, in the flange area toward the the turbine shaft. They were 10 – 500 mm long (which was determined through magnetic particle testing) and 60 – 100 mm deep (determined through ultrasonic testing). The generator rotor hub was made of cast steel 25L, in accordance with the standard 977-75.The repair methodology by welding / surface welding in cracks detected zones at the casted part of the generator rotor hub has to, due to the structural solution and function in service of the generator rotor, embrace a large number of details, carefully reconsider them and ensure carrying out of all activities with extreme care in order to enable the safe operation and continuous use of the hub. Overlooking, underestimation or incorrect perception of important details could cause significant problems during the operation of the hydroelectric generating set. This paper, due to the specificity of the repair methodology, contains the arranged preparatory activities procedure apart from the welding / surface welding technology. It should especially be noted that a huge amount of money was saved, because the making of the new generator rotor would cost more than 4.000.000 € (mass of the generator is larger than 300 t), not taking into account the time needed for its making (6 – 12 months), which is directly related to the amount of energy a hydroelectic generating set would produce during that period. This methodology of repair welding is also applicable for the reparation of other components and structures of turbine and hydromechanical equipment subjected to various causes of damage during exploitation.

Keywords: hydroelectric generating set, turbine shaft, ventilator ring vane, damage repair.

RAD U VODEĆEM ČASOPISU NACIONALNOG ZNAČAJA (M51)

M. Arsić, M. Mladenović, Z. Savić, S. Bošnjak, Ž. Šarkoćević

TECHNICAL DIAGNOSTICS OF THE CONDITIONS OF DRILL PIPES AND OIL AND GAS TRANSPORT PIPELINES

Energija, 2018, Vol. 20, No. 1-2, 411-414.

Columns of welded pipes in the oil and gas wells and pipelines for their transportation to consumers fall into high responsible structures prone to corrosion and cracks. Therefore it is important to know the remaining strength of the pipes in the case of occurrence of any of the mentioned types of damage. Steels intended for the production of protective pipes for oil and gas drills are specified by the API 5CT standard.Premature failure or damaging of parts and components of welded pipes columns in wells, as well as pipelines for the transport of oil and gas is generally caused by the simultaneous influence of a large number of technological, metallurgical, structural and exploitation factors. Therefore convenient structural solutions, which provide the mechanical safety of parts and the integrity of structures, can be realized only through total comprehension of their behavior in various operation regimes.The paper elaborates the importance of technical diagnostics for monitoring and analysis of protective pipes conditions in the wells and pipelines during the oil and gas transportations. Also, an analysis of the causes of failure of the pipes and pipelines is conducted and the importance of forming of database is considered.

Keywords: drill pipes, transport pipeline, damage, technical diagnostics, database.

M. Arsić, S. Bošnjak, V. Grabulov, Ž. Šarkoćević, Z. Savić

CAUSE OF LAMELLAR TEARING OF PARENT MATERIAL AND DEGRADATION OF WELDED JOINTS AT VITAL WELDED STRUCTURES OF THE TURBINE AT HYDRO POWER PLANT ĐERDAP 1

Energija, 2018, Vol. 20, No. 1-2, 129-133.

Vertical Kaplan turbines, manufactured in Russia, are installed in 6 hydroelectric generating units at "Djerdap 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 'Djerdap 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 structure, non-destructive test, lamellar tearing of parent material, degradation of the welded joint.

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

ANALYSIS OF CURRENT STATE AND STRENGTH EVALUATION OF THE PIPELINE AT HIDRO POWER PLANT PIROT

Welding & Welded Structures, 2018, Vol. 63, No. 1, 17-22.

Hydro power plant Pirot, which was built in 1990, is an accumulation-derivative power plant, which consists of 2 above-ground vertical hydroelectric generating sets that contain Francis turbines with nominal power of 41,5 MW, manufactured in Czech Republic, a tunnel and a sunken pipeline with overall length of 2.030 m and diameter that ranges from 3.000 to 3.500 m. Pipes have been made of

S275J2G3 steel. Pipe wall is 22 mm thick. Maximum pressure of 2.5 MPa occurs in front of the turbine cover. Geodetic measurements have been conducted permanently from the day the assembly was finished and pipeline was put into service, both when pipeline is empty and unloaded by hydrostatic pressure and when it is full. Analysis of obtained data regarding the movements along the pipeline route showed that from year 2003 there are significantly higher differences in movements comparing the situations when the pipeline is full and when it is empty in comparison with the previous period. This paper contains the analysis of current state and strength evaluation of the pipeline as a whole on the basis of results of non-destructive tests performed on the vital butt-welded joint in the curvature area at chainage 1+263 m (visual testing, magnetic particle testing, penetrant testing, ultrasonic testing, radiographic testing, metallographic replication testing).

Keywords: hydroelectric generating set, crack, repair technology, pipeline strength.

M. Mladenović, M. Arsić, Z. Savić, S. Bošnjak, N. Gnjatović

INFLUENCE OF DEGRADATION OF PARENT MATERIAL AND WELDED JOINTS ON THE INTEGRITY OF THE BREECHES PIPE LOCATED AT PIPELINE III OF HYDRO POWER PLANT PERUĆICA

Energija, 2018, Vol. 20, No. 1-2, 528-534.

Hydro power plant ’Perućica’, which comprises 7 hydroelectric generating units, each with installed power of 330 MW, is the oldest hydro power plant in Montenegro and was put in service in 1960. High pressure hydro power plant ’Perućica’ is a complex hydroenergetic system, which comprises of a 3335 m long concrete tunnel, surge with a broadening and overflow and three steel pipelines with two-sided Pelton turbines with horizontal shafts installed. Five turbines have nominal power of 38 MW, while two have nominal power of 58,5 MW (307 MW overall).The biggest problem at hydro power plant ’Perućica’ refers to the parent material and weld metal of the breeches pipe 1A located at pipeline III. Significantly lesser problems were detected at parent material and weld metal of breeches pipes 7B, 8A and 8B. Pipeline and breeches pipes were made of microalloyed steel ’Nioval 47’ (steel mill ’Jesenice’). Stresses that occur at pipelines in service during the process of execution of functional tasks (stationary and dynamic loads) and during the disturbed process of exploitation

(non-stationary dynamic loads), cause severe damaging of parent material and weld metal at structural components of breeches pipes (collars and anchors), thus endangering the integrity of pipeline structure as a whole. Role of the collar, which enables the leaning of the breeches pipe on the foundation, is to receive static and dynamic loads (mean pressure of up to 6,1 MPa in pipeline axis, specific load that occurs due to the quantity of water in the pipeline, action of the force of gravity) and displacements which occur due to non-stationary dynamic loads that occur at the pipeline, while the anchor has the role to strengthen and balance the mass of the breeches pipe. In this paper the results of non-destructive tests performed on parent material and weld metal (collar and anchor) of breeches pipes with designations 1A, 7A, 8A and 8B and results of destructive tests performed on parent material of the anchor are presented. Tests that were carried out include visual testing (VT), magnetic particle testing (MT) and ultrasonic testing (UT), while destructive tests included determination of chemical composition, tensile properties, impact energy and hardness. On the basis of results of test results it was determined that the main cause of occurrence of significant damages (degradation of parent material of the anchor and weld metal between the collar and anchor, as well as between the pipeline and the anchor) at the structure of the breeches pipe 1A of the pipeline III at the hydro power plant 'Perućica' is the fact that the breeches pipe did not lean on the collar, as was predicted by design, but on the anchor which, due to the size of its cross-section, could not endure all loads that occur at the breeches pipe during service. Damages that occurred on parent material and weld metal of breeches pipes 7B, 8A and 8B are directly caused by flaws in welding technology and conditions of exploitation. Executed researches showed that degradation of parent material and weld metal does not influence the integrity of the pipeline III as a whole.

Keywords: breeches pipe, collar, anchor, material degradation, welded joint, integrity.

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CIVIL ENGINEERING,
HYDRAULIC ENGINEERING,
OFFSHORE TECHNOLOGY,
SOIL MECHANICS

T 220
GRAĐEVINARSTVO,
HIDRAULIKA,
PRIOBALNA
TEHNOLOGIJA,
MEHANIKA TLA

RAD U ČASOPISU MEĐUNARODNOG ZNAČAJA VERIFIKOVANOG POSEBNOM ODLUKOM (M24)

D. Bojović, N. Bašić, K. Janković, A. Senić

ASSESSMENT OF CONCRETE COMPRESSIVE STRENGTH USING DIFFERENT MATURITY FUNCTIONS: CASE STUDY

Građevinski materijali i konstrukcije (Building Materials and Structures), 2018, Vol. 61, No. 3, 55-65.

Compressive strength is a property of significant importance for civil engineering, consequently, there have been strong need for developing method, which will estimate rise of concrete compressive strength in a construction. According to Serbian legislation, assessment of compressive strength in construction relies on laboratory results obtained under constant conditions.

This paper presents and compares results obtained in a laboratory, results obtained by maturity method, which is based on correlation between concrete compressive strength, concrete age and ambient temperature, and results obtained by ConReg 706 instrument, which also takes in consideration outside and concrete temperature. There have been applied two approaches of maturity method, Nurse & Saul and Arrhenius.

For this research concretes class C30/37 was used, prepared as two different mix designs, MB35 and MB 40. Casting was performed in summer time in Ostriznica bridge near Belgrade. Elements that were casted are deck slab, pile cup and bearing beam.

Key words: concrete maturity, mass concrete, temperature.

K. Božić-Tomić, N. Šušić, M.Uljarević

THE SYSTEMATIZATION OF ANALYTICAL AND NUMERICAL METHODS OF LANDSLIDE STABILITY CALCULATION

Građevinski materijali i konstrukcije (Building Materials and Structures), 2018, Vol. 1, 129-160.

Given the complexity of geometry of the relief of the earth's surface, slopes represent one of the problematic geological forms in geotechnics. he slopes are characterized by a sudden change in geometry of the terrain (denivelation) with a predisposition to the change of this geometry due to the effects of various factors. The most common and most complex type of soil disturbance and slope geometry is the stability of the terrain, whether natural slopes or artificial slopes. Very often, in practice, problems with the stability of the landslide are encountered, when after the conduc-ted field investigations, laboratory-geomechanical tests, defining the causes and conditions of landslide forma-tion, it is necessary to define repair measures. However, in order to successfully manage all project situations of the landslide stability analysis and landslide repair, it is necessary to have high quality mathematical models and landslide methods. Previous experience shows that there is a need for the implementation of more complex (more realistic) mathematical models for practical purposes and further improvement of existing landslide stability methods. The aim of the research presented in this paper is to further systematize the methods of landslide calculations and modelling algorithms with a special emphasis on numerical stability analyses.

Keywords: landslides, analythical methods, numerical methods, landslide stability.

M. Ćosić, R. Folić, B. Folić

FRAGILITY AND RELIABILITY ANALYSES OF SOIL - PILE - BRIDGE PIER INTERACTION

Facta Universitatis, Series: *Architecture and Civil Engineering*, 2018, Vol. 16, No. 1, 93–111.

The purpose of this paper is to present the methodology for performance-based seismic evaluation of soil-pile-bridge pier interaction using the incremental nonlinear dynamic analysis (INDA). The system's input signal is treated through the generated artificial accelerograms which were subsequently processed by soil layers and for the bedrock. The INDA analysis was post processed separately for the pier and for the pile, so that the constructed *PGA=f(DR)* curves are in the capacitive domain. For these curves the authors identified the performance levels, while the regression analyses were conducted based on the specific *DR* and *PGA* parameters. Fragility curves were constructed based on the solutions of regression analysis and the probability theory of log-normal distribution. Based on the results of fragility analysis, reliability curves were also constructed. The methodological procedure for seismic performance analysis presented in this study provides an integrated quantitative-qualitative consideration and evaluation of the complex soil-foundation-structure interaction (SFSI).

Keywords: incremental nonlinear dynamic analysis, pile performance, fragility, reliability, artificial accelerograms.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

B. Folić, S. Brčić, M. Čokić, M. Ćosić, S. Sedmak

THE EFFECT OF AFTERSHOCK ON 2D RC FRAME FOUNDED ON PILES WITH P-Y CURVES

22nd European Conference on Fracture *ECF22 (Loading and Environment Effects on Structural Integrity)*, Belgrade, 2018.

This paper presents the manner of modeling the aftershock (in an earthquake), the phenomenon whose significance has been noted in the second half of the 20th century. It lists the constructional systems in which the consideration of the aftershock is important. It shows in more detail the model of the skeletal RC construction, i.e. the 2D RC facade frame constructed on the 60cm-diameter drilled RC piles. The dynamic interaction soil-pile, i.e. the non-linear behaviour of the soil is modelled with the horizontal p-y curves for sand, applying multiplastic link elements. For the accelerogram El Centro during time history (TH) the general movement and (local) drift, the condition of plastic hinges were considered. On one pile, the dissipation of seismic energy according to debth for the first (major) and the aftershock (of the earthquake) was analysed.

Keywords: soil-pile-structure interaction, *p-y* curve, dissipation of seismic energy, after shock.

B. Folić, S. Brčić, M. Ćosić

ANALYSIS OF INTERACTION OF 2D RC FRAME MODEL USING P-Y CURVES UPON PILES

6th International Conference of Earthquake Engineering and Engineering Seismology, Kraljevo, 2018, 397–406.

The paper presents a seismic analysis of a 2D reinforced concrete (RC) frame founded on piles. The soil-pile interaction is represented by the so-called *p-y* curves. At the base, the piles may be both fixed or elastically supported. P-y curves are determined according to Rees, Cox and Matlock model for sand. Using SAP 2000, *p-y* curves are applied on both sides of the pile, as the link elements.

Link elements are assumed as a multi-linear plastic type, i.e. as hysteresis envelopes according to the Takeda model. The linear part of the link element corresponds to initial stiffness of the *p-y* curve. Curves are exposed to compression only and to almost negligible tension. In the analysis of seismic action, the curve coefficients for a repeated, i.e. cyclic load were assumed. In such a way, numerical model asymptotically simulates the real actions and seismic response of structures in dynamic interaction of the pile-structure-soil system. This model offers many options for further development and study of seismic performance.

Keywords: dynamic interaction, soil-pile-structure, *p-y* curves, link elements, 2D frame.

B. Folić, S. Sedmak, M. Ćosić, Ž. Žugić, M. Čokić, L. Babić, A. Folić

THEORY GAME, POSSIBILITY INVOLVING PLASTIC HINGE STATE OF THE MIDDLE RC FRAME CROSS-ROAD PROBLEM STRENGTHENING MASONRY INFILL AND REPAIR PH

22nd European Conference on Fracture *ECF22 (Loading and Environment Effects on Structural Integrity)*, Belgrade, 2018.

This paper presents a possibilities of seismic reinforcing of a bridge or overpass structure. Common requirement for bridge structures is that, for the a given level of seismic activity, the columns are allowed to take damage, but should not collapse and that the road plate (beam) most remain undamaged, i.e. the bridge should remain functional and capable of being used for transportation even after the earthquake. In case of building, the order is reversed.

Bridge columns founded on piles are built either as massive, in cases where the appearance of plastic hinges is allowed, or as frame columns when plastic hinge opening is expected in beams below the road plate level.

The overpass was designed as a regular double-spanned prefabricated monolithic structure, with spans of 2x24m=48m (figure). Upon finishing the usual preparations, building of the bridge begins by making HW bored piles.

Keywords: bridge, plastic hinge, nonlinear analysis, strengthening.

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

METHODS FOR ASSESSMENT AND IDENTIFICATION OF DISPERSIVE SOILS

XVI Danube – European Conference on Geotechnical Engineering, Skopje, F.Y.R. Macedonia, 2018, 205-210.

Dispersive clay soils represent a specific type of fine-grained soils, which can not be determined by the visual classification or using standard identification – classification tests such as granulometric (particle size) analysis, plasticity tests and similar. The paper gives an overview of the results of testing dispersivity of fine-grained soil using other classification tests: the crumb test, the double hydrometer test and the pinhole test. Tests were conducted on samples: sandy clay embankment dams of "Rovni", loess from different locations (Zemun, Novi Beograd, Titel, Kelebija, Srbobran, Slankamen, Ruma, Mali Iđoš) and kaolinite sandy clay deposits Grabež – Aranđelovac. In order to improve soil properties, special consideration was given to the influence of soil compaction to dispersion properties. However, dispersion tests obtained with the use of the pinhole method at different degrees of compaction showed that the degree of compaction has no significant effect on the soil behavior, i.e. its class of dispersion.

Keywords: Dispersive clays; Dispersible test; Crumb test; Double hydrometer test; Pinhole test.

M. Ćosić, S. Brčić, N. Šušić, R. Folić, K. Božić-Tomić

DEVELOPMENT OF GROUND MOTION RECORD SURFACE AND RESPONSE SPECTRA SURFACEMETHODS FOR ASSESSMENT AND IDENTIFICATION OF DISPERSIVE SOILS

6th International Conference of Earthquake Engineering and Engineering Seismology, Kraljevo, 2018, 343–354.

The paper is presenting a mathematical formulation of an originally developed *ground motion record surface* (GMRS) and *response spectra surface* (RSS) for the presentation of 2D seismic ground motion records (GMR) and the corresponding response spectra (RS), respectively. These surfaces are constructed by transformation from 2D polar coordinate system to a 3D cylindrical coordinate system and then to the 3D orthogonal coordinate system.

The principle of application of three orthogonal coordinates for each discrete value is used in order to achieve easy manipulation and interpolation of spatial surface. Scaling of accelerograms was carried out using two procedures: the *Least Square Method* (LSM) and *Spectral Matching* (SM).

Keywords: systematization, nonlinear seismic methods, performances.

REALIZOVANI PATENT (M92)

M. Prica, N. Šušić, K. Božić-Tomić

CEVASTI ELEMENTI ZA SANACIJU KLIZIŠTA

Mali patent br. MP-2017/0055 od 28.09.2017. Upisan u Registar malih patenata Zavoda za intelektualnu svojinu pod brojem 1529

Prilikom sanacije klizišta tehnički problem koji se želi rešiti je kako sprečiti dalje klizanje terena, a pri tome da se zadovolje sledeći kriterijumi: 1. da se prihvate što veći bočni (subhorizontalni) pritiscitla od klizišta, 2. da se obezbedi tehnički racionalno, jednostavno i efikasno izvodjenje radova, 3. da je sistem za sanaciju klizišta manjih dimenzija i sa manjim utroškom materijala, 4. da je lak za montažu, održavanje i rukovanje, 5. da je dugog veka trajanja, 6. da je ekonomski opravdan i isplativ, 7. da zadovoljava standarde za elemente ovog tipa i namene.

Prikazano rešenje zadovoljava navedene stroge tehničke uslove. Ono se odnosi na sistem cevastih elemenata za sanaciju klizišta kao novi geo-konstruktivni element, koji formira geo-konstruktivni sistem i koji ima funkciju da smanji težinu, tj. olakša čelo klizišta i time smanji bočne (subhorizontalne) pritiske tla od klizišta i omogući primenu tehnički lakših i ekonomski jeftinijih mera sanacije. Cevasti element se u osnovi sastoji od više cevastih segmenata, povezanih betonom. Cevasti segment su kružni valjkasti prstenovi, koji mogu biti od različitog materijala i to: od betona, čelika, plastike i sl. Više cevastih segmenata se ugradjuje u teren tako što se nakon iskopa vrši njihovo kontinualno postavljanje u jedan ili više redova u zonu čela klizišta i na taj način formira sistem cevastih elementa. Više cevastih elemenata se povezuje betonom, a po potrebi i armaturom.

Na ovaj način formira se kruta konstrukcija u zoni čela klizišta, C, koja ima funkciju da smanji težinu, G, olakša čelo klizišta i time smanji pritiske tla E od klizišta iz kretanog-nestabilnog terena A iznad klizne površi K. Smanjenje bočnih pritisaka tla E u čelu klizišta na vrednost E* (E* < E) omogućava da je za obezbedjenje stabilnosti terena (faktor sigurnosti Fs > 1,0) potrebna manja sila otpora tla T u klizištu, što doprinosi primeni tehnički jednostavnijih, a samim tim i ekonomski jeftinijih mera sanacije.

Smanjenjem dimenzija konstruktivnih sistema u sanacionim merama omogućava se izvodjački, tehnički i ekonomski lakši i optimalniji način izvođenja konstrukcija. Za izvođenje ovog geo-konstruktivnog sisteme nisu potrebna neka posebna znanja, uputstva ili iskustva da bi se uspešno primenio. Potrebna su i dovoljna samo ona znanja iz predmetne oblasti koja poseduje prosečan stručnjak.

Zato se ovaj sistem može primeniti na raznim terenima i pod raznim uslovima.

Ključne reči: klizišta, sanacione mere, cevasti elementi.

Za ovaj patent u 2018. godini dobijene su sledeće nagrade:

1. Zlatna plaketa sa velikom zlatnom medaljom *Nikola Tesla* na izložbi *Pronalazaštvo – Beograd 2018*, Savez pronalazača i autora tehničkih unapređenja, Beograd, 2018.

2. Nagrada ARCA na Međunarodnoj izložbi *International Innovation Exhibition: Inventions – Belgrade 2018*, Udruga Inovatora Hrvatske, Beograd 2018.

3. Zlatna medalja na Međunarodnom salonu pronalazaštva i novih tehnologija *INOVAMAK 2018*, National Association of Inventors of Macedonia and International Federation of Inventors Associations, 2018.

4. Special Golden Prize of Syrian Inventors for Best Invention, 2018.

5. Srebrna medalja, *10th International Exhibition of Inventions and 3rd World Invention and Innovation Forum*, China Association of Inventions, 2018.

6. Posebna nagrada *Citizen Innovation*, *10th International Exhibition of Inventions and 3rd World Invention and Innovation Forum,* Singapore Association of Inventions, 2018.

7. Posebna nagrada sa sertifikatom na Međunarodnom festivalu inovacija, znanja i kreativnosti *Tesla fest 2018*, Association of Portuguese Inventors, Innovators and Creatives APIICIS, Association of European Inventors – AEI, 2018.

T 340
MINING

T 340
RUDARSTVO

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

V. Todorović, D. Dramlić, D. Petrović

MOGUĆNOST REALIZACIJE RAZVOJNIH OPCIJA PODZEMNIH RUDNIKA UGLJA U REPUBLICI SRBIJI

3. međunarodni simpozijum *Investicije i nove tehnologije u energetici i rudarstvu*, Vrnjačka Banja, 80-86.

Strateškim dokumentom „Dugoročni i srednjoročni plan poslovne strategije i razvoja JP PEU Resavica za period 2017. -2027. godine“ predviđeno je da se izvrši reorganizacija sadašnjih rudnika zatvaranjem pojedinih rudnika i otvaranjem novih rudnika sa većim rezervama i prirodno-geološkim uslovima povoljnim za primenu savremene tehnologije eksploatacije. Osnovni uslov za realizaciju razvojnih opcija je poboljšanje državne investicione politike u oblasti ugljarstva, što je izostalo u poslednjoj deceniji.

U radu su obrađene razvojne opcije podzemnih rudnika uglja u Srbiji i dat pregled investiranja u ove rudnike, po strukturin i ukupno.

Ključne reči: ugalj, rudnik, podzemna eksploatacija, investicije u rudnike.

RAD U VODEĆEM ČASOPISU NACIONALNOG ZNAČAJA (M51)

D. Đukanović,, V. Todorović, D. Dramlić, J. Trivan

METHODOLOGICAL PROCEDURE FOR SELECTION OF THE TYPE AND CONSTRUCTION OF SELF PROPELLED HYDRAULIC SUPORT FOR COAL EXCAVATION ON THE EXAMPLE OF THE COAL DEPOSIT POLJANA

Mining and metalurgy enginering, Bor, 1-2/2018, 49-60.

For the application of a wide forehead method, decisive is an assessment, respectively, selection of the type and construction of self-propelled hydraulic support, both for horizontal and vertical excavation concentrations. This is especially important in the excavation of coal seams whose immediate floor and roof are composed of clay sediment.
In the last decades, this theme has not been more fully explored in the coal mines in Serbia, and its processing has the character of original research, whose aim is, with the obtained research results, to contribute to the development of mining science.
The coal deposit “Poljana”, with a comprehensive expert analysis, was assessed as promising for activation in the production sense, especially taking into account the certified reserves of quality coal and natural-geological conditions favorable for the use of mechanized wide forehead excavation systems.
It is particularly important that the research is related to concrete the working conditions, with a particular emphasis on the geo-mechanical aspect and its connection with selection the type and construction of the self-propelled hydraulic support.

Keywords: mine, coal, support, coal excavation, wide forehead, coal deposit.

T 350
CHEMICAL TECHNOLOGY
AND ENGINEERING

T 350
HEMIJSKA TEHNOLOGIJA
I INŽENJERING

RAD U MEĐUNARODNOM ČASOPISU (M23)

M.R.Vasić, Z. Radojević

UPDATE OF THE PROCEDURE USED FOR HEAVY CLAY DRYER OPTIMIZATION

Romanian journal of Materials, 2018, Vol. 48 (4), 315-323.

The description of the moisture transfer in porous media during drying was the subject of many scientific studies. The unique drying theory was developed five years ago and has recently won a general recognition in the scientific community. This paper is providing the update of the recently reported method for setting up the optimal drying parameters inside the heavy clay dryer. The main goal of this paper was to find a way how to reduce the number of experiments without affecting the quality of the previously proposed calculation method. The critical drying rate, as well as the drying behavior can be easily registered inside the laboratory recirculation dryer for any heavy clay product. These data provides a clear perception of how far the real drying curve, used in industrial dryer, is away from the shortest possible one. The algorithm of the updated procedure was based on the Box-Wilkinson's orthogonal multi - factorial experimental design. The updated model outputs were represented as the governing equations which were used to predict the time intervals between any two chosen characteristic points, specified in the unique drying theory, as a function of the drying air parameters. These equations were valid for any value of the drying air parameters taken from the previously established limiting boundary range. The updated procedure was compared with the original one for two predefined drying air parameters sets. Regardless to the fact that in the first case the results were not experimentally obtained they were similar to those which were in the second case experimentally identified. This was additional confirmation that the same quality degree has been maintained in both procedures, despite the fact that the total number of experiments was lower in the upgraded procedure than in the original one.

Keywords: dryer optimization, drying porous media, effective diffusion coefficient, clay tile, software.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

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

RECOVERY OF RARE EARTH ELEMENTS FROM COAL FLY ASH

Serbian Ceramic Society Conference *Advanced Ceramic and Application VII – New frontiers in multifunctional material science and processing*, Belgrade, 2018, 70.

Rare earth elements (REE) are often referred to as “the secret ingredients of modern industry”, as they are extensively applied in many branches of contemporary industry. These elements found their end applications as catalysts, battery alloys, magnets, and most importantly as dopants in ceramic materials. The quantity of RRE (i.e. specifically the fifteen lanthanides, as well as scandium and yttrium) is scarce, as they usually appear as companion elements of other ores in their deposits. Therefore, the unconventional REEs-containing resources have to be assessed. REE can be found in acid mine drainage, produced water, coal and most importantly coal byproducts. Fly ash, as a byproduct of coal combustion in thermal plants, often comprises REE concentrations that vary between 200 and 1500 ppm. This quantity of REEs can be isolated, even though the extraction can be challenging. In this study, the five phase extraction has been conducted on fly ash obtained from the five different landfill sites. The extraction of thirty two 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, Ti, V, Sb, Th, Zn, La) has been conveyed. The complexity of the obtained data was also examined by principal component analysis (PCA) and cluster analysis (CA) in the identifying chemical composition of each coal ash sample. The recovery of mentioned elements from fly ash was assessed by means of techno-economic analysis.

Keywords: extraction, chemical analysis, ICP, analytical modeling, reapplication, ceramic materials.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

M.R.Vasić, Z. Radojević

POREĐENJE RAZVIJENE METODE OPTIMIZACIJE PROCESA SUŠENJA SA LITERATURNO DOSTUPNIM REŠENJEM U PRAKSI

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, publikovano u *Izgradnja*, 2018, 55-64.

U našim prethodnim radovima su prezentovane teorijske postavke sa proračunima i postupkom za optimizaciju procesa sušenja opekarskih proizvoda. Iako je pomenuti metod usaglašen sa razvijenom teorijom, koja omogućava registrovanje svih transportnih procesa i mehanizma koji se javljaju tokom sušenja, do sada on nije bio poređen sa drugim literaturno dostupnim rešenjima za optimizaciju industrijskih procesa sušenja. Cilj ovog rada je da se uporede rezultati preporuka za optimizaciju procesa sušenja dobijeni primenom razvijene metode i literaturno predstavljenog rešenja koje je našlo primenu u Nemačkoj. Proučavanje procesa sušenja, modelovanje i optimizacija su sprovedeni na istoj sirovini po oba modela. Rezultati su potvrdili da se razvijeni postupak može koristiti za precizno predviđanje preporučenih industrijskih parametara vazduha za sušenje i pouzdanu projekciju kinetike procesa sušenja

Ključne reči: sušenje,porozni materijali, efektivni difuzioni koeficejent, prenos vlage.

T 002
CONSTRUCTION
TECHNOLOGY

T 002
GRAĐEVINSKA
TEHNOLOGIJA

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

M. Mirković Marjanović, Z. Petojević, R. Gospavić, G. Todorović

IN SITU EXPERIMENTAL DETERMINATION OF THE THERMAL TRANSMITTANCE OF A BUILDING WALL

6th International Conference *Contemporary achievements in civil engineering*, Subotica, 2018, 281-288.

In this paper, results of a long term experimental in-situ measurement of air temperatures and heat fluxes trough a building wall surfaces, are presented. Indoor and outdoor measurements were carried out simultaneously during the period of 1 month in a dwelling of residential building located in Belgrade, Serbia. The data were used to calculate the thermal transmittance of the wall according Standard ISO 9869-1:2014. The U-value obtained from the experimental data and those calculated in steady-state temperature regime are compared. Criteria for the data that have to be met in order to get accurate U-value are discussed.

Keywords: temperature measurement, thermal flux measurement, thermal transmittance.

SAOPŠTENJE SA SKUPA NACIONALNOG ZNAČAJA ŠTAMPANO U CELINI (M63)

M. Drpić

PRIKAZ METODOLOGIJA ZA DEFINISANJE/ ODREĐIVANJE TOPLOTNIH SVOJSTAVA OPEKARSKIH PROIZVODA ZA ZIDANJE I UPOREDNA ANALIZA REZULTATA IZ PRAKSE

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, publikovano u *Izgradnja*, 2018, 95-102.

U radu se razmatraju toplotna svojstva glinenih proizvoda za zidanje s obzirom na različite metodologije za određivanje tih svojstava, koje su određene standardom SRPS EN 1745:2014. Definisane su metode gotovih podataka (tabelarni podaci), proračunske metode, kombinacija proračunskih i eksperimentalnih metoda, kao i (isključivo) eksperimentalna metoda. Komparativna analiza rezultata iz prakse ukazuje na razlike koje potiču iz tačnosti - pouzdanosti primenjenih metoda, ali i na razlike u iskazivanju finalnih rezultata – pre svega s obzirom na prisustvo vlage u materijalu u praktičnoj upotrebi (praktični sadržaj vlage).

Ključne reči: toplotno svojstvo, opekarski proizvodi za zidanje, metodologija za određivanje.

M.R.Vasić, Z. Radojević

UPOTREBA STATISTIČKIH METODA ZA OCENU STALNOSTI PERFORMANSI PROIZVODA

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, publikovano u *Izgradnja*, 2018, 87-94.

U okviru standarda EN 771-1 pojedine performanse proizvoda treba da se deklarišu na osnovu određenih vrednosti fraktila i nivoa pouzdanosti. Nivoji pouzdanosti za svaku performansu elementa za zidanje treba da poseduju fiksnu vrednost koja se definiše uzavisnosti od toga koliko je značajna ta performansa u građevinskom objektu kada se taj elemenat ugradi u njega na pravilan način. Što viša vrednost nivoa pouzdanosti to je niži rizik da pojedinačni proizvod ne

zadovaoljava deklarisanu vrednost. Radi dokazivanja usklađenosti sa zahtevima CPR-a i pomenutog harmonizovanog standarda neophodno je da proizvođač poseduje fabričku proizvodnu kontrolu koja uključuje i statističku obradu rezultata. U radu su detaljno pojašnjeni kriterijumi koji definišu kategorije proizvoda i dati praktični primeri upotrebe statističkih metoda prilikom deklarisanja pojedinih performansi proizvoda. Potrebno je dotatno naglasiti da ovaj rad ne protivreči niti proširuje područje rada i ulogu notifikacionim telima niti stvara dodatna opterećenja proizvođačima, van onih definisanih CPR-om i standardom EN 771-1.

Ključne reči: CPR, statističke metode ocene, performanse građevinksih proizvoda.

M.R.Vasić, Z. Radojević, V.Milošević, I.Stanković

OCENA PODNIH OBLOGA OD KERAMIČKIH PLOČICA PO PITANJU RIZIKA OD KLIZANJA

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, publikovano u *Izgradnja*, 2018, 119-125.

Kako bi se predupredili rizici koji mogu nastati tokom eksploatacije podnih obloga još u fazi projektovanja je potrebno pažljivo specificirati zahtevane karakteristike materijala u skladu sa predivđenom namenom podne obloge. Otpornost prema klizanju predstavlja jednu od karakteristika podnih obloga koja uposlednje vreme dobija sve više na značaju. Nažalost do sada nije razvijen međunarodni ISO standard u kome bi bile definisane ispitne metode i zahtevi za određivanje otpornosti prema klizanju podnih obloga. U Evropi postoji pokušaj da se objedine i unaprede različite lokalne nacionalne metode ispitivanja. Tako je nastala tehnička specifikacija CEN/TS 16165. U ovom radu će nakon kratkog opisa tri najznačajnije ispitne metode biti prikazani rezultati određivanja otpornosti na klizanje utvrđeni na istim uzorcima podne obloge od keramičkih pločica za pomenute metode. U radu će dodatno biti predstavljeni i kriterijumi za ocenu otpornosti prema klizanju na osnovu kojih će se ispitana podna obloga biti razvrstana u odgovarajuće kategorije.

Ključne reči: otpornost prema klizanju, CPR, dinamički koeficijent trenja.

Z. Radojević, A. Drpić, Lj. Vasić, Lj. Santo

PRIKAZ REGULATIVE I PRIPREME EKO-ZNAKOVA I EKO-DEKLARACIJA ZA GRAĐEVINSKE PROIZVODE

VIII Kongres savremene industrije glinenih proizvoda Srbije sa međunarodnim učešćem, Zlatibor, publikovano u *Izgradnja*, 2018, 103-112.

U okviru domaće regulative postoji nekoliko zakona i pravilnika kojima se definišu standardi kvaliteta životne sredine, donose strateške procene uticaja na životnu sredinu i primenjuje načelo održivog razvoja. Za određivanje performansi građevinskih proizvoda i zgrada s obzirom na životnu sredinu značajno je preuzimanje i implementacija relevantnih zahteva ključnih standarda iz grupe ISO 14000, ali i standarda SRPS EN 15804:2016. Uticaj građevinskih materijala na životnu sredinu ocenjuje se kroz posmatranje životnog ciklusa proizvoda, a krajnji cilj je izdavanje eko-oznaka i eko-deklaracija za proizvod odn. građevinski objekat.

Ključne reči: građevinski proizvod, zgrada, standard kvaliteta životne sredine, eko-oznaka, eko-deklaracija.

T 003 TRANSPORT TECHNOLOGY	**T 003** **TRANSPORTNA** **TEHNOLOGIJA**

MONOGRAFIJA MEĐUNARODNOG ZNAČAJA (M12)

M. Mikić, J. Ćirilović, N. Vajdić, N. Ivanišević, G. Mladenović

MOTORWAY HORGOŠ - NOVI SAD (SECOND PHASE), SERBIA

Athena Roumboutsos, Hans Voordijk, and Aristeidis Pantelias, eds.: *Funding and Financing of Transport Infrastructure: Business Models to Enhance an Enable Financing of Infrastructure in Transport*, Routledge, Spon Research, 2018, 142-150.

This book seeks to enhance understanding of the impacts of project setup and its implementation environment on project performance by leveraging information from the study of a rich set of European transport infrastructure project cases. It puts forward a system's view of project delivery and aims to serve as a strategic tool for decision makers and practitioners. The proposed approach is not limited to specific stakeholder views. On the contrary, it allows stakeholders to formulate their own strategies based on an holistic set of potential implementation scenarios.

Furthermore, by including cases of projects that have been influenced by the recent financial crisis, the book aims to capitalise on experiences and provide guidelines as to the design and implementation of resilient projects delivered both through traditional as well as Public Private Partnership (PPP) models.

Finally, the book proposes a new Transport Infrastructure Resilience Indicator and a corresponding project rating system that can be assessed with an eye to the future, ultimately aiming to support the successful delivery of transport infrastructure projects for all stakeholders involved.

Keywords: PPP, transport, projects, financing.

RAD U MEĐUNARODNOM ČASOPISU (M23)

J. Ćirilović, A. Nikolić, M. Mikić, G. Mladenović

EX POST ANALYSIS OF ROAD PROJECTS: RESILIENCE TO CRISIS

European Journal of Transport and Infrastructure Research (EJTIR), 2018, 18 (4), 499-516.

This investigation aimed to reveal a mechanism of how different road projects' settings respond to macro-economic crisis. Qualitative and quantitative analyses were performed over a sample of 31 European road projects, in various funding arrangements and life cycle phases, all extracted from the Horizon 2020 BENEFIT project cases database. The project setting is described through a specific combination of project features and/or values of developed indicators. The analysis was applied to identify factors that contributed to projects' performance regarding the resilience to the global financial crisis of 2007–2008. By doing this, it became possible to determine potential liabilities of projects that are already in their implementation or use phases. The analysis showed there are equally strong contributors to a project's success within country-specific, as well as project-specific features. In order to boost resilience toward sudden and unpredicted disruptions, several factors have emerged, such as long term planning, investing in top priority projects (preferably medium size investments), with realistic traffic projections and experienced and responsible concessionaires, but also having in place strong regulatory bodies and government support.The identified mechanism of enhancing the resilience to crisis caused by a specific project setting can be beneficial to multiple stakeholders.

Keywords: crisis, financing, funding, PPP, road project.

SAOPŠTENJE SA MEĐUNARODNOG SKUPA ŠTAMPANO U CELINI (M33)

J. Ćirilović, G. Mladenović, C. Queiroz

LIFE-CYCLE ASSESSMENT BASED OPTIMIZATION MODEL FOR ASPHALT PAVEMENTS

7th Transport Research Arena TRA 2018, 2018, Vienna, Austria.

This paper shows an integrated optimization model that includes both Life-cycle assessment and Life Cycle Cost Analysis, on a road network. The model explores the relative significance of each phase of a pavement Life-cycle assessment on the overall environmental footprint of a road. The paper shows that a relatively moderate change in highly-significant components may have more impact than a large change in lowly-significant components, which indicates the importance of focusing on the most influential elements to improve the accuracy of the Life-cycle assessment. The paper also compares various maintenance treatments to determine their relative influence on the overall results, including costs to society. It is shown that the choice of maintenance treatments is associated with road transport costs and environmental impacts.

Keywords: Life-cycle assessment, Life Cycle Cost Analysis, pavements, integrated models.

RAD U VODEĆEM ČASOPISU NACIONALNOG ZNAČAJA (M51)

J. Ćirilović, G. Mladenović

INDIKATORI UTICAJA NA DRUŠTVO U SISTEMIMA ZA UPRAVLJANJE PUTNOM INFRASTRUKTUROM

Građevinski kalendar, 2018, Vol. 50, 92-140.

Uticaji na društvo, koji su posledica primene određene strategije održavanja putne mreže postaju sve važniji u kontekstu vrednovanja različitih strategija održavanja u sistemima za upravljanje putnom infrastrukturom. Oni mogu biti izraženi kako kroz određene koristi za društvo, tako i kroz posledice po društvo koje mogu nastati kao rezultat primene određene strategije održavanja putne mreže. U tom smislu, donosioci odluka koji se bave razvojem strateških analiza u oblasti putne infrastrukture se nalaze pred izazovom da sagledaju posledice svojih strategija i na tehničkom i na društvenom nivou.

U ovom radu su prikazani rezultati CEDR-projekta ISABELA (Integration of social aspects and benefits into life-cycle asset management - Integracija društvenih uticaja i koristi u upravljanju putnom imovinom na nivou životnog ciklusa) koji je imao za cilj da definiše sveobuhvatni okvir za upravljanje putnom imovinom. Sistem je zasnovan na razvoju i primeni indikatora uticaja na društvo (Social Key Performance Indicators - S-KPI) i modeliranju koristi za društvo kroz sagledavanje uticaja na društvo (koji mogu biti monetarni i nemonetarni), zaostalih potreba za održavanjem (sa aspekta koristi po društvo) i proceni socijalnog rizika.

Ključne reči: upravljanje putnom infrastrukturom, društveni uticaji, tehnički parametar, indikator uticaja.

ORGANIZATION
OF CONFERENCES

ORGANIZACIJA
STRUČNIH SKUPOVA

MEĐUNARODNI SIMPOZIJUM

THE 4TH IIW SOUTH-EAST EUROPEAN WELDING CONGRESS

Beograd, 10-13.10.2018.

Organizatori

Institut IMS Beograd

BBN Congress Management doo Beograd

Društvo za unapređivanje zavarivanja u Srbiji

Ovo je prvi Kongres o zavarivanju koji se održava u Srbiji, organizovan po pravilima Međunarodnog Insituta za zavarivanje (svetske zavarivačke asocijacije).

Pored 170 učesnika (od čega oko 70 iz inostranstva) i preko 70 radova na visokom nivou, kvalitetu Kongresa su doprineli uvodni predavači ili predavači po pozivu, a to su bili najeminentniji predstavnici Međunarodnog Instituta za zavarivanje (predsednik, bivši predsednik i predsedavajući komisije za regionalnu saradnju, članovi borda direktora), Evropske federacije za zavarivanje i srodne tehnologije (predsednik, izvršni direktor i saradnik Evropske komisije za istraživanje), kao i predsednik međunarodne grupe za obrazovanje (specijalističko, poslediplomsko).

Prezentirani su radovi koji se odnose na najsavremenija istraživanja. Kvalitet izloženih radova je bio na visokom nivou, uključujući i radove domaćih autora.

VIII KONGRES SAVREMENE INDUSTRIJE GLINENIH PROIZVODA SRBIJE SA MEĐUNARODNIM UČEŠĆEM

Zlatibor, 12-14.9.2018.

Organizatori

Institut IMS Beograd

Udruženje savremene industrije glinenih proizvoda Srbije

Društvo za ispitivanje i istraživanje materijala i konstrukcija Srbije

Kongresom su obuhvaćene teme vezane za geološka istraživanja sirovinske baze, eksploataciju, preradu sirovine, tehnološke procese oblikovanja, sušenja i pečenja i automatizacija procesa. Posebna oblast kojoj je Kongres posvetio pažnju je primena građevinskog materijala na bazi gline.

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

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

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

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

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

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

	OSNOVNA ISTRAŽIVANJA	
Ev. broj	**Naziv projekta**	
186010	Minerali Srbije: sastav, struktura, geneza, primena i doprinos održanju životne sredine	Dr Snežana Dević
172005	Uticaj nano i mikrostrukturnih konstituenata na sintezu i karakteristike savremenih kompozitnih materijala sa metalnom osnovom	Dr Zoran Odanović
174004	Mikromehanički kriterijumi oštećenja i loma	Dr Vencislav Grabulov
172057	Usmerena sinteza, struktura i svojstva multifunkcionalnih materijala	Dr Anja Terzić

SELECTED
BUSINESS REFERENCES

ODABRANE
STRUČNE REFERENCE

U ovom odeljku dat je pregled ključnih usluga koje je Institut IMS izvršio u 2018. 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 oceni kvaliteta opekarske sirovine sa lokacije Jagnjevo kod Kljajićeva, sa preporukama receptura za primenu u ciglani u Kljajićevu kod Sombora	GEOSTIM d.o.o. Beograd
2.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Pustara, sa preporukama receptura za primenu u ciglani u Inđiji	Univerzum-Kubršnica a.d. Aranđelovac
3.	Elaborat o oceni kvaliteta opekarske sirovine sa deponije ciglane sa preporukama receptura za primenu u ciglani u Prizrenu	IMN Tulltorja Sh.p.k. Landovice, Prizren
4.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Ledine, sa preporukama receptura za primenu u ciglani u Zrenjaninu	IGM Neimar Zrenjanin
5.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Baštine, sa preporukama receptura za primenu u ciglani u Sakulama	GEOSTIM d.o.o. Beograd
6.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Mlečika, sa preporukama receptura za primenu u ciglani u Maradiku	GEOSTIM d.o.o. – Beograd
7.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Čurug, sa preporukama receptura za primenu u ciglani u Čurugu	Dacko ZR Čurug

8.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije »Čonoplja« kod Sombora, sa preporukama receptura za primenu u ciglani u Čonoplji	PD Napredak EM
9.	Elaborat o oceni kvaliteta opekarske sirovine sa ležišta Garajevac-istok sa preporukama receptura za primenu u crepani IGM Polet, Novi Bečej	IGK Polet a.d. Novi Bečej
10.	Elaborat o oceni kvaliteta opekarske sirovine sa lokacije Selište, sa preporukama receptura za primenu u ciglani IGM Mladost, Leskovac, pogon u Stalaću	IGM Mladost Leskovac, Pogon u Stalaću
	Projekat optimizacije sirovinskih mešavina za proizvodnju energetskih blokova u ciglani IGM Mladost, Leskovac, pogon u Stalaću	IGM Mladost Leskovac, Pogon u Stalaću
11.	Studija o rezultatima dijagnosticiranja temperaturnog režima rada tunelske peći sa preporukama za optimizaciju procesa pečenja u ciglani u Prizrenu	IMN Tulltorja Sh.p.k. Landovice, Prizren
12.	Studija o rezultatima dijagnosticiranja temperaturnog režima rada tunelske peći, sa preporukama za optimizaciju procesa pečenja u crepani IGM Toza Marković, Kikinda	IGM Toza Marković Kikinda

	Laboratorija za kamen i agregat
R.b.	**Referenca**
1.	Laboratorijska ispitivanja uzoraka tehničkog i arhitektonskog kamena, šljunka i peska u cilju realizacije geoloških istraživanja ležišta
2.	Ispitivanje tehničkog i arhitektonskog kamena, ispitivanje kamenih agregata, atestiranje kamenih agregata, ispitivanje na prisustvo azbesta
3.	Ispitivanje materijala sa kulturno-istorijskih spomenika: Spomenik zahvalnosti Francuskoj, Beograd Park prijateljstva, Beograd Hram Svetog Save, Beograd tvrđava Kale, Pirot Banski dvor, Banja Luka Hram Svetog Simeona Mirotočivog, Berane

	Laboratorija za beton	
R.b.	**Referenca**	**Investitor**
1.	Završne ocene kvaliteta betona za objekte izvedene u Srbiji za firmu Širbegović grupa – GMT Konstrukcije, Gračanica, BiH	Širbegović Inženjering, Gračanica, BiH
2.	Nezavisna kontrolna ispitivanja za betonske radove, Koridor X	Ogranak Aktor A.T.E. Beograd
3.	Angažovanje na betonskoj bazi za objekat Sanacija klizišta na državnom putu II-a, reda br. 258, deonica Vladičin Han-Vranje	SABA BELČA, Preševo
4.	Tekuća kontrola kvaliteta betona na gradilištu: Autoput E-763, deo 3:Obrenovac –Ub, za China Shandong International Economic & Technical, Ogranak Beograd	China Shandong International Economic & Technical
5.	Kontrola kvaliteta materijala na građevinskom objektu: izgradnja autoputa E-75, deonica LOT 3 – tunel Predejane i LOT 4 – Tunel Manajle za Euro Alliance Tunnels JSC- Ogranak Beograd	Euro Alliance Tunnels JSC
6.	Kontrola kvaliteta na deonici autoputa E-75 Grdelica – Caričina Dolina za firmu Azvi	Azvi
7.	Angažovanje laboratorije za beton na poslovima vršenja kontrole kvaliteta materijala na izgradnji Autoputa E-763, deonica Surčin-Obrenovac	DEVIX Lazarevac

8.	LOT B3.2 Izgradnja Ostružničkog mosta u konzorcijumu sa UTIBER, Mađarska	JP Putevi Srbije
9.	Završne ocene kvaliteta betona za objekte izvedene u Srbiji za firmu Baupartner, Lukavac, BiH	Baupartner
10.	Nezavisna laboratorija za ispitivanje betona na izgradnji Autoputnog pravca E75, Deonica: Grdelica(gornje Polje)-Caričina Dolina, LOT2: Put i mostovi od Tunela Predejane do Caričine Doline	Trace – Ogranak Beograd
11.	Ispitivanje betona na mostu preko Save od stacionaže km22+516 do km 24+097	China communications Construction Company LTD. Ogranak Beograd Savski venac
12.	Kontrola kvaliteta na objektu Vetropark Čibuk1-Dolovo	CJR
13.	Elaborat: Studija primenljivosti hemijskih dodataka na svojstva betona sa cementom CEM II/A-L 42.5 R, CRH	CRH
14.	Izrada projekta betona za objekat: Temelji vetrogeneratora-Košava	NEXE, Novi Sad,
15.	Izrada projekta betona za objekat: Temelji vetrogeneratora-Alibunar	CRH
16.	Tekuća kontrola kvaliteta betonskih radova na izgradnji mostova na deonici Autoputa Surčin-Obrenovac	Freyssinet Ogranak Beograd
17.	Beograd, kontrola kvaliteta ugrađenih materijala tokom izvođenja radova na izgradnji	MBA Ratko Mitrović Niskogradnja

	petlje Petlovo brdo i petlje Orlovača	
18.	Izvođenje radova na izgradnji brane i akumulacije Arilje-profil Svračkovo	Hidrotehnika-Hidroenergetika Beograd
19.	Vršenje stručnog nadzora za kontrolu projekata i izvođenje građevinskih radova na obilaznici oko Beograda, sektori 4, 5 i 6	JP Putevi Srbije
20.	Nezavisna laboratorijska kontrola kvaliteta betona prilokom izvođenja građevinskih radova na izgradnji Autoputa E-75, LOT 1-Put I mostovi od Grdelice do tunela Predejane	Integral Inženjering Niš
21.	Kontrola kvaliteta betona na fabrici tokom izvođenja radova na deonicama autoputa E-75 LOT 6 I tunela Manajle i Predejane	5D Vranje

THE CENTRE
FOR METALS
AND ENERGETICS

CENTAR
ZA METALE
I ENERGETIKU

CENTAR ZA METALE I ENERGETIKU

Laboratorija za ispitivanje metala,
Kontrolno telo,
Laboratorija za etaloniranje mehaničkih veličina

R.b.	Referenca	Investitor
1.	Fabrički prijem opreme od strane instituta pri izradi i sanaciji delova hidroagregata u fabrikama LMZ, Silovie Mašini, Rusija; Litostroj, Ljubljana)	JP EPS BEOGRAD Ogranak HE Đerdap HE ĐERDAP 1 Kladovo
2.	Ispitivanje mašinske opreme	JP EPS BEOGRAD Ogranak HE Đerdap HE ĐERDAP 1 Kladovo
3.	Ispitivanje opreme za potrebe revitalizacije HE Đerdap 2	JP EPS BEOGRAD
4.	Kontrola kvaliteta zavarenih spojeva pri montaži VI BTO sistema	JP EPS BEOGRAD Ogranak
5.	Ispitivanje opreme bez razaranja HMO – HE PIROT	JP EPS BEOGRAD Ogranak HE Đerdap HE Pirot, Pirot
6.	Ispitivanje glavnih parovodnih linija RA, RB i RC i ispitivanje prestrujnih parovoda metodama bez razaranja za 2018. TENT A, blokovi A1i A2	JP EPS BEOGRAD Ogranak TE Nikola Tesla A, Obrenovac

7.	Ispitivanje turbinske opreme Ispitivanje NDT metodama (lopatice, vretena, ležajevi, ...) za remont 2018. blokovi A1 i A2	JP EPS BEOGRAD Ogranak TE Nikola Tesla A, Obrenovac
8.	Ispitivanje metodama bez razaranja, Blok B1 i B2 – TENT B	JP EPS BEOGRAD Ogranak TE Nikola Tesla- TENT B, Ušće
9.	Ispitivanje metala sa i bez razaranja	JP EPS BEOGRAD Ogranak TE KO Kostolac, Kostolac
10.	Ispitivanje zavarenih spojeva na cevovodima visokog nivoa opasnosti u TE KO Kostolac	JP EPS BEOGRAD Ogranak TE KO Kostolac, Kostolac
11.	Specijalna ispitivanja i ekspertize u TE KO Kostolac B	JP EPS BEOGRAD Ogranak TE KO Kostolac, Kostolac
12.	Ispitivanje preostalog radnog veka ventila koji rade u kritičnim uslovima – TENT – A	JP EPS BEOGRAD Ogranak TE Nikola Tesla A, Obrenovac
13.	Ispitivanje stanja materijala I, II i III cevovoda na HE Perućica	EP CRNE GORE A.D. NIKŠIĆ CRNA GORA

14.	Ispitivanje hemijskog sastava i mehaničkih osobina materijala	JP EPS, Ogranak TE KO KOSTOLAC, PRIM DOO, Kostolac PROLETER AD , METALSKA INDUSTRIJA, Arilje ALSIKO, Mladenovac TEHNOMARKET, Pančevo ŽICA PROMET PLUS, Arilje
15.	Sertifikacija betonskog čelika	KÜRÜM International Sh.A.Ish- Kombinati Metalurgjik Elbasan/Albania TRGOVIR DOO, Gračanica, BiH Arcelor Mittal, Zenica ALSIKO DOO BEOGRAD
16.	Ispitivanje mehaničko-tehnoloških osobina vijaka, navrtki i podloški	MARKANT, Valjevo DIV betonski pragovi, Svrljig
17.	Ispitivanja proizvoda od gvožđa i čelika (armatura, užad za prednaprezanje, cevi...)	OGRANAK TERNA S.A. Serbia, Beograd JP ZA PODZEMNU EKSPLOATACIJU UGLJA, Resavica Aktor A.T.E, Ogranak Beograd

18.	Etaloniranje uređaja za merenje mehaničkih veličina	EPS Beograd, Ogranak RB Kolubara, Poliester – Priboj La Farge, Beočin Azvirt – Beograd, Železara – Smederevo, JAT Tehnika – Beograd, Lasta – Beograd, Energoprojekt niskogradnja-Beograd Elita – Cop doo, Zemun Hemofarm a.d. Vršac GP Mostogradnja a.d. Beograd

THE CENTRE
FOR ROADS
AND GEOTECHNICS

CENTAR
ZA PUTEVE
I GEOTEHNIKU

CENTAR ZA PUTEVE I GEOTEHNIKU

Tokom 2018.godine Centar za puteve i geotehniku ispitao je nosivost i veličinu sleganja na preko 40 šipova različitog prečnika i dužina pri dinamičkom opterećenju metodom DLT.

Izvršeno je preko 3000 ispitivanja integriteta šipova SIT metodom, kao i ispitivanja više od 20 šipova statičkim probnim opterećenjem – SLT metodom za objekte različitih namena na teritoriji Republike Srbije

Urađeno je na desetine projekata sanacije klizišta na državnim putevima I i II reda na teritoriji Republike Srbije, kao i znatan broj Geotehničkih elaborata za objekte različitih namena.

U 2018. godini Centar za puteve i geotehniku uveo je u svoj širok dijapazon ispitivanja i novu metodu- CROSSHOLE SONIC LOGGING – CSL metoda - test integriteta šipa sa sondama .

R.b.	Referenca	Investitor
	Dinamičko ispitivanje šipova - DLT metoda	
1.	Vetrogeneratori u Kovačici	CJR Renewables
2.	Kula 2 Ušće u Beogradu	Energogroup
3.	Mostovi na autoputu E-763, obilaznica oko Beograda na deonici Surčin-Obrenovac	Freyssinet, Unogradnja, Westgradnja
4.	Železnička stanica PROKOP	Bauwesen
5.	Nekoliko stambeno–poslovnih objekata: Skyline u Beogradu, Central Garden u ul. Knez Danilova, Hotel MONA u Beogradu, Hotel u Lukovskoj banji, Voždove kapije u Beogradu , AVIV park u Beogradu (IT Tel)	

	Ispitivanje integriteta šipova - SIT metoda	
1.	Vijadukt na km 59+159 za potrebe izgradnje brze pruge Beograd - Stara Pazova - Novi Sad – Subotica - državna granica	Karin Komerc MD
2.	Kula 2 Ušće u Beogradu	Energogroup
3.	Vetrogeneratori u Izbištu	Prenecon
4.	Na Koridoru 10	Trace, Azvi, Integral Inženjering
5.	Mostovi na autoputu E-763, obilaznica oko Beograda, na deonici Surčin - Obrenovac	Freyssinet, Unogradnja, Westgradnja
6.	Tunel Čortanovci za potrebe izgradnje brze pruge Beograd - Stara Pazova - Novi Sad – Subotica - državna granica	Geosonda ad, Hyca
7.	Autoput Bar – Boljare	ABG Test
8.	Hidroelektrana Bajina Bašta - proširenje razvodnog postrojenja	Jadran d.o.o.
9.	Mostovi na putu Smederevo - Mala Krsna	Vojvodinaput Pančevo
10.	Most između tunela Lipak i Železnik	Azvirt Ogranak Beograd
11.	Silosi u Bačkoj Topoli (LHR)	
12.	Most preko reke Cernice	JP Putevi Srbije
13.	AVIV park u Beogradu	IT Tel

	Statičko ispitivanje šipova - SLT metoda	
1.	Vijadukt za potrebe izgradnje brze pruge na km 59+159, Beograd - Stara Pazova - Novi Sad – Subotica - državna granica	Karin Komerc MD
2.	Kula 2 Ušće,Beograd	Energogroup
3.	Most preko reke Save i Kolubare za autoput E763, obilaznica oko Beograda na deonici Surčin - Obrenovac	CCCC
4.	Rečno pristanište Kostolac	Aqua Mont
5.	Vetrogeneratori u Izbištu i Kovačici	Geosonda ad i CJR Renewables
6.	Stambeno-poslovni blok A	Geosonda ad

	CLS metoda	
1.	Kula 2 Ušće, Beograd	Energogroup

	Projekti sanacije klizišta
1.	Projektno - tehnička dokumentacija sanacije klizišta –deformacija na kolovozu i nasipu trupa puta (BRESNIČKO BRDO) na državnom putu IV-33, deonica puta br. 03310,Makce-Lješnica, km: 45+470- km:45+560
2.	Projektno-tehnička dokumentacija sanacije klizišta BUŠINSKO POLjE na državnom putu IIA-172, deonica puta br. 17201, Bajina Bašta (Perućac) – Perućac, km: 2+450
3.	Projektno-tehnička dokumentacija sanacije klizišta – deformacije na kolovozu i nasipu trupa puta na državnom putu IB-24, deonica puta br. 02407, Ravni Gaj – Vitanovac, km: 54+000
4.	projektno - tehnička dokumentacija sanacije klizišta –deformacija kolovoza i kosina nasipa trupa puta na državnom putu IIA-180, deonica puta br. 18001, Čačak-Guča (Turica), klizište JEZDINE 2, km: 4+800
5.	Projektno-tehnička dokumentacija pojačanog održavanja dela državnog puta IIA-176, deonica puta br. 17601, Valjevo (Brežđe) – Brežđe, km: 4+680 - km: 5+010 sa tehničkim rešenjem sanacije podtla, nasipa i posteljice
6.	Projektno-tehnička dokumentacija sanacije klizišta KOMARANE na državnom putu IIA-188, deonica puta br. 18801, Rekovac – Prevešt, km: 4+930
7.	Projektno-tehnička dokumentacija optimizovanog rešenja sanacije klizišta KRST 1 na državnom putu IB-27, deonica puta br. 02704, Žeravija (Tršić) – Krst, km: 8+627
8.	Projektno-tehnička dokumentacijaza sanaciju odrona– nestabilne kamene kosinena državnom putu IB-23, deonica br. 02332, Mijoska – Granica Srb/Cg (Gostun), Km: 259+600 – Faza II


ЗЛАТНА ПЛАКЕТА


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INTERNATIONAL SALON OF INVENTIONS
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DIPLOMA

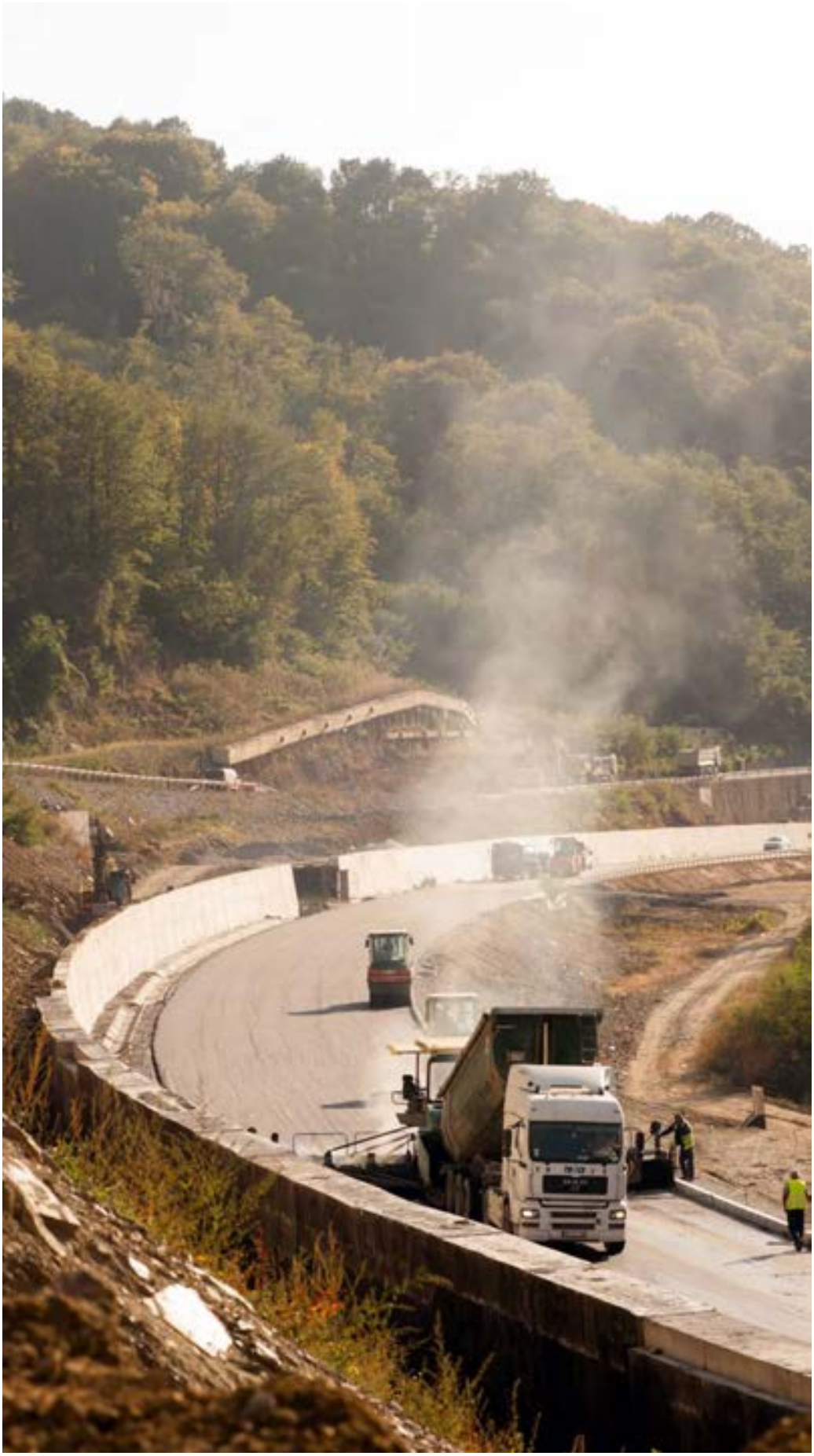
	Geotehnički elaborati	
1.	Geotehnički elaborati za potrebe izrade urbanističkog projekta projekta za građevinsku dozvolu projekta za izvođenje stambeno – poslovnog kompleksa u stambenom bloku 63 u Novom Beogradu (ugao Bulevara Jurija Gagarina i Nehruove ulice - KP 3347/70)	Građevinska direkcija Srbije
2.	Geotehnički elaborat o geotehničkim uslovima izgradnje podzemnog prolaza u krugu fabrike Cooper Tire & Rubber Company Serbia d.o.o u Kruševcu	Cooper Tire
3.	Izvođenje istražnih radova (terenskih i laboratorijskih) za potrebe izgradnje magistralnog Gasovoda Zaječar - Horgoš	Srbijagas
4.	SPT opiti za potrebe izgradnje petlje Petlovo brdo u Beogradu	MBA Miljković
5.	SPT opiti za potrebe izgradnje autoputa E763, Surčin-Obrenovac	Freyssinet, Westgradnja
6.	CPT opiti za potrebe izgradnje objekata različitih namena: stambeno-poslovnog objekta Beograd na vodi poslovni objekti LIDL u Beogradu, Loznici, Novom Sadu, Zemunu Tent A u Obrenovcu Vijadukt na km 59+159 za potrebe izgradnje brze pruge Beograd - Stara Pazova - Novi Sad – Subotica - državna granica Kalemegdanske terase - K Distrikt, u Beogradu	

THE CENTRE FOR
STRUCTURES
AND PRESTRESSING

CENTAR ZA
KONSTRUKCIJE
I PREDNAPREZANJE

CENTAR ZA KONSTRUKCIJE I PREDNAPREZANJE

	Odeljenje za prednaprezanje	
R.b.	**Referenca**	**Investitor**
1.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju prilazne konstrukcije desne obale mosta preko reke Save kod Ostružnice, na autoputu E70/E75: Dobanovci – Bubanj Potok, Obilaznica oko Beograda.	STRABAG d.o.o. Beograd Dinarik d.o.o. Ogranak Beograd
2.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju prilazne konstrukcije leve obale (polja L6-L16-S1) mosta preko reke Save kod Ostružnice, na autoputu E70/E75: Dobanovci – Bubanj Potok, Obilaznica oko Beograda.	STRABAG d.o.o. Beograd GP Nikolić d.o.o. Kraljevo
3.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju prilazne konstrukcije leve obale (polja L1-L6) mosta preko reke Save kod Ostružnice, na autoputu E70/E75: Dobanovci – Bubanj Potok, Obilaznica oko Beograda.	STRABAG d.o.o. Beograd Udarnik Gradnja d.o.o. Beograd
4.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju montažnih nosača mostova na km 0+047 i km 2+939 železničke pruge od Luke Smederevo do postojeće pruge Radinac-Smederevo	STRABAG d.o.o. Beograd GP NIKOLIĆ d.o.o. Kraljevo



5.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju konstrukcije za statičko ispitivanje šipova na Vijaduktu „Čortanovci", projekat izgradnje železničke pruge Beograd - Budimpešta	Karin Komerc d.o.o. Veternik
6.	Inženjerig usluge prilikom ugradnje, injektiranja i prednaprezanja ankera, za potrebe stabilizacije kosine Momin Kamen, na autoputu E-75, deonica Caričina dolina – Vladičin Han, lot 5, poddeonica Caričina dolina – Tunel Manajle	Integral Inženjering Ogranak Niš
7.	Inženjerig usluge prilikom prednaprezanja geotehničkih sidara i ispitivanje geotehničkih sidara, za potrebe stabilizacije kosina na autoputu E-75, deonica Gornje polje – Tunel Predejane, LOT 1, usek 2, 3 i 4	AZVI S.A. Ogranak Novi Sad
8.	Inženjerig usluge prilikom ugradnje, injektiranja i prednaprezanja geotehničkih sidara, za potrebe stabilizacije kosine, na autoputu E-75, deonica Gornje polje – Tunel Predejane, LOT 1, usek 5	Integral Inženjering Ogranak Niš
9.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju montažnih nosača Galerije, za potrebe saniranja dela kosine br. 2, na autoputu E-75, deonica Gornje polje – Tunel Predejane, LOT 1, usek 2	Integral Inženjering Ogranak Niš
10.	Prednaprezanje i ispitivanje geotehničkih sidara za potrebe stabilizacije kosina na izlaznim profilima tunela Predejane, na autoputu E-75, deonica Grdelica - Caričina dolina, LOT 3	Euro Aliance Tunnels JSC Ogranak Beograd Unogradnja V.V. d.o.o. Beograd

11.	Inženjerig usluge prilikom prednaprezanja geotehničkih sidara i ispitivanje geotehničkih sidara, za potrebe stabilizacije kosina i potpornih zidova na autoputa E-75, deonica Gornje Polje – Caričina dolina, LOT 2	TRACE GROUP HOLD PLC Ogranak Beograd F. HYČA S.R.O. MAKS PRO d.o.o. Zemun
12.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju konstrukcije u II fazi, mosta preko železničke pruge, kanala i lokalnog puta, na km 27+241, na autoputu E-763, deonica Obrenovac - Ub	SHANDONG HI-SPEED GROUP INGRAD d.o.o. Beograd
13.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju konstrukcije mosta na km 29+789 autoputa E-80: Niš – Dimitrovgrad, deonica: Bancarevo – C. Reka	AKTOR SERBIA
14.	Primena sistema prednaprezanja SPB i SPB SUPER i radovi na prednaprezanju konstrukcije mosta preko reke Nišave na km 0+739, objekta – veza petlje Dimitrovgrad sa ulicom Georgi Dimitrova u Dimitrovgradu	AKTOR SERBIA
15.	Ispitivanje sile u prednapregnutim geotehničkim sidrima, za potrebe stabilizacije klizišta na kosini iskopa za pristupne puteve brane i akumulacije Arilje, profil Svračkovo	Hidrotehnika – Hidroenergetika a.d. Beograd
16.	Prednaprezanje i ispitivanje geotehničkih sidara za potrebe osiguranja iskopa u zoni mašinske zgrade na levoj obali reke Lim, Projekta izgradnje MHE Rekovići u Priboju	HIDRO TAN d.o.o. Beograd
17.	Primena OVM sistema prednaprezanja i radovi na prednaprezanju konstrukcije mosta Ričice kod Zenice i BiH, na koridoru Vc	EURO-ASFALT d.o.o. Sarajevo PONT d.o.o. Sarajevo DIORIT d.o.o. Sarajevo
18.	Specijalistički stručni nadzor rada pogona za adheziono prednaprezanje elemenata	Martini Gradnja d.o.o. Inđija

	Odeljenje za projektovanje, nadzor i sanacije	
R.b.	**Referenca**	**Investitor**
1.	Glavni pregled - Elaborat o stanju konstrukcije mosta M16 na deonici 5, Autoput E763, Lajkovac - Ljig	West Gradnja d.o.o.
2.	Glavni pregled objekta Hangar 2 JAT Tehnika	JAT tehnika d.o.o.
3.	Vršenje stručnog nadzora na izgradnji mosta preko reke Save na autoputu E763 Surčin - Obrenovac	JP Putevi Srbije
4.	Istražni radovi i projekat postojećeg stanja vile guvernera Narodne banke Srbije u sklopu PRC Topčider, Beograd	Narodna banka Srbije
5.	Idejni projekat sanacije mosta u Kirovljevoj ulici u Beogradu	JKP Beograd put
6.	Stručno mišljenje o razlogu nastanka prslina na temelju glodalice u proizvodnom pogonu	MIND d.o.o.
7.	Istražni radovi i projekat sanacije objekata skladišta u Kremni	Sloboda Čačak
8.	Statički proračun fasadnog sistema	KOTO d.o.o.
9.	Statički proračun fasadnog sistema	WEBER THERM ROBUSTO
10.	Pregled 30 mostova na teritoriji Grada Beograda	JKP Beograd put

	Laboratorija za ispitivanje konstrukcija	
R.b.	**Referenca**	**Investitor**
1.	Ispitivanje probnim opterećenjem drumskih mostova na Auto-putu E-75, deonica: Grdelica - tunel Predejane : Investitor "AZVI" S.A.	West Gradnja d.o.o.
2.	Ispitivanje probnim opterećenjem drumskih mostova na autoputu E-80, deonica: Čiflik - Pirot : Investitor "AKTOR" A.T.E.	JAT tehnika d.o.o.
3.	Ispitivanje probnim opterećenjem drumskih mostova na autoputu E-75, deonica: Caričina dolina - tunel Manajle: Investitor "Integral Inženjering"	JP Putevi Srbije
4.	Ispitivanje probnim opterećenjem dalekovodnih stubova DV 2x110 kV u Kraljevu: Investitor JP EMS i "Energotehnika Južna Bačka" DOO	Narodna banka Srbije
5.	Ispitivanje stenskih ankera probnim opterećenjem na autoputu E-763, deonica: Lajkovac - Ljig, tunel "Brančići": Investitor "Energoprojekt - Niskogradnja" A.D.	JKP Beograd put
6.	Ispitivanje stenskih ankera probnim opterećenjem na izgradnji novog železničkog tunela u Čortanovcima: Investitor "Mosmetrostroj" ogranak Beograd	MIND d.o.o.

7.	Ispitivanje nosivosti i deformabilnosti nadvratnih greda, Univerzum ciglana d.o.o, Aranđelovac,	Sloboda Čačak
8.	Ispitivanje nosivosti podnih ploča izrađenih od kaljenog laminiranog dvoslojnog stakla probnim opterećenjem, Konkav konveks d.o.o, Dobanovci,	KOTO d.o.o.
9.	Ispitivanje mehaničkih svojstava panela za smanjenje saobraćajne buke tipa Magnum MG 10 od profilisanog čeličnog lima sa ispunom od kamene vune, Unipromet d.o.o, Čačak,	WEBER THERM ROBUSTO
10.	Ispitivanje mehaničkih svojstava panela za smanjenje saobraćajne buke tipa Magnum AC 10 od profilisanog čeličnog lima sa ispunom od kamene vune, Unipromet d.o.o, Čačak,	
11.	Ispitivanje mehaničkih svojstava panela za smanjenje saobraćajne buke tipa Magnum AL12 od profilisanog aluminijumskog lima sa ispunom od kamene vune, Unipromet d.o.o, Čačak,	
12.	Ispitivanje mehaničkih svojstava panela za smanjenje saobraćajne buke tipa Magnum AC 12 od profilisanog čeličnog lima sa ispunom od kamene vune, Unipromet d.o.o, Čačak,	
13.	Ispitivanje otpornosti prefabrikovanih ošupljenih ploča od prethodno napregnutog betona tipa HCS 200 na silu smicanja, Put inženjering, Niš,	

14.	Ispitivanje nosivosti i deformabilnosti instalirane balkonske ograde na zgradi Zemunske kapije u Zemunu, KOTO d.o.o, Beograd,
15.	Ispitivanje početne krutosti prstena cevi SUPERLIT GRP FW DN1600, Superlit Romania S.A., Romania

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) i 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).

Institut IMS ad je upisan u registar imenovanih tela za ocenjivanje usaglašenosti pod jedinstvenim registarskim brojem И 030.

Institut IMS ad je i u toku 2018. godine nastavio saradnju sa češkim institutom TZUS (www.tzus.cz) kroz zajedničko sprovođenje sertifikacije proizvoda prema harmonizovanim evropskim standardima, kao i kroz održavanje obuka u cilju pripreme osoblja Instituta IMS za predstojeće izmene regulative.

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

CONTROL BODY | **KONTROLNO TELO**

KONTROLNO TELO INSTITUTA IMS

Krajem 2014. Kontrolno telo je dobilo sertifikat o akreditaciji ATS br. 06-170. Akreditacija obuhvata oblasti kontrolisanja koje se sprovode u Centru za metale i energetiku.

Kontrolisanje nove opreme pod pritiskom.

Ocenjivanje usaglašenosti nove opreme pod pritiskom primenom modula B, B1, C1, F i G prema odredbama Pravilnika o tehničkim zahtevima za projektovanje, izradu i ocenjivanje usaglašenosti opreme pod pritiskom (Sl.Glasnik RS 87/2011) i relevantnih harmon izovanih standarda.

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 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).

PT PROVIDER | **PT PROVAJDER**

PIMS - PROVAJDER ZA ISPITIVANJE OSPOSOBLJENOSTI INSTITUT IMS

Provajder za ispitivanje osposobljenosti Institut IMS (PIMS) je tokom 2018. godine realizovao 13 šema ispitivanja osposobljenosti ispitnih laboratorija (ocenu njihove kompetentnosti), sa predmetima ispitivanja prikazanih tabelom. Učešće u realizaciji ovih šema uzelo je 106 laboratorije iz 34 zemlje Evrope, Azije i Afrike.

Od 11.01.2018. godine PIMS se nalazi na EPTIS kalendaru i u bazi podataka svetskih PT Provajdera.

Provajder za ispitivanje osposobljenosti Institut IMS je akreditovan 5.12.2018. godine kod Akreditacionog tela Srbije.

R.b.	Predmet ispitivanja osposobljenosti	Broj učesnika
1.	Cement	
	ciklus hemijskih svojstava	9 (5 iz Srbije)
	ciklus fizičko-mehaničkih svojstava	19 (6 iz Srbije)
2.	Kameni agregat	
	ciklus fizičkih i mehaničkih svojstava	10 (4 iz Srbije)
	ciklus fizičkih svojstava (u toku)	17 (4 iz Srbije)
3.	Ploče na bazi drveta	
	ciklus fizičkih, hemijskih i mehaničkih svojstava	9 (2 iz Srbije)
4.	Bitumen	
	ciklus fizičkih svojstava	10 (3 iz Srbije)
5.	Buka	
	ciklus u zatvorenom prostoru	15 (13 iz Srbije)
	ciklus nivo zvučne snage (u toku)	14 (1 iz Srbije)
6.	Toplotni izolatori u zgradarstvu	
	ciklus fizičkih svojstava	17 (1 iz Srbije)
7.	Elementi za zidanje od gline	
	ciklus fizičkih svojstava (u toku)	5 (1 iz Srbije)
8.	Požarna ispitivanja	
	ciklus ispitivanja negorivosti	11

9.	Keramičke pločice ciklus fizičkih svojstava	6 (1 iz Srbije)
10.	Čvrsti otpad ciklus hemijskih svojstava	9 (3 iz Srbije)
	Ukupno:	151 (44 iz Srbije)