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THE HISTORY OF PAPERMAKING INDUSTRY IN TURKEY: PAST, TODAY, AND FUTURE

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A COMPARATIVE ANALYSIS OF SURFACE ELECTRICAL RESISTIVITY IN CONCRETE WITH DIFFERENT COMPOSITIONS

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Content

Sadržaj

Dear reader,

The fourth issue of the magazine Techno Science presents nine papers from the area of technical sciences focusing on: graphic design, computer engineering, civil engineering and architecture.

Emphasis is placed on a professional approach and practical experience needed to achieve continuous development and improvement. We recognise that the rapid development of technology and technical achievements created an opportunity for research which will result in new findings, but the same rapid progress in the development of technologies is also one of the factors influencing research dynamics and the researchers' motivation which makes it difficult to make scientific discoveries and find new knowledge, rather using professional experience as practice and ideas for research papers.

In view of the above, we are aware of the efforts the Editorial Board makes to gather quality contents that will satisfy the demands and standards of the magazine and justify the status of an international scientific and professional magazine that strives to accomplish the respected rating and qualitatively apply for entry in the Web of Science citation database. In this issue we are publishing papers written by authors from Bosnia and Herzegovina and Turkey because we wanted to popularise national researchers, scientists, members of the academic community and practitioners so as to motivate them to continue their scientific and research trajectory and, through publishing their papers, see the importance of their contribution at a global level.

The magazine editors try to achieve design standards that will be recognisable and original. The magazine's design team keeps up with innovations and trends in technical editing, desktop publishing and design, which can be seen from the three previous issues. Changes are visible in all segments and they are still ongoing, representing the quality of the magazine, because we search for the best solutions that will please our readers.

One of the primary goals, present as early as the next issue, will be to draw attention to the promotion of scientific and research results through papers published in our magazine because this is the fastest way of reaching target readers and a responsibility to maintain trust and the quality that will satisfy the readers' needs and expectations.

For the following issues, our wish is to include a wider auditorium and new authors from various countries of the world, who will present their scientific and research results through papers in the area of technical sciences. The goal is to enrich the contents of each consecutive issue, make them more interesting and with a higher quality.

We invite you, readers, to become a part of our team and participate in running our magazine as an author or a member of a board. We will gladly receive your application and, in line with your references, determine the department where you could provide your contribution. It is important that, through your recommendations, we gain new readers and partners, so as to gradually increase our magazine user base and, at the same time, provide an opportunity for technical sciences to have the space and a place for expanding their ideas and scientific thoughts.

Amra Tuzović, PhD
Editor in Chief

Dragi čitatelju,

Četvrti broj časopisa Techno Science donosi devet radova iz oblasti tehničkih nauka orjentacijom na: grafički dizajn, inžinjersku informatiku, građevinu i arhitekturu.

Akcenat je stavljen na stručni pristup i praktično iskustvo koje je potrebno u cilju kontinuiranog usavršavanja i napredovanja. Cijenimo da je ubrzani razvoj tehnologije i tehničkih dostignuća otvorio mogućnost istraživanja preko kojih će se dolaziti do novih saznanja ali isto tako je brz napredak u razvoju tehnologija jedan od faktora koji utiču na dinamiku istraživanja i motivaciju istraživača pa se teže dolazi do naučnih otkrića i spoznaja a više se primjenjuju stručna iskustva kao prakse i ideje za istraživačke radove.

Zbog gore navedenog, svjesni smo napora uredničkog odbora da okupi kvalitetan sadržaj koji će zadovoljiti zahtjevima i standardima časopisa i opravdati status međunarodnog naučno – stručnog koji želi postići cijenjeni rejting i kvalitativno konkurisati za ulazak u Web of Science citatne baze podataka.

U ovom broju objavljeni su radovi autora iz Bosne i Hercegovine i Turske jer smo željeli da popularišemo domaće istraživače, naučne radnike, članove akademskih zajednica i stručnjake iz prakse, kako bi ih motivisali da nastave svoj naučno – istraživačku put i kroz objavljivanje svojih radova osjete važnost doprinosa na globalnom nivou.

Uredništvo časopisa se trudi da postigne standarde dizajna koji će biti prepoznatljivi i orginalni. Dizajnerski tim časopisa prati inovacije i trendove tehničkog uređenja, preloma i dizajna, što se može uočiti uvidom u predhodna tri broja.

Promjene su vidljive u svim segmentima i još uvijek aktuelne što i predstavlja kvalitet časopisa jer se traga za boljim rješenjima koja će zadovoljiti naše čitatelje. Jedan od primarnih ciljeva već od narednog broja je pobuđivanje pažnje za promociju naučno – istraživačkih rezultata preko radova u našem časopisu jer je to najbrži put do ciljanih čitatelja ali i odgovornost da se održi povjerenje i zadrži kvalitet koji će zadovoljiti potrebe i očekivanja čitatelja. Naša je želja da u narednim izdanjima uključimo širi auditorij i nove autore iz različitih zemalja svijeta koji će prezentirati svoje naučno – istraživačke rezultate kroz članke iz oblasti tehničkih nauka.

Cilj je da svako naredno izdanje bude bogatije, kvalitetnije i zanimljivije. I Vas, čitatelje, pozivamo da budete dio našeg tima i da učestvujete u radu našeg časopisa bilo kao autor ili član nekog od odbora. Rado ćemo primiti Vašu prijavu i shodno referencama odrediti odjel u kojem bi mogli pružiti svoj doprinos. Bitno je da kroz Vaše preporuke dobivamo nove čitatelje i nove partnere, kako bi bazu korisnika našeg časopisa postepeno povećavali a ujedno i dali priliku tehničkim naukama da imaju prostor i mjesto za širenje novih ideja i naučnih misli.

doc. dr. sc. Amra Tuzović
Glavna urednica

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Measuring and regulating parameters for the concentrate production process in the conditions of gravity concentration

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ABSTRACT

Mineral gravity concentration processes use combined effects of: grain mass, volume, density, size and shape so as to obtain different trajectories in a dynamic classification environment. Together with selecting minerals by hand, gravity concentration is one of the oldest methods for mineral concentration and most frequently conducted on cyclone separators which operate on the basis of differences between the masses and densities of "heavy", useful and "light", useless classes (intermediate products) in a centrifugal field within an optimal density suspension, most frequently a mixture of water and a suspensoid. Upon measuring and analysing the processed samples, disturbances that directly reflect the quality of manganese grain output fractions with disturbances in the suspension density stability and the operation of a heavy liquid cyclone with reflections upon the total condition of this part in the process were registered. This paper provides a systematic assessment of the incurred disturbances in manganese mineral gravity concentration within a heavy environment along with the selection of main process parameters that impact the quality of process operations and products, with special attention being paid to the managing measuring and regulation equipment.

Keywords: Heavy environment, disturbances, measuring and regulation.

The role of enriching mineral raw materials

Enriching or preparing mineral raw materials is recognised as the methods of selecting minerals by type, classifying them according to their size, fracturing, pulverisation, micronisation, separation of the useful from abortive materials, and for complex mineral configurations, separation of certain components with the goal of concentrating useful minerals, by using the selected methods, where their chemical composition remains unchanged. The systems of refining mineral raw materials are implemented by physical, physical and chemical or chemical methods so as to separate useful from the useless minerals and vice versa, with the goal of obtaining products that the market finds interesting. Likewise, refining mineral raw materials is recognised as all the thermal and chemical methods implemented in order to improve the characteristics and value or mineral raw materials where their chemical composition is not significantly changed.

The significance of mineral concentration

During the preparation of mineral raw materials, a significant role is attributed to technological operations: pulverisation, classification, floatation,

gravity and electromagnetic concentration. The procedures of concentrating useful minerals by applying artificial conditions of enriching in a gravitational field aims at the efficient separation of useful metal from the useless and harmful impurities out of the ore serving as the raw material. The concentrate is mostly composed of a useful mineral component, and apart from it, on a smaller scale, it also contains the useless ones, while the tailing, apart from the useless, contains some of the useful mineral component. The cause of this is the fact that mineral raw materials are, in view of their mechanical properties, chemical and granulometric composition, as well as mineral and petrographic structure, highly heterogeneous and complex due to which complete separation of mineral (useful or useless) components cannot be achieved.

Chemical properties of manganese ore minerals

According to the location where it is found in nature, manganese falls within lithophilic and hydrophilic elements. In the lithosphere, it is quite extensive in the composition of different minerals (0.1%mas.). Manganese oxide minerals are widespread in the world, namely the mineral pyrolusite MnO_2, followed by the minerals kurnakite/bixbyite Mn_2O_3 and manganite Mn_2O_3-H_2O. Manganese is also present in the composition of: silicate mineral braunite Mn_2O_3, $MnSiO_3$, carbonate mineral rhodochrosite MnCO and other minerals. Minerals of pyrolusite (MnO_2) and minerals of manganite [(MnO(OH)], are the most present in the minerals that create the ore reserve of Bužim mine, Table 1.

Table 1: Manganese mineral properties

Mineral	formula	density ρ [gr/cm³]	hardness [⁰] Mohs	structure
pyrolusite	MnO_2	5.06	2 to 6	tetragonal
manganite	MnO(OH)	4.33	4	monoclinic

The present mineral tailings: illite, tuff, serpentinite, quartz, limestone, opal and pyroxene are separated from the mineral intended to be concentrated by washing, sifting and classifying within the limits that are enabled by the technological solutions of the section “L”.

Classification methods of enrichment

Classification is a procedure of separating ores and other mealy materials into products of different sizes. Depending on the requirements and conditions of conducting a process, sieves, sifters, nets or bars are used for this purpose. The goal of enriching manganese minerals is achieving the necessary granulometric property, enhancing the Mn proportion in relation to the ore entering the process in order to achieve market competitiveness and decrease the proportion of undesirable (harmful) components that affect the product quality, for example, the presence of oxide Fe, Ti, Al and Cr. On the current level of development pertaining to the mineral enrichment technology, the access to classification methods in liquid or gaseous environments and the associated procedures are applicable and, as such, they can be called hydraulic (when the operating environment is water) or pneumatic (when the operating environment is air), while the devices are generally called classifiers. The function of classifiers is based upon different drop speeds of large and small particles pertaining to materials suspended in an immobile or mobile environment.

Gravity concentration methods application scope

Gravity concentration is a set of procedures for separating mineral grains on the basis of their density differences, i.e. it is based on the differences between the specific mineral mass and the density of the operating environment. It is usually conducted in water and water suspensions as the operating medium, but the operating environment can also be air. The procedure is performed on devices (classifiers) in which separation occurs due to the effects of the gravitational force accompanied by hydrodynamic and centrifugal forces, as well as the friction force. The upper limit of granulating grains that can be successfully separated is usually determined by the characteristics of the device, while the lower limit is approximately 0.02 mm. If the separation process is not conducted in air or in water, but in a suspension, we can talk about FS (float-sink) concentration (separation in a heavy medium, separation in a heavy environment), and the devices used for this purpose are different FS classifiers. Hydrocyclone devices use gravitational separation

in the field of centrifugal forces and do not have any mobile parts. The rotation trajectory of the fluid (a mixture of particles and water) is created due to the fluid flow through the device. Just as the fluid follows a rotational trajectory through the cyclone, particles of greater density than water move, under the influence of the centrifugal force, towards the outer cyclone walls in a spiral trajectory towards the exit (apex). Water and lighter particles are, in the eddy current, ejected into the spillway (vortex).

Manganese mineral gravity concentration

Gravity concentration and manganese ore mineral separation are most frequently conducted on the density differences between "heavy", useful and "light", useless classes (intermediate products) in orchestrated suspension conditions of water and ferrosilicon mixture. The density of Mn ore depends upon the structure and chemical composition of the present minerals and represents a diagnostic property in the function of locating the manganese ore deposits and emanations. It is conducted on heavy liquid separators, jig concentrators, tumbling mills, sluices and hydrocyclones (image 1).

Separation usage degree (R) grows alongside the increase of suspension dilution at the heavy liquid cyclone inlet, and also with a smaller proportion of solid particles in a suspension.

Image 1: Heavy liquid separator appearance pos. SF-2 type DSM

By conducting laboratory and semi-industrial examinations published in the Mining Institute Zemun (RS Serbia), a "Report on concentration examination" in d.d. Manganese mine Bužim was submitted with an emphasis on:

- the fact that the division of manganese mineral, silicon and other elements was balanced in all size classes, except a somewhat lower concentration of Mn in smaller classes,
- by conducting an "F-S" analysis (float-sink) an optimal suspension density, Δ=2.20 [gr/cm³], suitable for the concentration of all size classes from the "L" section plant was chosen,
- the product "heavy phase", as a useful component contains $_{max}$35 [%] Mn, Mn uptake of 36 [%] with a division of mass amounting to 18.87 [%]. The Mn concentration in the "light phase" amounts to 30.28 [%] Mn, which refers to the need of conducting additional operations.
- with an increase of suspension density over 2.20 [gr/cm3] there is an increase in Mn concentration in the heavy phase and a proportional decrease of mass uptake, which is not acceptable from an economic point of view.

A description of the enrichment plant

The industrial plant of the manganese ore enrichment process has the following technological sections:

- "L" - wetting, crushing, sifting, washing, wet classification and desludging,
- "SF" - the washed and classified product concentration in a heavy environment,
- "CH" - supplying water, purifying liquid waste, densification and
- "J" - draining and disposing of hard sludge to the landfill

Section "L"

Washed and classified ore in the amount of Q_{OR}=39.20 [t/h], kr=-15+0.5 [mm] density, Mn grain density and impurities indissoluble in water ρ=4.9 [gr/cm³] and wetness w=20 [%], is, from the input bunker L-20, over the vibrating feeder and a system of belt conveyors, transported to the SF-1 tub and mixed with ferrosilicon and water suspension.

There is a built-in automatic scale L-23 on the belt conveyor L-22 for measuring the mass flow rate of the washed ore that is not connected to the system of monitoring suspension density regulation in section "SF".

Section "SF"

The mixed and washed ore and suspension in the amount of $Q_{OR\Delta}$=110 [m³/h] are, by way of gravitation, inserted into the heavy liquid cyclone SF-2, type DSM, upon the concentration in the field of gravitational and centrifugal forces. Suspension preparation and regeneration are conducted in the SF-19 container. It serves as a process reservoir. It is composed out of

two parts:
- the first part for suspensoid regeneration, SF-19/1 and
- the second part for preparation and suspension reserve, SF-19/2.

The concentrated part of the separated heavy liquid from the concentration process (SF-3) gravitationally falls into SF-19/1 containers in the amount of $Q_{k\Delta}$=96 [m³/h]. A diluted suspension from the SF-19/1 container is, through a centrifugal pump SF-20, type SCC 3x3'', with the power of P=18.50 [kW], transported to the hydrocyclone (HC densifier) SF-21 in which the heavy mixture of water and FeSi (and impurities) in the amount of $Q_{k\Delta}$=11.60 [m³/h] is inserted into the other part of the container SF-19/2. SF-19/2 container part is at the bottom linked with the centrifugal pump type ISC 8x6'' with an electromotor power of P=40 [kW], which hydraulically transports the suspension in the amount of Q_{Δ}=102 [m³/h] to the tub SF-1 (H=26 m).

The pressurised pipeline for transporting the suspension to the height of 18 [m] in relation to the SF-19 container, has a built-in radioisotope gauge for suspension density type Cs 137 (Absc HIRM material Pb), produced by Hartman Brun, Germany. Ferrosilicon is, where necessary, manually inserted into the SF-19/2 container. The SF-19/2 container part is inserted with:

- a magnetic fraction from the magnetic separator SF-14 (separated ferrosilicon) in the amount of $Q_{k\Delta}$=11.40 [m³/h],
- a heavier fraction from the hydrocyclone SF-21 in the amount of $Q_{t\Delta}$=11.40 [m³/h],
- spillway water from SF-19/1 in the amount of Q_{pv}=71.00 [m³/h],
- additional water for stabilising density in the amount of Q_{tv}=15.87 [m³/h] and
- fresh FeSi in the amount of $Q_{\Delta s}$= 2.13[m³/h] or $Q_{m\Delta s}$=13 [t/h].

"Heavy environment"

In the suspension, as a crude dispersion system (S:L), solid particles of ferrosilicon are dispersed in water as a suspensoid in the size greater than 1 μm (10–6 m). Determining suspension parameters in industrial process conditions is based upon the obligatory determination of impurities and admixtures proportion by type and proportion, as well as the procedure of suspensoid regeneration with demagnetisation upon magnetic separation.

The suspension is usually dark brown. Upon completing the procedure of separating heavy from light manganese grains in DSM cyclone, the suspension is, together with the heavy fraction, elutriated on sieves, and then separated on magnetic separators and prepared for reuse. If the suspension contains greater particles (for example, clay particles from water or ore), after a long period of immobility, the used suspension can be separated into suspensoids and impurities by way of sedimentation, and the water can be clarified (technical water). "Knapsack" FeSi suspension and water, as a solid-liquid system (S:L) belongs to the group of homogeneous weakly structured suspensions. Pure technical water from the SF-24 reservoir is used as a dispersive environment.

A schematic arrangement of positions in the section of suspension preparation with measurement and regulation parameters is shown in Image 2.

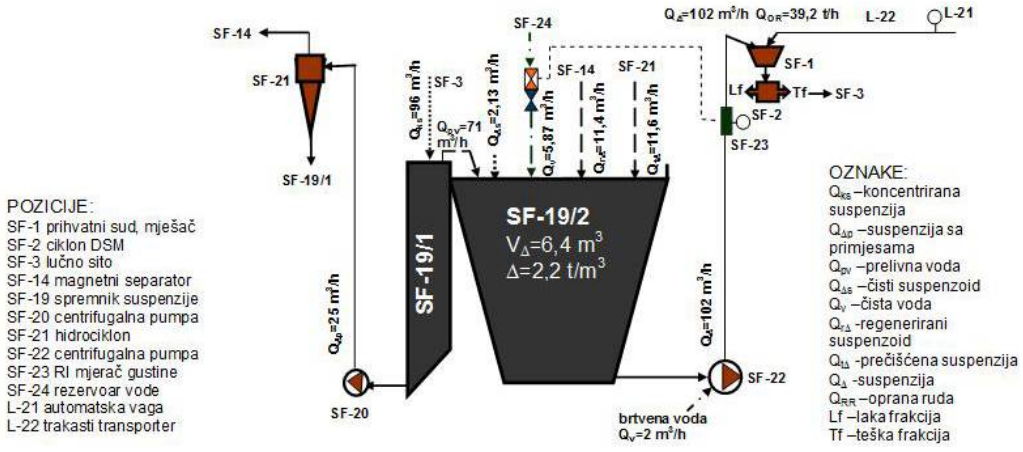


Image 2: A schematic overview of the suspension preparation process with measurement and regulation parameters

Technical indicators of the concentration process

1. Input technical values:

- =102.00 [m3/h], volumetric flow rate of the suspension
- Δ_r=2.20 [t/m3], referent heavy liquid suspension density dependent upon the implemented suspensoid density and its proportion in the suspension,
- suspensoid: atomised ferrosilicon (FeSi-15) in the density of Δ_s=6.10 [gr/cm³], the size of 95 [%] -55 [μm], concentration of Si in the amount of 15 % , with spherical particles, produced by Knapzack, Germany,
- ferrosilicon consumption: 13 [kg/h] or 200 [gr/t] of input ore. It belongs to the group of ferromagnetic suspensoids (Si concentration in the amount of 15%).

2. Suspension flow equations

- volumetric flow rate: $q_z = v_\Delta \cdot A$ [m³/s],
- mass flow rate: $q_m = \Delta \cdot q_z = \Delta \cdot v_\Delta \cdot A$ [kg/s], for Δ=2.20 [t/m³], amounts to q_m =224.40 [t/h]
- The mean velocity of suspension flow in the pressurised pipeline, for the pressurised pipeline diameter D_n=152 [mm], full profile amounts to:

$$v_\Delta = \frac{q_z}{A} = \frac{102.0}{0.01814} \text{ =5622.93 [m/h] =1.562[m/s]}$$

3. Active SF-19 container volume:

total volume: V=8.80 [m³], out of which:
-$V_{r\Delta}$=2.20 [m³], suspension regeneration part, SF-19/1
-$V_{a\Delta}$=6.60 [m³], active SF-19/2 volume
-$V_{r\Delta}$=6.40 [m³], operating SF-19/2 volume
-M_Δ=14.08 [t], operating suspension mass in SF-19/2

4. Material mass balance

- For Δ=2.20 [t/m³] and Δ_s=6.10 [t/m³] from the suspension parameters diagram (1) the following values are obtained:

- suspensoid mass concentration: $w_{\Delta s}$=1.44 [t/m³]
- suspensoid mass ratio: $x_{\Delta s}$=66 [mass %]
- suspensoid volume ratio: $\varphi_{\Delta s}$ =24 [%] or in relation to 1: $\varphi_{\Delta s}$=0.24
- water mass concentration: w_v=0.76 [t/m³]
- water mass ratio: x_v=34 [mass %]

- Balance of suspension masses in the SF-19 container in relation to $V_{r\Delta}$:

- Initial preparation with fresh FeSi and technical water:

$$M_\Delta = M_{\Delta s} + M_v$$
$$M_\Delta = V_{\Delta s} \cdot \Delta_s + V_v \cdot \rho_v$$
$$M_\Delta = 1{,}52 \cdot 6{,}10 + 4{,}85 \cdot 1{,}0 \text{ =14.12 [t]}$$

- suspension volume verification:

$$V_\Delta = \frac{M_\Delta}{\Delta} = \frac{14.12}{2.20} \text{ =6.42 [m³]}$$

- during the process:

$$M_\Delta = V_{\Delta s} \cdot \Delta_s + V_{\Delta s(r)} \cdot \Delta_{s(r)} + V_v \cdot \rho_v + V_p \cdot \rho_p$$

additional measurements are required.

5. Suspension density:

$$\Delta = \frac{\Delta_s}{x_s + \Delta_s(1 - x_s)} = \frac{6.10}{0.67 + 6.10(1 - 0.67)} \text{ 2.27[t/m³],}$$

6. Suspension parameters:

- suspensoid mass: $M_{\Delta s}$=9.23 [t]
- dispersive environment (water) mass: Mv=4.85 [t]
- suspension volume: V_Δ=6.40 [m3]
- suspensoid volume: $V_{\Delta s}$=1.52 [m3]
- water volume: V_v=4.85 [m3]

where:

$V_{\Delta s}$, $V_{\Delta s(r)}$, V_v, V_p –suspensoid, regenerated suspensoid, technical water and water with impurities volume [m³]

Δ_s,ρ_v, ρ_p – suspensoid, water and water impurities density [t/m³]

Δ_s $\Delta_{s(r)}$ –fresh and regenerated suspensoid density [t/m³]

7. Verification of the obtained results:

- suspensoid mass ratio in the suspension:

$$x_{\Delta s} = \frac{M_{\Delta s}}{M_\Delta} = \frac{9.27}{14.12} \text{ =0.66}$$

- water mass ratio in the suspension:

$$x_v = \frac{M_v}{M_\Delta} = \frac{4.85}{14.12} \text{ =0.34}$$

- suspensoid volume ratio in the suspension:

$$\varphi_{\Delta s} = \frac{V_{\Delta sv}}{V_\Delta} = \frac{1.52}{6.40} \text{ =0.24}$$

- water volume ratio in the suspension:

$$\varphi_v = \frac{V_v}{V_\Delta} = \frac{4.85}{6.40} \text{ =0.76}$$

- suspensoid mass in the suspension volume unit:

$$w_{\Delta s} = \frac{\Delta_s \cdot (\Delta - 1)}{\Delta_s - 1} = \frac{6.10 \cdot (2.20 - 1)}{6.10 - 1} \text{ =1.44 [t/m3]}$$

- suspensoid mass and volume in relation to $V_{r\Delta}$:

$$M_{\Delta s} = \frac{V_{r\Delta} \cdot \Delta_s \cdot (\Delta - \rho_v)}{\Delta_s - \rho_v} = \frac{6.40 \cdot 6.10 \cdot (2.20 - 1.0)}{6.10 - 1.0} \text{ =9.20[t]}$$

$$V_{\Delta s} = \frac{M_{\Delta s}}{\Delta_s} = \frac{9.20}{6.10} = 1.51 \text{ [m}^3\text{]}$$

8. Density regulation parameters, liquid/solid component

- Suspension density: Δ_r=2.20 [t/m^3]

$$M_v = \frac{V_{r\Delta} \cdot (\Delta_s - \Delta)}{\Delta_s - \rho_v} = \frac{6.40 \cdot (6.10 - 2.20)}{6.10 - 1.0} = 4.89 \text{ [t]}$$

- Suspensoid mass (M_s) in the volume unit necessary for an increase of suspension density from Δ^d to the referent density Δ:

a) through density:

$$M_s = \frac{\Delta_s(\Delta - \Delta^d)}{\Delta_s - \Delta} \text{ [t/m}^3\text{]}$$

b) through volume and density:

$$M_{\Delta x} = \Delta^d \cdot V_\Delta \; ; \; M_\Delta = \Delta \cdot V_\Delta \rightarrow \; M_s = M_\Delta - M_{\Delta x} \text{ [t]}$$

- Disturbances and value deviations Δ ($\pm\Delta$ or $\Delta^g\Delta_d$): Water mass (M_{dv}) necessary for diluting the suspension in the density of Δ^g to the referent density Δ:

- mass of the suspension in the density of Δ^g: $M_{\Delta^g} = \Delta^g \cdot V_{\Delta^g}$
- mass of the suspension in the density of Δ: $M_\Delta = \Delta \cdot V_\Delta$

By comparing: $M_{\Delta^g} = M_\Delta$ a relation is obtained:

$V_{\Delta^g} = \frac{\Delta \cdot V_\Delta}{\Delta^g}$ so the necessary amount of water is:

$V_{vd} = V_\Delta - V_{\Delta^g}$ [m^3], [x10^3 litres]

Technical indicators of the concentration process

According to the data from the main technological project of enriching manganese ore, the quality of Mn concentrate from the plant amounts to K_{max}=35% Mn. The minimal manganese concentration in the input ore reserve is 18%.

After the period of technological tests ended, the output quality of Mn concentrate from the plant amounted from 26 to 29%, with the Mn size +5 to 15 mm which significantly decreased the economic production effects with the problem of placing the concentrate on the global market. The recorded defects of the concentration process operations and product quality were:

1. The appearance of variable hydraulic impacts upon the mixture of ore and suspension at the inlet to the heavy liquid cyclone,
2. Based upon practical data, the degree of separation (R) upon the heavy liquid cyclone is approximately 60%, i.e. it shows how many particles with the size under 5 mm there are in the heavy fraction, which increases the concentrate mass balance in the heavy fraction, but it significantly decreases the concentration of Mn element.
3. Controlling or adjusting the pressure drop in the 12 [m] high vertical pipe with a reflection upon an increase in the degree of separation and a more balanced formation of heavy and light masses inside the cyclone.
4. The process or regenerating the used suspension does not include suspensoid demagnetisation flow on the demagnetiser
5. Measuring residual magnetism on the devices - magnetometers is not conducted after magnetic separation is performed on the separator SF-14,
6. The frequency of using the regenerated suspensoid is unfamiliar, i.e. how many times one and the same particles can be used in the recirculation system considering the appearance of friction, pulverisation, fracturing, appearance of corrosion on the deformational surfaces of FeSi particles and the like,
7. Locations and amounts of suspensoid loss: with concentrate, with tailings, with water, and due to the loss of suspensoid like abilities. Practical data shows that the loss goes up to 0.50 [kg/t] of product. In the TT concentration plant, the planned losses amount to 1.22 [kg/t] of product.

Identifying process disturbances

Upon measuring and analysing the processed samples, disturbances that negatively reflect the total condition of this part in the process are evident. The size of washed ore at the inlet is -15+0.5 [mm], while the mass ratio of washed ore and suspension amounts to m_{or}:m_s=1:5.72 (normal limits 1:3 to 1:5). During the process of manganese ore refinement, the radioisotope gauge for suspension density did not fully function due to technical reasons, which is why the suspension density could not be solely stabilised by adding water (the instance of increased density +Δ) because with -Δ it is necessary to regulatively add fresh FeSi.

Technical and technological qualifications of the TT cyclone concentrator, type DSM, position SF-2 in real conditions are expressed through operation parameters:

- input pressure p and pressure drop Δp,
- mass ratio of washed ore and suspension (m_{or}:m_s),
- centrifugal acceleration variations at the cyclone inlet,
- obstructed movement of grains in different density and size within the centrifugal field,
- the effectiveness of separation with a mass ratio of subclasses and superclasses in the heavy and light fraction,
- suspension stability is not the same in all parts of the container SF-19/2, which negatively reflects the concentration of Mn minerals, the operation and SF-22 hydraulic pump transport during the operation process,
- suspension homogeneity and maintaining the density on a referent value for multi-shift operation is not sustainable due to the loss of suspensoid alongside unstandardised values and the presence of mineral impurities from the washed ore that disturb the rheological suspension properties and the viscosity of the dispersive environment,
- introducing heavy fraction as a TT cyclone product +5–15mm in size on the II degree of classification due to the presence of -5mm class in this product
- effective duration of the procedure and the like.

The condition and importance of measuring physical values:

- a flow scale L-5 at the inlet to the plant for measuring the inflow of ore into the process "L",
- a flow scale on the washed and classified ore belt conveyor L-22 (towards the concentration),
- a radioisotope gauge for suspension density type Cs 137,
- a flow scale on the belt conveyor SF 11 for the final Mn concentrate.
- measuring and regulating suspension density is conducted in the measuring and control system: container SF-19 → density gauge SF-23 → technical water regulation valve in case of an increase in the density value +Δ. A regulating circuit for dosing fresh FeSi in case of a decrease in the density value -Δ has been left out,
- washed ore mass flow L-23 is not connected to the system of mixing washed ore and suspension, ratio: Q_{OR}:$Q_{Δ}$, as an important technical value,
- the final concentrate mass flow SF-11 is not related to the washed ore mass flow and balancing concentration masses in the SF-2,
- losses, demagnetisation and magnetised suspensoid regeneration are not on the suitable technical and technological level with consequences for the suspension homogeneity and economic losses,
- the water balance has not taken into account the water flow for sealing the SF-22 pump (connection to the EM) in the amount of 2 [m³/h].

The pressurised pipeline for transporting the suspension to the height of 18 [m] in relation to the SF-19 container, has a built-in radioisotope gauge for suspension density type Cs 137 (Absc HIRM material Pb), produced by "Hartman Brun", Germany. It is encased and placed inside a stainless steel capsule (case) and it is resistant to chemical and mechanical influences, so contamination is disabled. The minimal protection of these sources is defined by ISO 2919 standard. Practically, the material (a mixture of water and suspensoid) is exposed to radioactive emissions coming from the source, and then the radiation is weakened and as such comes to the detection device. This measurement signal is transformed into an output signal directly related to the "heavy suspension" density. It is related to the technical water flow regulation into the SF-19/2 container for the purpose of adjusting and stabilising density on the referent value. The Cs 137 half-life duration is around 30 years.

Impact factors for the suspension quality

a) suspension density (Δ= $m_Δ$/V, kg/m³)

Suspension density is the fundamental suspension characteristics that determines the conditions and ability of separating Mn mineral grains of different densities to: The heavy fraction (HF), Mn concentrate ($ρ_T$) and light fraction (LF), intermediate product (IP) + tailings (T) ($ρ_L$). In order for the washed Mn ore to be concentrated, the following condition has to be met:

$$ρ_L<Δ<ρ_T.$$

By performing a float - sink ("F-S") analysis on the basis of the washed ore properties, the optimal density of the suspension, Δ=2,20 [gr/cm³], suitable for concentrating all the washed ore size classes from the "L" section, has been selected.

In relation to the implemented suspensoid properties and dispersive environment, the main impact factors for the physical suspension properties are: density,

viscosity, presence of impurities- tailing admixtures, stability, homogeneity and entirety. The functional dependence of density can be provided through numerous values: suspensoid, water and impurities volume ratio, suspensoid particles diameter and shape, suspensoid and dispersive environment density, suspension viscosity, i.e.:

$$\Delta=f(\varphi_{\Delta s}, \varphi_v, \Delta_s, \Psi, \eta_\Delta, v_{kr}, d_s, \rho_v, \varphi_p)$$

Suspension density depends upon the implemented suspensoid density, its contribution in the suspension and the presence of impurities in the regeneration cycle. The suspension system is defined by the amount of components or phases present tin the observed system, and it is expressed by the mass and volume component ratios. Therefore, suspensions with a volume suspensoid ratio $\varphi_{\Delta s}$ greater than 10% show non-Newtonian properties, most frequently highly plastic or pseudo plastic ones. Practice shows that small classes of ore minerals can be concentrated in a centrifugal field with the existence of stationary conditions alongside the size limitations of -5 do +0.5 mm.

b) viscosity factor

Suspension viscosity is defined as the resistance of a dispersive environment to the motion of suspensoid particles and it is proportionally increased with an increase of suspension density. It remains almost unchanged with pressure variations, but with an increase in suspension temperature, it proportionally decreases. Suspension viscosity is smaller if the particles ds are in a wide range of sizes due to better packing of particles in different sizes. Taking into account that atomised FeSi in the size of 95 % -55 [μm] is used as a suspensoid, the existence of an increased viscosity can be assumed.

By increasing the concentration of solid particles, there is a viscosity increase, which is characteristic for the notion of the so called interrupted sedimentation, because the speed of suspended particle sedimentation grows in proportion to the viscosity decrease. The viscosity of heavily dispersive systems is most frequently expressed by dynamic viscosity η[Pa·s]. It is familiar that high viscosity negatively impacts the process of separating heavy from light fractions because there is an increased resistance to the motion and separation of Mn mineral grains.

According to the researched diagram of suspension viscosity dependence on suspension density, the preparatory suspension viscosity is η=8x10^{-3} [Pa·s]. The present impurities also have an impact on suspension viscosity: sludge (colloids), mineral dust particles. In normal conditions, the viscosity value for water is:

$\eta_v \approx 1 \cdot 10^{-3}$[Pa·s]

c) solid particles concentration factor

Suspensions with a suspensoid volume ratio greater than 10% show non-Newtonian properties, most frequently highly plastic or pseudo plastic ones. Effective viscosity is used as a value for controlling the state of suspension within the process:

$$\eta_{\Delta e} = \eta_o(1 + 2{,}5\varphi_{\Delta s} + 7{,}349\varphi_{\Delta s}^2 + 16{,}2\varphi_{\Delta s}^3)$$

The impact of solid particles concentration on the rheological behaviour of a suspension and its viscosity can be expressed through Einstein's equation that takes into account the impact of particle size, as well as the existence of other particles (impurities) having an impact on the suspension viscosity. This is valid for suspensions with $\varphi_{\Delta s}$<0.44 and η_Δ to 0.03 [Pa·s]:

$$\eta_\Delta = \eta_o(1 + 2{,}5 + 6{,}2\varphi_p^2)$$

where:

η_0 - dispersive environment (water) viscosity

$\varphi_{\Delta s}$ - suspensoid volume ratio

φ_p - the volume ratio of impurities in the suspension

The value of relative viscosity given through the relation of suspension viscosity η_Δ and dispersive environment (technical water) viscosity η_{ds} can refer to possible changes in the suspension condition, which is given through the formula:

$$\eta_r = \frac{\eta_\Delta}{\eta_{ds}}$$

d) suspension stability factor (homogeneity and entirety)

Represents its ability to retain the same density in all the container levels or in all the transport devices in static and dynamic conditions of the suspension state (immobility and mobility).

- Static stability functions as the suspensoid sedimentation characteristics, suspension viscosity $\varphi_{\Delta s}$ and the sedimentation speed. With static stability, the speed of suspensoid particle sedimentation for Δ=2.20 [t/m³] amounts to: v_t=7.25 [cm/min].
- Dynamic stability can be achieved through a forced suspension whirl in the SDF-19/2 container (mechanical stirrer, air currents of compressed air or water currents), especially when SF-19/2 is filled with fresh FeSi.

Dynamic stability of a suspension has a greater impact than the static one due to the need for maintaining suspension homogeneity in the SF-19/2 container, the continual encumbrance of the SF-22 centrifugal pump and measuring the suspension density in a part of the pressurised pipeline. When needed, ferrosilicon suspension can be stabilised by adding bentonite in the amount of 0.6 to 1% of the suspensoid weight.

e) impurity impact factor on the suspension density and viscosity

When the suspensoid grain moves in a dispersive environment enriched by deformed suspensoid particle mineral impurities and scum, there is a collision with the present impurity particles and an increase of suspension viscosity. The results of this condition directly reflect the quality of the separation process in the TT cyclone concentrator.

f) operational temperature change factor

The highest intensity of the TT separation plant operation comes during summer where, due to high operational temperatures, FeSi particles can become oxidised and the suspension density disrupted. A similar phenomenon is related to the so called acidic environments.

g) regenerated suspensoid demagnetisation factor

FeSi is a magnetic suspensoid, and as such has to undergo a demagnetisation procedure, which is not the case in the Bužim mine TT separation plant. The result is that a suspensoid without any traces of residual magnetism should be introduced in the concentration process. Otherwise, magnetised FeSi floccules with "trapped" impurity particles are formed and they are quickly (disruptively) sedimented in the SF-19/2 container.

h) the process equipment functionality factor

From the TT cyclone concentrator, the heavy phase falls upon the arc sieve with a 0.5 mm opening for the drainage and ferrosilicon separation procedures. Data gained through practice recommend the sieve openings to be 0.15 mm.

i) heavy liquid cyclone operation hydraulic factors

- *appearance of cavitation in the vertical pipeline leading to the TT cyclone* - Cavitation can decrease the TT cyclone operation efficiency degree due to vibrations. Namely, cavitation erosion of the hydraulic components with an appearance of air pockets due to uneven mixing of the washed ore and T-T suspension causing internal impacts on the technical line: stirrer - vertical pipe - DSM cyclone with reflections upon the irregular TT cyclone operation, and the concentration quality.

- *pressure drop or the height of the hydraulic drop upon the TT cyclone* - A hydraulic impact represents a sudden and large pressure increase due to the increased variation of washed ore and suspension flow speed in a vertical pipeline. The pressure increase depends on the initial mixture speed (velocity v_m and density ρ_m). There are several options to avoid or mitigate the hydraulic impact: by decreasing the initial fluid flow speed (for example using a wider pipe), decreasing impedance at the end of the pipe (installing valves for restricting pressure and flow), or a slow closure of the valve, as well as elongating or shortening the height of the pipeline and with it the possibility of regulating the pressure drop values at the TT cyclone inlet.

Managing and regulating the process, a new approach

The methodological foundation of building a new regulation and management system encompasses engineering the integral technological process of manganese ore processing with the already established control centre within the plant (command panel). The intensity of the Mn washed ore concentration process adapts, over time, to variable demands for movement and the quality of materials, as well as information.

The source of the most favourable technological solution for the suspension preparation system and material masses depends upon meeting the set demands and criteria.

Demands:

- enhance the existing qualitative technological schematics of the process in accordance with the set measurement and control parameters, while determining the mutual dependence and interactive effects on the management system,
- place an additional container with a stirrer for the purpose of homogenising the washed ore and suspension mixture (SF-1),
- examine the constructive and technical functionality of the existing measurement and process equipment,
- determine the optimal number of the measured

values and the measurement methods that will fully describe the complete concentration process, as well as the possibilities of obtaining derived values from several directly measured values (the automatization management system).
- due to the insufficient classification of light and heavy fractions and the presence of +0.5-5 mm class in the heavy fraction (degree of separation R) from the TT cyclone, it is necessary to classify and sort the resulting products on the sieves according to the size +0.5-5 mm and +5-15 mm (separating ferrosilicon by elutriation at the same time),
- the new laboratory tests have to research the possibility of a two-stage classification in the TT cyclones or sedimentation machines in the heavy environment,
- select the measuring equipment with the task of constantly measuring and regulating the main suspension parameters (the subsystem of regulating suspension and concentration), as the basic measurement values: suspension density Δ, the flow of the washed ore and suspension mixture Qm and the pressure drop Δp upon entering the TT cyclone, with adjusting the changes in the mixture flow and the height of the mixture's hydraulic drop, as synthesised indicators.

Criteria:
- accuracy of the primary and derived values, using both the direct and mathematical processing, as well as their operating applicability (interventions),
- the speed of processing input values, signal transmission, reaction and the time necessary for exchanging information within the suspension preparation subsystem and the total Mn ore processing system, a closed management system,
- the quality of technical equipment, current and perspective (measurement, and regulation devices, computer equipment and communication infrastructure), as well as the programme basis for supporting the activities related to gathering, processing and using information.
- a regulated concentration process, together with transforming information that affect it in the regulation function make a connected dynamic system of overall control and managing the concentration process (Image 3.)

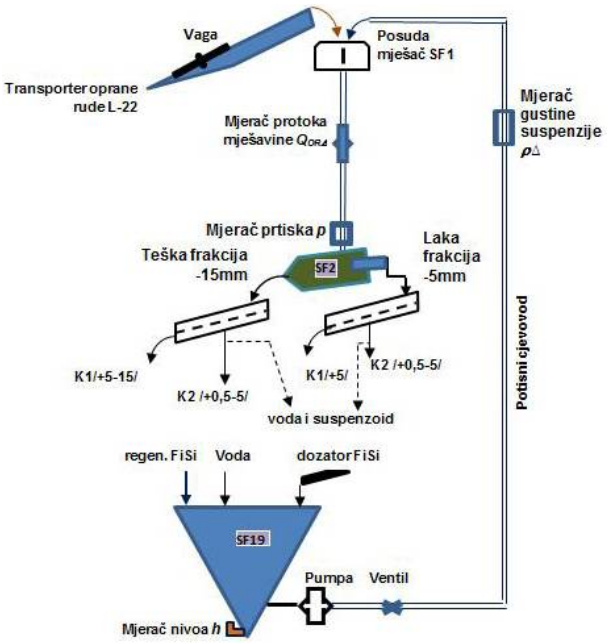


Image 3: A schematic overview of the suspension preparation process with measurement and regulation parameters, a new approach

Solutions for regulating the suspension preparation process are based upon selecting technical values that have to be measured and regulated:
- suspension density in the function of monitoring the maintenance of the set value. In case of deviations from the referent suspension density value, it is necessary to affect the ferrosilicon dispenser and water flow, as well as monitor the suspension level in the SF-19/2 (h) container in a closed management system, and thereby indirectly measure the suspension volume in the container.
- washed ore and suspension mixture flow in the 12m vertical pipeline by monitoring the mixture mass and pressure at the TT cyclone inlet. This value represents a sum of the washed ore mass flow QR and suspension flow Q_{Δ} , and it reflects the actual flow through the SF 2 TT cyclone accompanied by the operating pressure values.

The grounds for the selection:
- Measuring suspension density Δ in the SF-19/2 container is directly connected to the washed ore concentration process in heavy suspension, in the centrifugal field of separation on the Hp (heavy phase) and Lp (light phase). It can be changed in accordance with the variations in the quality of the washed ore,
- suspension mass flow Q_{Δ}, is a process value in the function of maintaining the appropriate ratio

of suspension and washed ore mixture (TΔ:$Č_{OR}$), and
- suspension height (h) reflects the suspension volume size in the SF-19/2 container related to the density changes and protecting the SF-22 pump operation under load.

Automatic regulation and SCADA systems

Automatic regulation is based upon the operation of the measurement converter with executive elements, that is previously adjusted based upon the management algorithm by comparing the formation of the projected output value at the end of the process with the appropriate activity at the beginning of the process using measurements. This regulation process automatically institutes and maintains the condition necessary for achieving the desired process condition.

Systems based upon SCADA systems (Eng. Supervisory Control and Data Acquisition System). They are used to automatically collect relevant data related to the function of the manganese ore technological process of enrichment into concentrated products, collected data analysis and, based upon them, management process . A system automated in such a way is frequently called an acquisition system that only possesses the ability of automatic gathering, in other words, gathering and analysing data.

Supervisory Control And Data Acquisition (supervision, monitoring, managing and collecting data) implies a wide spectrum of equipment, systems and solutions that enable gathering data on the enrichment process, their analysis, supervision and, in certain cases, reacting in an appropriate way.

A closed loop system, i.e. a system of automatic management with a negative feedback is shown in image 4. and defined as follows: A closed loop system uses the output signal measurements and comparisons with its desired value with the goal of generating the error signal that is then transmitted to the regulator (actuator).

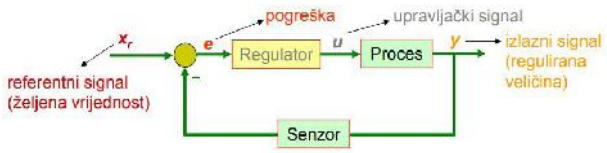


Image 4: A general schematics of the closed management system with a regulatory loop

Designing such a system of management begins with conducting a feasibility study. It is followed by the main project design that deals with electronics (SCADA process instrumentation and computer equipment) and information technology (SCADA application - programme support) by using a computer for the supported process management system - discrete linear management system. The principle block diagram of the process management system with feedback.

The central management unit (the existing command panel), as a higher level of management, principally visualises the process that is being managed and the necessary communication with the operators (initiating and stopping operations, changes in the operation regime, adjusting various parameters and the like).

The washed manganese ore concentration process management subsystem is created by managing process units consisting of PLC (Eng. Programmable Logic Controller-PLC) devices and a distant control centre in which most of the applicative management support is conducted.

Each process unit is in charge of data acquisition from multiple sensors and managing from several management loops where the connection with the instrumentation (transmitters, positioners,...) is frequently established by using wires, analogue current signal.

Measurements in open and closed loops

Directly measured and regulated values measured by an operator, as well as the measured values in an open loop such as: the level of washed ore in the L-20 bunker, washed ore mass flow (L-21) and the final product mass flow (SF-12), with the new measurement locations, with and without feedback: a) the residual remnant magnetism in the regenerated suspensoid, b) suspension viscosity and c) pressure drop in the pressurised pipeline with directly measured values and their resulting calculated derived values, d) the densified sludge density and others, can be connected using programmes and information technology into a unique management system.

Normally, the management system represents a complex structure that includes management levels, processing computer devices, regulators and information technology infrastructure. For example: automatic control over the washed ore concentration process depending on the mass flow and suspension density can be ensured by using a local PLC device, which is connected to the PC with a LAN and modem, as well as the SCADA management system.

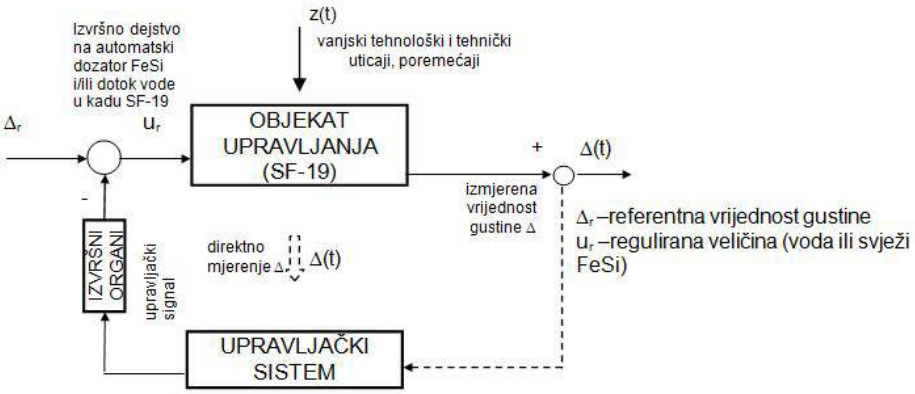


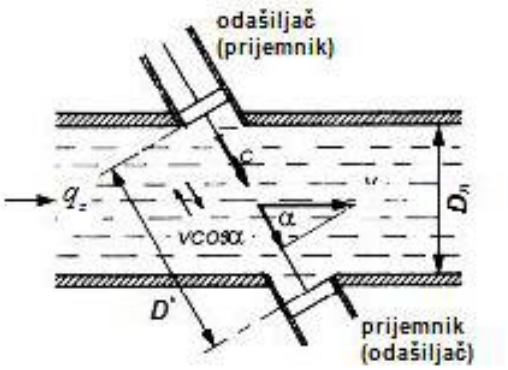
Image 5: A schematic overview of the suspension management and control in the SF-19 container

Selecting flow measurement devices

a) ultrasound flow measurement technique

It is selected on the basis of understanding that the sensors are not directly connected with the suspension due to the FeSi characteristics, given that otherwise the measurement device operating elements can become worn-out, and resistance to movement can occur. Devices that implement the principles of this techniques operate on the basis of various ultrasonic wave rates of propagation down and up the suspension stream in the pipeline.

Ultrasonic wave rate of propagation is much greater than the suspension stream velocity (Image 6.).



Volumetric flow rate (m^3/s):

$$q_z = v_\Delta \cdot A$$

$$q_z = \frac{D^2 \cdot \pi \cdot c^2}{8 \cdot D \cdot \cos\alpha} \Delta t = K \cdot \Delta t$$

where:

D - the normal space between the measured locations

c - ultrasonic wave rate of propagation

Δt –the difference between periods of ultrasonic flow down and up the suspension stream

α -the angle formed by the suspension speed vectors (vΔ) and

Image 6: Suspension flow measurement schematics

B) electromagnetic flow measurement devices

Besides the previously stated flow measurement technique, electromagnetic devices useful for measuring the movement of conductive suspension are also used. When the fluid velocity is not equal in average, but if it is symmetric in relation to the medial axis, the generated electromotive force can be calculated by solving Maxwell's flow equations and using the mean suspension movement speed.

Conclusion

Gravity concentration in a heavy environment demands an active maintenance of suspension density at a referent level, the support from the managing and regulation technique, device functionality, control over the size and the washed ore "degree of purity", technical functionality of the ancillary equipment, organising measurements of the primary values (mass flow rate, density, viscosity) and monitoring the process efficiency of classification when using the degree of separation and the quality of creating the "heavy" and "light" fractions in the DSM cyclone.

Suspension density, as the primary manganese washed ore concentration parameter, is functionally dependent upon the process values: suspensoid, water and impurities volume ratio, suspensoid particles diameter and shape, suspensoid and dispersive environment density, suspension viscosity,

the applied suspensoid, its contribution in the suspension and the presence of impurities in the regeneration cycle, etc.:

$\Delta=f(\varphi_{\Delta s}, \varphi_{v}, \Delta s, \Psi, \eta_{\Delta}, v_{kr}, d_{s}, \rho v, \varphi_{p})$

Based upon the registered process disturbances, the observed defects in the technological preparation process and manganese mineral concentration, as well as defects (and existing measurement equipment dysfunction) in the key process values measurement devices, this paper provides a systematic approach to improving the process with special attention being paid to the part related to measuring and control. The regulated concentration process, together with transforming information that affect it in the regulation function make a connected dynamic system of overall control and managing the concentration process.

By implementing (designing and executing operations) the solutions given within the plant modernisation project, we can expect a better control over the concentration process, an increase in the mass of the useful Mn concentrate and stability in the course of process operations.

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Mjerenje i regulacija parametara u procesu proizvodnje koncentrata u uslovima gravitacijske koncentracije

SAŽETAK

Gravitacijski procesi koncentracije minerala koriste kombinovane efekte: mase, zapremine, gustine, krupnoće i oblika zrna bi se dobile različite putanje u dinamičkoj sredini klasifikacije. Gravitacijska koncentracija, zajedno sa ručnim odabiranjem minerala, spada u najstarije metode za koncentraciju minerala i najčešće se izvodi na ciklon-separatorima koji rade na bazi razlika masa i gustina „teških" korisnih klasa i „lakih" nekorisnih klasa (međuproizvoda) u centrifugalnom polju, u suspenziji optimalne gustine, najčešće mješavine vode i suspenzoida. Nakon mjerenja i analize obrađenih uzoraka evidentirani su poremećaji koji se direktno odražavaju na kvalitet izlaznih frakcija zrna mangana sa poremećajima sabilnosti gustine suspenzije i radu teško-tekućinskog ciklona sa refleksijama na ukupno stanje ovog dijela procesa. U radu je data sistemska ocjena nastalih poremećaja gravitacijske koncentracije minerala mangana u teškoj sredini sa izborom glavnih procesnih parametara koji utiču na kvalitet procesnih operacija i proizvoda, sa posebnim akcentom na upravljačku mjerno-regulacionu opremu.

Ključne riječi: Teška sredina, poremećaji, mjerenje i regulacija.

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Aluminum Profile Extrusion Simulation using "Comsol Multiphysics" Software Package

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ABSTRACT

Global aluminium consumption in the last decade followed by an overview of deformation theory and extrusion process basics are presented in the Introduction of this paper. The components of the extrusion press with additional equipment and integrated systems are presented in the next chapter of this work. The extrusion die design is described in detail, from the designing to the manufacturing process of the extrusion die. This is followed by an introduction to the theory of the finite element method and numerical analysis. The extrusion process simulation represents the final part of this work; in this work, the "L" profile, manufactured by the German company "HUECK GmbH", with the profile number P447937 is used for the simulation. The extrusion is simulated in the COMSOL software. Following the end of the simulation process, referent measurements like billet temperature, extrusion velocity, isothermal exchange of extrusion and deformation are presented. The simulation results are used to help in predicting die damage, so it could be eliminated and corrections could be made at the right time. In this way, it is possible to save time and money.

Keywords: Deformation, extrusion, simulation, COMSOL.

Introduction

Extrusion is a process of shaping where the material, most frequently cold, is, under the influence of a force, brought to a state of plastic flow and pushed through a gap between the press and die or through an opening in the die.

The plastic flow of cold metals is analogue to the flow of a viscous liquid and it is defined by the laws of hydromechanics.

In 2015, China was the largest manufacturer of raw aluminium (not including recycled aluminium), producing 31 million tonnes, that is, 55% of the world aluminium production.

Russian production amounted to 7% of the global production, Canada produced 5%, and the UAE 4%. Just like steel, aluminium production in China grew rapidly. In 2004, China produced 6.7 million tonnes of aluminium, which is an average annual growth rate of 16% over the decade to 2015. [5] Even though China is the world's largest producer and consumer of aluminium, it is not a large exporter or importer of aluminium. Russia was the world's largest exporter of aluminium, exporting 3.4 million tonnes, or 18% of world exports in 2015. In 2015, the world's largest importer was Germany with 2.59 million tonnes, or 11% of the world's total imports. [5]

Image 1. shows the world's aluminium consumption growth for the last twelve years. During this period, the total aluminium consumption increased by 23 million tonnes or 68%.

The largest consumer is China, which currently accounts for more than 50% of the world's consumption. In the course of the last decade, China's aluminium consumption more than doubled, which represents an increase of more than 22 million tonnes. [5]

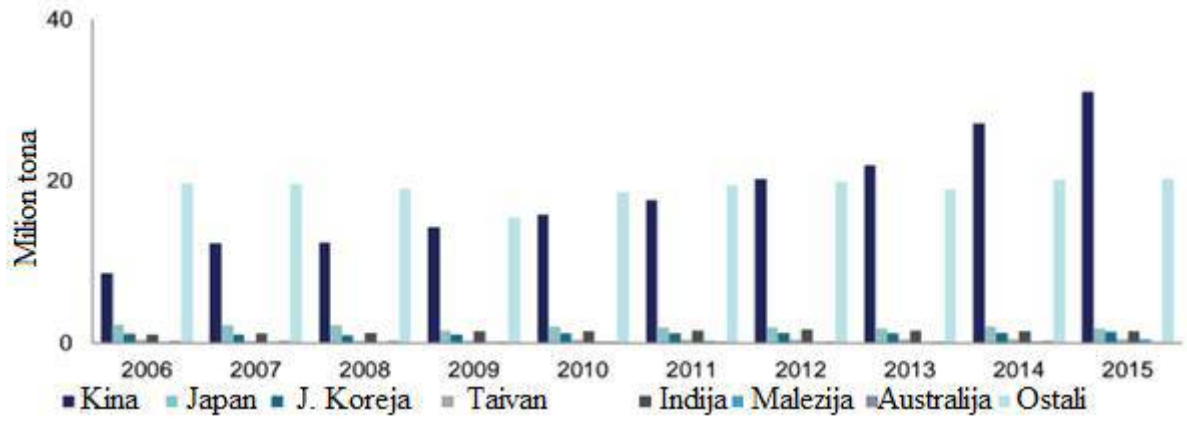

Image 1: World's aluminium consumption from 2006 to 2015 [5]

Numerical simulation

COMSOL is a powerful engineering software for running simulations by applying the finite element method whereby intended for solving problems ranging from primary linear analyses to extremely demanding nonlinear simulations. It has a large library of elements which enables the creation of different model geometries.

Designed as a general simulation tool, COMSOL can be applied in researching not only structural problems.
It enables heat transfer simulations, mass transfer through diffusion, thermoelectric analysis, acoustics, soil mechanics, piezoelectric analysis, electromagnetic analysis and fluid dynamics.
COMSOL software package has an environment that offers a simple, consistent interface for creating, monitoring and evaluating the results by using the COMSOL simulator. The package is composed of several modules where each one defines a logical aspect of the modelling process such as:

- defining geometry,
- specifying the properties of materials
- mesh generation.

Transitioning from module to module creates a model from which ABAQUS generates an input file necessary for performing the simulation process. Results analysis is performed in a separate module where COMSOL receives information that enable progress monitoring and output database creation. Reading output data, reviewing and correcting the results of the analysis are enabled by applying the module intended for visualisation. The entire COMSOL analysis consists of three phases: pre-processing, simulation, post-processing.

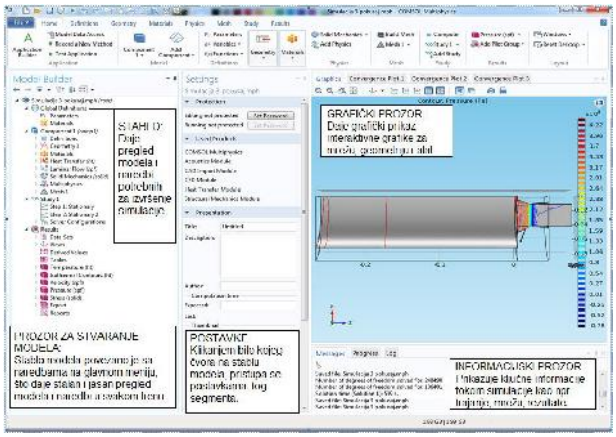

Image 2: The main functions of the COMSOL software

The produced profile has a composition of the AlMgSi0.5 alloy, where it is the most prominent one in the extrusion process when it comes to the profile extrusion.

The extruded profile sample along with the utilised documentation is shown in Image 3.

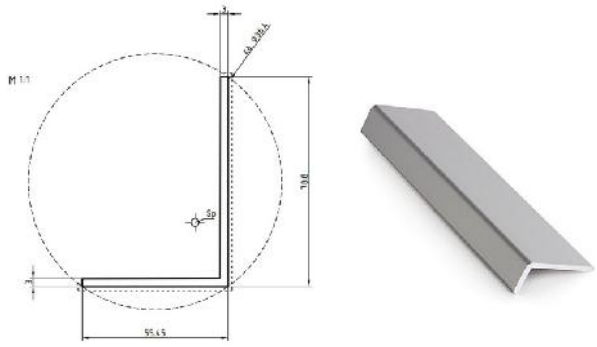

Image 3: An overview of the extruded profile dimensions and sample

By defining a mesh at the output cross section, we can see that there is a clear distinction that the mesh is properly distributed in relation to the die mesh, which means that there will be no mesh deviation, that is, profile deformation. On the other hand, there is a probability that deformation and die damage will occur. An overview of the die mesh and the extruded profile is presented in Image 4.

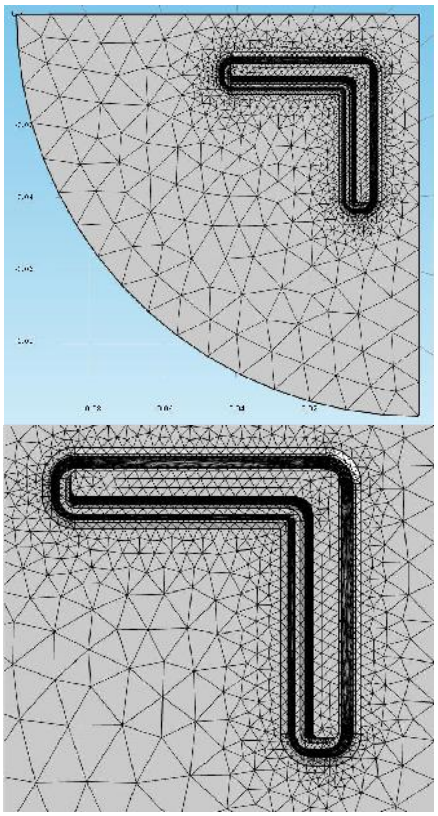

Image 4: A detail of the extrusion profile mesh and the extrusion zone

The appearance of a different mesh density can be noted on the lateral side of the model cross section and at the container and die inlets considering that billet heating starts at the inlet, while billet deformation and the process of shaping it into a profile that is extruded starts at the die inlet, so mesh thickening is expected to occur in those areas. The changes are shown in Image 5.

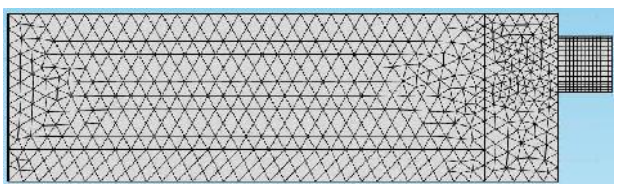

Image 5: Mesh thickening

Simulation results

The results obtained during the simulation give a clear overview of the tool and billet state after the simulation is finished where, based upon the results, we can see where it is necessary to perform tool corrections and correction in the extrusion process. Image 6. shows the billet temperature change where the lowest temperature is noted at the container inlet and the highest one at the die exit, that is, at the location where the profile is finally shaped.

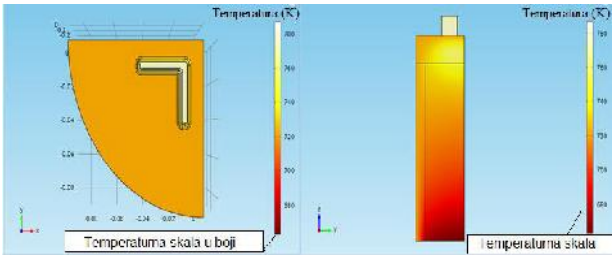

Image 6: Billet temperature change displayed in COMSOL

Images 7. and 8. display isothermal temperature changes where they completely correspond to the temperature growth shown in Image 6.

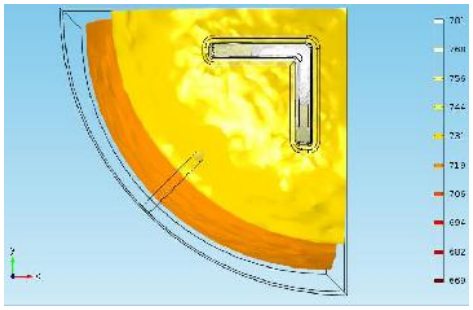

Image 7: Isothermal billet temperature change displayed in COMSOL on the x-y plane

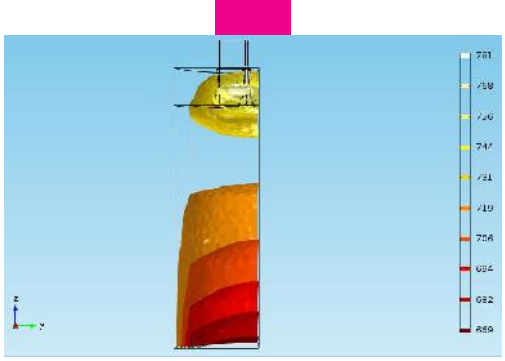

Image 8: Isothermal billet temperature change displayed in COMSOL on the y-z plane

Image 9. shows the speed of aluminium flow through the die where the maximum speed is noted in the middle of the aperture, while the minimum one is seen at the edges of the aperture. Image 10. displays die stress distribution where it can be noted that the stress expands towards the edges of the die, which leads to die deformation.

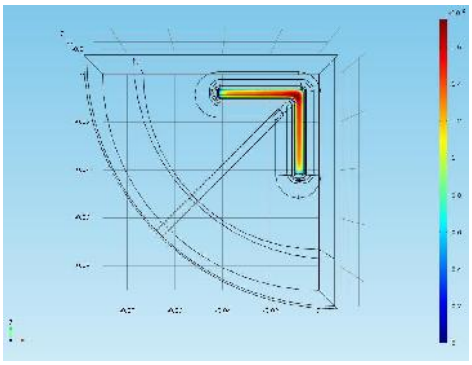

Image 9: Aluminium flow speed displayed in COMSOL on the x-y plane

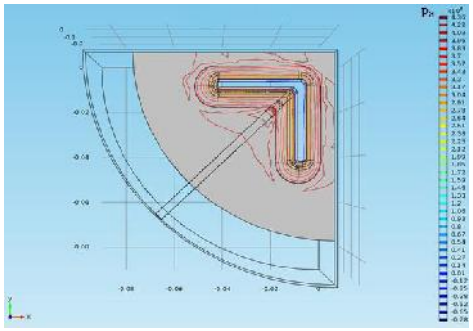

Image 10: Stress distribution in the cross section

Considering that extremely high temperatures and pressure are involved here, die strains can be detected by way of simulating the cross section, which is shown in Image 11.

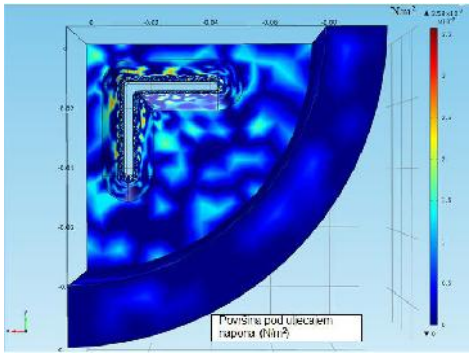

Image 11: Regular strain distribution

Image 12. displays the velocity fields and the aluminium flow patterns in the profile cross section.

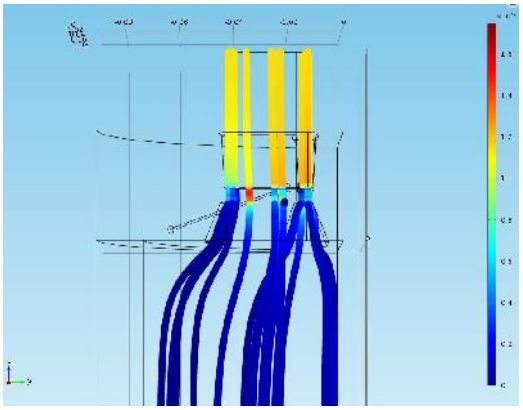

Image 12: Aluminium flow patterns and velocity fields

Image 13. shows the flow patterns, velocity fields and deformation of the profile during extrusion where red arrows represent the heat flux of the extruded aluminium.

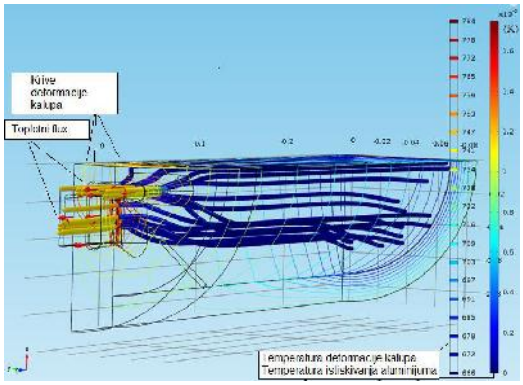

Image 13: Flow patterns, heat flux and profile deformation

Image 14. shows the mesh deformation under stress.

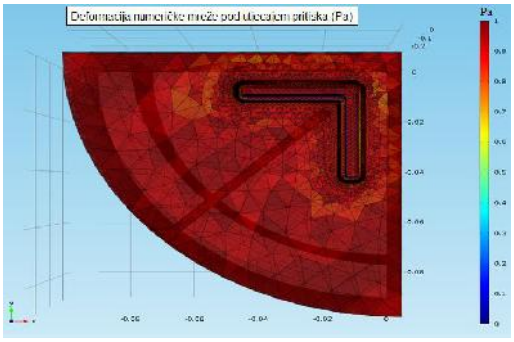

Image 14: Mesh deformation under stress

Conclusion

In many cases, software programmes for 2D and 3D modelling help in predicting how the processed item will behave thereby predicting and preventing potential mistakes, which automatically saves time and money. Automotive industries, aircraft industries and all the world's companies base their production on the usage of software packages because it is impossible to imagine product manufacturing without previous performance tests being made (even if it is theoretical, conducted under ideal conditions).

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Simulacija ekstruzije aluminijskih profila korištenjem softverskog paketa „Comsol multiphysics"

SAŽETAK

U uvodu ovoga rada predstavljena je globalna potrošnja aluminijuma u posljednjoj deceniji, nakon koje slijedi i prikaz osnova teorije deformacija i procesa ekstruzije. Komponente ekstruzione prese sa dodatnom opremom i integrisanim sistemima su predstavljene u sljedećem poglavlju ovog rada. Dizajn ekstruzionog kalupa je detaljno opisan, od projektovanja do njegove proizvodnje. Nakon toga uvodimo teoriju metoda konačnih elemenata i numeričku analizu. Simulacija procesa ekstruzije predstavlja završni dio ovog rada; u radu se za simulaciju koristi profil "L" proizveden od strane njemačke kompanije "HUECK GmbH", sa brojem profila P447937. Ekstruzija je simulirana u softwareu COMSOL. Nakon završetka simulacije, prikazane su referentne mjere poput temperature gredice, brzine ekstruzije, izotermne razmjene ekstrudiranja i deformacije. Rezultati simulacije se koriste kao pomoć u predviđanju oštećenja kalupa, kako bi se ista mogla ukloniti, te korekcije izvršiti u pravo vrijeme. Na ovaj način je moguće uštedjeti vrijeme i novac.

Ključne riječi: Deformacija, ekstruzija, simulacija, COMSOL.

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History of the Papermaking Industry in Turkey: the Past, Present and Future

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ABSTRACT

Paper is made in the following steps: fibrillation, swelling and cutting alongside the beating process, forming sheets by draining the suspension through a filtration unit and the creation of strong sheets that build hydrogen bonds between fibres during the drying process. Paper is more important than petroleum products for many applications in human life. Books, newspapers, magazines, notebooks, packaging, diapers, tissue papers, paper money, etc. are indispensable for us. The per capita consumption of paper is one of the indicators showing how much the community develops. The global paper industry is still growing, even though there are many crises in the world. However, the growth is far greater than in previous years. The total paper production reached 410 million tonnes. Since 2007, the production of packaging and tissue papers continuously increased, while the printing and writing paper production decreased. It is clear that Asia, Europe and North America have the biggest potential for production and consumption. North America and Western Europe export paper and board to other regions. It is clear that newsprint is produced in regions which are rich in mechanical pulp and its resources. The export of bleached softwood fibres from North and South America is higher than the import. Short fibres such as fibres from Eucalyptus trees are distributed from South America (Brazil, Chile, Uruguay, Argentina). North America and Western Europe have a higher waste paper export. Asia is the biggest consumer of recycled fibres used in paper production because the Chinese paper industry has been growing year after year.

Keywords: Paper, cellulose, fibers.

Introduction

Paper is made in the following steps: fibrillation, swelling and cutting alongside the beating process, forming sheets by draining the suspension through a filtration unit and the creation of strong sheets that build hydrogen bonds between fibres during the drying process. Paper is more important than petroleum products for many applications in human life. Books, newspapers, magazines, notebooks, packaging, diapers, tissue papers, paper money, etc. are indispensable for us. The per capita consumption of paper is one of the indicators showing how much the community develops. It is clear that Asia, Europe and North America have the biggest potential for production and consumption.

The history of paper in Turkey

Even though it is claimed that paper was invented by Tsai Lun, the archaeological heritage in the 20th century and the latest one in 1978 showed that paper and goods similar to it go way back to 300 B.C. in Turkestan. Ramie and flax fibres were used in the production of these papers. Paper was produced by fibrillation, just like felt. Previous investigations showed that felts have been made and derivated by the Turks. “Kepenek”, a type of felt, has been used for making shelter and garments for herdsman and villagers. It is still used in Anatolia. Sigrid Hunke wrote that Tsai-Lun was inspired by the felts made by Turkish tribes when he invented paper. Recent

studies in Central Asia proved this. "Kakat" is a name given by the Turks to a sheet produced from silk fibres by pounding. Additionally, they named pastrami produced by pounding buffalo meet as "Kakaç". In the old Turkish language, "kakaç" means pounding and years later, it became "kakat". In many languages this word has a similar pronunciation, such as "kagez" in Indian, "kami" in Japanese, "kokci" in Chinese, and "kağat, kakaz, kağad" in Iranian, Afghanistan and Urdu languages. Samarkand was the centre of paper production from cotton and cotton textile residues because Central Asia was rich in cotton plantations. When the Arabs came to Central Asia, they recognized the advanced papermaking techniques in Samarkand and thus, the Islamic World was introduced to papermaking by the Turks. It was proved that Turkish papermakers played a role in the expansion of papermaking through Europe during the Crusades (1).

The pioneering paper mills in Europe were established by skilled men experienced in paper mills from Anatolia. Yalakabat paper mill was built in 1746 in Yalova to meet the paper demand of the first modern press house. Another mill was placed near Kağıthane River and it operated periodically from 1453 to the reign of Selim III (1789-1807). It is known that there was a paper mill located in Bursa during the reign of Beyazıd II (1477-1512) (1).

The first paper mill was built in Halkapınar-Izmir in 1846, during the Ottoman period. Mason Scott provided machines and equipment for Hamidiye Paper Mill built in 1980. Straw and textile residues were used and water was taken from Beykoz River. One of the four machines produced cigarette papers. Its operations stopped and the copper and bell metal parts were disassembled to make war merchandise in 1915 (1).

In the Turkish Republic, governments built several paper mills named SEKA:

- İzmit Paper Mill, in 1938,
- Zonguldak-Çaycuma Paper Mill: Kraft pulp and paper, in 1970,
- Giresun Paper Mill: Mechanical pulp and newsprint, in 1970,
- Dalaman Paper Mill: fine paper, cardboard and bleached pulp, in 1971,
- Afyon Pulp mill: bleached pulp from annual plants, in 1979,
- Balıkesir Pulp and paper mill: thermomechanical pulp and newsprint, in 1981,
- Silifke Kraft pulp and testliner paper, in 1984,
- Kastamonu paper mill, in 1984

Governments sold all these paper mills to a private company in 2000s and totally withdrew from the paper industry. In addition to the privatized paper mills, 28 paper mills operated in those years. Following these investments, paper production capacity exceeded 2 million tonnes.

Today's paper industry

According to the report of the Pulp and Paper Industry Foundation in Turkey, the growth of paper industry amounted to 2.4% in 2016, in comparison with the previous year. The real growth, excluding a decrease in newsprint and wrapping paper production, was 4.8%. The per capita consumption of paper increased from 74.5 to 75.2 kg in 2016 (2).

Paper production capacity

In 2016, half of the total paper production capacity was used for producing corrugated paper, which is a trend similar to past years. Newsprint demand was meet by the imports since it is not produced in Turkey.

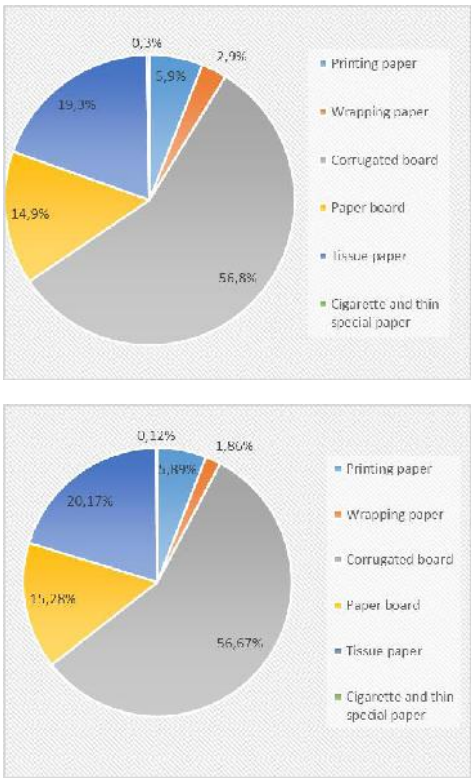


Figure 1: The production capacity and actual production of the paper industry in 2016

It is clear that the total production increased to 250.000 tonnes in 2016. The corrugated paper production amounts to 2.280.532 tonnes/year with 56.67% proportion in industry. Tissue paper is the second with 811.572 tonnes/year and a proportion of 20.17%.

Table 1: The production capacity and actual production of the paper industry

	Capacity in 2016 (tonne/year)	Actual production in 2015 (tonne/year)	Actual production in 2016 (tonne/year)
Newsprint	0	0	0
Printing paper	298.500	232.500	237.100
Wrapping paper	144.000	80.000	75.000
Corrugated board	2.860.500	2.190.028	2.280.352
Paperboard	751.000	577.291	614.898
Tissue paper	971.000	660.487	811.572
Cigarette and thin special paper	15.000	5.000	5.000
Total	5.040.000	3.745.306	4.023.922

The Main Components of Papermaking

Recycled paper use reached 2.9 million tonnes in 2016, which is 72% of the total raw material. The use of virgin pulp, both short and long fibre, was about 1 million tonnes, which is 2% of the total raw material. Pulp production decreased drastically after the privatization of state paper mills. Today, only Oyka paper mill in Zonguldak produces Kraft pulp.

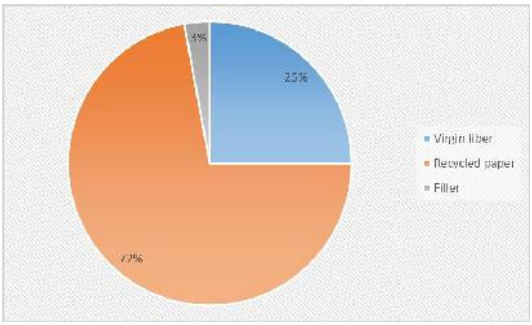


Figure 2: Raw materials used in paper industry

Table 2: The amounts of raw material used for papermaking

	Tonne/year
Virgin fibre	1.006.856
Recycled paper	2.900.927
Filler	116.500
Total	4.024.283

The use of waste paper

Corrugated and Kraft packaging paper represent 64% of the consumed recycled paper. The second is mixed waste paper followed by 1st class office waste paper used in paperboard and tissue production.

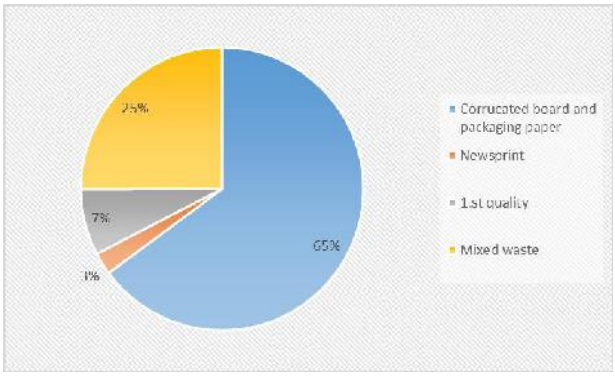


Figure 3: Types of recycled paper

Table 3: Types of recycled paper and their amounts

	Tonne/year
Corrugated board and packaging paper	1.887.815
Newsprint	74.051
1st quality	219.508
Mixed waste	729.553
Total	2.910.927

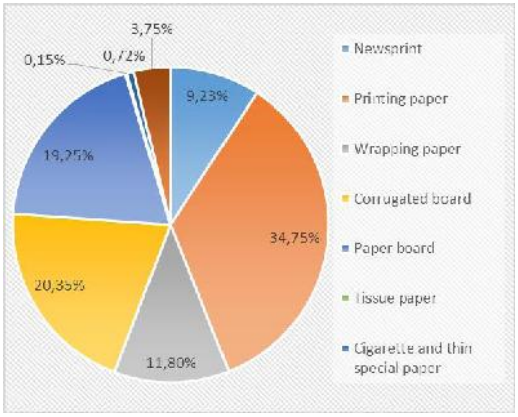
Exported and imported papers

Import data shows that the amount of printing paper is the first among imported papers. The amount of newsprint decreased to 262.763 tonnes/year in 2016.

The total imported paper also decreased in 2016.

It is also clear that the amount of exported tissue and corrugated board have a higher portion among the other papers. It is interesting that there is exported newsprint from Turkey. It is due to direct exports after newsprint is imported.

Import



Export

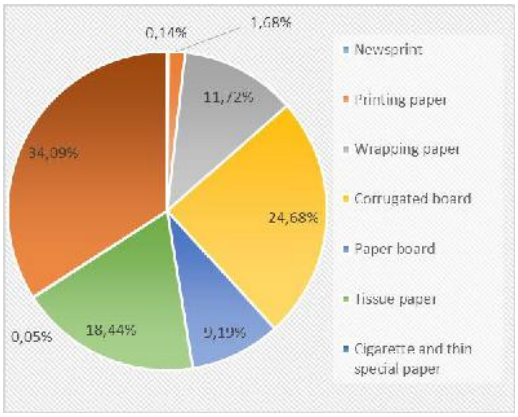


Figure 4: The export and import amounts by paper types in 2016

Table 4: The amount of export and import by paper types in 2015 and 2016

	Import (tonne/year)		Export (tonne/year)	
	2015	**2016**	**2015**	**2016**
Newsprint	347.614	262.763	1.261	949
Printing paper	959.930	989.412	15.261	24.331
Wrapping paper	348.313	336.063	106.276	122.272
Corrugated board	570.224	579.540	223.734	270.072
Paperboard	538.339	548.029	83.332	77.600
Tissue paper	7.674	4.307	167.193	266.200
Cigarette and thin special paper	19.081	20.499	447	468
Other paper products	127.333	106.638	309.102	349.565
Total	2.918.508	2.847.251	906.606	1.111.457

The Future of the Turkish paper industry

The total production of paper amounted to 4 million tonnes in 2016, and it is expected to reach 4.5 million tonnes in 2019. Tissue and corrugated board productions seem to increase.

Table 5: The expected production change in paper industry per years

	2015 (tonne/year)	2016 (tonne/year)	2017 (tonne/year)	2018 (tonne/year)	2019 (tonne/year)
Printing paper	232.500	237.100	245.000	250.000	250.000
Wrapping paper	80.000	75.000	75.500	76.500	78.500
Corrugated board	2.190.028	2.280.352	2.482.500	2.525.000	2.580.000
Paperboard	577.291	614.989	643.500	677.000	677.500
Tissue paper	660.487	811.572	894.00	908.500	916.500
Cigarette and thin sp. paper	5.000	5.000	5.000	5.000	5.000
Total	3.745.306	4.024.013	3.451.500	4.442.000	4.507.500

Paper Industry in the World

The global paper industry is still growing, even though there are many crises in the world. However, the growth is far greater than in previous years. The total paper production reached 410 million tonnes.

Since 2007, the production of packaging and tissue papers continuously increased, while the printing and writing paper production decreased.

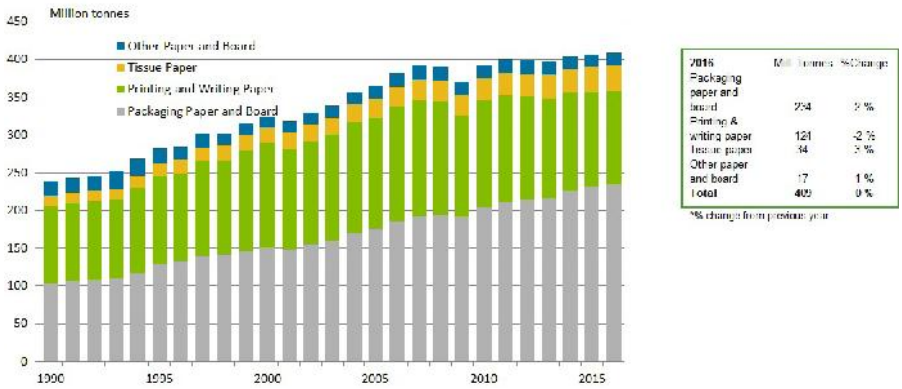


Figure 5: The total production of different kinds of paper (4)

Figure 8. shows that Asia is the biggest paper consumer when compared to other continents. However, paper consumption in North America didn't change noticeably.

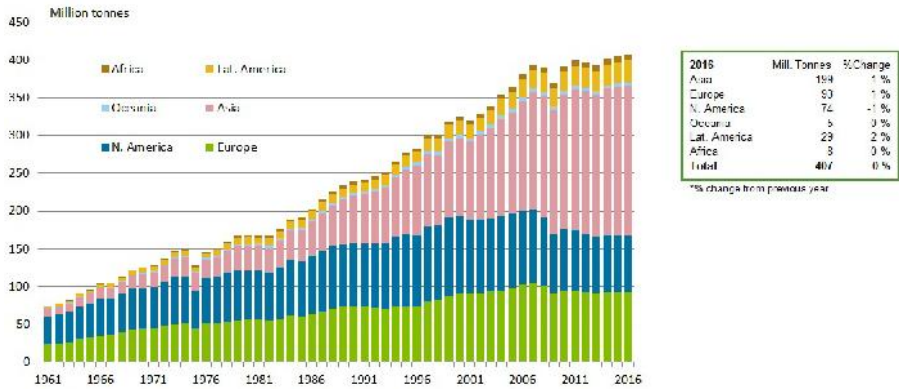


Figure 6: Paper consumption by continents (4)

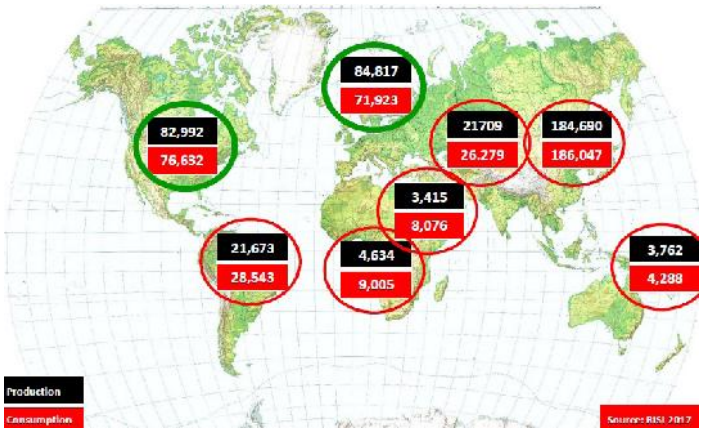


Figure 7: Paper production and consumption in different continents (3)

It is clear that Asia, Europe and North America have the biggest potential for production and consumption. Additionally, the consumption in South America and Asia is higher.

Table 6: The export and import amounts of different papers (3)

	Exports minus Imports				
	P&B	Wood Pulp	Bleached Softwood	Bleached Hardwood	Recovered Paper
World	-1,033	-1,216	-491	-145	-771
North America	5,856	8,633	8,066	-1,199	19,775
Western Europe	13,978	-4,132	701	-4,764	7,508
Eastern Europe	-4,879	-446	-131	-762	806
Africa	-5,088	-424	-449	77	164
Asia	-89	-19,681	-9,747	-6,414	-30,053
Oceania	-566	581	232	-176	1,698
Latin America	-7,303	14,900	1,203	13,354	-1,044
Middle East	-4,647	-648	-367	-260	375

North America and Western Europe export paper and board to other regions. It is clear that newsprint is produced in regions which are rich in mechanical pulp and its resources.

The export of bleached softwood fibres from North and South America is higher than the import.

Short fibres such as fibres from Eucalyptus trees are distributed from South America (Brazil, Chile, Uruguay, Argentina). North America and Western Europe have a higher waste paper export. Asia is the biggest consumer of recycled fibres used in paper production because the Chinese paper industry has been growing year after year.

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Historija industrije proizvodnje papira u Turskoj: prošlost, sadašnjost i budućnost

SAŽETAK

Papir se pravi u sljedećim koracima: fibrilacija, bubrenje i sječenje sa procesom drobljenja, formiranje ploča sa odvodnjavanjem suspenzije kroz jedinicu za filtriranje i kreiranje čvrstih listova koji stvaraju vodonične veze između vlakana za vrijeme sušenja. Papir je važniji od naftnih proizvoda za mnoge primjene u ljudskom životu. Knjige, novine, časopisi, sveske, ambalaže, pelene, upijajući papir, papirni novac, itd. su nam neophodni za svakodnevnu upotrebu. Potrošnja papira po stanovniku je jedan od pokazatelja razvoja zajednice. Globalna industrija papira i dalje raste, iako je svijet pogođen mnogim krizama. Međutim, rast je dosta znatniji u odnosu na prethodne godine. Ukupna proizvodnja papira je dostigla 410 miliona tona. Nakon 2007. godine, proizvodnja papira za pakovanje i upijajućeg papira se kontinuirano povećavala, dok se proizvodnja papira za štampanje i pisanje smanjivala. Jasno je da Azija, Europa i Sjeverna Amerika imaju najveći potencijal za proizvodnju i potrošnju. Sjeverna Amerika i Zapadna Evropa izvoze papir i karton u druge regione. Novine se proizvode u regijama koje su bogate mehaničkom celulozom i njenim resursima. Izvoz beljenih vlakana od mekog drveta iz Sjeverne i Južne Amerike je veći od uvoza. Kratka vlakna, kao što su vlakna dobivena iz stabala eukaliptusa, distribuiraju se iz Južne Amerike (Brazil, Čile, Urugvaj, Argentina). Sjeverna Amerika i Zapadna Europa imaju veći izvoz otpadnog papira. Azija je najveći potrošač recikliranog vlakna za proizvodnju papira, jer papirna industrija Kine raste iz godine u godinu.

Ključne riječi: Papir, celuloza, vlakna.

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Photography as an (im)possible way of depicting historical truth

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ABSTRACT

Within the matter of contemporary and historical trauma, this paper deals with questioning the possibilities of the representations' visual structure, that is, the possibility of witnessing through photography. First of all, it starts with key photography theoreticians who analysed the relations between a photograph and reality, history and historical truth, then it continues to review representative photographs of the Holocaust and finally analyses the most explicit visual material from Auschwitz, that is, four photographs of the Sonderkommando members.

Keywords: photography, the Holocaust, Sonderkommando

Introduction

A photograph is supposed not to evoke but to show. That is why photographs, unlike handmade images, can count as evidence. But evidence of what?
Susan Sontag, Regarding the Pain of Others (2003)

Through all the periods in history, based upon the available relevant documentation, we can trace a continuity of crime, motives for its execution and different ways of its manifestation. Religious, invasive and civil wars, inquisitions, reformations and counterreformations, genocide and other forms of crime have been built in the foundations of many countries. Different groups, i.e. national, ethnic, racial and religious ones, have experienced as such an attempt to partially or completely exterminate, so the 20th century can unfortunately be called the century of genocide.

The Holocaust may belong to a rare historical experience where we are faced with a lack and an impossibility of establishing rational awareness and strength. Through a ruthless abolition of all humanistic principles, it has marked a complete breakdown of hope and reason. Much has been written about the tragedy of the European people, but, despite all of it, we stand in front of a series of unfathomable and insoluble questions. This only proves that the event itself is unspeakable and inconceivable in its dimensions of representation and trauma. On the other hand, there is a need to speak about the Holocaust as a paradigmatic instance of the expression through which we strive to arrive at the omnipresence of evil in humanity; the events of the Holocaust seem more immanent because, by merely determining our collective history, it is possible to intervene in the present.

That is why, for the last couple of years, we have witnessed different discursive reconstructions of the incurable trauma from the history - memoirs, historical studies and theoretical reviews, films and photographs, as well as an institutionalisation of the memory on the mass destruction of the European Jews. New technologies have mostly revolutionised the ways of preserving and awakening memory "At the end of the 19th and in the 20th century, photography and then sound films, radio and TV, have made a more complex dynamic of the history's intervention (...) The new time machine has enabled us to observe the past form different perspectives..."(Kuljić, 2006) Within the matter of contemporary and historical trauma, this paper will pay attention to the visual structure of representations, that is, the possibility of witnessing through photography. A photograph is a narrative that reveals and masks at the same time. Its indicative nature should be understood as a mimetic nature of

an image that constructs instead of memories and reflects the reality of the Holocaust. A photograph utters "this happened", its referent "has indeed existed" (Barthes,2003), and that is why it functions as an index symbol.

However, the credibility of a photograph does not so much depend upon photographic technique but upon a series of discursive, social and culturally conditioned practices. Understanding a photograph is related to the way we interpret visual perceptions, that is, symbols. A semiotic approach does not only question the established categories of perception and photograph analysis but it also focuses on producing a meaning, which indicates that observing is not enough, one should also read. Observed from the viewpoint of the semiotics pertaining to reading a photograph of the Holocaust, it can be concluded that the image represents a meaning polysemy and that it would be wrong to contemplate about unequivocal visual perceptions and forms. Thus, a photograph is much more than passive observation.

Photography and reality

Contemporary life gives us multiple opportunities to observe the suffering of others owing to the phenomenon that is photography. A photograph of the Holocaust revives the dark world and provides an opportunity to semiotically read the visual text and meaning of the details shown in the picture. It is the language and utterance in the absence of the victims' memories - „....All photographs are memento mori (a reminder of death). To take a photograph is to participate in another person's (or thing's) mortality, vulnerability, mutability. Precisely by slicing out this moment and freezing it, all photographs testify to time's relentless melt." (Sontag, 2009)

A photograph enables the memory to become communicative, just like history marked by blood - as a trace, document, witness, memory, biography and autobiography, political fact, presence and absence of the past. It represents the culture of memory by developing a visual history of reality. Theories of photography are based upon examinations of photographic, artistic, aesthetic, semiotic, historical and cultural aspects. In theories and studies of photography after the Second World War there are two most frequent directions according to M.Šuvaković: "1. The starting point is the attitude that the primary trait of photography is the technical ability of a faithful reproduction of the world and 2. Photography is interpreted as a technical medium that allows expressions of subjective views and accomplishments of experimental demands" (Šuvaković, 2005, p. 234.)

The relationship between reality and photography is primarily the result of technical production. It is known as a product of chemical and physical processes, that is recording scenes from reality on a layer of a light-sensitive material (film or a photographic plate). The exposure itself is devoid of "a human's creative intervention" that "is present in the procedure through his or her choice of the photographed object and a purpose they have in mind", but it does not have a role in the actual production process. (Bazin, 1967) The way in which the production process of a photograph is automated proves and secures a lack of human interference, "...a photograph affects us as a natural phenomenon", and gives its objective nature. At the same time, it ensures the existence of the depicted object because it is a necessary precondition for photo-chemical processes. The objects or persons depicted in such a way are shown as "the necessarily real thing which has been placed before the lens, without which there would be no photograph" (Barthes, 2003, p.20).

According to Barthes "every photograph is a certificate of presence", which means that it brings forth a frozen part of time always related to the past. It freezes the moment and records a moment in time that is already a part of the past thereafter connecting reality with the past. This trait makes photography extremely convenient for history, both for private usage in reminiscing about memories from the past and as a historical document of former situations, historical depictions of cities etc. However, despite a certain relationship between a photograph and the past, many theoreticians who analyse photography doubt in the value it gives history or even discard the idea. Even though it can confirm the presence of the past, it is often not possible to discern the situation at hand and, for the observer to do so, the photograph would have to be placed in a context in the form of narration or description, that is, a title (W.Benjamin). In his book Camera Lucida Barthes (Roland Barthes) analysed photography from a poststructuralist point of view as a representation. On the one hand there is denotation that is elaborated on different levels of a photographic production (the choice, technical processing, cropping, etc.) and on the other hand an accompanying text that limits the polysemic meaning of the image, that is a floating chain of signifiers. Contrary to Benjamin, Barthes does not see titles as signs that will help the reader experience them

as "evidence of the historical phenomenon" but as a way of selection and its fundamental meaning. When it comes to the relationship between writing and an image, both authors focus on the potential of photography. Nevertheless they differ because according to Barthes a photograph contains multifaceted information and meaning, while for Benjamin a photograph shows too little reality.

In her book On Photography, Susan Sontag also supposes that a photograph has multiple meanings. She observes it as a surreal medium that is made out of pathos as a message from time past. She has a historical reason for doubting the appropriateness of photographs due to their time structure "...most subjects photographed are, just by virtue of being photographed, touched with pathos" (Sontag, p. 23.) continuing with " all photographs testify to time's relentless melt." (ibid) and in such a way they are "both a pseudo-presence and a token of absence." She talks about the fact that the camera's rendering of reality must always hide more than it discloses and concludes that the knowledge gained through photographs will always be some kind of sentimentalism "... It will be a knowledge at bargain prices—a semblance of knowledge, a semblance of wisdom..." (ibid, p. 30)

All three theoreticians aimed at drawing a conclusion about the relationship between a photograph and history, that is, social reality. Barthes mentions a related position of reality and the past. By explaining the essence of photography he wants to name its importance, that is, its noeme. Photography does not talk about that which is gone but only and certainly about that has been. (Barthes)

If we follow Barthes' phenomenological ideas, photography does indeed provide us with historical truth. However, this of course hypothesises that images can be deciphered or read solely in the context of a historical narration, which implies the necessity of acquiring knowledge on the object of photography. Previous knowledge can be acquired from personal experience (memories - as in the case of Barthes' knowledge about his mother and the circumstances in which the photograph was taken), or historical knowledge (as in the case of the Holocaust photographs). In this way, the knowledge a viewer possesses about the photograph is necessary for depicting the truth. As a target, a photograph is not the event itself; it does not contain a clear narrative but represents a trace, a two-dimensional print that can only provoke assumptions, creation and construction of the potential narrative placed in the context by the observer. In other words, a photograph always portrays, indicates, presents, represents and the road towards construction is always open.

Pulling a trigger on the camera or a gun[1]

In art, portraits of suffering have always been represented through an image or a sculpture - the portraits of fights ordered by the rulers functioning as witnesses of victories in war. It is a genre with a long tradition in the history of art. Nevertheless, the overlapping relationship between photography and modern warfare has deeper foundations. When it comes to photography, we basically evoke a section of the time past.

The Holocaust provides a challenge in visualising historical truth from the photographic representation. It is possible to visualise such structures and organisational procedures using graphs, but they are photographically indescribable because even when descriptions that give the photograph intelligibility are provided, the information will be limited.

Extermination and the range of extinction are elements that further complicate the photographic representation. The number of people who were killed exceeds human imagination and cannot be visually represented; they are only implied in the form of metonymy (piles of shoes, clothes or dead bodies). It is impossible to visualise the extermination of Jewish people in Europe because it demands visibility of the object.

What is visible in a photograph of the Holocaust is solely that which was not completely destroyed, i.e. it is not final (yet). Thus, piles of dead bodies, prisoners and concentration camps shown in the photograph only represent traces of the systematic extermination. Despite the problem of depicting the systematic destruction of the European Jews in the photograph, there are numerous ones that depict the Holocaust. Marianne Hirsch point out that "... the Holocaust is one of the visually best documented events in the history of an era marked by a

[1] In this context I am paraphrasing the words of S. Sontag who refers to this metaphor: "...a camera is sold as a predatory weapon (...) Just as the camera is a sublimation of the gun, to photograph someone is a sublimated murder—a soft murder, appropriate to a sad, frightened time. Eventually, people might learn to act out more of their aggressions with cameras and fewer with guns..." On Photography, p. 23

plenitude of visual documentation." (Hirsch, 2001) All photographs, whether taken by the perpetrator or images of souvenirs or concentration camps after liberation only show a fragment that cannot by visualised easily. However, human imagination can, thorough a photograph, envisage people's experiences in extermination camps.

The majority of photographs witnessing the Holocaust have been captured by the perpetrator and taken from concentration camps and ghettos. Not all of them were meant to be published; they were ordered for official purposes such as documenting the construction of the Auschwitz concentration camp, for the purpose of medical experiments or as illustrated reports from concentration camps and the like.

The reports from concentration camps have been necessary to refute the rumours on the prisoners' grave conditions and photographs of prisoners working or spending their spare time have been taken for that purpose. The Nazis were, in this case, using the truth in photography (Barthes, p. 140) as the means to stop the spread of falsity. After the war, the deed brought upon the destruction of photography as a visual value of evidence.

Jürgen Stroop's final report on the Warsaw Ghetto Uprising in 1943, contains more than fifty titled photographs. They document the activities of the German Nazi army during April and May of the same year representing burnt houses, forceful evacuation of people from their hiding places, prisoners, arrests and deportations. One of the most famous Holocaust photographs that originated from this report is A boy with his hands raised, titled in the report as "Mit Gewalt aus Bunkern hervorgeholt" (Forcibly pulled out of bunkers).

The image shows imprisoned Jews in the Warsaw Ghetto in front of which a boy stands with raised hands. The photograph symbolises the innocence of the National Socialism's victims and the boy is a precisely perfect representative of all the victims (just like Anne Frank).

At the same time, an innocent face of a child - beyond any historical responsibility, awakens empathy and the awareness of guilt. One of the rare photographic collections and evidence on what had been happening is the Auschwitz Album, whose original goal was never resolved and it contains 193 photographs showing the arrival of the deported Hungarian Jews. It can be considered as the only surviving visual evidence of the process leading to the mass murder at Auschwitz. The Album was found after the war and the photographs show the selection process undertaken before sending people to the gas chambers.

Apart from the official photographs, there are numerous amateur ones depicting certain aspects of the Holocaust - for example, pictures taken among German soldiers and visits to the Warsaw Ghetto. Their photographs show typical street scenery: A Warsaw streetcar, the Star of David, barricades and check points emphasising captivity, street beggars, exhausted people, from which we can interpret a clear segregation in all the spheres of life. There is also a series of photographs where soldiers stand proudly behind a number of bodies lying on the ground, as well as a series of photographs documenting murder.

Some of the amateur photographs gained larger publicity in the last couple of years. These photographs are often more convincing than the photographs taken by professional photographers. The result of their strength is in the manner of presenting, i.e. they depict a situation by showing the inhumane treatment of prisoners.

In Barthes' words: "Usually the amateur is defined as an immature state of the artist: someone who cannot - or will not - achieve the mastery of a profession. But in the field of photographic practice, it is the amateur, on the contrary, who is the assumption of the professional: for it is he who stands closer to the noeme of Photography." (Barthes, p. 122)

Apart from the more significant photographs, that I briefly mentioned, there are around two million photographs of diverse quality and content in public archives.

The fact is that the Holocaust is the most visually documented event in history. Even though photographs can never provide the proper knowledge on the Holocaust, that is, prove the actual existence of a given situation, they are but an index that subsequently grows into a symbolic picture with a multitude of possibilities for interpretation on the connotative and semiotic levels. We can conclude that reality is placed behind the photograph as a trace, the visual puts reality in the field of the unfathomable, the untold, but forever present in symbolic representations.

The Sonderkommando photographs - Four pieces of film snatched from hell

Even though the success of certain photographs can explain the symbolic content, aesthetics, multiple interpretation and visual representation integrated into specific memory and remembrance practices, the matter of other less prominent Holocaust photographs remains. Such photographs, that have recently been placed at the centre of attention, are four highly unusual images taken by a smuggled camera in 1944, on part of a Sonderkommando member (special commandos) in Auschwitz.

The photographs are the only visual evidence of killing with gas at the time of its application: "Testimony produced by the prisoners themselves, meant to be transmitted, like the famous Sonderkommando manuscripts, beyond the closed world - the implacable sealing of space and implacable inevitability of time - that was Birkenau." (Huberman, 2012, p. 36)

The photographs have poor quality and they are partially blurred; two of them show a heap of dead bodies, the third is an unidentified view of a tree, with a naked woman in a corner, and the fourth photograph is shaded with a treetop being the only visible thing. Four pieces of film snatched from hell were hidden in a tube of toothpaste, buried in newspapers and dug up only after the Liberation.

The importance of these photographs is that they were taken by a prisoner at Birkenau, as opposed to the previously discussed famous SS photographs, that is the Auschwitz Album or the Warsaw Ghetto photographs. The photographs were taken by one or two members of the Sonderkommando, units composed out of Jewish inmates and Russian prisoners-of-war who were forced to work in the gas chambers and Auschwitz crematoria in the Summer of 1944. For the members of Sonderkommando, the gas chamber was a daily "workplace", an inferno where the witnesses (photographers) worked.

"The gesture of the clandestine photographer was, altogether, as ordinary as it was heroic: entering the gas chamber, the same one in which the SS officers forced him to unload the bodies of the recent victims, he transformed, in the couple of rare seconds of stolen attention from the guards, the captive labour, his slave labour in hell, in a true action of resistance." The four photographs were first shown to the public in 2000 as a part of the exhibition Mémoire des Camps, and later published in the book Images malgré tout (Images in Spite of All).

A text written by Georges Didi-Huberman was placed in the exhibition catalogue. In it, he described the photographs as an act of the prisoner's resistance who tried to defy the absolute extermination and inconceivable events. By examining these photographs and writing about them, Huberman tries to see them up close, outlining the phenomenology, situating its historical content and understanding the disturbing value in our opinion.

Through his work, he faces the difficulties present in such images, as well as with external difficulties tied to the controversy of giving them such meaning, i.e. the possibility, legitimacy and ethics of publishing explicit visual materials. He points out that the difficulties are not his alone: "...I think that they follow every cultural decision linked to the transmission and museification of a historical event whose stakes - memorial, social, philosophical and political - are significant." (Huberman, 2012, p. 43)

Huberman believes that if it is true that photographs can be transformed into symbolic images, we then witness such a process in this moment. He not only claims that photographs are closer to reading, but also forms a theory about the image where he focuses on the photographs' historical truth on the one hand, and determines the relevance of their reception on the other. The following argument of Hannah Arendt shows the four photographs as "moments of truth". It is needless to say, he states, "that the four photographs from August 1944 do not tell all of the truth. It would be very naive to expect this from anything at all - things, words or images: they are tiny extractions from such a complex reality, brief instants in a continuum that lasted five years no less. But they are for us - for our eyes today - truth itself, meaning its vestige, its meagre shreds: what remains, visually, of Auschwitz." (Huberman, p. 38)

In his text, Didi-Huberman further analysed these photographs, describing in detail each visual level, that is, starting from the formal aspects of a photograph in the first part. He pays particular attention to the big black frames of the photographs; their presence points at a place from which the photograph was taken, i.e. hiding in the moment when the shutter release was pressed.
Formal traits become the basis of determining what

happened, that is, morphological analysis enables us to see the effectiveness of these photographs, it does not directly relate to its readability and the evidence of the depicted, but to the significance of the material, visual layer.

The thing that Huberman notices, and criticises in the analysis, is that the photographs were reframed so as to make the reality to which they testify more legible, and states: "...The image of the women running toward the gas chamber here is merely a close-up taken from the real photograph of which the birch wood itself occupied a far greater part. The two images showing the cremation of the bodies in the open air have been corrected so as to supress precisely what had made them possible: namely, the slanting angle and the substantial darkness - that of the gas chamber itself - thanks to which the covert photographer was able to take out his camera and frame his shot. Indeed, he had to hide in order to see, and curiously this is what memorial pedagogy would have us forget here. (ibid)

Likewise, in today's Auschwitz Museum, only three photographs are exhibited, the fourth is missing; for the organiser of the place of memory this photograph is useless, because it has no referent, i.e. there are no people in it. As an answer to the question whether visible reality is necessary for the testimony to happen, Huberman states: "For us who accept to look at it, this failed, abstract or disoriented photograph testifies to something that remains essential: It testifies to danger itself, the vital danger of seeing what was happening at Birkenau. It testifies to the situation of urgency, and to the near impossibility of testifying at that precise moment in history." (ibid)

The proof of a photograph as a testimony is also shown in the choice of the viewpoint, that is, recording as taking a moral stance. In 1961, the director Jacques Rivette wrote a short text for Cahiers du cinéma, in which he precisely emphasises how the recording point is significant to the matter of reality and, at the same time, morality.

He points out that: "What matters is the point of view of a man, the auteur, and the attitude that this man takes in relation to that which he films, and therefore in relation to the world and to everything: that which can be expressed by a choice in situations, in the construction of the storyline, in the dialogue, in the play of actors, or in the pure and simple technique, "indifferently but as much"...There are things that should not be addressed except in the throes of fear and trembling. Death is one of them, without a doubt; and how, at the moment of filming something so mysterious, could one not feel like an imposter?" (Rivette, 1961)

What Huberman further points out and what definitely comes from a formalistic approach is history, that is, narration based on photographs. He describes he Sonderkommando members' circumstances. He reconstructs the event by using visual matter and a series of other documents and memoirs that help him describe the organisation of the concentration camps, as well as a strict ban on photography.

The reconstruction and interpretation of these events would be impossible without Huberman's reliance on background documents. Huberman's text also deals with the conditions that enable the construction of a historical discourse in the context of the inconceivable and the untold that dominate the Holocaust discourse. He treats the four photographs as visual phenomena, enabling deliberation through a dialectical relationship between that which is inconceivable and the process of the conceivable. In the context of the conceivable matter in relation to history we can discern two realisations - on the one hand, there is the inconceivable that shows different forms of the ban on photography, and on the other hand there is the conceivable, a potentially limitless ability of producing, assimilating, observing and absorbing the photographs.

Talking about the Holocaust is based upon the inconceivable. Despite everything, the photographs advocate research in the possibility of creating knowledge based upon fragmented visual materials and the analysis of historical knowledge with their foundations being set in specific images and formal traits.

Didi-Huberman claims that only these photographs can give us an opportunity to experience that which happened in Auschwitz: "the four photographs, of course, don't tell all of the truth (it would be very naive to expect this from anything at all - things, words or images: they are tiny extractions from such a complex reality, brief instants in a continuum that lasted five years no less. But they are for us - for our eyes today - truth itself..." Huberman's position and arguments can serve as a justification for all the theoretical models of deliberation on the Holocaust experience. In accordance with this alternative way of thinking, the formal dimension of a photograph has to be taken as the basis for analysis in which the ethical aspect and the photograph's epistemic values

are considered inseparable. In other words, in order to transfer the Holocaust experience, one should take into account the structure of the photograph. Huberman poses the question: "Are they useless images, then?"

Of course, they are far from it, they are infinitely precious to us, we should know how to perceive, despite everything, despite the destruction and eradication, i.e. perceive as an archaeologist. That is how things start to spring up from times past. Memory does not demand that we offer only meticulous mementos. The most important witnesses, like the clandestine photographer from Auschwitz, have given us so many clear depictions and irrefutable facts.

That is why we are touched even by the photographer's urgent choice to enable visual coexistence "...where the unrecognisable rivals the recognisable, just like the shadow rivals light, to give form to its despairing testimony." (ibid, p. 40.) That is, by returning time that was lost, those are "images that - torn from all earlier context - stand as valuables in the sober chambers of our perception..."

Therefore, memory cannot be reduced to the clearly visible, archaeology does not only explore the past, but also a collection of data with the goal of understanding the present "...a true memory must, at the same time, provide an image of the person who remembers (...) and show the layers through which it had to pass in order to reach them."

Here I am pointing out the status of these photographs as historical documents, their usage as evidence and the way theory can help in approaching the observer's visual representation. Special attention has to be paid to the contradiction between the immediate response of those who give the photograph the status of evidence, and, on the opposite side, those who consider it as a depiction and those offering a certain proximity, as well as an emphasised distance. In the end, in Barthes' words "... The photograph must be silent: this is not a question of discretion, but of music. Absolute subjectivity is achieved only in a state, an effort, of silence (shutting your eyes is to make the image speak in silence). The photograph touches me if I withdraw it from its usual blah-blah: "Technique," "Reality," "Reportage," "Art," etc.: to say nothing, to shut my eyes, to allow the detail to rise of its own accord into affective consciousness. (Barthes, p. 70)

Conclusion

The Holocaust left behind permanent consequences representing an event that, in the history of the Western civilisation, brought that which no other genocide before it did - heinous crimes of mass destruction of human lives. Remembering the Holocaust has a historical value for all humanity, since the memory cannot be left to the past and oblivion. Above the entrance to the Dachau Museum there is an inscription in the words of an American-Hispanic poet George Santayana: "Those who cannot remember the past are condemned to repeat it."

The main hypothesis in this work is related to the analysis of the relationship between photography and reality by observing the theoreticians' analysis of different concepts and evidence on the possibility of depicting the truth. What is the ability of photography as a way of depicting historical truth or as a testimony? In relation to the theoreticians, we can conclude that it reflects and shows reality at the same time but also transforms, that is, depends upon the interpretation of the viewpoint and opinion in different contexts.

Meaning occurs in historical and social situations, in specific circumstances and cultural conditions. In Regarding the Pain of Others, Susan Sontag points out that Wittgenstein equalised meaning with use, and that photographs of the deceased can, when necessary, glorify death in service of the country, but also stimulate hatred towards the enemy, which implies that meaning is established through emotional reactions; thus comprehensive deliberation is required.

The question of reality can be observed in different ways, and it certainly has to include the point of view/recording as the possibility of testimony, which, by analysing the Sonderkommando photographs, points at an absolute reality of the Holocaust. Therefore, the fact is that in photographs there is a long way to go from observing to understanding.

Considering the medium of photography as cognition, it can be concluded that, even though we live in a period of an absolute flood of images, the scenes from the Holocaust invite us to pay attention, learn and think about the possibility of connecting with the historical truth and reconstruction of memory and knowledge.

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Fotografija kao (ne)mogućnost prikazivanja povijesne istine

SAŽETAK
U sklopu problematike savremenih i povijesnih trauma, rad se bavi pitanjima mogućnosti vizualne strukture reprezentacije, odnosno mogućnosti svjedočenja pomoću fotografije. Najprije polazi od ključnih teoretičara fotografije koji su analizirali odnose fotografije i stvarnosti, povijesti i povijesne istine, potom pregledom reprezentativnih fotografija holokausta, te konačno analizom najeksplicitnijeg vizualnog materijala iz Aušvica, odnosno četiri fotografije pripadnika Sonderkommanda.

Ključne riječi: Fotografija, holokaust, Sonderkommando.

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Applied physics in GPON network technology...A new era of telecommunications

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ABSTRACT

The need for a fast internet access, as well as other services, in the area of telecommunications has imposed applications of multiplexing channels and broadband networks implementation. The entire industry of cable systems in the world has already been at a high level, so the operators in the region could find technical solutions rather easily, provided that they have a good financial support. In time, operators realized the gravity and capacity of services, so they started introducing professional equipment made by renowned manufacturers and setting up a completely new infrastructure with far better technical characteristics by installing active broadband equipment that enables the construction of a large and quality infrastructure. Building such networks started by applying the HFC configuration logic. Passive system components with completely new technical characteristics were built in the entire infrastructure which contributes to the service quality.

Keywords: Internet, GPON networks, systems.

Introduction

It is increasingly resorted to building and installing optical threads / fibres (glass fibres), the technology of distributing information and data through a controlled medium - glass thread by using light signals, which is a direct application of the basic laws of physics, i.e. the branch of optics, the discovery of the dual nature of light (corpuscular and wave - motion), the photoelectric effect and discovery of the laser, with the goal of approaching the end user with this infrastructure.

The new generation of telecommunications infrastructure is currently reflected in the installation of GPON networks. GPON are passive optical networks with large capacities that use an optical thread / fibre to connect with the end user, where the only active system equipment is partly situated with the end user and partly at the operator's main station, and all other infrastructure consists of passive components. This type of architecture provides a more stable system, as well as a system that is more resilient to interference with the environment which ultimately raises the quality and stability of services to a new level of highest standards.

GPON architecture

Gigabit Passive Optical Network (GPON) is currently one of the fastest growing access technologies on the market. GPON evolution and standardisation offers new opportunities that will support future broadband access networks and services. The trend of establishing access networks on wavelength-division multiplexing (WDM) will enable a new generation of optical broadband access in the near future.

It is estimated that today, private users' data communication needs go up to 100 Mbps downstream and 30 Mbps upstream. The demands mainly come from triple play services that combine voice, data and video transmission. New services such as Video on Demand (VoD), interactive

IPTV, HDTV (High Definition Television), 3D TV, videoconference systems for many participants, telemedicine and other applications that require a more significant bandwidth capacity will definitely become the main incentive for developing the next generation of access networks that will satisfy the ever growing demands in terms of transmission speed. Estimates that there will be a demand for 1Gbps speed per household in the near future are quite realistic. Furthermore, there are ever growing demands for symmetry (downstream and upstream). The prevailing, present solutions for broadband access networks are networks based on a Digital Subscriber Line (DSL) and cable television (CATV).

However, both technologies have limitations because they are based on the infrastructure primarily intended for transmitting voice and analogue TV signal. Considering the limitations of the existing copper pairs, it is impossible to assign a DSL technology to all pairs in a cable because, in such a scenario, mutual harmful influences (the so called crosstalk) between the pairs in a cable would be too great and would additionally limit the range and quality of transmission. Due to network saturation, not all users are able to have the same broadband internet access and IP television service quality, and certain copper pairs do not even support the stated services. In the following period, it is expected that the operators will invest in optical access infrastructure with the goal of satisfying the users' needs, i.e. so as to be able to offer a wide spectrum of services such as transmission of a multi-channel HDTV, Video on Demand and videoconferences, as well as voice transmission services via the Voice over Internet Protocol (VoIP).

It is estimated that, in the next couple of years, the world will see a significant increase in the number of Passive Optical Networks (PON) alongside the GPON (Gigabit Passive Optical Network) system domination as an optical access technology. GPON supports the highest transmission speeds and a wide range of applications and services, and it is especially suitable for video and TV services. GPON can be applied in different network architectures, combined with VDSL2 (Very high speed Digital Subscriber Line) in the FTTC architecture (Fibre to the Curb), or in the FTTH architecture (Fibre to the Home) for a residential access. However, even the existing optical access networks have limitations in terms of a guaranteed bandwidth and service quality, so, in the near future, they will not be able to satisfy the ever growing capacity demands for the upcoming services. That is why it is important to define a simple and efficient evolutionary track from the existing PON systems towards the next generation of PON systems without significant changes in the installed optical infrastructure. GPON evolution offers new opportunities for future broadband access networks and services.

The following step in GPON evolution is an increase in the transmission speed from the current 2.4 Gbps to 10 Gbps downstream, and from 1.2 Gbps to 2.4 Gbps upstream. The general characteristics of passive optical networks is the absence of active components in the distribution network. Optical Line Termination (OLT) is an active component placed in the central office CO-HUB (Image 1 and 2), while Optical Network Units (ONU) or Optical Network Terminals (ONT) are placed with the user.

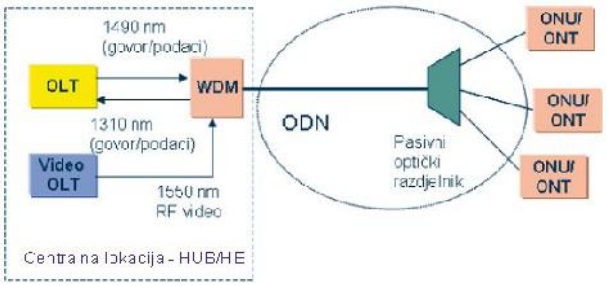

Image 1

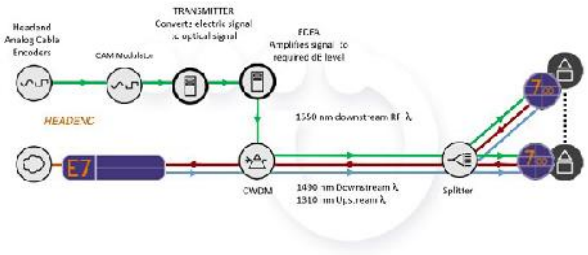

Image 2

The primary advantage of using passive optical networks in Point-to-Point Fibre Optic Links lies in savings when building cable infrastructure, because the PON usage decreases the necessary amount of optical threads/fibres.

The signal strength transmitted to end users is divided in the ratio of 1:N were N equals the number of end users connected to the passive optical splitter.

Optical splitters can be placed near the OLT or closer to the end users depending on the availability of optical infrastructure or the PON implementation strategy. In general, passive optical networks are based upon three network topologies: FTTH (Fibre To The Home), FTTB (Fibre To The Building) and FTTC (Fibre To The Curb) (Image 3).

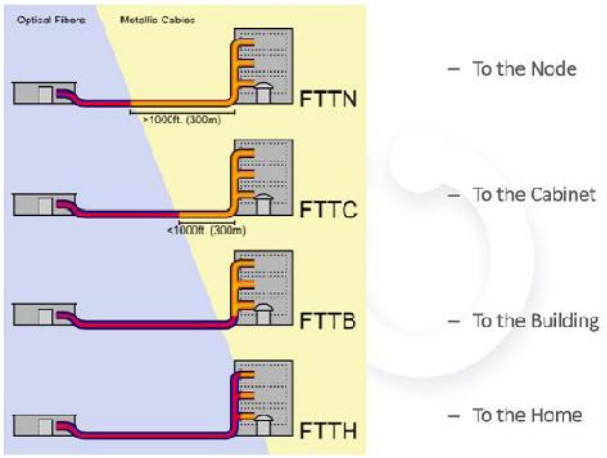

Image 3

Image 4

This process is called ranging. The OLT unit determines the time slot in which its assigned unit ONU/ONT will transmit its information. Ranging is performed during the activation of optical units ONU/ONT, and it can also be performed during operations. One of the greatest advantages of PON is the fact that it can support different transmission speeds and different services without changing the optical components between the central office CO/HUB and the subscriber's end devices. This represents a simple solution for the Optical Distribution Network (ODN).

Conclusion

Apart from improving the quality of telecommunications services, increasing data flow and information access speeds both towards the users and from the users towards world networks, additional safety from interception at the physical layer of communication as opposed to the physical layer essentially made from precious metals, the widespread networks are additionally significant from the environmental aspect. All passive optical networks without active components that do not need a power supply provide an additional contribution to savings in terms of usage and exploitation of fossil fuel and decrease the production of different metals, electronic components and other products that require special conditions for exploitation and recycling. GPON networks directly replace large amounts of cables made from precious metals that, apart from the function they perform in transmitting a signal, can present a danger in case of undesirable atmospheric discharge, or a direct contact with electrical grids of different voltage levels, and even inductive dangerous impulses due to their vicinity, which is not the case with optical cables in GPON networks.

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Primjenjena fizika u tehnologiji GPON mreža...novo vrijeme telekomunikacija

SAŽETAK

Pojava potrebe za pristup brzom internetu, kao i drugim servisima, u oblasti telekomunikacija, nametnula je primjene multipleksiranja kanala i realizaciju širokopojasnih mreža. Cijela industrija kablovskih sistema u svijetu je već bila na zavidnom nivou, tako da su operateri u okruženju mogli vrlo jednostavno doći do tehničkih rješenja naravno uz dobru finansijsku potporu. Sa vremenom, operateri shvataju ozbiljnost i mogućnost usluga pa počinju da uvode profesionalnu opremu renomiranih proizvođača instalirajući potpuno novu infrastrukturu daleko boljih tehničkih karakteristika ugrađujući širokopojasnu aktivnu opremu koja omogućava izgradnju velike i kvalitetne infrastrukture. Ovakve mreže počinju se graditi primjenom logike HFC konfiguracija. U cijelu infrastrukturu ugrađuju se i pasivne komponente sistema sa potpuno novim tenhičkim karakteristikama što doprinosi kvalitetu usluga.

Ključne riječi: Internet, GPON mreže, sistemi.

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Marble Cladding in the Interiors of Adolf Loos

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ABSTRACT

Adolf Loos (1870-1933) was a journalist, critic, architect and interior designer. Today, students of architecture learn their first lessons on modernism from his white, smooth facades without ornaments. Loos's rejection of the artificial ornament, his harsh criticism of historicist architecture, reviews of the Secession decoration and the Gesamtkunstwerk, his essay Ornament and Crime and the development of the spatial plan known as Raumplan, are most often analyzed and cited in the context of Adolf Loos's contribution and his place in the theory and history of architecture. However, it is equally interesting to discuss Loos's perception and use of materials. His facades are deprived of ornaments, and buildings, shaped like simple compositions, are mostly of white cubic volumes. However, his interiors - whether in adapted and renovated venues or in new buildings - fascinate with a wide range of luxurious materials used to maximize their intrinsic, textural and colorful features. Adolf Loos's approach to using material and his understanding of the "truth to materials" principle expressed in his texts and projects, had, in addition to other aspects of his work, influenced the development of modern 20th century architecture.

Keywords: Stone, interior, cladding, material, design.

Inside and Outside: "Splitting of the Wall"

"To address the interior is to address the splitting of the wall." [1]

Colomina Beatriz

When a scaffold was removed from the House of Michaelerplatz in Vienna in 1911, revealing its facade, the citizens were taken aback, and the city authorities faced a problem. When in sight of the "house without eyebrows", which, as a challenge, emerged across the Imperial residence of the Hofburg with its smooth facades without decorative ornaments, the Emperor would allegedly pull the curtains not to see its hideously bare walls.[2] Later called Looshouse in honor of the architect, this building is one of the most well-known and most analyzed buildings designed by Adolf Loos: in its design Loos had already, in his early stages, clearly expressed a number of the principles he applied in his later work. The facade of the building Loos designed for his earlier clients[3], a tailor company Goldman & Salatsch, whose store is located on the ground floor, is completely devoid of historicist ornament. The entrance pillars and facade of the ground floor are covered in Cipollino marble, while pure white surfaces with simple openings and no ornaments dominate the floors above. The interior, however, suggests a different approach to surfaces, characteristic of Loos' later work and theoretical discourse. The contrast between the inside and outside shows the dual nature of the wall and of a unique architectural structure: both volume and space, as mask and frame. Pure and clear square blocks of his buildings, framed by white and smooth surfaces, do nothing to hint at the rich interiors in which both vertical and horizontal surfaces carry expressive textures and the color of the materials used - most commonly, different in each respective room.

- 1. Beatriz Colomina: Intimacy and Spectacle: the Interiors of Adolf Loos, AA File, No. 20, 1990, p. 13.
- 2. Edward Rothstein, Herbert Muschamp, Martin Marty: Visions of Utopia, Oxford University Press, 2003, pp. 32,33
- 3. In 1898, Loos designed the interior of the Goldman & Salatsch store in Graben Street. Panayotis Tournikiotis: Adolf Loos, Princeton Architectural Press, 1994, p. 17.

Figure 1: The Goldmann and Salatsch Department Store, Michaelerplatz, Vienna

"The house does not have to tell anything to the exterior; instead, all its richness must be manifest in the interior"[4] – claims Loss. As the suit of a modern man, a simple black coat he wears "outside", does not say much of its owner, so the facade of his house should not reflect more than its function. The abundance of marble, onyx and wooden cladding fully reveals its luxurious and unique patterns in the interior of the house "where the urban inhabitant is free to remove the social mask and be himself. The exterior (...) must be as inconspicuous as the well-tailored black frock coat – preferably cashmere, classically styled, and with black, not brass, buttons."[5] Although this distinct difference in the treatment of the facade can be understood as the treatment of an interior and an exterior that reflects the character of the inner and outer space: exterior - public, and interior - private, it has wider connotations. It does not only apply to setting the barrier between the outside, as in the perception of what is outside the home, and inside, in the sense of what is inside of it. It refers to the concept of the spatial boundary that determines a specific place and function: "(..) the split wall is not limited to the enclosure that separates the inside from the outside. The schism quite logically runs through all the walls. Surfaces belong not to their particular wall section, but to the spaces they face. This contrast between the two faces of Loos's walls was preconditioned by the Semperian model."[6] This is evident in interiors - both the adapted apartments and the villas that Loss designed in their entirety. Reflection on the enclosure, considers Loos, precedes the reflection on the construction; in 1898, Loos writes about the meaning and significance of the envelope in the text "The Principle of Cladding"[7] : "The architect's general task is to provide a warm and livable space. Carpets are warm and livable.

- 4. Adolf Loos: Heimat Kunst (1914), in Trotzdem (essays 1900-1930) (Innsbruck, 1931). According to: Colomina Beatriz, as cited above, p. 13.
- 5. Harry Francis Mallgrave: Modern Architectural Theory, a Historical Survey, 1673–1968, Cambridge University Press, 2005, p. 218.
- 6. Kent Kleinman, Leslie Van Duzer: The Interior of the Glove: The Lining of Adolf Loos, in: Trina Deines, ed.: 83rd ACSA Annual Meeting Proceedings, CSA Annual Meeting, 1995, p. 358-363.
- 7. Adolf Loos: The Principle of Cladding, in Spoken into the Void: Collected Essays 1897–1900 [Cambridge, MA: MIT Press, 1982], originally published in Neue Freie Presse, September 4, 1898), p. 66.

He decides for this reason to spread out one carpet on the floor and to hang up four to form the four walls. But you cannot build a house out of carpets. Both the carpet on the floor and the tapestry on the wall require a structural frame to hold them in the correct place. To invent this frame is the architect's second task. That is the correct and logical path to be followed in architecture. It was in this sequence that mankind learned how to build. In the beginning it was cladding."

The concept of elemental shelter, the "house of curtains", for Loos, should stay present in architecture - to make a place, a man needs a skin, not beams and pillars. They are needed to hold the enclosure.

Material: Language of Forms

"Matter must become divine again. Materials are utterly mysterious substances. We must feel a deep, respectful wonder that such things were created at all. And as for decorating fine materials, perfect in themselves, with ornamentation? 'Improving fine mahogany with purple stain? These are crimes."[8]

Adolf Loos

Even in his early work, Loos clearly defines his attitudes on treating cladding material, refusing imitation and emphasizing its natural features: "Every material possesses its own language of forms, and none may lay claim for itself to the forms of another material".[9] A deep understanding of the nature and properties of the material, and the tendency to follow their "language of form", should be considered in the wider context. The reflection on the ethical use of materials, and ethics in general in the creation of an architectural work that corresponds to its time, is evident in Loos's other texts as well. Loss compares the return to the historical style which dominated in Vienna during the reconstruction and construction of structures around the Ringstrasse, with the construction of Potemkin's villages: "They were villages of canvas and pasteboard, villages intended to transform a visual desert into a flowering landscape for the eyes of her Imperial Majesty. (...) But the Potemkin city of which I wish to speak here is none other than our dear Vienna herself. (....) Whenever I stroll around the ring, it always seems to me as if a modern Potemkin had wanted to carry out his orders here, as if he had wanted to persuade somebody that in coming to Vienna he had been transported into a city of nothing but aristocrats."[10]. Loos harshly criticizes the historicist buildings, the structures built in the period that preceded: the facades of the "Renaissance" and "Baroque" palaces "have tendency" to be something different and "pretend" to be made of stone, or of stucco. However, their ornamental details, corbels, cartouches are "nailed-on poured cement".[11] Instead of decorative plastics and any kind of artificial ornaments, Loos covers the walls of his interiors with quality materials that have been crafted to perfection, but only to the extent to reveal their natural beauty. Subtle and discrete or powerful and expressive, abstract drawings, hidden in stone blocks and "drawn out" by cutting and polishing the surfaces, appear on the wall claddings and frames of openings, ceilings, floors. The material is allowed to speak, and it gives identity to the spaces to which they belong. The architect who has so harshly criticized imitation in "cladding that pretend to be something else" discovered discontinuities, layers, and large crystals hidden in the rock that appear on treated surfaces as lines, shapes, colors. The "cladding principle" stipulates that stucco can be used in all forms except in the stone and brickwork patterns; that wood can appear in all colors except the color of wood, and Loos demonstrates these principles in his designs with stone. Organic patterns on the walls and columns of his interiors belong exclusively to nature. Although, somewhat reasonably, in the context of his rejection of the ornament and decoration, the highly decorative features of marble and onyx linings may seem debatable, that is not the case. By refusing ornaments, Loss does not negate the properties of

- 8. Adolf Loos: Regarding Economy, in Raumplan Versus Plan Libre: Adolf Loos [and] Le Corbusier, ed. Max Risselada, 010 Publishers, 2008, p. 174.
- 9. Adolf Loos: "The Principle of Cladding," in Spoken into the Void: Collected Essays 1897–1900 [Cambridge, MA: MIT Press, 1982], originally published in Neue Freie Presse,September 4, 1898), p. 66.
- 10. Adolf Loos: Potemkin City, in Spoken into the Void: Collected Essays 1897–1900 [Cambridge, MA: MIT Press, 1982], p. 95.
- 11. Adolf Loos: Potemkin City, in Spoken into the Void: Collected Essays 1897–1900 [Cambridge, MA: MIT Press, 1982], p. 96.

the natural material, and his "cladding principles" require the material to be presented as what it is. Perhaps it is precisely the selection of the stone with a pattern that suggests the way the rock is made and emphasizes its inner structure and texture, and thus represents the strongest argument for the authenticity of the material.

Space, matter, light

"The sign of a truly felt architectural work is that in plan it lacks effect."[12]

Adolf Loos

The Kärntner Bar (American bar) in Vienna, built in 1907, is one of the obvious examples that Loos really did not "draw designs"[13], as much as he articulated the space. Loos believes that the quality and character of space, created in the imagination of an architect, cannot be conveyed by two-dimensional drawings; the effect that the matter has on the observer, showered in different types of light, cannot be "described" by standard graphic presentation techniques. Indeed, the materials reveal their presence, not only visually, but also through the acoustics of space, through the haptic experience. The position of the light source, its quantity and color, the interaction of materials with each other produce different effects, which create the experience of architecture. And indeed, no drawing can credibly convey the optical illusion of the infinite depth of the space multiplied in mirrors set between marble pilasters, the light effect on thin onyx surfaces, or the atmosphere created by the "..interior, which depends on the colour and level of light transmitted through an onyx screen".[14] Various materials are combined within limited space: columns and beams are made of dark Skyros marble, with mirrors set between them. The coffered ceiling is covered in light venous marble, whose organic pattern is not expected within rectangular panels, defined by a strict orthogonal grid. The upper layers of shorter walls are covered in onyx cladding. On the chess-board patterned floor, the shades of dark and light marble fields intertwine. Natural colors, patterns and textures of the material used - marble, onyx, wood - in combination with frame-free mirrors, under the light, create the interior of a unique, authentic atmosphere. Loos points out that the perception of the space and its character depend on the form and the material: "There are architects who do things differently. Their imaginations create no spaces but sections of walls. That which is left over around the walls then forms the rooms. And for these rooms some kind of cladding is subsequently chosen, whatever seems fitting to the architect. The artist, the *architect*, first senses the effect he wishes to produce and then envisions the space he wishes to create. The effect he wishes to bring to bear on the beholder – be it fear or horror in a prison, reverence in a church, respect for the power of the state in a government bureau, piety in a tomb, a sense of homeyness in a dwelling, gaiety in a tavern – this effect is evoked by the material and the form."[15]

The world of comfort and warmth: "...this is what I call sitting"

"'But Mr. Architect! Have you forgotten? You designed these slippers yourself!' 'Certainly!' The architect thundered. 'But for the bedroom! With these impossible pieces of colour you are destroying the entire atmosphere. Don't you even realize it?"

Adolf Loos

- 12. Adolf Loos: "Architektur" (1910). According to : Colomina Beatriz: Endless Interior: Kiesler's Architecture as Psychoanalysis, in: August Sarnitz, Inge Scholz-Strasser, Eds.: Private Utopia: Cultural Setting of the Interior in the 19th and 20th Century, Walter de Gruyter, 2015, p. 139.
- 13. "I do not design plans, facades, sections, I design space. Actually there is neither a ground floor, an upper floor or a basement, there are merely interconnected spaces, vestibules, terraces..." Adolf Loos, according to: Fred Scott: A Short History of the Room, in: The Handbook of Interior Architecture and Design, Graeme Brooker and Lois Weinthal, Eds., Bloomsbury, 2013, p. 136.
- 14. David Dernie: New Stone Architecture, Laurence King, 2003, p. 22.
- 15. Adolf Loos: The Principle of Cladding, in Spoken into the Void: Collected Essays 1897–1900 [Cambridge, MA: MIT Press, 1982], p. 66-67. Originally published in Neue Freie Presse, September 4, 1898.
- 16. Adolf Loos: Poor Little Reach Man, in: August Sarnitz: Adolf Loos- 1870-1933- Architect, Cultural Critic, Dandy, Taschen, 2003, p. 20.

Interiors that Loos designed in apartment buildings in Pilsen in the 1930s - as well as a number of his other designs - reflect the key features of his attitude towards material. The unique paintings and colors of stone cladding on the walls, change with space they are built in, suggesting that the interior of each living space is a world of its own - intimate, closed and focused inward. That world, Loos believes, should create a comfortable and cozy atmosphere for those who inhabit it - for specific people whose lifestyle and habits are "allowed" to leave a mark in the places they live in. Each room, depending on its purpose, is decorated differently and with different materials, and, when furnishing the interior, Loos often incorporates the furniture of other designers. However, the "poor little reach man"[17], who entrust an architect with interior design to the finest detail, is in doubt when he realizes that, in his "perfect" and "complete" home, he cannot find a place to put away the birthday gifts received from his children and wife. He becomes utterly disappointed when the architect, the creator of the complete space and everything it contains, asked for advice on what the home owner should do in such a situation, criticizes him for wearing the wrong slippers in the wrong room, and says that gifts should not be received because the home is complete, and there is no space in it for new things. The 1900 "Poor Little Reach Man" essay is an ironic review of the concept of "a total work of art"[18] in which the architect leaves his personal mark on everything - from the color of walls to utensils; where the smallest objects for everyday use are artistically shaped and have their own, precisely defined places, as exhibits in the gallery. Ultimately, a man becomes subordinate to the space he lives in, that is, to the design applied: in such a world, he must follow the precisely-defined patterns of behavior and clothing, patterns designed to the smallest details elaborated by someone else. For Loos, however, clients are not just passive consumers of the completed space they are subordinate to. "The inhabitants of a house perceive it as an environment, not as an object (....) Loos's interiors are experienced as a frame for action rather than as an object in a frame (....) The house should be a stage for the theatre of the family, a place where people are born and live and die. It is an environment, or stage, whereas a work of art presents itself as an object to a detached viewer."[19], claims Colomina Beatriz. People who walk, wake up and talk in their apartments and houses are participants, not observers. They are actors on the stage where different scenes, scenes of everyday life, take place in each space. There is no room for *predictability* of typical ornament in such a scene; in such a scene every pattern of marble surface is unique and specific for each cut block, as are unique the people inhabiting the space between the walls. Allowing customers to give their living space individuality by hanging and rearranging pictures, choosing pieces of furniture and various details, Loos believes that the architect's task is to provide comfort and articulate the space so that it produces a pleasant atmosphere, a sense of privacy, protection, warmth: "It is therefore the task of the architect to define exactly the sentiment. The room must evoke a warm feeling, the house must be pleasant to live in."[20] In this micro-world, a direct and firm bond between a man and the surrounding material is established, based on the sensory perception which engages all the senses and not just the sight: "For photography renders insubstantial, whereas what I want in my rooms is for people to feel substance all round them, for it to act upon them, for them to know the enclosed space, to feel the fabric, the wood, above all to perceive it sensually, with sight and touch, for them to dare to sit comfortably, and feel the chair over a large area of their external bodily senses, and to say: this is what I call sitting!"[21]

Drawings in marble

"Adolf Loos had shown me, if only a glimpse, a soul of marble."[22]

John Hejduk

If we analyze, in Loos's interiors, the "images" and "drawings" that appear on the marble surface after

- 17. Poor Little Reach Man is the title of Adolf Loos's essay from 1900
- 18. "Here Loos tells the story of a wealthy man who engaged an architect to design his entire house in the contemporary manner as a total work of art, a Gesamtkunstwerk." Suzie Attiwill: Interiorizt, p. 116. In this essay Loos criticizes the approach of his contemporaries, architects, to such shaping of the interiors: „Josef Hoffmann's determination to control every detail of the Palais Stoclet was, for example, strongly criticized by his fellow countryman, the architectural critic Adolf Loos." Penny Sparke: The Modern Interior,.p. 53.
- 19. Beatriz Colomina: Intimacy and Spectacle: the Interiors of Adolf Loos, AA Files No. 20, 1990, pp. 9, 12. This paper does not include a discussion on the specific aspects of Loos's interiors related to spatial analysis in which Colomina elaborates the concept of a theatre box, privacy and security, theatricality etc.
- 20. Adolf Loos: Architektur, in: Adolf Loos: Trotzdem, 102–3. According to: Harry Francis Mallgrave: Modern Architectural Theory, a Historical Survey, 1673–1968, Cambridge University Press, 2005, p. 218.
- 21. Adolf Loos: Regarding Economy, in Raumplan Versus Plan Libre: Adolf Loos [and] Le Corbusier, ed. Max Risselada, 010 Publishers, 2008, p. 175.
- 22. Joh Hejduk, Veins of Marble, Foreword, in Leslie Van Duzer, Kent Kleinman: Villa Muller: A Work of Adolf Loos, Princeton Architectural Press, 1997, p. 14.

cutting and polishing the cladding panels and their arrangement on respective foundation, it can be seen that the panels are most often “book matched” ("quarter matched") and sometimes “side matched”, while the "blend pattern" is used less frequently. The “book matching”, typical of the stone cladding in Loos's interiors, does not appear only as a common system where two or four, inversely polished panels are placed one next to the other in the mirror symmetry pattern. Although such an arrangement is often used on continuous large surfaces, it is often found that inversely polished panels from the same block are separated, but arranged to frame a particular sequence or an object – a focal point. Thus, for example, they appear as lateral walls' cladding or pilasters that accentuate the central element of the composition in the symmetrical balance. Curved, meandering lines of "drawings" on the stone cladding introduce a soft, smooth rhythm in spaces that are often defined by a relatively uniform repetition of straight-lined elements or even an orthogonal grid of a coffered ceiling, floor covering or in some other manner. Loos does not choose stone varieties with homogeneous, grainy structures, but those with inserted fragments of various sizes, or with interlayers, that appear on polished surfaces as shapes of rounded contours or as soft lines connected in dynamic, fluid patterns. The surface is covered in wavy lines on the surface of travertine panels; oval forms that are often repeated in the radial rhythm on onyx plates, and complex composite lines on venous marble panels.

Figure 2: The Apartment of Dr. Vogl, Pilsen

Pilsen interiors belong to Loos's later work, and were designed mainly during the 1920s and 1930s. Loos originally designed the apartment at 12 Klatovska Street in 1908, while the project from the 1920s, commissioned by the Vogl family, included its complete redesign. Although the most common stone used in Loos's interiors is marble, the walls of the dining rooms in 12 Klatovska Street apartments are covered in travertine, with mirrors placed between stone claddings in niches.

Although most of the interior is not original, after the renovation two rooms have been preserved: a salon and a dining room with travertine cladding.[23] In the period from 1930 to 1931, Loos worked on the interior of the apartment in 10 Bendova Street, for Vilem and Gertruda Kraus. Here, he once again used Cipollino marble that is present in many of his buildings - namely, on the porch and the ground floors cladding of the Looshouse facade, in the interior of his most famous building, the Muller House and on the pillars and columns of the Knize store. In the Kraus family apartment, Cipollino is used

- 23. http://www.adolfloosplzen.cz/projects-and-investors-in-pilsen/12-klatovska-street/. Accessed on 20th January 2018

for pillar cladding in the living room connected with the dining room, and for cladding of the wall where the fireplace is located. Again, as in the Kärntner Bar and some other interiors, the polished stone is found in combination with facing mirrors creating the impression of "infinite enfilade". This interior, as well as the previously mentioned one, has been recently renovated and reconstructed since, during and after World War II, it suffered various alterations and, in part, was destroyed.[24]

Figure 3: The Apartment of the Kraus Family, Pilsen

The interior of the apartment of Helena and Hugo Semler in Klatovska Street in Pilsen, whose core, until recently, was relatively well preserved[25], is the result of several transformations, that is, renovations. Loos joined the adaptation in 1930, when Hugo Semler asked him to do the upgrade and redesign. The living area consists of a guest room with a dining room and a music room, which were designed by Loos's associate Norbert Krieger in the period from 1931 to 1932.[26] The music room is considered to be Loos's work, while the interior decoration of the other two rooms is done in line with his style. The walls of the music room are covered with light venous marble with the pattern of dark curved lines (the so-called Fantastico). The stone cladding does not cover the entire height of the room; the line where the stone and the white wall meet is covered with veneer, as is the line where the vertical and horizontal planes – the wall and the ceiling - connect. All vertical planes are covered with marble in a book-matched (quarter-matched) pattern. Thus, on the larger continuous walls, as well as on the smaller ones, in the areas between the openings and the niches, the vertical surface becomes the carrier of abstract paintings, visually superior and almost isolated from the surrounding straight-lined elements. It softens the effect produced by noticeable axial symmetry, especially expressed in the sequence of three consecutive spaces in the enfilade configuration, with the central positioning of the fireplace, niches and mirrors.

Figure 4: Hugo Semler's Apartment, Pilsen

- 24. http://www.adolfloosplzen.cz/projects-and-investors-in-pilsen/10-bendova-street/
- 25. http://www.adolfloosplzen.cz/projects-and-investors-in-pilsen/19-klatovska-street/
- 26. http://pam.plzne.cz/en/object/c1-289-helena-and-hugo-semler-s-apartment

Figure 5: Hugo Semler's Apartment, Pilsen

Raumplan

"...And since the cladding follows the same rules that govern the configuration of space, it is not surprising that, written onto the surfaces of the interior, is the story of the Raumplan."[27]

Kent Kleinman, Leslie Van Duzer

Raumplan, a spatial concept developed by Adolf Loos, implies organizing space by a vertical line, where units of different functions are placed at different levels and are often of different heights. Functional connectivity is achieved by short staircases, and the spaces are often visually connected through the openings, even when there is no direct physical connection between them. A particularly illustrative example of a developed disposition is Villa Muller, but the early stage of Raumplan development can be recognized as early as in 1918, in the Strasser House in Vienna, where Loos worked on adapting the existing space. Here one can recognize all the characteristic elements of Loos's interior - those specific of his earlier years and those of a later period. Each room is treated differently, with different materials of rich texture and color quality. The walls of the dining room are covered in onyx with yellowish and greenish veins cut off from the same block in a book-matched pattern, up to the frieze with a relief of figures.
The Muller House is the last urban villa Adolf Loos worked on and designed in 1930, at the end of his life. Kleinman and Van Duzer claim that it reflects Loos's views on cladding in interiors, following, at the same time, the logic of the Raumplan space composition: "And since the cladding follows the same rules that govern the configuration of space, it is not surprising that, written onto the surfaces of the interior, is the story of the Raumplan."[28] Cipollino marble, the favorite stone of Adolf Loos, is used in the living area. The material was not applied so as to clearly follow the logic of the frame and the filling, supported and bearing structures; it is used in different shapes, in different positions and on elements that do not have the same constructive or spatial - functional role: on pilasters, columns, the fireplace frame, partition wall..... Although it is, at certain places, visually clearly defined as cladding, marble, with its specific curved pattern, as in the Knize store and Kraus's apartment, on the pillars "cascades" from the ceiling to the floor. The surface is covered with stone at full height, and such volumes are perceived as unique sculptural compositions.[29] The expression of the constructive principle applied - emphasizing the frame, that is, the structure, with different treatment of the cladding on the constructive and architectural elements - is not the idea that guides the architect in creating the interior. "The material supersedes theoretical distinctions between structure and cladding. The creation of this interior, as in many of Loos's other interiors, is following a different logic: a logic of the material's poetic presence."[30]

Conclusion

Numerous researchers have studied the work of Adolf Loos. His projects are still interpreted and valorized in many ways by many theorists discussing the spatial quality, meaning and design of his

- 27. Kent Kleinman, Leslie Van Duzer, as cited above, p. 359.
- 28. "The cladding reveals the full scope of Loos's position. The textile origins of the enclosure, the two-faced nature of the wall, the empathic aura of the interior, the charge of the partially obscured, the authority of technique: these are all concretized, in subtle relief, on the surface of the wall. And since the cladding follows the same rules that govern the configuration of space, it is not surprising that, written onto the surfaces of the interior, is the story of the Raumplan." Kent Kleinman, Leslie Van Duzer, Ibidem, p. 359.
- 29. Tozer points in his doctoral dissertation on sculptural character of walls and columns: "the absence of decorative surface elements, particularly at its junctions with the wall and floor, enables it to be read as a sculptural composition in the form of a continuous folding and stepping surface." William Richard Eric Tozer: A Theory of Making: Architecture and Art in the Practice of Adolf Loos, PhD Dissertation, University College London, 2011, p. 120.
- 30. Claire Zimmerman: Marble Craft and Ornament, in: 85th ACSA Annual Meeting Proceedings, Architecture: Material and Imagined; Volume Editor: Lawrence W. Speck, ACSA Annual Meeting 1997, p. 600.

interiors or buildings. However, this paper focuses on one aspect of his work. It was Loos's attitude to the material, what motivated this research. In that context, his deep respect for the material and striving to avoid an imitation should be highlighted.
Loos introduces a diverse and rich range of materials to his interiors, believing that it is one of the essential tasks of the architect to create an atmosphere that matches the purpose of the interior space. The wall has two, often different, faces: the cladding is selected and treated according to the importance and function of each area. For example, in residential interiors, stone most frequently appears in the living space with a social character: in the dining room, in the salon, in the music room, while other materials appear in more private spaces. The manner in which the stone cladding is treated is the result of Loos's relationship to the material, of which he speaks in various texts. Considering that the natural texture and chromatic qualities should not be "embellished" with ornaments or coatings that would mask the properties of the material and alter their identity, Loos selects the stone of a distinct pattern: varieties of marbles - most often Cipollino and Skyros, onyx or travertine. The abstract drawings, hidden in the rock, are "drawn" on the surface of the wall cladding by cutting and polishing the panels. However, although visually expressive, the stone, and the material in general, for Loos, has a more complex role and a wider meaning. It goes beyond the world of visual, determining the character of the inner space with all its properties. Indeed, in the interior that it covers, where the human senses are affected by various stimuli; in direct contact, the material is not only seen but also experienced within the unique experience of the interior space.

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Mermerna obloga u enterijerima Adolfa Loosa

SAŽETAK
Adolf Loos (1870-1933), bio je novinar i kritičar, arhitekt i dizajner interijera. Na njegovim bijelim, glatkim fasadama bez dekoracije, studenti arhitekture i danas uče svoje prve lekcije o pojavi modernizma. Odbacivanje artificijelnog ornamenta, oštra kritika arhitekture historicizma, osvrti na secesijsku dekoraciju i Gesamtkunstwerk, rukopis Ornament i zločin, te, razvoj prostorne dispozicije poznate kao Raumplan, najčešće su analizirani i spominjani u kontekstu doprinosa Adolfa Loosa i njegovog mjesta u teoriji i historiji arhitekture. Jednako je, međutim, zanimljivo rasvijetliti i način na koji Loos vidi i upotrebljava materijal. Njegove fasade lišene su ukrasa, a zgrade, oblikovane kao jednostavne kompozicije, najčešće bijelih kubičnih volumena. Međutim, enterijeri – bilo da se radi o adaptaciji i opremanju postojećih prostora ili o kompletnim projektima novih objekata, fasciniraju primjenom široke palete luksuznih materijala, znalački obrađenih i ugrađenih tako da u najvećoj mjeri oslobađaju svoje intrinzične, teksturalne i kolorističke kvalitete. Pristup Adolfa Loosa upotrebi i tretmanu materijala i shvaćanje načela „truth to materials" koje iskazuje u svojim tekstovima i projektima, su, pored drugih značajnih aspekata njegovog rada, također uticali na razvoj moderne arhitekture XX stoljeća.

Ključne riječi: Kamen, enterijer, kamena obloga, materijal, design.

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LIS Software Development Methodology

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ABSTRACT

This paper deals with the issue of implementing an information system in BiH public administration. IS implementation is a complex process that implies solving problems such as: examining the theoretical aspects of IS development, analysing the current situation, choosing the most appropriate method of IS development, IS implementation, post-implementation support, as well as measuring the practical benefits of IS implementation.

Keywords: Systems, IS process, implementation.

Introduction

Several methodologies are present in the software development and engineering theory and practice. Today, development and engineering are realised by forming mixed teams consisted of: users (real system analysts), systems analysts, computer scientists and software engineers.

The project team, using contemporary tools for software development and engineering (CASE - Computer Aided Software Engineering), develops a software by stages depending on the selected methodology.

Today, the answer to the question how should software actually be developed and engineered within information systems related to the automation of certain functions at municipal levels, i.e. departments is very popular. However, due to the immense complexity and informality of certain functions and processes in the systems, for which a software should be developed, it is necessary to invest a lot to find the methodology that will meet the software development needs best.

Researching new methods is especially stimulated by failures in developing and engineering more complex information and software systems, as well as low productivity of project teams.

Concept Proposal for LIS Development

By using past experience in working on IS development, applying some of the existing methodologies and using the acquired knowledge on applying the MIRIS methodology (Information Systems Development Methodology), we are providing a concept for LIS development. Only a combination of multiple available methodologies would, perhaps, completely suit IS development for the local administration present in BiH today.

If we opt for top-down IS development, it is necessary to:

- at least, form a Government Information Centre for Computer Science (Bos. ICVI: Informacioni centar vlade za informatiku) at the level of entities,
- define the role government plays in development

The primary task of ICVI would be to create a satisfying public administration informatisation. The Government Information Centre for Computer Science would, among other things, be in charge of:

- developing application software,
- consulting the authorities on planning and introducing information technology,

- professional monitoring during the development and introduction of application software,
- quality assurance for information technology services and products, and
- methodological and technological coordination during project development.

The listed tasks are closely related to the chosen information system development methodology. Apart from the stated tasks, ICVI would have to keep track of the process of designing the methodology that would deal with public administration IS development. State authorities would take part in the public administration informatisation as service users and, in certain segments, as contracting authorities. The Government Information Centre for Computer Science would function as a professional coordinator and contractor, doing most contracting tasks. In such a situation there is often a case where, during individual developments, very different approaches are used resulting in diverse products (this is primarily related to the stages of analysis and planning). Such diversity hinders, if it does not disable, the effective professional monitoring and quality assurance, which is the responsibility of the Government Information Centre for Computer Science. Moreover, the repeated applicability of the development product and a comparison between different development projects is hindered.

In order to create a quality IS, it is necessary to include the government at the entity levels for several reasons:

- the software for municipalities would be cheaper,
- the software quality would certainly be infinitely greater due to the suggestions given by several municipalities during the application development,
- we would have a universal system applicable in BiH as a whole,
- people would have certain standard procedures for solving their problems wherever they may be,
- the government would have better control over the operations of certain municipalities,
- the Electoral Commission would receive unique data,
- the bureaus of statistics and various monitoring departments for municipality development would also have the necessary data,
- simply put, everyone would get something; the state, the municipalities and service users.

The primary purpose of the suggested information systems development concept for the Government Information Centre for Computer Science and, of course, other state authorities is to offer:

- assistance in preparing, establishing, coordinating, managing and supervising information systems development projects implemented for the needs of the Government Information Centre for Computer Science (joint projects) and other state authorities,
- a gradual approach in developing and implementing the state authorities' information systems,
- methodological support for monitoring the quality of project implementation conducted by hired contractors, and
- providing additional guidelines for the hired contractors' operations.

An Overview of LIS Development Methodology

Table 1: The contents of information systems development methodology [46]

Information systems development methodology								
Information systems development structural methodology			Information systems development object methodology			Workflow applications development methodology		
The rules and usage of diagramming techniques	Development procedure	CASE tools	The rules and usage of diagramming techniques	Development procedure	CASE tools	WfMc model	Development procedure	An overview of BPR and WF tools

STRUCTURAL METHODOLOGY

Diagramming techniques for data and functional modelling without which it is not possible to imagine a good approach in developing information systems, the information systems development procedures and examples of diagrams with CASE tools that offer a solid support for teams developing IS and those maintaining them are presented in the structural methodology. The information systems development structural methodology is based upon the information engineering methodology, Oracle CDM methodology and SSADM methodology.

The rules and usage of diagramming techniques Clearly understandable and structural diagramming techniques defined in detail are of vital importance when developing information systems. When developing information systems, a close participation of those who develop IS (developers, analysts) and IS users, where everyone have their own role from the very beginning of IS development to its implementation and even in IS maintenance is necessary. Diagramming techniques are priceless for exchanging ideas and in the final stage, with their clarity, they guarantee that the developers will, properly and down to the smallest details, understand the operations and significance of the system organisation itself. Due to the operations automation, for analysts who use CASE tools, clearly defined diagramming techniques are even more important because they enable syntax translation, automatic transitions between different diagramming techniques and automatic translations of diagrams at a logical level into diagrams at a physical level. There are a lot more reasons why the information systems development and maintenance cannot possibly be imagined without the usage of structural diagramming techniques.

Several diagramming techniques recommended by the structural part of information systems development methodology for different stages in information systems development are presented hereafter. Diagramming techniques, used in the analysis stage, serve for presenting performance and information needs of an organisation system (state authority) or performance of an area within an organisation system at a logical level, and the following physical operations of the information system are not conditioned. Diagramming techniques, used in the planning stage, already reflect the structure, that is, the application systems draft to be developed in the performance stage.

An overview of diagramming techniques used in various stages of information systems development can be seen in the (following) table.

The leftmost column states diagramming and other formal techniques with their usage recommended in the information systems development methodology; the first row states information system development stages. At the intersection of a stage and diagramming technique a product is stated showing the exact diagramming techniques which is used in that stage. If the intersection is empty, the diagramming technique is not used in that stage.

Table 2: An overview of diagramming techniques by information system development stages

Diagramming technique development stages	Strategic planning	Work area analysis	Application systems planning
Decomposition diagrams	Organisation scheme, Functional, Decomposition, Strategic elements (goals, problems, critical success factors)	Detailed functional decomposition	Application system structure plan
Data flow diagrams	Data flow analysis	Detailed functional model	
Entity diagram	Global entity model	Detailed data model	
Connection matrices	Connection matrices Functions - entities	Connection matrices Processes - entities	
Action diagram		Detailed functional model	Process plan
Structural diagram			Application system structure plan,
Structured language			Process plan
Decision tables and tree			Process plan
Transit diagram			Process plan
Relation schema			Data structure plan

DEVELOPMENT PROCEDURES

The image shows IS development described in the structural part of the information systems development methodology. The time axis contains stages, in succession, and the vertical axis contains activities within which it is necessary to perform one or several activities. An individual activity (determining demands for example) can be performed only within one stage; most activities are performed in several stages. A product (output), which will be based on one or more outputs presenting an input in one of the activities, should be created as a result of each activity. Considering the dependence among activities, it is possible that some of them are simultaneous or have a degree of overlapping, and some follow one another.

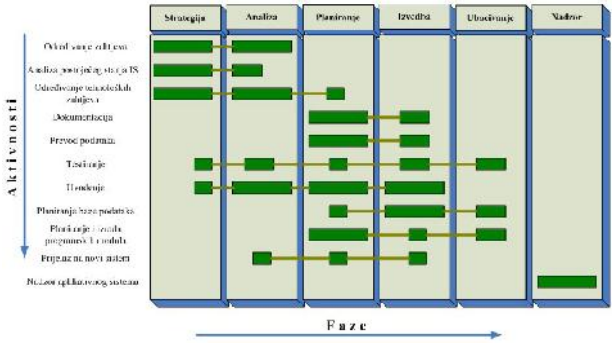

Image 1: Development according to structural methodology

Development tools - Contemporary CASE tools are essential for information systems development. In the structural part of the information systems development methodology, when making diagrams, it is necessary to include tools such as Oracle Designer/2000, or others, in the PowerDesigner. Development diagrams should clearly indicate which diagramming techniques support the tools and the type of the graphic notation that should be described.

WORKFLOW APPLICATIONS DEVELOPMENT METHODOLOGY

Basic concepts

The tools used to support workflow can roughly be divided into:

- workflow analysis and planning tools (Business Process Reengineering Tools - BPR Tools) and
- workflow management tools (WorkFlow Management Systems – WFMS).

Workflow analysis and planning tools are intended for creating images of the existing processes, their future modelling and detailed analysis. The process models created with such a tool serve for its evaluation, considering costs, time (performance, waiting and total time) and amounts (the number of performances in a time unit). Within the basis of process evaluation results, renewed process models for which it is possible (if the tool provides) to verify feasibility and compatibility at the same time are made with the same tool. Workflow management tools enable workflow performance. Before it is possible to perform the processes, they have to be modelled in the way recognised by the individual tool. In order to avoid repetition, for different tools, it is necessary to design instruction manuals that enable data transfer in the model from the process analysis and planning tools, as well as workflow management tools. Workflow management tools enable information monitoring and workflow directing from one activity to the other, i.e. from one contractor to the other. When directing processes, it is necessary to inform the users that they have to perform a task guaranteeing them with the appropriate toolkit which will be able to perform the desired task, to guarantee appropriate data the tool needs and enable the users to see where their demands belong in the process as a whole, which can contribute to a gradual process improvement.

Development procedure - The workflow application development procedure differs from a classical approach. Since the work area of such an application can present an overall performance of the organisation system, it is really important to have a developed approach to the description of the organisation system. Key elements of such a description are organisation scheme and workflow description. The main reason there are differences between a classical approach and an approach during workflow management application development is in the emphasis on contents, not on performance.

Integrating other Methodologies and Projects

One of the approaches in the beginning of creating an information systems development methodology should be that the methodology has to be harmonised with the existing ones already in usage, those ICVI uses and those that could be used for state authorities' informatisation. Introducing a new methodology, that would not be harmonised with the existing and methodologies already in use, would actually create a lot of questions and dilemmas which would be exactly opposite to the objective of the new methodology.

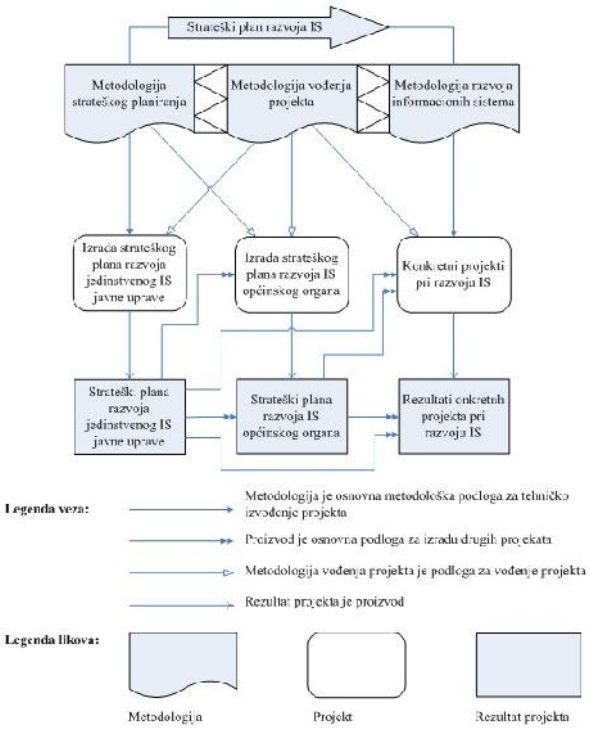

Image 2: A meta-model of relations between methodologies, projects and products

The image shows that the information systems development methodology is connected to the strategic planning methodology and other methodologies used in introducing information technologies in public administration, such as project management methodologies.

Thus, for example, the strategic planning methodology can be made on the basis of the information engineering methodology, within which strategic planning is the first stage. Strategic planning methodology has to describe procedures, products in development and final products of strategic planning for information systems development, which would serve as a fundamental methodological background for implementing projects related to creating information systems development strategic plans. It will be shown that strategic plans for developing a unique public administration information system and strategic plans for information system development of certain state authorities are input "products" in specific information system development projects and with that one of the foundations for their products. The products, created upon the strategic planning methodology and those the methodology accepts as results, should be accepted as input data in the information systems development methodology.

Project management methodology in public administration can be created on some other foundation. Project management methodology in public administration should be a described project organisation, management procedures. Such methodology can be used in all projects in the area of information technology for project management and quality assurance. The relations shown in the meta-model suggest that, in information systems development projects, several methodologies can be used:

- information systems development methodology according to which technical activities are performed and technical products prepared, and
- project management methodology according to which the project management and quality assurance are implemented

This means that project management methodology in public administration / information technology determines that the project is divided into stages, and the new methodology determines which ones. Furthermore, the methodology should determine which content and technical activities will be performed and what will their sequence be like, and the project management methodology in public administration / information technology determines which management and quality assurance activities

will be performed and when will they be performed in relation to the content and technical activities. The used methodologies should overlap and that is why it is sometimes really difficult to determine which boundaries are defined by the first, and which by the second methodology.

Methodology Application Projection

Considering the purpose of information systems development methodology, which is at the very beginning of a proposal for developing a methodology for the municipality's IS development, a projection of its application can also be made if we take into consideration the fact that one of the users is the information system development project manager, who will use MIRIS to help define appropriate engineering activities and select surveillance points, as well as tools that will be created in the development process. The project manager will select the appropriate approach (structural, object,...) according to which the project will be developed. In the part of the methodology which presents the IS development procedure, an output, that will be used later and that will determine the flow of the following stages constituting the project, will appear as a result. Of course, the project manager will be able to retain the actual condition and, based upon his or her experience, keep the recommended stages or even break them into multiple ones. The presented division into stages in the methodology cannot be taken as absolute, but as a mere example corresponding to most, but not all of the actual development projects. The fact that the suggested division into stages is not absolute was already stated in the structural part of the methodology proposal, where, based upon the first presentation of a complete approach, a contracted one would be also presented.

In the contracted approach, certain stages have to be joined having in mind that the activities within the stages are actually truncated. Furthermore, the project manager will, in the part describing the development process, find a proposal of activities and their sequence within the stages. The activities and their sequence are determined based upon experience in working on several projects and that is why it is recommended that the project manager uses them as much as possible, with the possibility to join or change individual activities according to his or her own judgement.

The second part of this chapter mentions in passing that the methodology is intended for managers and team members developing IS. In order to reach a satisfying quality, the team leader finds interesting the part where the development procedure is presented, because, among other things, there is a proposal showing to best way to separate certain stages in the development project and which outputs would be used as inputs in one of the stages. Analysis and planning products are of key importance for IS development; the biggest traps and the most frequent shortcomings appearing later in the IS development stage are hidden there.

Conclusion

As an addition to the conclusion, it could be added that this is a Bosnian E-management model with foundations build on tradition and professional systems influencing municipal administration for the last couple of decades. The term transformation should also be understood as elimination, rotation and introduction of new methods in administration related to the citizens, without having to eliminate too much of the old one. So, the road shown for BiH municipalities' development is not extreme, neither in relation to economic efficiency nor in relation to introducing bureaucratic ideals. It is placed in a grey area, between black and white, where all justifications are satisfying, but there is no collective ideal model for who, what and how it is accomplished. The pressure put on municipalities by the environment and the ICT development speed can take part in improving tendencies, that can be seen in relation to the competition, orientation towards the citizens, responsibility, goal orientation and auctioneering and, in the future, they can take part in the apoliticism of terms like profit and result orientation .

Just like other methodological materials, neither the information systems development methodology, created for the needs of state administration, nor the written document (Document: UNDP BH ICT4D – ICT FOR DEVELOPMENT) will remain unchanged forever. It has to be properly renewed and supplemented. That is why, in the following years, the necessary materials will be further supplemented based upon practical experience, new needs in the area of public administration information system development and new technological trends. The information systems development methodology adds another piece in the mosaic that is the methodological order of public authorities' informatisation.

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Metodologija razvoja programskih sistema za LIS

SAŽETAK
U ovom radu je obrađena problematika implementacije informacionog sistema u javnoj upravi BiH. Implementacija IS-a je kompleksan proces koji podrazumjeva rješavanje problema kao što su: razmatranje teorijskih aspekata izgradnje IS-a, analizu postojećeg stanja, izbor najpogodnije metode izgradnje IS-a, implementaciju IS-a, post implementacijsku podršku, kao i mjerenje praktičnih koristi implementacije IS-a.

Ključne riječi: Sistemi, IS proces, implementacija.

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Reliability of water supply systems

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ABSTRACT

Applying reliability analysis is very important to achieve technically and economically sustainable water management systems. The classic organisations whose task was to deliver water to consumers, regardless of the price and quality of services, are transformed into high-tech enterprises and those using computer science, where one of the dominant criteria is economic or financial sustainability. Under such conditions, the actual data on produced and distributed water, as well as accurate data on the network state become imperative, since they are the basis for making decisions regarding the water management system and economic cost effectiveness evaluation management. During the exploitation process, the consequences can be pronounced due to the water supply system functional failure. The water system is subject to external and internal influences, which reflects its ability to distribute water. Impacts are manifested by the water supply system components failure and water losses. During the water systems exploitation, various types of energy (mechanical, thermal, etc.) affect the change in their planned function project (water distribution).
Reducing water losses and increasing reliability should be the goal of every water supply system, as this will lead to an improved economic and environmental performance, and certainly a better service for users. Reliability can be considered as the water supply system's ability to function in relation to the failure of one or several components. Similarly, it can be viewed as the ability of the system to provide a service at an acceptable level, despite the failure and complex operating conditions. The creation of reliable water supply systems is not possible without reliability standardisation by way of basic indicators, important for indicating technical conditions. Under the term reliability standardisation we mean a list of indicators and their markings important for assessing the water supply system accuracy. Water systems are very complex configurations with targets, constraints and a number of connections with the environment. Difficulties in planning the water systems management are numerous uncertainties; uncertainties and random effects of input sizes and the required output states. The water supply system is a stochastic system characterised by the probability or reliability of the system functioning. By doing this, the reliability analysis can establish a model for monitoring the water supply network maintenance process and, by analysing the collected data, objective decisions can be made.

Keywords: Reliability, water supply system, water losses, decision criteria, failure, indicator analysis, standardisation.

Water Systems Reliability and Management

There are two primary objectives in the projection and exploitation of the water distribution system, which are the minimum water supply costs and maximum water supply system reliability. The two objectives are in conflict, but regardless of the increase, i.e. an increase in water supply reliability, the increase in costs is almost inevitable. The problem of designing and exposing the water distribution system is its multi-functional nature. The main problem faced by engineers and government representatives involved in the design, management and maintenance of the water supply system distribution is how to bring reliability and costs to a satisfactory level.

The part of the process happening in the water supply system affects its technical characteristics. These processes temporarily change the parameters of the constituent parts (water pipes, water metres, etc.) and/or the water supply system in some limits, without progressive deterioration The most characteristic example of such processes are elastic deformations, temperature deformations, etc.,

where, for example, extremely low temperatures lead to freezing in certain parts of the pipeline, water metres, valves, etc., and thus prevent its functioning, the functioning of a part of the water supply system or the system as a whole. The second group are processes that, over time, lead to a progressive deterioration of the water supply system technical characteristics. The most characteristic examples are attrition, corrosion, weariness, etc.

System diagnostics

The notion of diagnostics, or diagnosis, first appeared in medical science where it has a broad meaning. It comes from the Greek word diagnosis, which denotes recognition (conclusion) and evaluation. Ea doleni con re et occullesed unt, quost landesti nonserit rehenem. This term should include all activities that are undertaken in order to assess the current state of the water supply system in order to take over the planned activities of maintaining the water supply system in the future.

Water distribution reliability and the water supply network diagnostics and maintenance are interconnected terms which determine the water supply system's technical condition as a whole. Diagnostics is an important component of the water supply system technical maintenance, since it enables the disassembly (which includes excavations, testing and other construction works) to determine the system's technical condition and to predict the resource of its safe operation in the future.

Checking (controlling) the accuracy of the water supply system or its component elements (pipelines, fittings, etc.) during the construction and exploitation period allows defective parts to be detected in time (whether pipes, bolts, etc.). Technical diagnostics in water system testing is applied in determining: the distribution state, the degree of damage or water loss and the quality of water distribution and maintenance. There are two options available for the implementation of measures: permanent ones, or permanent and periodic diagnosis.

With permanent diagnostics, diagnostic devices (e.g. flow and pressure metres) are permanently installed on the water supply system itself (water lines, nodes,...); on the basis of selected diagnostic parameters, they control the state of the most important parts of the water supply system for the time of its operation or the water distribution. As a disadvantage, there is a need for increased investments in diagnostic devices, since every major segment of the water supply system should have such devices built-in. In contrast, in the periodic diagnosis, the diagnostic measures are applied after a certain time passes in the water supply system operation, and the disadvantage is that the response related to the system malfunction is not immediate, or we cannot recognize the occurrence of a malfunction immediately after its emergence as with permanent diagnostics.

RELIABILITY STANDARDISATION

Reliability standardisation and estimation by way of certain results' a priori information indicate the actual state of the water supply system at a given moment and the default exploitation conditions. Predicting the behaviour of the water supply system in the future, depending on changes in parameters and operational conditions, engages and examines the area of anticipation (predicting technical conditions in the future). Based on the results of predicting, we can manage reliability in the operation and exploitation process through test planning and technical maintenance.

Basic reliability predicting data relate to:(1) predicting the legality pertaining to system reliability in relation to the perspective of the water supply system's water supply development, finding new materials for water supply systems, raising the parameters of the work process and other tendencies; (2) predicting the water supply system reliability based on its measured parameters, and (3) predicting the system reliability for functioning in extreme conditions. In general, all predicting tasks can be separated according to the design, production and exploitation stages, so as to interconnect them, because special methods are needed for solving them.

Elements of the water supply system reliability theory

The water supply system functioning is the supply of chemically and bacteriologically pure drinking water to consumers with the required pressure in the distribution network, while meeting the users' needs for the water amount. If one of these components does not respond to the request, due to failure, the water system will "fall" because it does not support / meet the generally required: consumption, operating pressure and quality of the delivered water.

The water distribution system is based on, or exists on, several different key components, such as: water pipes, valves, pumps and nodes. For the system components, we say that they are mechanically independent, but also dependent on hydraulics. This practically means that the mechanical failure of the pipe or node will be reflected as a disruption to the output performance in a hydraulic sense, which affects the water quality or leads to interruptions in the water supply. Mechanical reliability is the ability to maintain components in a functional state, where proper maintenance gives the required level of functioning. Hydraulic reliability is the ability of a water distribution network to provide the required water supply or a minimum pressure to the hubs required so as to supply the required amount of water consumption. The necessary / required pressure is the pressure at which all consumption is available at all the designated points of interest, and the minimum required pressure is the one where there are no interruptions in the water supply. The minimum pressure can also be determined by the pressure that is considered to be missing from the water. The hydraulic reliability of the water distribution network can be improved if the rainwater supply is used (network stops) or if there is more than one supply source. Mechanical reliability is a function of the quality related to the built-in elements that can be improved by regular maintenance.

SYSTEM FAILURE

There are three basic conditions for all water distribution network components: full functioning, partial functioning and non-functioning. All three conditions apply to both hydraulic and mechanical conditions. From the aspect of this work, only the states of full functioning or non-functioning are important. Under the term failure of network components we mean a situation when they no longer perform their required function.

The mechanical failure can be estimated using probability or empirical formula (failure rate analysis) or by combining both modes. Failure probability is the probability that a particular component can be cancelled at a given time or a time interval (we use time dependency in the calculation). Failure probability can be applied to all components of a given type, providing the estimated number of failures. This can be estimated using different formulas or statistical approximations based on the available data for this type of system component. The empirical failure rate is based on the measurement data database, i.e. based on the collected data. The failure rate is the number of failures expected from a number of components or it may indicate the number of failures that happen during a year, by using the length of the water line (network) or the year of construction. It provides an estimate of the failure probability for a particular component or system element.

Hydraulic failure is a function or a form of mechanical failure or initial conditions, in terms of the wrong starting values in relation to the required ones. There are three types of hydraulic failure: connection failure, pressure failure (inadequate pressure) in the network and water supply cancellation, and they are all mutually dependent. A connection failure is the failure of a connection, a connection that connects two nodes, or if the pressure drops before the node reaches a value below zero. This cancellation will affect the rest of the network and lead to the next failure, which is the cessation of water supply and pressure behind the affected nodes. Pressure failure occurs when the demand for a node is greater than that available (projected, foreseen,...) for the pressure. It happens when the location of the shaft connection is farther away from the intended and the water needs additional nodes for reaching the destination resulting in an increase in speed and thus an increase in the loss of pressure (the increase in speed is directly proportional to the pressure drop). The failure of the water system depends on each connection (link) break or a reduction in the necessary pressure, and in case the node consumption / demand is not fully met.

Conclusion

Maintenance during the water supply system functioning combines a series of accompanying activities, starting with the idea and definition of the concept, the evaluation of their cost-effectiveness, realization, exploitation, up until the system failure due to use. The process of maintaining the components and elements as one of the essential parts of the water supply process has the task of preventing and eliminating system failures, primarily through rationalization and optimization of their use, increasing productivity and cost-effectiveness in the process of exploitation. An analysis of the system "life cycle" is required and presented through a systematic and analytical overview of the resources needed to support the factional process with the aim of identifying and quantifying them. One of the basic characteristics of the modern water supply systems functioning is providing a high level of their reliability.

The concept of reliability should be present in all periods of the water supply system development and use, i.e. during its entire life cycle. Failure leads to a standstill in the water system operations and causes a significant increase in the exploitation costs. The lack of adequate reliability considerations has consequences reflecting material losses and slowing down technological advances at various organization levels. Reliability predicting is a continuous process that begins with predicting on paper, based on the construction and information on earlier failures, and ends with reliability measures. It should not be considered that reliability prediction is only an end in itself. The reliability forecasting process is justified only if it proves useful in providing a more reliable end result, i.e. proper water supply.

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Pouzdanost vodovodnih sistema

SAŽETAK

Primjena analize pouzdanosti je veoma važna kako bi se postigao tehnički i ekonomski održiv sistem upravljanja vodama. Od klasičnih organizacija čiji je zadatak bio da bez obzira na cijenu i kvalitet usluga isporuči vodu ka potrošačima, transformišu se u preduzeća visoke tehnologije i informatike, gdje je jedan od dominantnih kriterijuma i ekonomska ili finansijska održivost. U takvim uslovima, stvarni podaci o proizvedenoj i distribuiranoj vodi, kao i tačni podaci o kvalitetu vode postaju imperativ, jer se na osnovu njih donose odluke o upravljanju radom vodovodnog sistema kao i ocjene ekonomske isplativosti. U toku procesa eksploatacije tj. snabdijevanja vodom mogu nastati izražene posljedice zbog prestanka funkcionisanja vodovodnog sistema. Vodovodni sistem je podvrgnut spoljnim i unutrašnjim uticajima, a što se odražava na njegovu sposobnost distribuiranja vode. Uticaji se manifestuju putem otkaza sastavnih dijelova vodovodnog sistema i gubitaka vode. U toku eksploataciji vodovodnih sistema, na izmjenu njihovog projektom predviđenog funkcionisanja (distribuiranja vode) utiču razni vidovi energije (mehanička, toplotna, itd). Smanjenje gubitaka vode i povećanje pouzdanosti trebalo bi da bude cilj svakog sistema vodosnabdijevanja, jer će to dovesti do poboljšanih ekonomskih i ekoloških učinaka, a svakako i bolje usluge za korisnike. Pouzdanost se može smatrati sposobnošću funkcionisanja sistema vodosnabdijevanja u odnosu na otkaz bilo koje komponente ili više njih. Slično kao i sposobnost sistema da obezbijedi usluge na prihvatljivom nivou, uprkos otkazu i složenim uslovima funkcionisanja. Stvaranje pouzdanih sistema vodosnabdijevanja nije moguće bez

standardizacije pouzdanosti po osnovnim pokazateljima, značajnim za ukazivanje tehničkih stanja. Pod standardizacijom pouzdanosti podrazumijevamo spisak pokazatelja i njihove oznake važne za procjenu tačnosti sistema vodosnabdijevanja. Vodovodni sistemi imaju dosta složenu konfiguraciju, ciljeve, ograničenja i brojne veza sa okolinom. Poteškoće u planiranju upravljanja vodnim sistemima su brojne neizvjesnosti, neizvjesnosti i slučajni efekti ulaznih podataka i potrebnih izlaznih stanja. Vodovodni sistem je stohastički sistem koji karakteriše vjerovatnoća ili pouzdanost izvršavanja sistemske funkcije. Uzimajući ovo u obzir, analizom pouzdanosti može se uspostaviti model za praćenje procesa održavanja vodovodne mreže, a analiziranjem prikupljenih podataka mogu se donijeti objektivne odluke.

Ključne riječi: Pouzdanost, vodovodni sistem, gubici vode, kriterijumi odlučivanja, otkaz, analiza pokazatelja, normiranje.

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A comparative Analysis of Surface electrical resistivity in Concrete with different compositions

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ABSTRACT

Research on the application of electrical resistivity for concrete condition assessment started during the 1970s by adopting this method from the area of geophysical soil research, but the application for the purpose of assessing the condition of concrete constructions was intensified in the last twenty years. Experimental research on concrete samples of different compositions are presented in this paper. During the research, the samples were exposed to various environmental conditions. The paper presents electrical resistivity development curves for the tested samples. Based upon previous experience from the studied materials and experimental research results, the paper presents possibilities and limitations regarding the application of this approach for concrete condition assessment.

Keywords: Electrical resistivity, concrete, porosity, durability.

Introduction

Market availability and an acceptable price in relation to other materials contributed to the fact that concrete is the most applicable material in construction today. Engineering AB constructions is founded on the concept of safety where questions regarding the object's stability and functionality have been fairly defined and conceptually determined. Solving the problem of concrete constructions' durability still presents a challenge for researchers and engineers in the construction practice. The complexity of this problem is particularly shown in highly aggressive environments such as industrial zones.

Research implemented so far in the area of measuring concrete electrical resistivity, as a non-destructive method, shows that certain responses can be gained in terms of concrete pore structure, thus serving as an indirect assessment of concrete properties in the sense of a possibility for aggressive substances to penetrate through the concrete structure. Experimental research shown in this paper are conducted on concrete samples made by different formulations and with diverse raw material inputs. In order to establish an appropriate correlation and perform an analysis of the possibility for applying this procedure in concrete condition and exploitation period assessment, the samples have been exposed to various environmental conditions. All research have been conducted in laboratory conditions. The measurements were carried out by applying a device, with a commercial name "Resipod" produced by the company "Proceq", which operates on the principle of a Wenner Probe. The stated instrument serves for measuring concrete electrical resistivity of the surface layer up to 50mm in depth, which is enough to assess electrical resistivity in the concrete protective layer. During preparations for this experiment, previous research have been studied and the most significant ones are hereafter presented, We subsequently presented the results of our research, on the basis of which we made conclusions about the possibilities and limitations for measuring electrical resistivity in assessing the exploitation period for concrete constructions, considering the previously studied research.

An overview of previous research

Paper [1] presents some of the first research, on the basis of which the connection between electrical conductivity and porosity of concrete was proposed. Since concrete diffusivity also depends on its porosity, it is clear that there is a possibility of establishing a connection between conductivity and diffusivity. Based upon the stated experimental research, the paper [2] presents a formula:

$$\frac{D}{D_0} - \frac{\sigma}{\sigma_0} - \Phi\beta \qquad (1)$$

where:
σ - conductivity of the electrolyte-saturated sample or a porous medium (concrete) (mS/cm)
σ_0 - electrolyte or porous solution conductivity (mS/cm)
D - porous medium diffusion coefficient
D_0 - porous solution diffusion coefficient
Φ - porosity
β - pore structure parameter

Concrete electrical resistivity depends on the quality of concrete and exposure conditions, which is reflected through relative humidity and the degree of pore saturation. Image 1. shows concrete electrical resistivity dependence on the environmental exposure conditions.

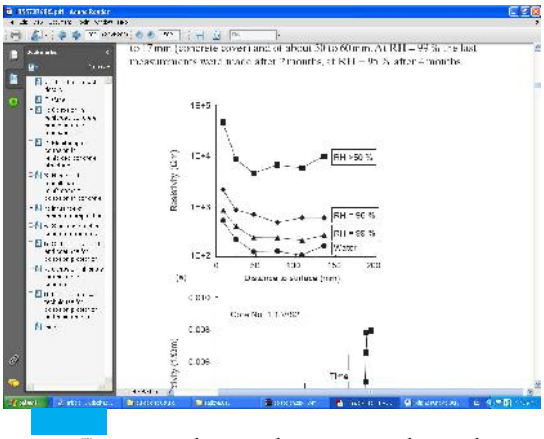

Image 1: Concrete electrical resistivity dependence on environmental exposure conditions (relative humidity RH)

Concrete electrical resistivity is altered by changing the degree of saturation in the pores. There is even a multiple size gradation. Typical and saturated concrete electrical resistivity amounts to 50 Ωm, while dry concrete resistivity goes up to 10^9 Ωm [4]. Image 2. shows the research conducted in dissertation [4], in the sense of quantifying concrete electrical resistivity for concrete formulations with water-cement factors 0.4, 0.5 and 0.6, as well as different degrees of saturation in the concrete pore structure.

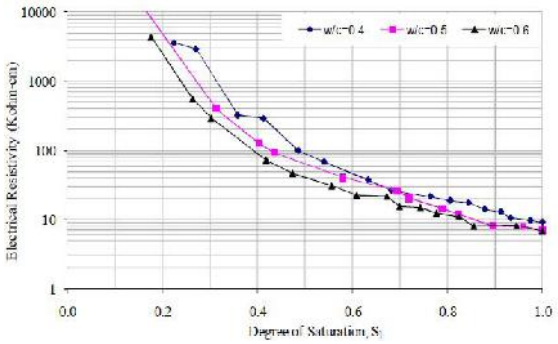

Image 2: Concrete electrical resistivity depending on the water-cement factor and the pore saturation degree of concrete

The electrical resistivity of concrete primarily depends on the cement paste microstructure, i.e. capillary pore size, the complexity of the pore system and moisture content. Changes in the type of aggregate can affect concrete electrical resistivity. Therefore, according to [5], concrete resistivity with a sandstone aggregate amounts to 18 000 Ωcm, while concrete resistivity with a granite aggregate amounts to 880 000 Ωcm. Also, some research have shown that alongside an increase in aggregate contents, there is an increase in the electrical resistivity of concrete. Throughout the hydration process development, during the process of solidifying a concrete mixture, electrical resistivity changes. In paper [6], the formula for changing electrical resistivity in time is proposed in the form of:

$$\rho_t = \rho_0 \left(\frac{t}{t_0} \right)^q \qquad (2)$$

where:
q - aging factor, with proposed values of 0.22 to 0.57.

The report [7] and paper [8] show research in the possibility of applying electrical resistivity as an alternative to rapid chloride permeability tests. Within the research, certain parameters affecting the intensity of electrical resistivity and measurement precision were analysed. Research have shown that electrical resistivity increases with an increase

in drying days. Within the research analysis, there is an emphasis on the importance of balancing the measurements, i.e. equalising the samples' saturation conditions by performing measurements immediately after the sample is removed from the humid environment where it was tended to. Image 3. shows the dependence of electrical resistivity in relation to the age of concrete.

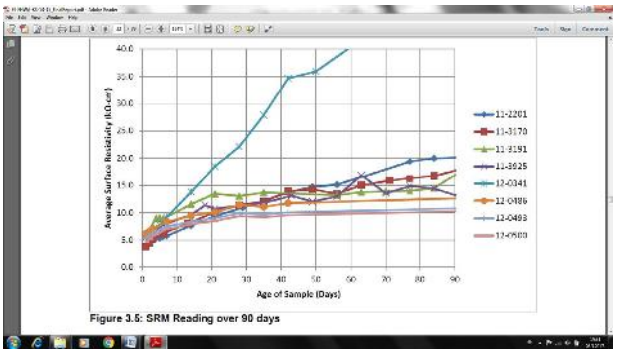

Image 3: Dependence of electrical resistivity and the age of concrete samples

An overview of the value attributed to electrical resistivity for different concrete formulations and the age of concrete samples is given in papers [9] and [10]. Research have shown that the highest increase in electrical resistivity happens until the 15th day when the values range from 40 to 80 Ωm.

Paper [11] researches the effect of fly ash addition to PC, as well as slag addition in the sense of concrete resistance to chloride ion penetration. The measured electrical resistivity of concrete varies from 10^1 to 10^5 Ωm, depending on the moisture content in concrete and the composition of materials.

The fly ash and slag additions increase concrete density thereby increasing its electrical resistivity. The methods used for measuring electrical resistivity are the Wenner Probe, a Two-Electrode Method and a Multi-Ring-Electrode Method.

The Wenner Probe, initially developed for soil testing and later modified for concrete constructions, is the most intensive method applied for measuring concrete electrical resistivity of the surface layer [12].

The Wenner Probe was chosen as the standard method for measuring electrical resistivity of concrete in Europe, due to its efficiency and simplicity of use [13]. Measuring resistivity is performed in such a way that an alternating current is released through the external electrodes, while measuring the difference in potentials on the internal electrodes. Resistivity is calculated according to the formula:

$$\rho = 2\pi a V / I \quad (3)$$

where:
p - resistivity
I - alternating current (A)
V - difference in potentials (V)

The application of "Resipod" instruments for measuring electrical resistivity is presented in paper [14]. All papers emphasise the importance of a proper contact with the surface so as to perform reliable measurements. That is why it is necessary to perform measurements as soon as the sample is removed from water, before the surface starts to dry. Humidity variance significantly affects the results.

Our experimental research

Within the experimental research, three sets of concrete samples were made according to different formulations bearing the marks CM1, CM2 and CM3. The concrete mixture compositions are shown in Table 1. In order to obtain as many results as possible and depending on the input components in the concrete mixture composition, the CM1 and CM2 formulations were made from the same type (origin) of aggregate and cement, while the CM3 formulation had a different type of concrete integral components.

Table 1: Concrete mixture composition

Formulation	Cement (kg)	Water (kg)	w/c	Aggregate (kg)				Total (kg/m3)
				0-4	4-8	8-16	16-32	
CM1	320	160	0.50	840	300	340	500	2,460
CM2	440	220	0.50	850	284	416	378	2,588
CM3	265	160	0.60	700	304	384	580	2,393

For each set, 87 samples of concrete shaped like a cube were made in dimensions of 15cm. All samples were treated in appropriate laboratory conditions until the age of 28 days, after which they were exposed to different environmental simulations and surface electrical resistivity tests. Testing the physical and mechanical properties of the created concrete samples was conducted on 15 samples, and the results are shown in Table 2.

Table 2: Test results of the applied formulations' physical and mechanical properties

Formulation	Subsidence consistency (cm)	Compressive strength	Porosity (%)	Fresh concrete density (kg/m³)	Hardened concrete density (kg/m³)
CM1	8.0	24.97	12.65	2,399	2,401
CM2	9.5	36.18	15.70	2,405	2,423
CM3	17.0	27.55	13.45	2,423	2,435

*Strength on the 28th day

The remaining samples were divided into three groups, with 24 samples each, and exposed to various environmental conditions during the testing period. The first group was exposed to air in laboratory conditions (samples marked SA). The second group was exposed to chloride injection under pressure, i.e. the samples were held in a special container under a 2 bar pressure in a solution of 16.5% NaCl, and afterwards left to age while exposed to air in laboratory conditions (samples marked PPT). The third group of samples was freely immersed in a 16.5% NaCl solution, with the solution height being above the contact surface of 20 mm (samples marked BDT). BDT group samples were continually held in the solution during the testing period that lasted 90 days. As illustrated in the previous description, the samples were subjected to different treatments so as to compare the electrical resistivity of concrete exposed to various environmental conditions.

The samples were simultaneously tested in the appropriate periodic intervals. 10 measurements were taken from each sample, five measurements for each diagonal, by moving the instrument for 5-6 mm (Image 4.).

Image 4: Measuring electrical resistivity with a Resipod instrument

The representative values of the measurement results, obtained after a statistical results analysis, are presented as diagrams on Images 5-7.

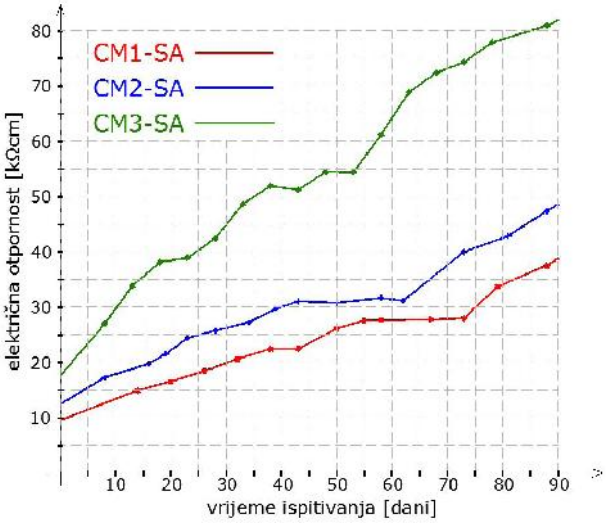

Image 5: The values of surface electrical resistivity for the sample set SA

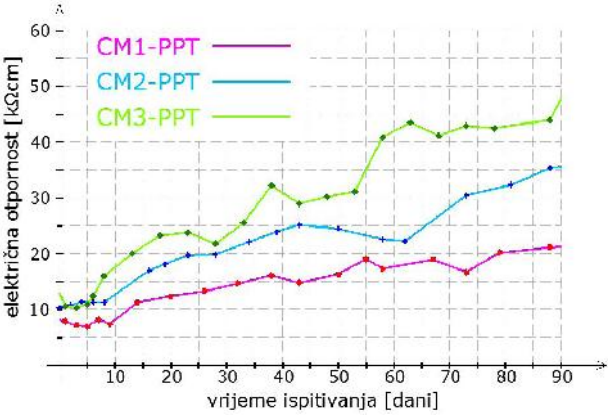

Image 6: The values of surface electrical resistivity for the sample set PPT

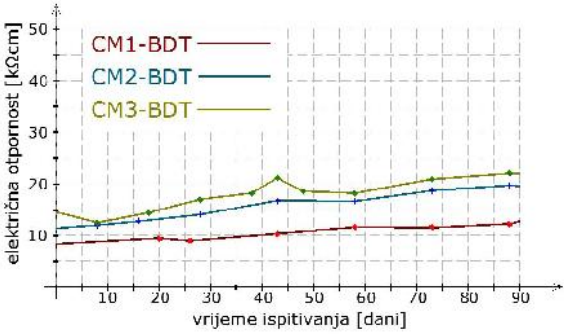

Image 7: The values of surface electrical resistivity for the sample set BDT

Conclusion

By analysing the obtained results, it can be stated that the samples with a CM3 formulation, in all three cases of environmental exposure, have greater values of surface electrical resistivity in relation to the other two formulations, during the entire testing period. The opposite goes for samples with a CM1 formulation. Since the CM1 and CM2 formulations were made of the same input components, it can be concluded that, by increasing the amount of cement in the formulation, there is an increase in electrical resistivity. However, it can be seen that, by changing the raw material inputs (CM3 formulation), we can obtain greater values of electrical resistivity with a significantly smaller amount of cement.

In the period of 90 days, during which measurements were taken, the obtained results show a smaller increase of electrical resistivity in PPT samples, that were, for 10 days, exposed to chloride under pressure and then to air, in relation to the SA samples that were exposed to air the whole time. Therefore, concrete exposure to an aggressive environment under pressure, even during short periods of time, causes a decrease in the electrical resistivity of concrete. Measurements have shown that there is a small increase of electrical resistivity in BDT samples that were continually immersed in the NaCl solution.

Research conducted so far can confirm that this method of assessing the concrete condition by measuring electrical resistivity can provide certain answers in view of the concrete pore structure, thus serving as an indirect qualitative assessment of concrete properties. The question of concrete resistivity measurement precision remains. Concrete is a highly inhomogeneous material, so its electricity, i.e. electrical potential is not uniform. There is an attempt to address this problem by multiple measurements.

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Uporedna analiza površinske električne otpornosti kod betona različitog sastava

SAŽETAK

Istraživanja u smislu primjene električne otpornosti za ocjenu stanja betona započela su sedamdesetih godina prošlog vijeka, preuzimanjem ove metode iz područja geofizičkih istraživanja tla, ali je primjena u svrhu ocjene stanja betonskih konstrukcija intenzivirana u zadnjih dvadesetak godina. U okviru ovog rada prezentirana su eksperimentalna istraživanja na uzorcima betona različitog sastava. Tokom ispitivanja uzorci su izlagani različitim uslovima okoliša. U radu su date uporedne krive razvoja električne otpornosti ispitanih uzoraka. Na osnovu dosadašnjih iskustava iz proučene literature i rezultata prikazanih eksperimentalnih istraživanja, date su mogućnosti i ograničenja primjene ovog postupka za ocjenu stanja betona.

Ključne riječi: Električna otpornost, beton, poroznost, trajnost.

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