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REPAIRING THE EXISTING OLD CONCRETE STRUCTURES BY APPLYING MODERN METHODS AND NEW MATERIALS
RIPARIMI I STRUKTURAVE TË VJETRA PREJ BETONI ME METODA DHE MATERIALE BASHKËKOHORE

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PERMBLEDHJE
Nevoja për të përdorur strukturat e vjetra ekzistuese nga betoni në kushte të caktuara të ambientit kërkon një analizë më të thellë të këtyre strukturave sesa të strukturave të reja. Këto struktura, kryesisht kanale dhe rezervuarë nga betoni që përdoren për furnizimin e hidrocentraleve në Kosovë, paraqesin një sfidë të mundësisë së shfrytëzimit të strukturave ekzistuese përmes aplikimit të materialeve dhe të metodave te reja gjatë procesit të sanimit (riparimit) të tyre. Strukturat e tilla prej betoni degradohen me kalimin e kohës dhe riparimi i tyre është i domosdoshëm meqë ato gjenden në vende të papërshtatshme për ndërtim të ri. Vjetërsia e këtyre objekteve është kryesisht më shumë se 60 vjet, prandaj sanimi (riparimi) i tyre me metoda dhe materiale të reja do ta përmirësonte dukshëm shfrytëzimin e tyre. Në këtë punim janë prezantuar disa raste në Kosove, si: Kanali i Degëzimit të Ujit për hidrocentralin në Radaç, afër Pejës dhe Rezervuari i Ujit në Podujevë. Aplikimi i metodave dhe materialeve është pjesë e realizimit të këtyre projekteve, që janë studiuar një kohë të caktuar.
Fjalët kyçe: betoni, materialet, metodat, ekzaminimet, vlerësimet.

SUMMARY
The need for using existing concrete structures under the several environmental conditions during the long period, requires a deeper analysis than new structures. These structures, mainly concrete channels and water tanks for supplying hydro plants in Kosova, present a challenge for all those wanting to use existing structures by applying new methods and new materials during repairing process. They wear of normally as the time passes, and their repairing is necessary because they occupy such positions that make new construction difficult. In most cases they are over 60 years old, therefore repairing them with new methods and new materials would significantly improve their utilization. In this paper we present several cases in Kosova, such as: Derivation water channel in Radac near Peja and Water Tank in Podujeva. Application of methods and materials is part of execution of these projects realization, which have been studied for many years.
Key words: concrete, materials, methods, examinations, assessment.

INTRODUCTION

Application of concrete as a construction material has passed through several important phases which have observed in continually with changes of constituent components and production technology.

In general the constituent components were limited depending on the technological process, were are use: aggregate from river not separated in fractions, cement of that time and water.

Also the concrete production technology was mainly manual which makes uninterrupted production difficult.

Facilities that have been at the focus of this analysis, and their positions brought unfavorable elements relative to their geographic position and their altitude above sea level. Structures are finalized in certain conditions, and it made it possible for these facilities to be used for relative long period of time for certain purpose.

But time under the several environmental conditions has had significant impact in these facilities, and this is mostly presented as damages to concrete as the main material.

The need to use the same facility for more than one purpose made us think of need to repair and improve concrete as a material in construction, since it was studied and found to be the most efficient option for the moment.

1.a. The behavior of concrete as a material during the stages of use in the first facility

In structures analyzed in this paper: the derivation water channel in Radac, near Peja and the water tank in Podujeva, concrete has been subject under the several conditions. In both cases the facilities were underground, so the effect of outside temperatures is not taken into consideration.

- Characteristics of derivation water channel in Radac, near Peja

The water channel is underground and it is 500 meters long. The role of this channel is to bring water from water source to the water tank. The function is stopped since the hydroplant in Radac became dysfunctional.

The present situation of channel is presented in the following photos.

Pictre 1. The channel condition at the time of the assessment

• Geometric elements and existing state of the channel

The shape of the channel is an ellipse form with a height of ~ 1.20 m. The carrying capacity of the channel, with these dimensions, cannot withstand the design capacity. The impact of loads has caused very big cracks as can be seen in the picture above. Some segments are heavily to completely damaged from the lateral and above load as a result of the impact of slope dirt to the channel itself. Sources of grave concern were a number of segments where joints were not functioning due to considerable displacement of the slabs. The channel was built in 1939, when the inside surface was plastered manually.

Mainly the constituent materials such aggregate used directly by stream of river Drini i Bardhe which is crushed in several pieces during the flowing. We can see that there are many coarse aggregate or pieces of gravel in big dimensions, and variety of aggregate. The cement of that time did not have any high quality technology but it played its bending between the aggregate.

The most adverse elements are the cracks, respectively the division the slabs from the wall, which causes loss of water or make it dysfunctional. This assessment state is done to evaluate and to undertake the following steps.

• Assessment of current state and recommendations

The water channel in current conditions is out of use, but the level of damages is not the same in total length. In this sense, they were divided in three parts, such as:

- Severe level damage that cannot be repaired
- Severe damage but reparable
- Medium level and reparable damage

Since damages of first part, which cannot be repaired is not the objective of our study, we analyzed the reparable parts of the channel, followed by adequate recommendations.

a/ second part

Since the damages are smaller and the cracks are rarer in channel's surface taking into consideration the existing conditions it was recommended to repair them by undertaking these activities:

- Removing damaged parts, i.e. non quality concrete
- Cleaning the surface
- Injecting the cracks in considerable depth
- Water stopping from flowing in place where are the water loss
- Repairing the channel surface with polymer materials

b/ third part

We deal with damages that do not express any serious problem, with cracks present even though to a smaller extent. In this part the following activities were undertaken:

- Injecting in certain places in deeper distance
- Repairing the surface with polymer based materials

1b. The behavior of concrete as a material during the stages of use in the second structures

• Characteristics of Water Tank in Podujeva

The destination of this water tank is to supply water to the town of Podujeva with 120000 citizens. This tank has been used without being maintenance, therefore the impact of loads caused cracks which started to grow with time and caused the major water loss. This was the reason of increased water reduction in this town.

The conditions of the structure in the time it was emptied for assessment, and the state are given in the following photos.

Picture 2. Conditions of the structure during the evaluation moment

• Evaluation of the existing state of structure

Major water loss happens as a consequence of segregated concrete in some parts that caused significant water leaks. But the most important elements that caused the loss of water are cracks between the tank slab and walls in many parts of perimeter of structure. Consequence of the lack of maintenance for a long time is also the corrosion in some parts of concrete structure, as well as in the steel tubes inside the water tank that are used for taking the water from the tank to the distribution.[1, 4].

Recommendations in this structure are in direct connections with followed steps:

- Cleaning the concrete surfaces
- Removing damaged concrete pieces with high pressure water
- Stopping the water leaks
- Injection in perimeter of water tank, especially in the connection between the slab and the wall
- Protection the reinforcement steel from the further corrosion
- Protecting the concrete structure in segregated places with appropriate plastering with polymer materials.

2. Repairing the concrete, methodology and materials

2.a. Repairing the concrete in derivation channel in Radac near the Peja

Repairing the concrete is closely linked with the previous assessment, but it is directly linked with the quality of existing materials, in this case the concrete.

• Injection method [1, 2, 4]

The quality of the concrete shows that expect in some places where damages are evident, there aren't any damages in structure. This was a facilitating circumstance which allowed us to apply the injection method in repairing the cracks that were quit big dimensions. The injection method is followed by internal expanding forces which require sustainable structure in cases of major cracks as they were present here.

In places where cracks were very big dimensions, there was used preparatory method which requires specific materials, that is known as the method of leak closure. Using this method we managed to eliminate the big leaks, which result with water loss while flow through the channel.

Injection method is interlinked with a special technology which requires certain equipments and materials. Mainly these equipments are pumps with relatively high pressure, and the material is quite liquid, and also performs movement of material through the gaps and when it stops it results with expansion and fills the gaps.

All this movement is followed with a pressure which is possible to follow in equipment, where the filling of the cracks is ascertained.

The injectors are placed in mechanic way in wholes prepared before, and their position is depends of filling the structural cracks during the process.

The repaired parts then in next step are plastered in large area of surface in order to provide protection of repaired parts as well as the

uniform water stream through the channel without loss.
A sample execution is presented in the following photos: [1], [3].

Picture 3. Phases of executing of the work in derivation channel

2.b. Repairing the concrete in Water Tank in Podujeva

Water tank's function itself requires a different approach which is linked with repairing of key pint which are potential of causing water loss, identified in preliminary assessment.

• Methodology of water stop

Fast and huge amount water streams occur frequently in facilities like water tanks. Applications of quick hardening method which is followed by expansion is very efficient because the hardening becomes effective within 30 seconds and the water is stopped. In general the material contains polymer and accelerator such as additives for quick hardening, as it is shown in literature or in this practice case. [2], [3], [7]

Picture 4. Water stops leaks with quick hardening materials

Application this quick method are creates precondition for creating appropriate surface for the next step which is placing injectors and application the injecting method in most parts of perimeter, and in this case to create a "knitting-connection" between concrete slab and wall. This method and the steps of application are presented in following photo.

3. Materials used during repairing the structures

In general material has been evaluated in the function of the structure which has been repaired.

Picture 5. Repairing steps in the water tank

The content of materials are polymers and additive in depend of position where it is applied.
In general the essential condition is the connection between two materials, the base material and new material that will be applied. In this case is important to reach compatibility in the behavior of the both materials, so that they behave as a whole.
It is particularly important their behavior in the first phase, deformations and creep must be controlled to protect them from eventual cracks that can cause problems in the function of the structure itself.
To make this clearer we will present some technical characteristics of these materials in the following Table 1.

Class based on Standard EN 1504-3	R4
Type	CC
Density (gr/cm^3)	1.35
Content of solid substance (%)	100
Content of chlorides (%)	≤0.05
Compressive strength (MPa) EN 12190	≥45(after 28 days)
Flexure strength (MPa) EN 196/1	Not request
Module of elasticity (GPa) EN 13 412	≥20 (after 28 days)
Strength relating to the concrete EN 1542	≥2 (after 28 days)
Depth of penetration (mm) EN12390/8	Not request

Table 1. Physical and mechanical properties of materials used as mortar for repairing [3]

The execution of repairer is linked with an important element, which is the examination or evaluation of repairing compared with the requirements set by the project.
In the above mentioned projects the required technical conditions have been met and the examinations have shown a safe performance. Time is the key factor in this type of repairs. For this reason we present that the Water Tank in Batllava is checked every year for water loss, and

it shows that the repairing is functioning well. And relating to the derivation channel in Radac, the project hasn't been finished yet, but it has been more than a year and there is no seen the eventual damages or cracks.

Density (kg/m3)	1100
Content of solid substance (%)	100
pH of mixtures	12.8
Compressive strength (MPa) EN 12190	17 (after 30 min) 46 (after 28 days)
Flexure strength (N/mm^2)	3 (after 30 min) 9 (after 28 days)

Table 2- Physical and mechanical properties of materials for rapid closure of leaks [3]

CONCLUSIONS AND RECOMMENDATIONS

Issue of repairing requires broad knowledge in several aspects related to the given structure. In particular repairing is closely related to the information and knowledge available on existing materials in the facility opportunities to apply new materials and methods in this field.

Based on the experience from different (especially in these two projects) projects we can conclude as follows:

- The first step should consist of assessment of conditions of existing structure, or materials
- Ensuring the good binding between the layers so that they can behavior such a same material
- Selecting the adequate materials and carrying out preliminary evaluation of materials properties
- Application of new methods that are interlinked with a well trained staff, what we can say that is lacking in our region

For a justification and improvement of this field we recommend:

- The establishment of specific groups for training in this field that would deal mainly with the application of methods and materials for repairing important structures that need to be repaired and there isn't economic justification to build new ones.

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