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REHABILITATION OF GRAVITY DAMS. CASE STUDY: CLUCEREASA DAM STRUCTURE ON TARGULUI RIVER, IN THE ARGES DISTRICT.

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Abstract

The gravity dams are massive constructions, built out of concrete, which counteract the force of water pressure with only action of self-mass. First dam of this type was built around 1220 in Spain, and the building method remained the same until today, the only difference being the building technique and the materials used. The reasons for which the gravity dams need rehabilitation are mainly the time damage and the destructive effects of flash floods and earthquakes effects. Nevertheless, their lifetime can be extended if regular maintenance applied, which most frequently, in the case of cracks presence, it means: waterproofing the fissured areas with epoxy resins, injecting the fissured areas or reinforcing the dam with tension cables in those areas which present horizontal cracks. In the case of Clucereasa's dam, the deterioration was caused by the extraordinary solicitations of the large quantities of water in transit during the flash floods. This thing leaded to the dilapidation of the dam wall all the way to the armature. These kinds of solicitations, even if they feature a low frequency, have a very important effect upon the built structure. The dam of Clucereasa is a small dam that uses two pumping stations that ensure the water supply for the Dacia-Renault Mioveni car plant and for the city of Mioveni. The dam maintenance was performed over time in acceptable limits and the infiltrations and deformations had remained within reasonable limits, being actually insignificant in case of clogging. For this instance, demolition works of the damaged concrete had been imposed by the usual procedure, followed by the restoration of the wearing concrete at the edge discharge and washing tunnels, reparation with ordinary concrete and the rock-fill embankment of the mobile berm. For the wearing concrete, a type of reinforced disperse concrete was used, having metallic fibers (MFC), obtained by introducing an amount of metallic fibers in the concrete's composition as being prepared, this way obtaining a much more superior resistance.

Key words*: gravity dam, rehabilitation, concrete*

INTRODUCTION

The gravity dams are massive constructions, built out of concrete, which counteract the force of water pressure with only action of self-mass (Figure 1). First dam of this type was built around 1220 in Spain, and the building method remained the same until today, the only difference being the building technique and the materials used.
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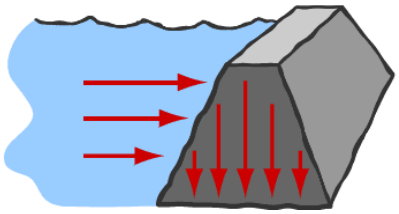

Figure 1. Forces involved on dam

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MATERIALS AND METHODS

The failure risk problem of hydrotechnical constructions in general, and of dams, in particular, acquires other dimensions in comparison with other types of civil and industrial constructions.
In the case of the dams, the risk management is a very difficult problem and it is the responsability both of the dams's owners, whichever the title, as of the authorities, population and of the traders in the area likely to be affected.
Thus, a brief overview of the law and the Company Sheet for Hydraulic Works on the reliability of dams is to be done.

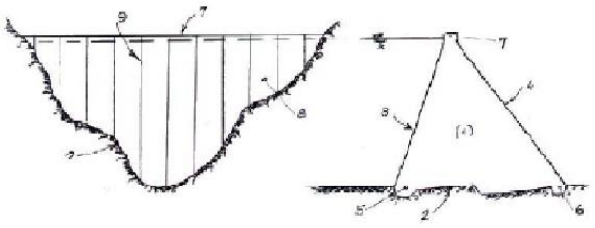

Figure 2. Section in dam

As a case study, we have chosen Clucereasa water intake dam, a small dam, that uses two pumping stations that ensure providing water for the correct function of the Dacia-Renault car plant and the Mioveni city.
The main purposes of this investment are increasing the safety levels, reduce the degradation, lower the subsequent operating costs, flood protection of downstream settlements, insuring the uses for which the dam has been built and maintaining the ecological balance in the area.
A section in Clucereasa water intake dam is emphasized in Figure 2.
As we speak of Clucereasa gravity dam, the damage has occurred due to outstanding requests that the time transit of major water flows produced, leading to the deterioration of the dam wall until reaching the armature.
These types of requests are characterized by a low frequency rate, although they have a very important effect.
Along time, the maintenance of the dam had remained within the limits, as well as the fact that deformation and infiltration remained within the previous predicted limits, and in case of clogging this became almost not important.

RESULTS AND DISCUSSIONS

The water intake dam of Clucereasa was designed by Institute of Hydroelectric Studies and Design in Bucharest, and has entered the use in the year 1968, as specified in G.D. 261/1994; the construction is part of the "C" level category of importance.
The dam is located on the Targului River, affluent of the Arges River, in the city of Clucereasa. From a geological point of view, this area is located in a major structural unit of the Meridional Carpathians (the Dambovita – Otasau partition of the Gaetic basin, upon which sedimentary formations had been depositated.
In terms of seismic work, the project fits into the "8_2" macro-zone of seismic intensity.
The project includes embankment works in the river bed, (excavation and fill) and construction works in order to repair the concrete wearing and the washing galleries, as well as the execution of sorted raw stone sills.
The earthworks in the river bad are:

- cleaning the land requirement;
- stripping the topsoil;
- excavating the river bed;
- fillings;
- improvement of the slope.

After stripping the topsoil in 30 cm depth, a part of the quantity is to be saved into a deposit, preserving the required quantity for being spread in order to grass over the anti-erosional armed mattress. From the entire quantity of the excavating, a part is used for the fills, by deposing the material on the banks, in those areas where systematization of the land is needed.
The construction works are:

- cleaning the damaged concrete wear from the overflow dam and the drain galleries;
- execution of the concrete wear;
- execution of the sills and concrete walls;
- reabilitation of the hydromechanical equipment.

Restoration works of the concrete wear layer mean, in fact, cleaning and reconstructing it, using reinforced concrete, dispersed with metallic fibers.

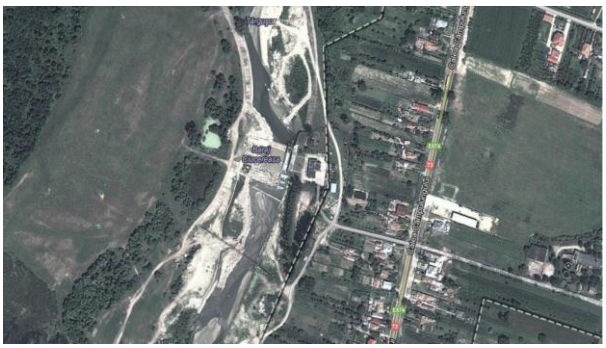

Figure 3. Dam area satellite view

This is obtained by introducing an amount of mettalic fibres (80 kg/m^3) in the moment the concrete shall be prepaired.

The advantages of using this type of concrete are the increased usage and shock resistance, the ability to resist the iterative process of frost and defrost (compared to the regular concrete), as well as the reduction of the fissure tendency that concrete tolerates.

For the reinforcement, there had been used 123 GQ 396welded meshes.

These had been embedd.ed in the dam's body by means of steel anchors: PC 52, ∅ 16, measuring 1,00 m length, installed by drilling holes in the cast concrete.

Execution and consolidation of the walls, embankements and sills, in concrete.

Embankement consolidation are placed on the Targului river, on the left shore as well as on the right one, having a total length of 610 m, 409,40 m on the left shore and 206,60 m on the right shore.

Shore consolidation consist of the execution of a concrete wall and an antierosional, grassed matress.

The support wall is at least 2,00 m above the valley floor and it is embedded 1,5 m into the ground, having 50 cm of canopy width and the water slope 2:1.

After the calculations, there can be estimated and presented the quantities for the main type of work regarding the repair of the spillway dam. (Table 1)

For the wearing concrete, it has been used the reinforced concrete, disperse armed with metallic fibers (BFM) which can be obtained by introducing into the concrete composition, during the time of prepare, a quantity of metallic fibers, that offer thereby an improved resistance.

The additional metallic fibers that appear in BFM's composition (in comparison with the current produced concrete) represent the dispersed armature.

This is delivered in various types which are differentiated by:

- section, that may be circular, square, rectangular;
- form, that may be straight, wavy, with tassels at the ends, etc.;
- surface appearance, manufacture mode;
- presentation mode;
- fiber length, that can be 5 – 6……70 – 80 mm;
- fiber diameter (for the fiber with circular section) that varies between 0,13 – 0,15……1,0 – 1,2 mm;
- the ratio between length/diameter between 20…100;
- the side of the fibers with square or rectangular section between 0,50 x 0,50……1,00 x 1,00;
- tensile strength for the fibers in carbon steel, material used for producing the fibers, and that often varies between 1000-3000 N/mm$^{2;}$
- the density of the steel fibers is 7850 kg/mc;
- the elasticity module E = 210 kN/mm^2
- elongation at break of 3 – 4 %.

Depending on the exposure classes, the dispersed reinforced concrete must represent a sustainable material, which stands in good condition to the physical, mechanical and chemical demands due to operating conditions and the environment.

The durability of the concrete, as being assured throughout an entire set of measures, since the conception and design of the project, to the execution, exploitation and maintenance of the works, among the measures required to insure the durability of disperse armed concrete, worth taking into consideration when designing the compositions, we mention:

- the selection of the proper cement and the adequate dosing;
- the selection of a qualitative and maximum density aggregate mix;

Table 1. Quantities for the main type of work

Concrete demolition	mc	17,00
Transport of the	to	40,8

demolished concrete		
Wearing concrete mass reinforced	mc	612,00
Plain concrete	mc	215
Concrete rehabilitation	mp	600
Transport of the concrete – 25 km	to	1985
Welded meshes 123 GQ 396	kg	16.447
Anchors 16 mm	100 buc	20
Curved formworks	mp	39,00
Straight formworks	mp	48,00
Rough stone rockfills	mc	780,20
Rock shipping	to	1.560,4
Geotextile bags crosspieces	100 mc	111,90
Crosspieces shipping	to	21.265
Sealing foil, g=1,55 mm	mp	7.730,25
Crosspieces demolition	100 mc	111,90
Sealing joints	100 ml	3,39
Crane function hours	ore	844
Temporary steel pipe	m	100,00

- providing the required workability for the fresh concrete, at a A/C minimum ratio in terms of data by using plasticizers or superplasticizers additives;
- insuring a correct technology for the preparation and development of works;
- insuring a structure for the hardened concrete, without structural flaws, with a maximum possible waterproofing level, in the correct working conditions, in order to assure a good protection of the armature;
- providing the air percentage for the concrete that has been subject in exploitation to the repeatedly freeze – thaw phenomenon;
- the pH of the dispersed reinforced concrete or/and the concrete with rebar made up of OB bars and stirrups must be minimum 12, and in the one with prestressed rebar, minimum 12,5.

CONCLUSIONS

Clucereasa dam rehabilitation aims to prevent total damage, protection against future floods and maintaining water alimentation productivity for objectives that it serves.
Considering the national economic importance of Dacia plant, which is supplied with water from the dam, the rehabilitation was high importance.
As a result of rehabilitation, the life of the dam increased with minimum 15 years with good maintenance and periodic repairs.

REFERENCES

Priscu R., 1974. Hydrotechnical Constructions (Vol. I). Didactic and Pedagogic Publishing House, Bucharest (in Romanian).