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PHYSICAL STABILITY ANALYSE CONCERNING CAVNICULUI VALLEY TAILING DAMS

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Abstract

In the Maramures County, on the Cavnicului Valley, there is three tailing ponds belong to the Cavnic Mining Company from C.N.M.P.N. REMIN Baia Mare: Vranicioara, Malaini and Plopis-Rachitele. This paper presents an analysis from physical and chemical stability point of view. The conclusion is that Vranicioara and Plopis-Rachitele waste deposits present stability from sliding point of view, but there is not secure in extremely meteorological or seismical conditions.

Key words: *tailing dam, stability, static and dynamic charges, Valea Cavnicului, pollution, risk.*

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1. Introduction

In the north of Romania in Maramures County, along Cavnicului Valley a large volume of mining waste generated by the polimetalics ore processing by Cavnic Mining Exploitation (in the frame of REMIN mining company) were and is deposited. The mining waste mixed with water is hydrotransported and deposed in tailing dams. Long time ago (starting in 1957) four tailing dams were built: Vranicioara, Malaini, Plopis and Rachitele. The Plopis and Rachitele tailing dams are close one to the other and considered, now, one tailing dam: Plopis-Rachitele.

This paper expresses our point of view concerning the risk of the dams regarding physical stability (in the case of static and dynamic charges and uncommon meteorological phenomenon). Because of the large data base volume, we didn't mention in detail the laboratory analyses and the stability factor calculation, just the results and the particular interpretation for this research, to underline the risk generated by the stability of these tailing dams in different conditions.

2. Tailing dams description

Malaini tailing dam is placed on the left side of the Cavnicului Valley, 3 km downstream of Cavnic city. It was functional between 1969 and 1973 and it's presented some instabilities. In the year of 2003 2004 the tailing dam constitutes the object of a project and an investment for stabilisation and environmental rehabilitation. The works where realised without respecting important rules for insuring long time physical stability and without taking care of specific meteorological condition. Even if in the area of the tailing pond no uncommon meteorological phenomenon was mentioned for now, some signs of tailing dam instability are visible (figure 1 and 2). The ravine phenomenon is very pregnant and visible short time after the rehabilitation. The soils deposed on the geo membrane are gone with water and this one is visible and starts to degrade. In the dam zone the slope is too important and the charge was realised with raw material which doesn't respect filter criteria (figure 3 and 4). This tailing dam was the first rehabilitation experiment but finalised with a failure.

Fig. 1. The ravine phenomenon

Fig. 2. The geo membrane visible

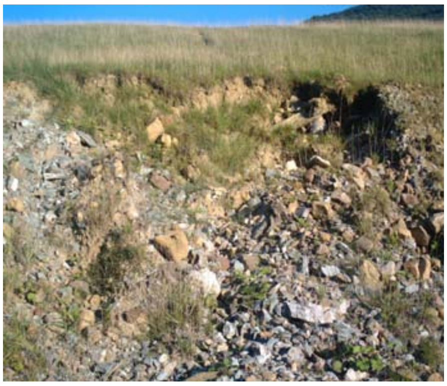

Fig. 3, 4. The starter dam instability

Vranicioara tailing dam is placed on the right side of the Cavnicului Valley, at 3,5 km downstream the Cavnic City. This tailing dam is in conservation. It was functioning between 1957...1977, but because of stability problems of Plopiş tailing dam, it was used like a reserve deposit in 1985, 1986 and 1988.

Plopis-Rachitele tailing dam is placed near Plopis village, along Răchițele stream, which was modified. It's placed at 7 km of Cavnic City. The Plopis tailing dam started to function in 1978, and Rachitele started in 1989. This tailing dam is active, used to depose the mining waste from Cavnic Processing Plant.

3. Actual situation of tailing dams and physical stability estimation

3.1. Vranicioara tailing dam

The dam suffered several modifications on the surface and inside. Actually the slope presents exfiltration on different levels, ravines with different dimensions, very large on the top and the absence of the vegetation on the majority of the tailing dam surface. The suffusion and erosion contribute to modelling the slope relief. In both cases the raining water transports the material at the bottom.

The tailing dam construction was realised by spigotting with an average slope of 16° on the bottom side and with more important slope, 25...26°, on the top side, the last 10...15 m.

On the superior part of the dam is wrinkled by a lot of ravines generated by rainy water and the vegetation is completely absent. On the bottom side, it's visible how a part of the material transported from the top cover the existent vegetation.

At one exfiltration the presence of suffusion is visible, and upstream there is a ravine with almost 3 m depth, being the result of the concerted action of suffusion and erosion.

On the Western side of the tailing dam several small slides appear and exfiltrations are generated. Inside the dam the water pressure is important and acts on the toe dam which is impermeable and generates fissures and shifts.

To estimate the drainage capacity of the material of the dam, we realised laboratory determinations concerning granulometry. These analyses present an important variation of the material granulometry, both vertically and horizontally on the dam body, and prove levels with different permeability degrees. There are levels which contain fine material under 50 μm with 3...24% (Fig. 2). These levels are layers almost impermeable generating exfiltration in different points on the dam body.

To estimate the permeability the following relation was used:

$$K = 0{,}019\ d^2_{10}\ (m/s) \qquad (1)$$

On the base of this relation it was obtained permeability coefficients with values of 10^{-5}...10^{-6} m/s, proving the existence of layers with very low permeability values. These layers create a risk for the dam stability and provoke conditions for slopes on the dam body. On the same time, grow up of the hydrostatic level get to diminution of the stability coefficient.

To estimate the physical stability it was calculated the stability coefficient with Fellenius and Bishop method. The calculations were realised both numeric and analytic, considering hydrostatic level and dynamic charges (seismic and blasting). For the seismic coefficient calculation it was considered the specific values for the area (k_s=0,08 ; k_s=0,12). The obtained value for the stability coefficient was 1,1 close to the stability limit for static charges. For dynamic charges the value is situated on the instable domain. In the case of dynamic charges or uncommon meteorological conditions it appears the risk of the dam failure.

3.2. Plopis-Rachițele tailing dam

The construction of the Plopis tailing dam started in 1977. The first damage was in 1978 when a slope produced in the foundation field destroys the dam and the start dam 30 m along. In 1985 another slope happened, the slope surface passing under Cavnic River, and on the dam this surface extends 300 m along. The tailing dam was temporarily out of service till 1986. In 1989 start in the neighbour the Rachitele tailing dam construction, keeping a separation wall between the two tailings. In 2001 Rachitele tailing dam arrive to the Plopis tailing dam level and the alternate exploitation start, but by security reasons the Plopis tailing dam is in exploitation in summer time only.

The general slope of the dam is 18°. On the slope surface it is visible frequently the result of erosion phenomenon, suffusion being very few. On the Western side of Plopis tailing dam on the contact area with Rachitele, approximately 50 m along, the infiltration curve is in the start dam body, observing exfiltrations on 1...2 m. This phenomenon is present on the NV side on several square meters.

To estimate the drainage capacity of the dam material it was determinate the granulometry of the material in different sections. The determinations proved a vertical granulometry variation, the percentage of material less than 50 μm is lower of 12% in comparison with Vranicioara tailing pond. The permeability coefficient, for levels with high content in fine material, estimated with anterior relation, is on the order of 10^{-4} m/s.

To estimate the physical stability it was calculated the stability coefficient similar to Vranicioara tailing dam. The value obtained in the hypothesis of static charges is 1,2. For dynamic charges the value is situated on the instable domain. In the case of dynamic charges or uncommon meteorological conditions it appears the risk of the dam failure.

4. Conclusion

The Valea Cavnicului tailing dams present physical also chemical stability risk. The values of the stability coefficients are inferior to safety coefficients, both for static and dynamic charges.

Plopis-Rachitele tailing dam will become a grave environmental problem due to the high content in pyrite, if the confination will not be realized.

We can conclude that the two dams – Vranicioara and Plopis-Rachitele – are stable (speaking about a huge slope) but not sure – the supra-unit stability is lower that safety coefficient - without uncommon meteorological or seismical conditions. If some special conditions happen the tailing dams support the risk of slope which could move important quantities of material. This material in movement menaces the national road and the Cavnic River which have the capacity to transport it on long distances.

To assure the stability and the risk of accident diminution for these tailing dams the realisation of some researches are imperative. The goal of these studies is the development of rehabilitation solutions as well as to ensure the stability for uncommon meteorological and seismical conditions.

An alternative to mining activity diminution or closure in Cavnic is the introduction of the area in tourist network but the first step should be environmental problems solution. The actual situation of Valea Cavnicului tailing dams makes difficult this project realization.

Another major risk is the geographic location of these tailing dams in the neighbour of Cavnic River, which generate transboundary effects of pollution.

5. References

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