Panel discussion: Rehabilitation of tailings and sludge storages

Débat de spécialistes: Remise en état des dépôts de stériles miniers et de boues

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ABSTRACT: General consideration concerning abandonment and rehabilitation of tailings and sludges storages are discussed. The attention is paid to their geotechnical and revegation aspects. As an example, effects of the revegatation measures of Gilow tailings storage in Poland are presented.

RESUME: Les remarques générales concernant la fin de la période d'exploitation et la réhabilitation des retenues des stériles ont étées présentées. On a particulierement mis l'accent sur l'aspect géotechnique et végétal. La retenue de Gilow en Pologne est présentée comme exemple de l'effet de rehabilitation.

1 INTRODUCTION

Storages both of dredging sludges as well as of tailings will remain in existence long after their closure following completion of the capacity. It is important to underline that storages remain after ceasing operation of associated mines or plants.

It is therefore of utmost importance to assure the long term safety performance both of the stored sediments as well as containment embankments with all ancillary structures.

The design of tailings and dredging disposals, besides the general scheme for placement of slurry and technical aspects of the storage should contain the schedule for its abandonment, ground contour after reclamation and proposal for revegetation.

2 OBJECTIVES

Rehabilitation measures result from their objectives.

According to ICOLD Bulletin 106, A Guide to Tailings Dams and Impoundments (1996) the principal objectives for tailings storages rehabilitation, are as follows:

- stabilization of the impoundment (this will involve consideration of long term stability, seismology, erosion protection, drainage systems)
- hydrology (long term assessment of catchment runoff and diversion arrangements, including risk of overtopping and breaching)
- contamination (including leachate control or containment, surface and seepage water quality, emission control and dust hazard)
- visual impact (ground contouring, planting and soiling, and general landscape measures)
- afteruse considerations (including restoration for leisure, agricultural or commercial enterprise)
- safety (public accessibility and inherent dangers, long term surveillance and monitoring)

The importance of the above objectives can significantly differ for particular storages, because they depend strongly on topographical, geological/geotechnical and climatic conditions. But the most important factor influencing the intensity of rehabilitation measures is the storage localization with the reference to the environmental impact. If storage is located in densely populated area, the rehabilitation measures to achieve the mentioned objectives must be incomparably wider to those for storage located in barren, mountains or desert.

In each case the rehabilitation measures for tailings and sludge storages are strongly dependent on geotechnical properties of materials stored, containment embankments and their foundations.

3 GEOTECHNICAL ASPECTS

Depending on the percentage of fines, sludges and tailings deposited in storages may exhibit poor consolidation properties. This results in a very low bearing capacity of sediments, which may limit the area of rehabilitation works on the surface of the storage.

It is therefore of great importance to take into consideration in the design process, the sedimentation and consolidation behaviour of the material deposited in the storage. Consequently, this will allow to plan the future rehabilitation measures. In case of necessity, an improvement of soil properties may be implemented. In last decades the knowledge of the behaviour of fine grained material increased and several methods of modeling of the sediments consolidation were developed (Carrier and Bromwell, 1984).

When disposal of tailings or dredging sludges is ceased, the general stability of a storage begins to improve, mainly due to natural lowering of the phreatic surface in sediments and in impounding dams. Therefore it can be considered that safety factor for long term stability of the storage in comparison to the factor during operation, is higher.

However, it is important to note that in case of location of tailings or sludge storage in densely populated area, the long term stability has to be carefully analyzed. Despite the mentioned trend of increasing safety factor in long term stability after closure, the designer has to consider probability of coincidence of extremely unfavourable conditions, e.g.: significant pore pressure increase caused by rise of phreatic surface in sediments due to catastrophic precipitation (flood) and seismic or paraseismic (caused by mine operation) shock, etc.

4 REVEGETATION OF GILÓW TAILINGS STORAGE

Within two of the above mentioned principal objectives of rehabilitation of tailings storages, namely: visual impact and after use considerations, the problem of vegetative covering should be considered as an important one. This is not only to soften the form and adjust to the surrounding landscape but also to protect against dusting. Some parts of the storage surface might also be used for planting cereal crops or for grazing.

There are three possibilities of revegetation on the surface of the tailings storages:

- natural succession,
- covering with fertile soils, transported from outside of the storage,
- mineral fertilizing and sowing.

As an example of the effects of the mentioned methods, revegetation measures in Gilów tailings storage will be

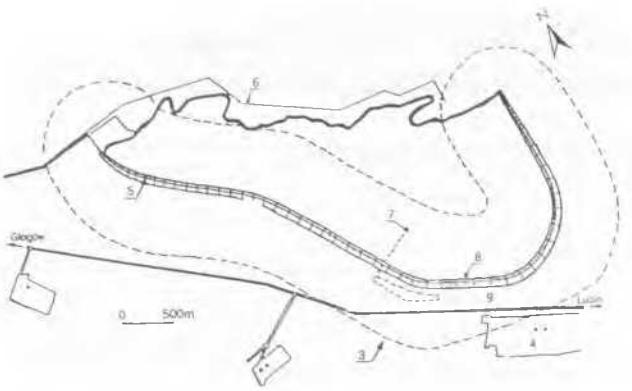

Fig.1 General layout of abandoned tailings pond Gilow.
1,2,4-Shafts, 3-Border line of protection embankment, 5-Tailings transportation pipeline along embankments, 6-Tailings transportation pipeline along axis of the pond. 7,8-Decant towers. 9-Decant water pipeline.

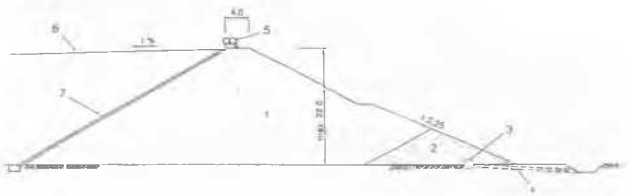

Fig.2 Cross-section of Gilow tailings dam.
1-Medium and fine sand compacted by equipment. 2-Sand-gravel mixture. 3-Drainage. 4-Concrete conduits. 5-Tailings supply pipelines. 6-Beach. 7-Concrete plates 6x6m (15cm thick) on mortar.

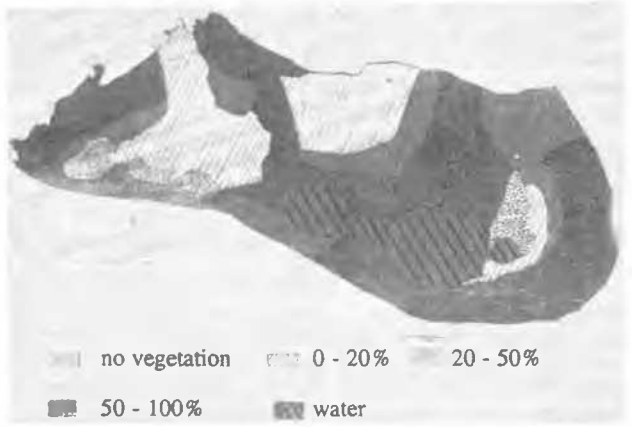

Fig.3 Vegetation coverage of Gilow storage (Tasz and Piasecki, 1989)

presented.

In Gilów storage, located in south-western part of Poland, copper tailings were impounded. The storage was abandoned more than fifteen years ago (KGHM Polska Miedz S.A, 1996). The total capacity of the storage is ca. 68 million cubic m and the covered area is 5.4 square km (Fig.1). The dam height reaches 22 m (Fig 2).

Due to alkaline properties, heavy metals and some postflotation chemicals present on the surface of sediments, natural succession was practically limited to the small areas (Ostrowski and Sklodowska, 1996).

The expensive method based on covering with fertile soils was used in the limited range, in the northern part of the storage, later used for agricultural purposes.

Most widely used was the method of mineral fertilizing and sowing. For this purpose small aeroplanes were used. The solution of mineral mixtures and communal sewage with addition of grass as well as seeds of papilionaceus plants were sprayed. This method was effective and particularly useful on not accessible, soft areas. In Fig.3 the effects of the revegetation works, estimated 8 years after closure of the storage, are shown.

5 CONCLUSIONS

Rehabilitation of tailings and storages should be foreseen in a design stage. Measures taken during and at the end of impoundment should facilitate the final rehabilitation works, after ceasing of tailings and sludge disposal.

Particular attention should be paid to rehabilitation procedures when storage is located in populated areas.

It has to be considered that effective revegetation needs costly procedures as for instance fertile soil covering or fertilizing procedures, with application of aeroplanes.

REFERENCES

Carrier, W.D.III, Bromwell L.G. 1984. Disposal and Reclamation of Mining and Dredging Wastes. *Seventh Panamerican Conference*.

ICOLD 1996. A. Guide to Tailings Dams and Impoundments. Bulletin 106. Paris

KGHM Polska Miedz S.A. 1996, Monografia. Lubin.

Ostrowski M., Sklodowska A. 1996. Male Bakterie, Wielka Miedz. SCI & ART, Warszawa.

Tasz W., Piasecki J. 1989. Ocena skutecznosci prac rekultywacyjnych na zbiorniku Gilow. ZBiPM Cuprum. Wroclaw.