The Failure of the Embankment of the Red Mud Reservoir at Ajka (Hungary)

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Abstract

The NW corner of the embankment of the Reservoir No. 10 of the Ajka Alumina Refinery of MAL Zrt failed on October 4, 2010, shortly after noon. The basic facts and various explanations which could have been collected by the end of November 2010 were presented as a keynote lecture of the XVIIIth Symposium of ICSOBA in Zhengzhou, China. Over the next year further information was made public by studies, on the legal circumstances, the industrial, governmental and other actions, or their lack, which played a role in the failure of the embankment and the tragic consequences. The scientific study results, the activities of civil organizations, the report of a parliamentary committee, a study report of the "green party" of Hungary, the expert opinion of a leading civil engineer, and a court verdict were summarized in another paper published also in an ICSOBA Newsletter in 2012. This paper recalls the earlier comprehensive studies and provides an insight to a more recent one. The primary objective of the present publication to find an answer to the basic question: "Why did the embankment collapse?"

Keywords: bauxite residue, red mud, storage, embankment, failure.

1. Introduction

The NW corner of the embankment of the Reservoir No. 10 of the red mud storage area of the Ajka Alumina Refinery of MAL Zrt (Hungarian Aluminium Production and Trade Company Limited by Shares) failed on October 4, 2010, shortly after noon. The facts, various explanations which could have been collected by the end of November 2010 were presented as a keynote lecture of the XVIIIth Symposium of ICSOBA in Zhengzhou, China and as a paper in an ICSOBA Newsletter [1].

Over the next year further relevant information was made public by studies, on the legal circumstances, the industrial, governmental and other actions, or their lack, which probably played a role in the failure of the embankment and its tragic consequences. The scientific study results, the industrial and governmental actions, the activities of civil organizations, the report of an ad hoc parliamentary committee, a study report of the "green party" of Hungary, the expert opinion of a leading civil engineer and a court verdict were summarized in a paper that was published also in an ICSOBA Newsletter [2] in 2012.

The facts on the failure of the embankment of the Reservoir No. 10 of the red mud storage area of the Ajka Alumina Refinery and the consequences were summarized in the mentioned two papers. In summary: the amount of slurry containing bauxite residue (red mud) as solid phase may have exceeded 1 million m^3 when it was suddenly released just after the collapse of the NW corner of the embankment. Ten residents lost their life [3], 286 people were given medical care, out of them 120 were hospitalized or treated for a longer period of time. The slurry inundated 1017 ha agricultural land and 367 properties (houses and other buildings). Most of the houses and other properties were demolished, the rest were renovated; a number of new houses were built in Kolontár and Devecser, the two most effected places.

This paper recalls the earlier comprehensive studies, provides an insight to a more recent one, and also a summary on the still ongoing legal procedures. The primary objective of the present publication is to answer: "Why did the embankment collapse?"

2. Schematic of the Red Mud Disposal

A schematic of the red mud disposal system of the Ajka Alumina Refinery is shown in Figure 1 (based on the paper of Baksa and Kajdi [4]).

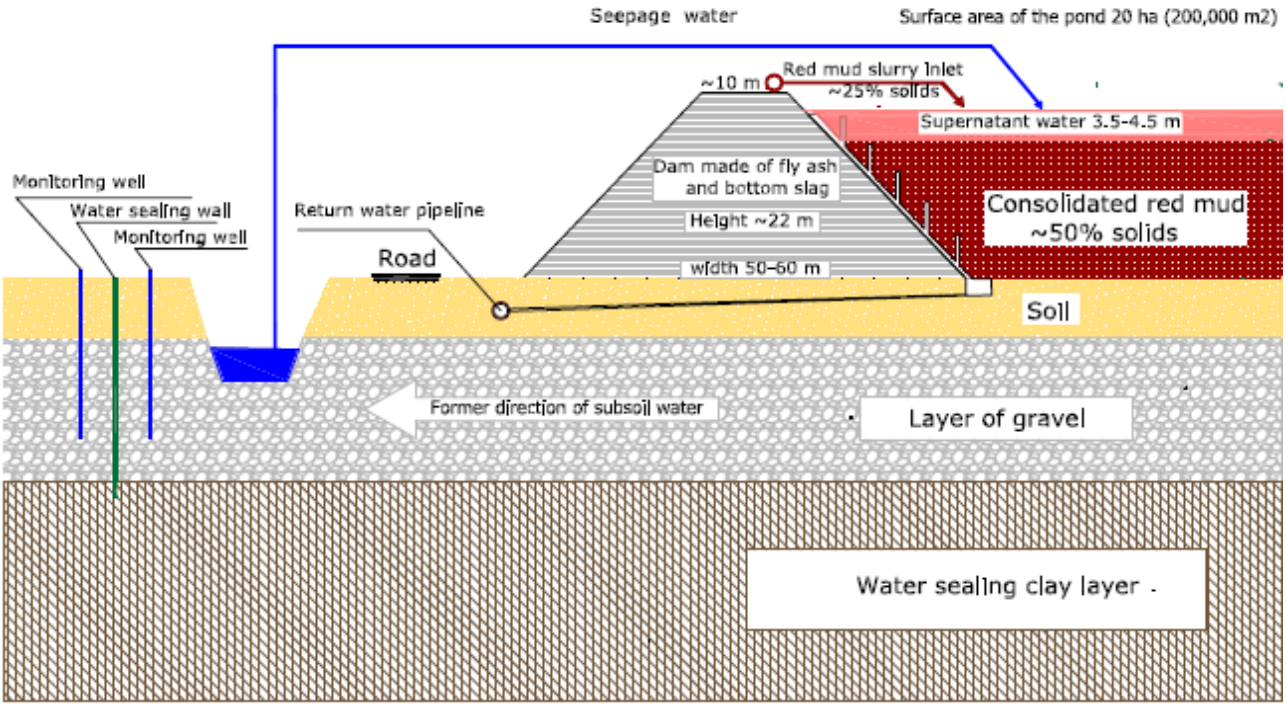

Figure 1. Schematic of the red mud disposal system at the Ajka alumina refinery.

The embankments of the red mud disposal Reservoirs No. 6 – 10 were constructed by utilizing the hydraulic character of the fly ash and bottom slag having considerable CaO content. The fly ash and bottom slag originated from the brown coal fired power plant located in the vicinity of the Ajka Alumina Refinery (and the aluminium smelter when the refinery was constructed). The fly ash and bottom slag were slurried in water and transported to the embankment being built in layers of about 50 cm height. After settling the bottom slag and fly ash, the supernatant water was collected and pumped back to the power plant. The settled mixture solidified by itself in a few days time and a special type of concrete having relatively low quality was formed. The embankment was constructed in stages. This procedure commenced in the 1960s starting with the Reservoir No. 6. By this method a readily available waste, i.e. fly ash and bottom slag was used for the construction of the reservoirs of another waste, the bauxite residue.

The red mud was pumped into the reservoir as a slurry of 300 – 350 g/l solids content and was charged close to the inner wall of the embankment. Therefore, the shape of the bauxite residue (red mud) layer was rather like the bottom of a basin than flat The average height of supernatant water was about 4 – 4.5 m; 0.4 – 0.6 m at the perimeter, up to more than 8 m at the middle of the Reservoir No. 10. The slope of the Northern embankment was 1:1 as shown in Figure 2, at the Western side it was 1:2.

8. Acknowledgements

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