(57) Abrégé/Abstract:
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Abstract (continued):

drainage systems, it will accelerate the consolidation process. In addition, the stability of the tailing will also increase due to the negative pore water pressure generated in the tailing media. Furthermore, the environmental risk and liabilities associated with the tailing potential seepage will be reduced by implementing the new approach.
METHOD TO SPEED UP THE CONSOLIDATION PROCESS OF TAILING SLURRY BY EMBEDDED DRAINAGE SYSTEM

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ABSTRACT

New method is proposed to accelerate the process of tailing slurry consolidation. The time needed to consolidate certain amount of tailing slurry will depend on the distance that the water has to travel to be drained. By reducing this distance by means of embedded drainage systems, it will accelerate the consolidation process. In addition, the stability of the tailing will also increase due to the negative pore water pressure generated in the tailing media. Furthermore, the environmental risk and liabilities associated with the tailing potential seepage will be reduced by implementing the new approach.
SPECIFICATION

Introduction

Tailing dams continue to be an important component of the mining supporting infrastructures. However, they pose significant environmental and engineering challenges. Dewatering the tailing slurries was always one of the biggest challenges facing the mining industry. Some attempts such as Thickened Tailings Disposal proposed to dewater the slurries at the source prior to discharge to the dam. The proposed method will dewater the slurries within the basin.

Proposed Technique

There are two main steps during dewatering process. First is sedimentation where there is no effective stress between the solid particles. Second process is the consolidation. Both steps may be combined into so-called large strain consolidation. In both steps, the time required to achieve every process will depend on how far the water has to travel to dissipate the excess pore water pressure which is the length of the drainage path.

This invention propose the use of embedded subdrains in the tailing slurries to decrease the drainage path. This invention also propose some practical methods to construct such subdrains.

The consolidation theory known in Soil Mechanics is somewhat applicable to the tailing slurry behavior. It indicates that the time needed to achieve field consolidation at the same degree as the laboratory consolidation equals the product of laboratory time at that degree of consolidation times the square of the relative thicknesses as shown in the following formula:

\[ t_{\text{field}} = \frac{(H_{dr})_{\text{field}}}{(H_{dr})_{\text{lab}}} \times t_{\text{lab}} \]

Where:

- \( t_{\text{lab}} \): the time needed to achieve certain consolidation degree in the lab (50, 80, 90%, etc)
- \( t_{\text{field}} \): the time needed to achieve the same degree in the field
- \( H_{dr} \): the length of drainage path (if drained from top and bottom than it is half of the thickness)

Similarly, the consolidation time needed for tailing slurry of different thicknesses is proportional to the square of the ratio of their lengths of drainage paths. Therefore, by embedding subdrains which will reduce the drainage path, the time
needed to achieve stable slurries will be decreased. In addition, other benefits will achieved such as increase the
dams capacity and reduces its potential risks. These benefits will be discussed in details later.

Generally, the drainage path in typical tailing dam is as illustrated in Figure 1 enclosed. The drainage path will equal to
the depth of the tailings in a given dam. In the proposed method, a series of subdrain system will reduce drainage path.
Figure 2 illustrates the drainage path when one subdrain is installed. Consequently, the drainage path is reduced to one
third, and the consolidation time by almost one ninth. For thirty meter deep tailing dam, if subdrains were installed every
three meters (drainage path of 1.5 m), the consolidation time will be reduced by 400 times.

This concept seems simple, but probably the big challenge is how to effectively construct such subdrain in tailing dams.
Some practical techniques are discussed later in the text.

Practical Construction Techniques

Large scale permeable layer may be constructed by using geotextile to separate the tailing away from the proposed
permeable draining layer. Figure 3 illustrates this technique. Two geotextiles separated by coarse gravel such as rip rap
will allow the water to drain and excess pore water pressure to dissipate. The gravel layer could be connected to outlet
which collect the water to be used in mining again.

One challenge to this technique is to be able to place gravel on the top of the slurries without being sunk. One might use
plastic-type gravel which is light enough to float on the slurries, coarse enough to maintain high permeability, and strong
enough to transfer the stresses between the top and the bottom layers. Further, to reduce the cost associated with the
installation, the two layers of geotextiles and the middle permeable layer in between may be manufactured off-site in a
form of thick mat then brought to the site. The bulk density of such mat could be adjusted (by choosing different
permeable materials) to accommodate the density of the slurries.

Another method is the use of perforated network of pipes sunk within the tailing dam. Once in place, negative water
pressure may be applied, i.e., suction which will reduce the drainage path.

Any other method by embedding drains in the tailing body will be useful in reducing the drainage path will also reduce
the consolidation time. The drains may be installed vertically or horizontally or in an angle before, during, or after mining
operation, i.e., accumulation of tailing slurries.

Advantages of This Technique

The implementation of the new technique will have some practical advantages as discussed below.

1. The main advantage is to reduce the time that these tailing will consolidate, and the surface land can be used for
development at an earlier time.
2. Increase the capacity of the dams. Along with the consolidation process, the void ratio of the tailing slurry decreases. Therefore, a given dam may be able to accommodate more tailing than ever before. This will increase the live expectations of tailing dams and reduce the need for new dams.

3. Reduce the environmental and general risk associated with these dams. Risks are function of the hazard (severity) multiplied by the exposure which is in turn function of time. For example, the risk for an individual to get into a car accident increases if the time spent driving increases. Insurance companies apply similar rules while providing car insurance. Similarly, the risk associated with tailing slurries will be depended on how long the slurries need to become stable.

4. The draining by interlayer will also decrease the pore water pressure in the deep layers remarkably as illustrated in Figure 4. This will increase the effective stresses and lead to over loading. Which will also accelerate the consolidation process even further.

5. If negative pore water pressure (suction) applied to the permeable draining layer, the effective stresses will be increased. This is similar to the overloading condition which will accelerate the consolidation process. In addition, it will help increasing the tailing shear strength and might be useful to absorb any excess pore water pressure that might generate as a result of liquefaction.

6. After the tailing has been stabilized, air might be pumped into the permeable layer. The air will increase the liquefaction resistance significantly because the soil will be in a state of unsaturated conditions. Yang et al (2004) have indicated that the liquefaction resistance increases (CRR) by at least two time when the saturation degree decrease to 90 %. For near dry conditions, the resistance is practically infinite.

Limitations

The assumption that the consolidation time is proportional to the square of the relative length of the drainage path is based on the applicability of the consolidation theory on the overall drainage process in tailing slurries.

Reference

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

I. Before and during mining operation:

The use of subdrain or any type of draining system installed with the body of tailing slurries or the tailing dam structure to reduce the drainage path, accelerate the dewatering process, accelerate the consolidation process, locally stabilize the tailing slurries and/or increase the dams capacity.

II. After the tailing slurries have been discharged to dams:

The insertion of drainage system within the tailing slurries or the tailing dam structure to reduce the drainage path, accelerate the dewatering process, accelerate the consolidation process, in situ stabilize the tailing slurries and/or increase the dams capacity.
Figure 1: Drainage Path in Conventional Tailing Dams

Figure 2: Drainage Path with a Single Drainage Layer
Figure 3: Details of Proposed Subdrain

Figure 4: Total and Effective Stresses in the Proposed Technique
Drainage path equal to H/3

Permeable Drainage (Filter)

Impermeable base

Drainage Path with a Single Drainage Layer