

# Sensitivity analysis of tailings disposal and drying cycles in a bauxite tailings dam

Vinícius S Feijó <sup>a,\*</sup>, Thainá Rainho do Sacramento França <sup>a</sup>, Juliana Santos Fabre <sup>a</sup>,  
Sabrina de Paula Ferreira <sup>a</sup>, Luciana de Moraes Kelly Lima Bittar <sup>a</sup>, João P Freire Neto <sup>a</sup>

<sup>a</sup> Pimenta de Ávila Consultoria Ltda, Brazil

## Abstract

*This study aims to evaluate opportunities for improvement in the disposal and drying cycles adopted in the operation of a storage reservoir for thickened tailings from bauxite processing that is part of a project located in the northern region of Brazil. The reservoir is divided into quadrants and, currently, the disposal occurs in 0.5 m-thick sequential discharge layers of tailings, with approximately 34% solids content by weight (SC). In the routine operation of the structure the subsequent layer is released when the lower layer reaches an SC of around 60%. After occupying the useful volume of the quadrant, mechanical excavation of the disposed dry tailings is carried out. This is directed towards the closure of the mining areas of the project, freeing up space for a new cycle of operation at the structure. The work proposes a sensitivity analysis of the expected drying curve through analytical equations and the assistance of numerical tools for evaluation of consolidation and drying. Fifteen combined variations will be performed, including different SC (between 30% and 38%) and five different layer thicknesses. Such analyses will make it possible to understand the drying times necessary to obtain the minimum SC for mechanical excavation and, consequently, will allow an evaluation of the complete operating cycle of the reservoir.*

**Keywords:** *tailings dam, bauxite tailings, disposal and drying cycle, consolidation, sensitivity analysis, optimisation*

## 1 Introduction

The bauxite tailings disposal and drying system studied in this work operates through cyclical processes of disposal, drying and mechanical excavation of tailings, and alternating the arrangement between quadrants to maximise the operational efficiency of the structure. Currently, tailings with a solids content by weight (SC) of approximately 34% are released by spigots in one of the quadrants until a layer thickness of 50 cm is reached. During the drying process, when the SC reaches 60% at depth, the arrangement of a new layer begins. This cycle is repeated until the quadrant reaches its maximum height, when the process called ‘tailings dry backfill’ (mechanical excavation) begins, directing the excavated tailings to exhausted extraction areas of bauxite and allowing the re-use of the quadrant for new disposal cycles.

The main objective of this study is to analyse the drying behaviour of the tailings, providing relevant tools to optimise the operations of the structure. For this, the fillings of the quadrants will be simulated using the computer program CONDESO, focusing on the variation of the SC at the time of launch and the thicknesses of the layers. In addition, the expected performance for disposal with solids levels lower than the current practice, e.g. SC = 30%, will be evaluated in order to verify the feasibility of directing volumes that are currently directed to other structures at the site.

The optimisation of the disposal and drying processes seeks to improve the management of tailings, meeting the production demand of the processing plant. In the next phases of the study, field tests will be important

---

\* Corresponding author. Email address: [vinicius.silva@pimentadeavila.com.br](mailto:vinicius.silva@pimentadeavila.com.br)

to validate the results obtained through modelling, in order to improve the understanding of the phenomena involved and guide safer and more efficient operational decisions.

The site is in the northern region of Brazil, which is characterised by extreme weather events including prolonged rainfall periods and high solar incidence during the dry season, leading to high evaporation rates. In climatological terms, the region has well-defined dry and rainy periods that exert a significant influence on the drying time of the tailings discharged. During the dry season, from June to November, the drying time of each cycle is estimated at 25 days on average, while in the rainy season, from December to May, this time is 40 days. Data regarding rainfall and evaporation in the region were obtained from monitoring with rain gauges installed in the region and class A pans located in nearby pluviometric stations.

Understanding these variables and optimising the tailings disposal cycle are crucial to ensuring a sustainable and efficient operation, extending the life of the system and minimising environmental impacts, such as eliminating the need to build new tailings storage structures. This study offers options for future decision-making, contributing to the improvement of operational planning and tailings management.

## 2 Phenomenon of consolidation and desiccation

The phenomenon of consolidation and desiccation in fine materials such as bauxite tailings is widely studied in geotechnics due to its importance in the stability and efficiency of storage systems, as well as its influence on other types of geotechnical structures involving cohesive soils (Foster et al. 2000; Oliveira Filho 1998; Peng & Zhang 2012; Take 2003; Talbot & Deal 1993; Xu et al. 2020).

Consolidation is the process of reducing the volume of the material caused by the expulsion of water from the pores under the action of applied stresses, resulting in an increase in the density and strength of the material (Terzaghi 1943).

In turn, desiccation is a phenomenon related to the evaporation of water contained in the material, influenced by climatic conditions such as temperature, relative humidity and wind, in addition to the physical properties of the tailings, such as particle size and permeability (Fredlund et al. 1996). The interaction between these processes results in a complex behaviour that can influence the storage capacity and stability of tailings dams, and it is essential to understand and control these phenomena to optimise the operation of disposal structures.

### 2.1 1D and 3D desiccation

According to the theory of dryness for fine soils proposed by Abu-Hejleh & Znidarcic (1993, 1995), the process of water loss by evaporation can be divided into two phases. The first phase is controlled by evaporation only on the surface of the tailings and the contraction of the soil occurs only in the vertical direction (1D), while in the later phase, drying is controlled by the formation of cracks whose morphology depends on the mineralogy of the soil and the climatic conditions (Almeida 2004). At this stage, both vertical (settlement) and free lateral contractions occur and, in general, the formation of cracks in the soil is generally associated with changes in energy, the stress state or soil volume (Tang et al. 2021).

In this context, when analysing the behaviour of bauxite tailings which have been exposed to drying for prolonged periods, it is perceived that the formation of cracks is a phenomenon that influences the behaviour of the material, as well as other similar cohesive materials. In the field of mining, the behaviour of cracks has also been the subject of several studies (Almeida 2004; Morris et al. 1992; Rodríguez et al. 2007; Silva 2003), as have the various methods for obtaining crack parameters (Tang et al. 2021).

### 2.2 Computational tool for modelling (CONDES0)

In order to simulate the tailings drying process, the modelling was implemented in the CONDES0 software developed by Yao & Znidarcic (1997) to solve the drying model formulated by Abu-Hejleh & Znidarcic (1993, 1995).

The 3D desiccation model, which considers the effects of consolidation and contraction of the material due to surface drying and crack formation, was used. The constitutive model used to determine the compressibility and permeability relationships of the tailings is expressed by Equations 1 and 2, respectively.

$$e = A(\sigma'_v + Z)^B \tag{1}$$

$$k = Ce^D \tag{2}$$

where:

$e$  = void ratio

$k$  = permeability coefficient

$\sigma'_v$  = vertical effective stress

$A, B, Z, C$  and  $D$  = empirical parameters determined by means of hydraulic consolidation tests (HCTs).

The formulation that describes consolidation in this case can be represented by Equation 3, obtained by Gibson et al. (1967, 1981).

$$\frac{\partial}{\partial a1} \left[ K - \frac{K}{\gamma_w} \frac{(e\gamma_w + G_s)}{(1+e)} \left( 1 - \frac{\partial \sigma'_v}{\partial e_{cr}} \frac{de_{cr}}{d\sigma_v} \right) - \frac{K}{\gamma_w} \frac{\alpha(1+e_{cr})}{1+e} \left( \frac{\partial \sigma'_v}{\partial e} \frac{\partial e}{\partial a1} \right) \right] - \eta E \frac{\partial \alpha}{\partial a1} = \frac{1}{\alpha(1+e_{cr})} \frac{\partial e}{\partial t} \tag{3}$$

where:

$G_s$  = specific gravity of solids

$e$  = void ratio

$e_{cr}$  = crack opening void ratio

$\sigma'_v$  = vertical effective stress

$\sigma_v$  = total vertical tension

$\gamma_w$  = specific weight of water

$\gamma_s$  = specific weight of grains

$K$  = hydraulic conductivity function

$a1$  = Lagrangian spatial coordinate

$E$  = rate of evaporation

$t$  = time

$\eta$  = factor of loss due to cracks.

It is noteworthy that the  $\eta$  function represents an intrinsic characteristic of the site, influenced by climatic conditions and the pattern of crack formation. Due to the lack of specific data for this factor in the region and in the material studied, it was determined by means of adjustment, using calibration with real field data including the estimated drying times, the final height of the reservoir and the number of cycles performed.

At the moment of crack opening, the void ratio is related to the total vertical stress by the cracking function, obtained experimentally in the laboratory or field observations. The  $\alpha$  function describes the geometry of cracks from the beginning of 3D contraction until reaching a void ratio, being expressed as the ratio between the volume of the cracked soil and its height, in unit area. Yao & Znidarcic (1997) proposed empirical expressions for both functions, which are described by Equations 4 and 5, respectively.

$$e_{cr} = \frac{1}{d^*} + \frac{1}{(b^* \sigma_v^{cf} + a^*)^{c^*}} \tag{4}$$

$$\alpha = \frac{1+e}{1 + \frac{2}{3}e_{cr} + \frac{1}{3}e} \tag{5}$$

where:

$\sigma_v^{cr}$	=	vertical stress at crack opening
$e_{cr}$	=	void ratio at crack opening
$e$	=	void ratio
$a^*, b^*, c^*$ and $d^*$	=	cracking function adjustment parameters determined by laboratory tests in centrifuge or direct measurements in the field.

In summary, the program numerically solves the equation of consolidation and desiccation by means of the central and advanced mixed method of finite differences, providing the distribution of the void ratio along the soil layer, in instants of time provided by the user and in the definition of the intervals. In addition, the pore pressure distribution along the layer, the height of the soil layer, the SC and the average dry specific weights are also provided at any given time.

It is important to highlight that CONDES0 provides a solution for the consolidation and desiccation of homogeneous soft fine soils with high compressibility, low resistance and low permeability, with a uniform or non-uniform distribution of void ratio (Almeida 2004). In addition, it simulates the processes for the saturated soil condition, being automatically interrupted when the soil void ratio reaches, at any instant of time, the void ratio corresponding to the contraction limit ( $e_{min.}$ ) obtained from the free shrinkage test. This condition, however, does not constitute a limitation for the software since it is known, from the shrinkage limit, that although the loss of water from the soil voids continues to occur, no volumetric variation/deformation is significant.

Other information on the numerical methods and techniques used by CONDES0 for the solutions of the equations that model the processes of consolidation and dryness can be obtained from Yao & Znidarcic (1997) and Yao et al. (2002).

### 3 Numerical modelling

#### 3.1 Database

The simulations in CONDES0 were carried out based on inputs that were defined based on reference works (Silva 2003; Almeida 2004; Marinho 2024), monitoring data and field and laboratory trials carried out for bauxite tailings. In all, the laboratory investigation campaign included: three free shrinkage tests to determine  $e_{min.}$ ; five granulometry tests to determine the particle size distribution; five pycnometer tests to determine the real density of the grains; and two HCTs to determine the parameters of compressibility and permeability.

The field data include historical series of evaporation data in the study region; field monitoring of the SC of the tailings throughout the drying cycles and readings of rulers installed at the disposal sites to monitor the thickness of tailings in the field in the last eight filling cycles of each quadrant.

#### 3.2 Parameters for 3D drying simulation

For the implementation of the numerical model, the parameters of the adopted constitutive model, boundary conditions and the geometry of the problem must be assigned. According to the constitutive model proposed by Yao & Znidarcic (1997) for 3D resection, the permeability and compressibility parameters presented in Table 1 are necessary and were determined based on HCT tests performed for the material for two different initial SC (34% and 38%). The parameters for the compressibility and permeability curve with 30% of initial SC were obtained by means of adjustments and estimation from the curves referring to the other contents.

**Table 1 Compressibility and permeability parameters of bauxite tailings for different initial solids contents by weight**

SC (%)	A	B	C (m/day)	D	Z (kPa)
30	3.30	-0.19	0.00030	2.40	0.03
34	3.39	-0.22	0.00039	2.64	0.13
38	4.21	-0.31	0.00076	2.17	0.89

The actual particle density determined by the pycnometer test was 2.767 and the minimum void ratio determined by the free shrinkage test was 0.64. For the crust, the parameter was adopted as equal to the minimum void ratio, following the premise presented by Almeida (2004). The cracking function parameters were determined by monitoring cracks in the field and also observing bauxite tailings, as carried out by Marinho (2024). These parameters are shown in Table 2.

**Table 2 Physical indices of bauxite tailings and cracking function parameters**

Gs	$e_0$	$e_{crust}$	$a^*$	$b^*$	$c^*$	$d^*$
2.767	0.64	0.64	0.096	0.075	0.978	1

The evaporation rate was adopted as the boundary condition at the top of the disposed layer, and at the base the no-flow condition (impermeable base) was defined. Based on field monitoring data, for the dry period an average evaporation of 0.005 m/day was adopted, and for the wet period, 0.003 m/day.

The geometry of the problem can be defined as the height of the tailings release, since the CONDES0 software evaluates the consolidation in a 1D mesh. Therefore, the release heights of 20, 50, 80, 110 and 140 cm were defined for each SC value used.

In the software it is also possible to perform simulations in filling and drying stages from an input of filling flow and filling or waiting time. With this, it was possible to obtain an estimate for the base curve covering all cycles currently practiced in the tailings disposal system and calibrate the model to real field data.

### 3.3 Methodology and limitations

In general, the drying study was divided into two stages: calibration and sensitivity analysis. The initial calibration of the model and the  $\eta$  function were carried out based on field data covering the entire cycle of tailings disposal and from the SC of 34% and disposal thickness of 50 cm, which are initial premises for operation of the system. The process began with a simulation of filling up to a specific level of tailings corresponding to a given release thickness to generate the profile of the deposited layer. Then the drying and consolidation of this layer was simulated, resulting in a new profile of reduced thickness due to water loss and material consolidation.

With the results obtained, the time necessary for the SC to reach 60% (the value at which the next layer is currently released) was identified in the output files. This time was then compared with the field monitoring data to validate the calibration of the  $\eta$  parameter. After the simulation of drying the first layer, the software made it possible to continue the simulations using these results as a starting point, allowing modelling of the subsequent layers. Thus, simulations of filling and drying new layers were carried out until reaching a total height of approximately 3.2 m.

Then the  $\eta$  function was calibrated for the drying of only the first layer and sensitivity analyses of the drying curve were conducted, considering different contents of initial solids and release thicknesses. These analyses demonstrate the expected relationship between the SC over time and the applied thickness for each initial SC. The developed charts serve as predictive tools to evaluate drying behaviour under various operating conditions.

As regards limitations, the modelling considered the filling and drying process at only one specific point of the reservoir, which may not adequately represent the entire disposal area. Another point was the lack of information on the water flow at the base of the layer, which was assumed to be impermeable in the model to provide a conservative estimate of the drying time. In addition, the model did not incorporate the effect of overload consolidation of the upper layers or the presence of a water level that would be drained by spillways and could impact the beginning of the moisture loss process.

### 3.3.1 Calibration

In the calibration stage some assumptions were adopted based on operational criteria:

- The evaluation of the SC was done at a single point.
- The tailings disposal duration was considered one day.
- Based on the safety and workability criteria of the tailings in the field, the SC of 60% was defined as the target for the start of the tailings dry backfill process (mechanical excavation).
- After reaching 60% of SC at depth, the analysis point would already be able to receive new releases.
- Under current conditions, eight filling and drying cycles are carried out until a height of approximately 3.2 m is reached inside the reservoir.
- The tailings are released with an initial SC of 34% and a thickness of 0.5 m.

After defining these aspects, the  $\eta$  was calibrated based on the average drying time of the eight disposed layers, the final height of the tailings and the number of cycles performed. This calibration aimed to validate the software's capability to accurately predict the behaviour of bauxite tailings during the consolidation and drying phases using real field data. As a result, the complete curve of tailings disposal and drying cycles was obtained, with values that coincide with the current operation of the structure, and the  $\eta$  parameter corresponding to the dry and rainy periods.

### 3.3.2 Sensitivity analysis

After the base curve was defined, the  $\eta$  function was adjusted based on the observed drying times for the first layer disposed. Then 15 combinations of thicknesses and initial SC were established for the simulations. Drying simulations were performed for each combination, and the results were organised in charts that show the evolution of the SC over time as a function of the layer thickness. The results presented serve as a practical tool for evaluating the influence of initial SC and release thickness on tailings drying. In addition, charts assist in estimating the expected drying behaviour under different conditions, helping in the planning and optimisation of tailings release and drying operations.

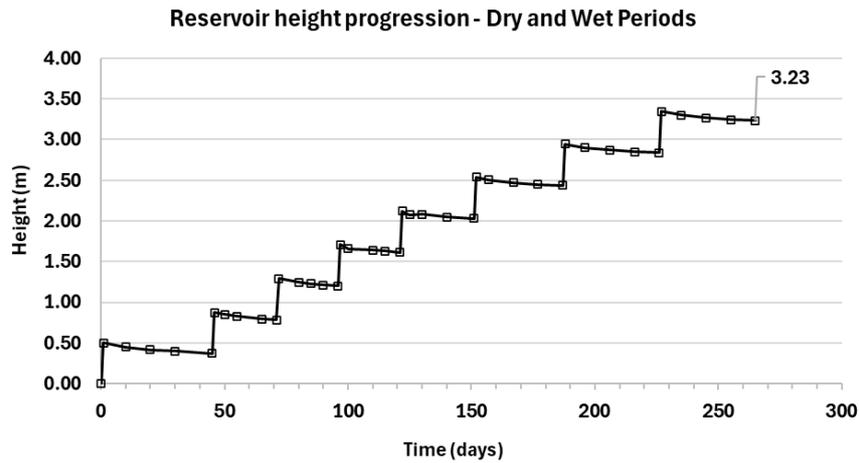
It is important to note that the drying of a single layer was simulated without evaluating the impact of the upper layers deposited later. In practice, upper layers with different SC can influence the drying behaviour of the lower layer, especially when they retain more water, increasing the drying time. In addition, as mentioned before, the model did not incorporate the effect of overload consolidation of the upper layers, which could accelerate water loss due to additional compression of the lower layers, resulting in a shorter drying time than estimated.

On the other hand, the premise of an impermeable base for the layer of tailings released was adopted as a simplification of the modelling. This approach disregards drainage or induced percolation scenarios at the base, which could significantly reduce drying time.

## 4 Results and discussion

### 4.1 Base drying curve

In view of the occurrence of filling and drying cycles in both the dry and rainy periods, it is understood that the best way to simulate this condition in CONDES0 is to perform part of the cycles with the average evaporation of the dry period and another part with the average evaporation of the rainy period. Thus, it was decided to simulate the filling of the structure with the four initial cycles in the dry period and the final four cycles in the wet period, as shown in Figure 1.

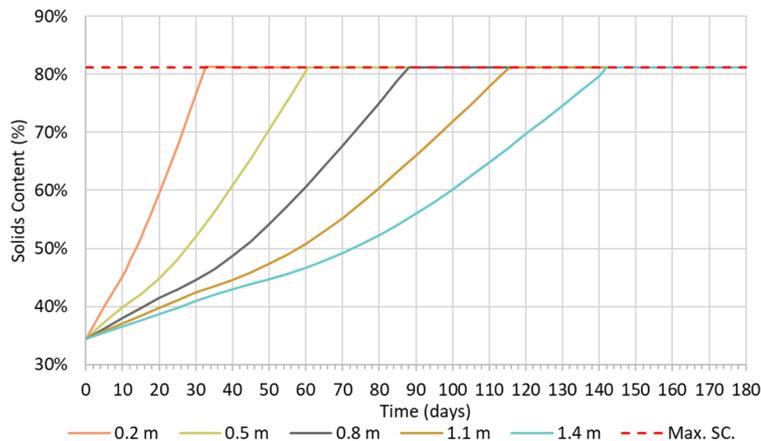


**Figure 1 Progression of reservoir height after 8 layers of 50 cm with initial solids content by weight of 34%**

It is verified, therefore, that the simulated scenario is close to the real behaviour in the field, especially when the premise of four cycles in the dry season and four in the rainy season is adopted. For this, the value of  $\eta = 1.0$  for the rainy season and  $\eta = 1.5$  for the dry period was used. However, it is observed that when these constants are adopted, the first cycle has a longer time for drying, possibly due to the boundary conditions at the base of the layer (no-flow). Therefore, to calibrate the model with the drying times observed in the field in the first layer, the values of the  $\eta$  parameter were adjusted to 3.9 in the rainy season and 4.1 in the dry season.

### 4.2 Sensitivity analysis results

From the calibration performed for the  $\eta$  function, the drying charts for the first layer were obtained and are shown in Figures 2 to 7.



**Figure 2 Tailings drying chart with initial solids content by weight of 34% – wet period**

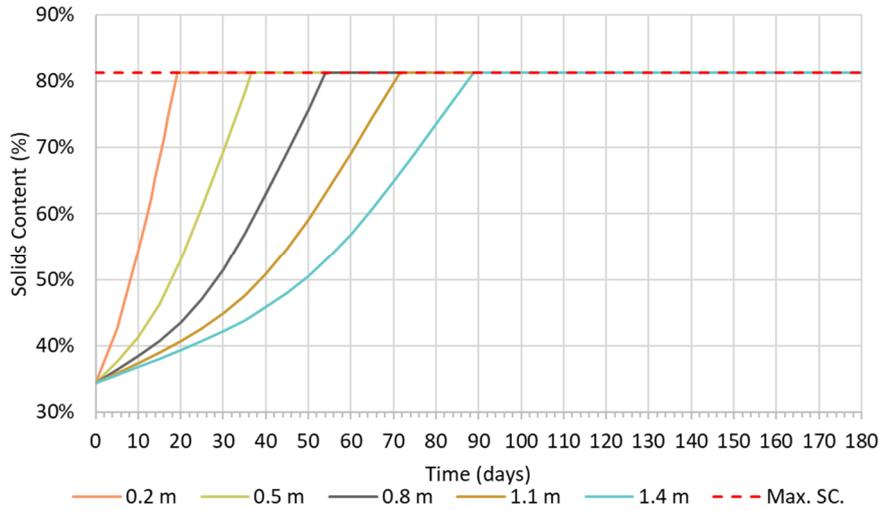


Figure 3 Tailings drying chart with initial solids content by weight of 34% – dry period

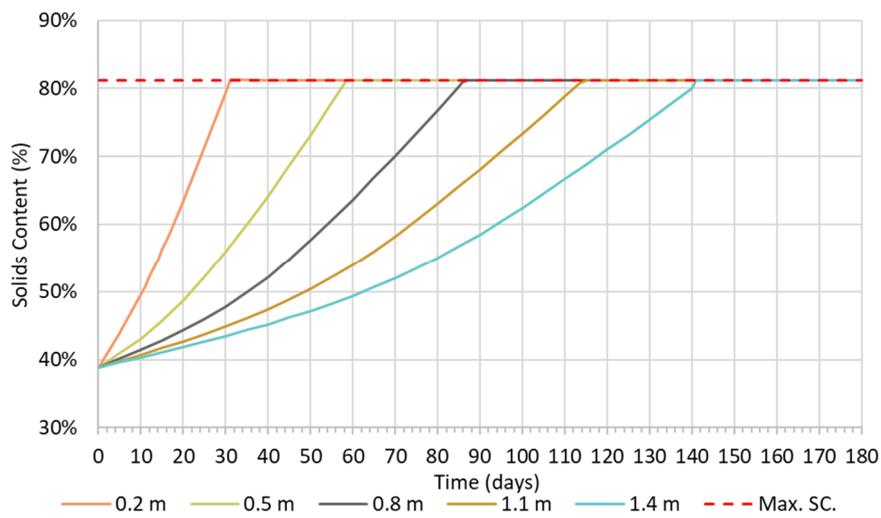


Figure 4 Tailings drying chart with initial solids content by weight of 38% – wet period

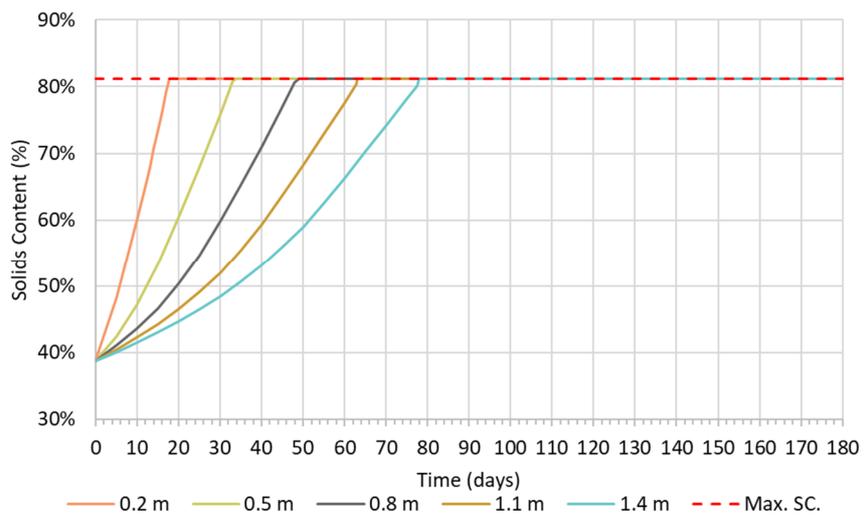
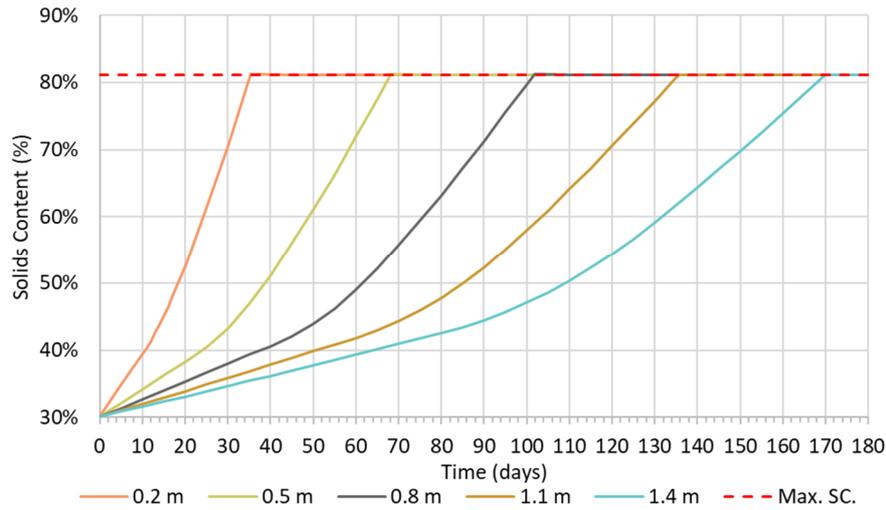
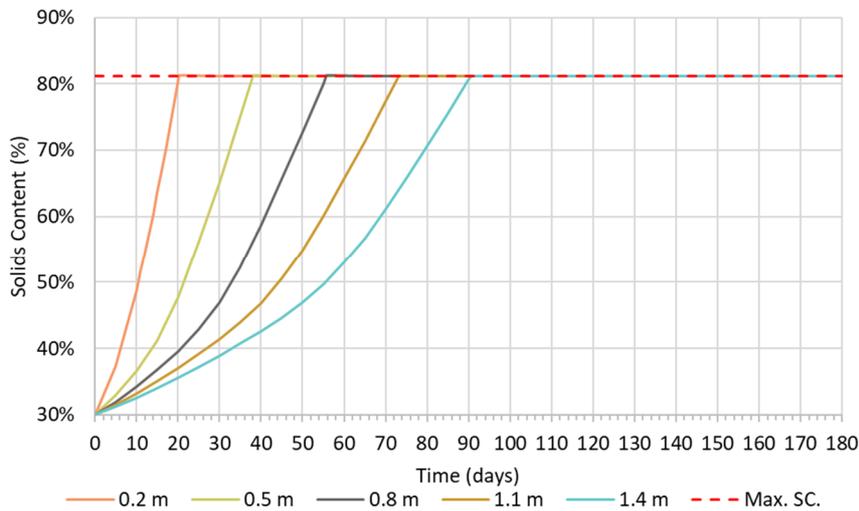


Figure 5 Tailings drying chart with initial solids content by weight of 38% – dry period



**Figure 6 Tailings drying chart with initial solids content by weight of 30% – wet period**



**Figure 7 Tailings drying chart with initial solids content by weight of 30% – dry period**

The required time for the tailings to reach a SC of 60% was determined for the different simulated conditions, as shown in Tables 3 and 4. It is evident that an increase in layer thickness and a decrease in initial SC both lead to longer drying times across all scenarios.

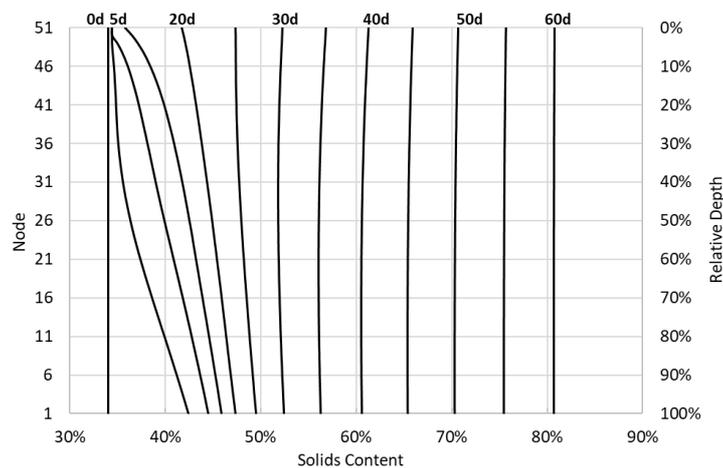
**Table 3 Drying time of bauxite tailings to the target of 60% solids content by weight – dry period**

Initial Solids Content	30%	34%	38%
<b>Thickness</b>			
0.2	14 days	13 days	10 days
0.5	28 days	25 days	20 days
0.8	42 days	38 days	30 days
1.1	56 days	51 days	41 days
1.4	70 days	64 days	51 days

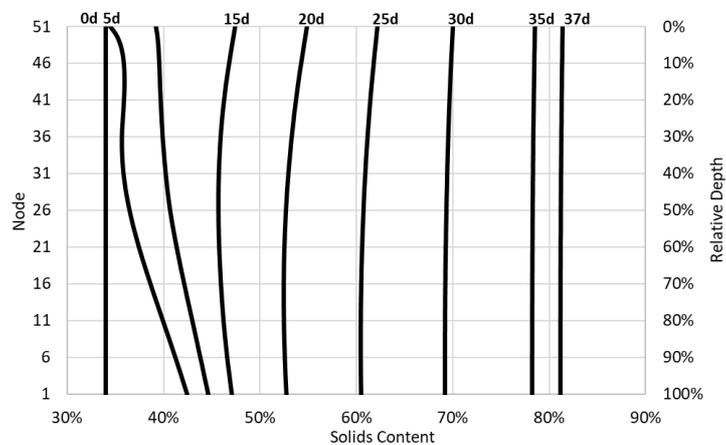
**Table 4** Drying time of bauxite tailings to the target of 60% solids content by weight – wet period

Initial Solids Content	30%	34%	38%
Thickness			
0.2	24 days	20 days	17 days
0.5	49 days	39 days	35 days
0.8	76 days	60 days	55 days
1.1	104 days	80 days	75 days
1.4	131 days	100 days	95 days

Another way to evaluate the drying of the material is through in-depth assessment of SC. In CONDES0, the domain is divided into 51 nodes, where the 1st node is at the base and the 51st at the top of the layer. As the layer thickness decreases over time, the concept of relative depth is introduced, representing the position of each node as a percentage of the total layer thickness at a given time. This allows consistent evaluation of moisture loss along the layer. Figures 8 and 9 illustrate this variability for an initial SC of 34% and a disposal thickness of 50 cm, during dry and wet periods, respectively.



**Figure 8** Solids content by weight at depth for 50 cm disposal with initial solids content by weight of 34% – dry period



**Figure 9** Solids content by weight at depth for 50 cm disposal with initial solids content of 34% – wet period

## 5 Conclusion

The limitations of these models lie in the difficulty of accurately representing the real field conditions, such as the intrinsic heterogeneity of the materials and the climatic variability, among other phenomena that can occur during drying. In addition, the parameters necessary to calibrate the models are not always easily obtained and may require detailed laboratory and field tests, which can increase the cost and time of analysis.

Despite this, the estimate presented for the parameters of compressibility and permeability of bauxite tailings with 30% of initial SC were consistent with the results obtained, indicating the possibility of adjusting these curves when other tests are available for the same material. However, it should be noted that this estimate must be validated via laboratory tests or field trials. It is also important to consider that climatic factors can influence the drying curves, and that the curves obtained relied on past climatic events. Therefore, any climatic change can impact the results of tailings drying times in the field.

The charts developed (Figures 2 to 7) in this study play an important role in the daily operation of the site, providing a practical tool for decision-making related to tailings management. By correlating the release SC with the estimated drying time to achieve the excavation solids content, charts allow operators to plan and optimise the use of disposal structures, promoting operational efficiency. In addition, the charts provide support for real-time operational adjustments, allowing for quick responses to weather or operational variations, which contributes to an operation aligned with the site's safety and productivity objectives.

Although the models of consolidation and resection offer relevant information about the behaviour of tailings, the validation of these models through real test areas in the field is essential to ensure their practical applicability. Test areas allow you to observe how the tailings respond to actual operating conditions, including climatic variabilities, material heterogeneities and structural interactions that are difficult to replicate in numerical models. In addition, field tests make it possible to calibrate and adjust the parameters used in the modelling, increasing the accuracy of the forecasts. Thus, field tests play a crucial role in validating the results obtained through modelling, allowing a deeper understanding of the phenomena involved and supporting safer and more efficient operational decisions.

In summary, the CONDES0 software allowed the drying analyses to be conducted to meet the criteria defined for the type of simulated problem, providing important results for understanding of the drying times of tailings in the field. As conclusions, the study showed that:

- The software used proved to be efficient regarding the simulation of the consolidation and desiccation of the bauxite tailings to the extent that the results of the base curve calibration were adherent to the field monitoring data.
- Regarding the sensitivity analysis, the results are also consistent with what is expected for SC other than 34%. While releases with higher initial water contents tend to have longer drying times, larger release thicknesses also suffer the same effect.
- In general, the effect of the variation in the disposal thickness was more relevant in the drying time than the variation of the initial SC range. Moreover, for the layers with a thickness greater than 80 cm during the rainy season, the variation in the SC had a relevant impact on the drying time.
- The evaluation of the progression of the SC at depth shows that, at first, there is a greater gain in SC in the deeper zones. From a certain point, water loss becomes greater in the most superficial area. This behaviour may initially be related to the phenomenon of consolidation, which promotes the expulsion of water more significantly at the bottom of the layer and, later, to the opening of cracks, which favour drying on the surface. Also, during the dry period, the drying mechanism has a greater impact on the increasing of SC when compared to results in the wet period.

As next steps, future studies should be deepened through complementary tests, including new HCTs, to refine the technical parameters and further develop understanding of the behaviour of the tailings. The implementation of field trials is also planned to validate the curves obtained and verify the performance of the tailings under typical operating conditions.

## Acknowledgement

We express our gratitude to Pimenta de Ávila Consultoria Ltda for its continued support and collaboration throughout this study. The technical expertise and insights were invaluable in the development and application of the methodologies presented.

## References

- Abu-Hejleh, AN 1993, *Desiccation Theory for Soft Soils*, PhD thesis, University of Colorado, Boulder.
- Abu-Hejleh, AN & Znidarcic, D 1995, 'Desiccation theory for soft cohesive soils', *Journal of Geotechnical Engineering*, vol. 121, no. 6, pp. 493–502.
- Almeida, FE 2004, *Numerical Analysis of the Drying Process of a Fine Tailings From Iron Mining*, Master's thesis, Federal University of Ouro Preto, Ouro Preto.
- Foster, M, Fell, R & Spannagle, M 2000, 'The statistics of embankment dam failures and accidents', *Canadian Geotechnical Journal*, vol. 37, no. 5, pp. 1000–1024.
- Fredlund, DG, Rahardjo, H & Freire, EG 1996, *Soil Mechanics for Unsaturated Soils*, Wiley, New York.
- Gibson, RE, England, GL & Hussey, MJL 1967, 'The theory of one-dimensional consolidation of saturated clays: I. Finite nonlinear consolidation of thin homogeneous layers', *Géotechnique*, vol. 17, no. 3, pp. 261–273.
- Gibson, RE, Schiffman, RL & Cargill, KW 1981, 'The theory of one-dimensional consolidation of saturated clays: II. Finite nonlinear consolidation of thick homogeneous layers', *Canadian Geotechnical Journal*, vol. 18, pp. 280–293.
- Marinho, CA 2024, *Evaluation of the Disposal and Drying Processes of a Bauxite Washing Tailings*, Master's thesis, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro.
- Morris, PH, Graham, J & Williams, DJ 1992, 'Cracking in drying soils', *Canadian Geotechnical Journal*, vol. 29, no. 2, pp. 263–277.
- Oliveira Filho, WL 1998, *Verification of desiccation theory for soft soils*, PhD thesis, University of Colorado, Boulder.
- Peng, M & Zhang, LM 2012, 'Breaching parameters of landslide dams', *Landslides*, vol. 9, no. 1, pp. 13–31.
- Rodríguez, R, Sanchez, M, Ledesma, A & Lloret, A 2007, 'Experimental and numerical analysis of desiccation of a mining waste', *Canadian Geotechnical Journal*, vol. 44, no. 6, pp. 644–658.
- Silva, DR 2003, 'Experimental studies of the drying process of a fine mining tailings', *Revista Escola de Minas*, Universidade Federal de Ouro Preto, Ouro Preto, pp. 261–265.
- Take, WA 2003, *The Influence of Seasonal Moisture Cycles on Clay Slopes*, PhD thesis, University of Cambridge, Cambridge.
- Talbot, JR & Deal, CE 1993, 'Rehabilitation of cracked embankment dams', *Geotechnical Practice in Dam Rehabilitation: Proceedings of the Specialty Conference*, American Society Of Civil Engineers, New York, pp. 267–283.
- Tang, C S, Zhu, C, Cheng, Q, Zheng, H, Xu, J, Tian, B & Xi, B 2021, 'Desiccation cracking of soils: a review of investigation approaches, underlying mechanism, and influencing factors', *Earth-Science Reviews*, vol. 216, <https://doi.org/10.1016/j.earscirev.2021.103586>
- Terzaghi, K 1943, *Theoretical Soil Mechanics*, Wiley, New York.
- Xu, J-J, Zhang, H, Tang, CS, Cheng, Q, Liu, B & Shi, B 2020, 'Automatic soil desiccation crack recognition using deep learning', *Géotechnique*, vol. 72, no. 4, <https://doi.org/10.1680/jgeot.20.P.091>
- Yao, TC, Oliveira Filho, WL, Cai, XC & Znidarcic, D 2002, 'Numerical solution for consolidation and desiccation of soft soils', *International Journal for Numerical and Analytical Methods in Geomechanics*, vol. 26, pp. 139–161.
- Yao, TC & Znidarcic, D 1997, *User's Manual for Computer Program CONDES00*, University of Colorado, Boulder, Colorado.