



## **Creation of an evacuation protocol for bedridden and mobility impaired people in mining tailings dam disasters**

### **Criação de um protocolo de evacuação para pessoas acamadas e com dificuldades de locomoção em desastres de barragens de rejeito de mineração**

**Marcelo Marques de Sant'Ana**

Master in Defense and Civil Protection UFF

**Alexandre Luís Belchior dos Santos**

Master in Defense and Civil Protection UFF

**Paulo Gustavo Von Krüger**

Master in Defense and Civil Protection UFF

**Márcia Motta Pimenta Velloso**

Master in Defense and Civil Protection UFF

**Armando Hideu Momose**

Master in Defense and Civil Protection UFF

**Flávia Mello**

Master in Defense and Civil Protection UFF

**Keywords:** Evacuation protocol, Dam disasters, Mines.

## **1 INTRODUCTION**

The various events related to dam ruptures, especially those occurred by the Fundão dam in the city of Mariana in 2015 and by the Córrego do Feijão dam in the city of Brumadinho in 2019, have shown that there is a possibility that populations that are downstream, or below, these structures and are exposed to the risk of disasters are not contemplated with prevention and response actions such as emergency drills and orientation seminars.

That is why there is an extreme need to plan actions in this direction, which will be presented below in this research work.

## **2 OBJECTIVE**

Verify the need for a rescue protocol for people with walking difficulties during the response to disasters involving dam ruptures in Secondary Safety Zone (SSZ) areas,



where there is no requirement by legislation for effective actions for the removal of people with walking difficulties.

### **3 METHODOLOGY**

Through the analysis of bibliographies and standards, which address the research theme, the state of the art was verified, proceeding to a bibliographic review with the areas of engineering and civil protection and defense. The qualitative inductive method was used in the research to study and describe the profile of vulnerable populations, who live daily in the impact zones, by hypothetical risk of impact of dam rupture, including people with walking difficulties and bedridden.

In the literature review, it was verified, through the careful analysis of the dam safety standards, that the following descriptors are used: the disaster characterized by the dam failure, the risk scenario, time of arrival of the flood spot, depth and speed, priority for rescue of people, resources necessary for evacuation, calculation of displacement, rescue and referral to safe places.

And it was used, to support the data collection to the rescue procedures of people with locomotion difficulties in disasters of dam ruptures, the Regaste Plan for People with Locomotion Difficulties for the locality of Honório Bicalho in the municipality of Nova Lima/MG, highlighting the information referring to the ZSS of the Emergency Action Plan for Mining Dams - PAEBM of the B3/B4 dam.

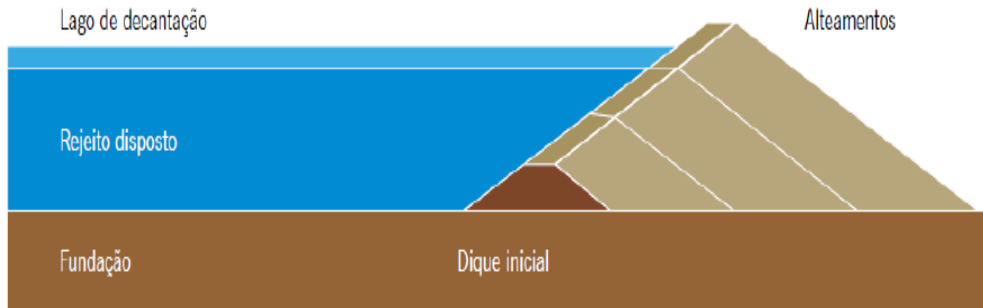
### **4 DEVELOPMENT**

A tailings dam is an earthen structure designed to store solid waste and water from mining operations. In the phase called 'ore processing', the amount of waste produced is very large and its distribution is made on the surface of the land, in disposal basins composed of dams. (MINAS GERAIS, 2019)

There are dams built in a single stage with the purpose of damming water; however, in the case of mining, because it is necessary to keep up with the pace of mining, the so-called elevations are carried out, which happen according to the production of tailings. (MINAS GERAIS, 2019)

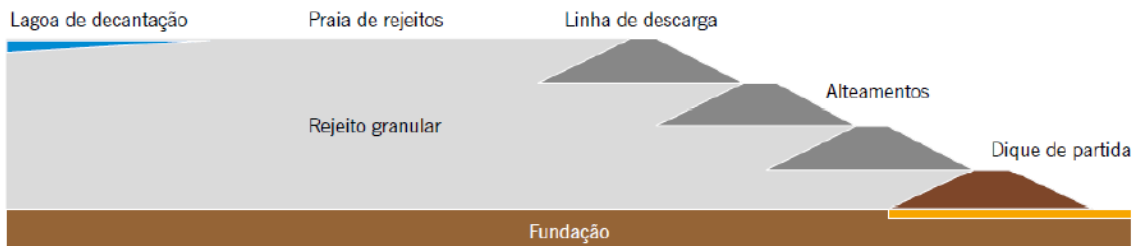
Thus, in Brazil, there are three main types of dam elevations, and the risks associated with these structures are closely linked to their elevation mode: downstream, upstream and centerline, according to Figures 1, 2 and 3, respectively. (BRAZILIAN MINING INSTITUTE, 2016)

Figure 1 - Downstream elevation.



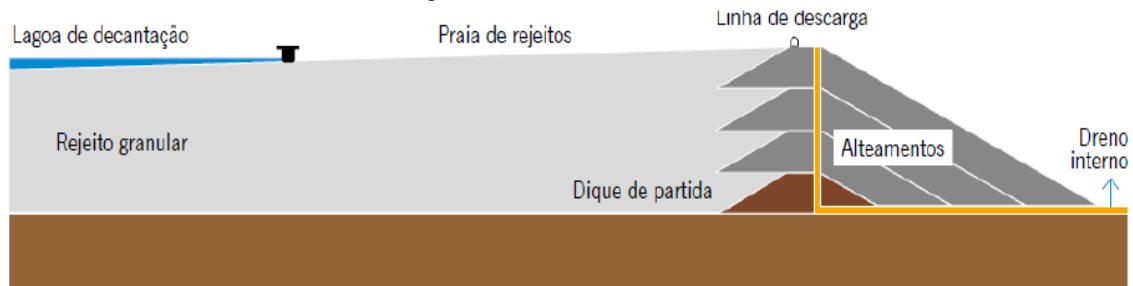
Source: IBRAM, 2016 (adapted).

Figure 2 - Upstream raising.



Source: IBRAM, 2016 (adapted).

Figure 3 - Centerline elevation.



Source: IBRAM, 2016 (adapted).

In the event of a dam failure, which are these earthen structures intended to store solid waste and water from mining, many victims may arise from this type of technological disaster (Brazil, 2014), especially those who are more vulnerable, bedridden and physically disabled, who do not have adequate rescue conditions and who may easily die.

Sometimes, what is seen is that in areas where the flooding by tailings after the rupture of the structure exceeds 30 minutes or 10 km, called Secondary Safety Zone (ZSS), the Public Power represented by the Municipal Civil Defense and / or the State Civil Defense is, in fact, unaware of the risk that the populations concerned in these areas are exposed since the entrepreneur (mining companies), have no concrete responsibilities



in the areas that exceed the ZAS, observing what is provided for in ANM RESOLUTION No. 95, OF FEBRUARY 07, 2022. (ANM, 2022)

Even in the face of legislation that regulates evacuation protocols in the SAZ, there is no objective technical criterion for evacuation in the later zone, which is the SSZ. Most of the time what we have are people without any kind of training or knowledge of the risk to which they are exposed, which makes the bedridden and disabled population more vulnerable.

Thus, it is evident that there are no practical means of evacuation of this portion of the population and there is an urgent need to find ways to pacify the survival of the mining sector, which involves tailings dams, with the communities downstream of these enterprises, especially those in the ZSS, where bedridden people and people with locomotion difficulties are located, and for these there is no specific action plan for effective rescue and rescue.

## **5 FINAL CONSIDERATIONS**

The results of the research with the case study presented, showed that the evacuation time of part of the population concentrated in the ZSS, does not minimally match the premises of safeguarding lives, evidencing that it is necessary to create specific protocols for the rescue of people. And that it is necessary to point out and plan the means and resources to be used to register the population, according to the time of arrival of the flood spot.

Efforts need to be directed towards ensuring that all areas or zones of impact and risk of these structures are treated in an isonomic manner, bringing safety to people's lives, regardless of how far they are residing downstream of these dams.

Therefore, it is necessary to establish protocols for civil protection and defense actions, aimed at the bedridden and people with difficulty in walking, especially prevention and response actions, and the effective participation of mining companies in the planning and execution of these actions, that scientific and technical methods be applied in the elaboration of these protocols to minimize the risk and damage produced.



## REFERENCES

BRASIL. Resolução n. 4, de 15 de fevereiro de 2019. Agência Nacional de Mineração. Brasília, 2022. Disponível em: <<https://www.gov.br/anm/pt-br/assuntos/barragens/legislacao/resolucao-no-95-2022.pdfw>> Acesso em: 28/04/2023.

BRASIL. Portaria n. 187, de 26 de outubro de 2016. Secretaria Nacional de Proteção e Defesa Civil do Ministério da Integração Nacional. Brasília, 2016. Disponível em: <<https://sogi8.sogi.com.br/Arquivo/Modulo113.MRID109/Registro1255855/portaria%20mi%20n%20187%20de%2026102016.pdf>> Acesso em: 29/04/2023.

BRASIL. Portaria n. 70.389, de 17 de maio de 2017. Departamento Nacional de Produção Mineral. Departamento Nacional de Produção Mineral. Brasília, 2017. Disponível em: <<http://www.anm.gov.br/dnpm/documentos/portaria-dnpm-no-70-389-de-17-de-maio-de-2017-seguranca-de-barragens-de-mineracao>> Acesso em: 01/05/2023.

Classificação das Barragens de Mineração Brasileiras - Data Base Fev/2019. Disponível em: <<http://www.anm.gov.br/assuntos/barragens/pasta-cadastro-nacional-de-barragens-de-mineracao/classificacao-oficial-anm>> Acesso em 04/05/2023.

Informações sobre barragens - Agência Nacional de Mineração. Disponível em: <<http://www.anm.gov.br/>> Acesso em 04/05/2023.

MINAS GERAIS. Lei n. 23.291, de 25 de fevereiro de 2019. Belo Horizonte: ALMG, 2019. Disponível em: <<https://www.almg.gov.br/consulte/legislacao/completa/completa.html?tipo=LEI&num=23291&ano=2019>> Acesso em: 05/05/2023.

MINAS GERAIS. Decreto n. 46.993, de 02 de maio de 2016. Belo Horizonte: ALMG, 2016. Disponível em: <<https://www.almg.gov.br/consulte/legislacao/completa/completa.html?tipo=DEC&num=46993&comp=&ano=2016>> Acesso em: 10/05/2023.

COORDENADORIA ESTADUAL DE DEFESA CIVIL - CEDEC - MG. Instrução Técnica 01/2021: CRITÉRIOS PARA ELABORAÇÃO E APROVAÇÃO DO PLANO DE AÇÃO DE EMERGÊNCIA - PAE. 1. ed. Minas Gerais, 2021.

INSTITUTO BRASILEIRO DE MINERAÇÃO – IBRAM. Gestão e Manejo de Rejeitos da Mineração. Brasília: IBRAM, 2016, 128 p.

BRASIL. Ministério da Integração Nacional. Secretaria Nacional de Proteção e Defesa Civil. Classificação e Codificação Brasileira de Desastres (Cobrade). Brasília, 2014.

AGÊNCIA NACIONAL DE MINERAÇÃO - ANM. Resolução nº 95, de 07 de fevereiro de 2022. Resolução ANM Nº 95, de 07 de fevereiro de 2022. Brasília, DF, 07 fev. 2022.