Cahora Bassa Dam South Bank protection design and execution – XIVth ISL, Chambéry 2024

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Introduction:

As part of an international tender, HYDROKARST & RAZEL-BEC were selected to secure a cliff in Mozambique. This work was carried out with the collaboration of HYDROGEOTECHNIQUE and SETEC geotechnical design offices.

The purpose of the study was to design a rockfall protection of the downstream slopes on the South Bank of Cahora Bassa Dam. This study was based on field investigations and 3D modelling using photogrammetry.

This work was performed in a challenging environment as often encountered in such remote international projects (logistics, security, climate, fauna, etc.).

The Cahora Bassa Dam is located on the Zambezi River, in the northwestern part of the country, in the province of Tete.

Figure 1. Project location

The area to be secured was located above the access road to the hydroelectric power plant. The study area covered a length of 650m and was divided into two distinct zones, on either side of the access tunnel at the bottom of the dam.

- Sector 1: vertical cliff, 350m long, 250m high, located between the dam and tunnel head.
- Sector 2: sub-vertical slope, 150m long, 350m high, located between two tunnel heads, further downstream.

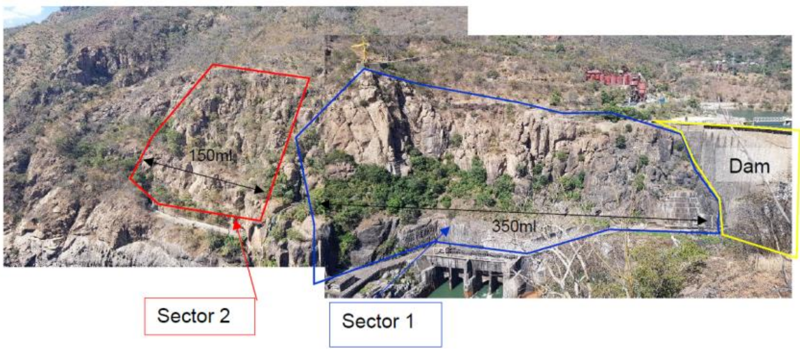


Figure 2. Zone definition

Survey techniques :

An important work of inspection using rope access was done to identify the type of materials and main rock instabilities. This task was led by one Geotechnical Engineer with the help of four Rope Access Technicians and a Civil Engineer specialized in rock reinforcement.

The site visit using alpine techniques allowed to perform fracture readings of unstable masses (dimensions, splitting possibilities, slip plane survey, type of cracks and supported orientations).

Visual and non-destructive reconnaissance were carried out with a geologist's hammer to test the weathering condition of the rocks, and a compass with clinometer to measure the orientations and inclinations of the fracture planes. Measurement of unstable zones was done with decameter and laser range finder.

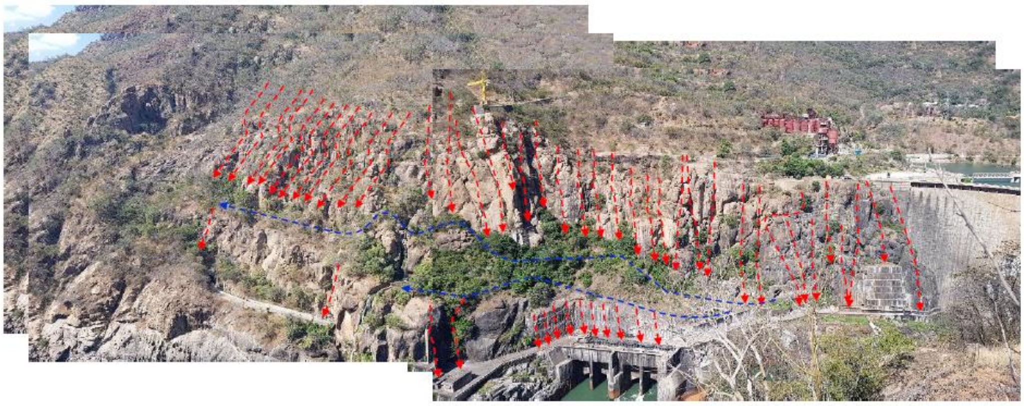


Figure 3. Inspection paths used during the geotechnical survey

Evaluation of the trajectory of unstable elements and coverage of the terrain crossed. These trajectories were studied in the office on tracking software, but the observation and "feeling" in the field were also very important (presence of trees that can impact trajectories, small intermediate projections, etc.).

A preliminary positioning of protective structures foreseen on site was done on maps and photographs from aerial surveys.

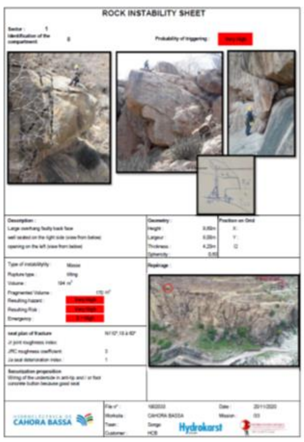


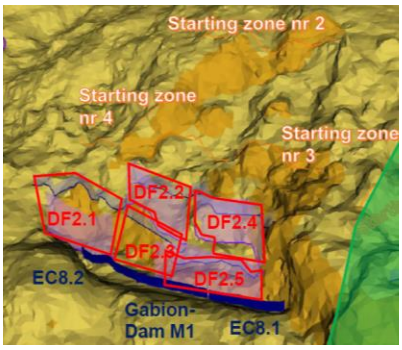
Figure 4. 3D mode base on photogrammetry

Figure 5. Rock instability sheet.

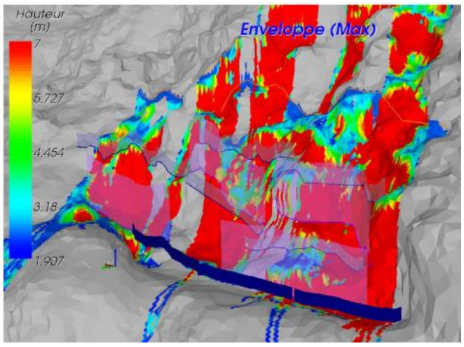
Modeling and design of protective structures:

Using the data collected during the survey, the Geotechnical Engineer was able to model the cliff of zone 2 using the RocPro3D software.

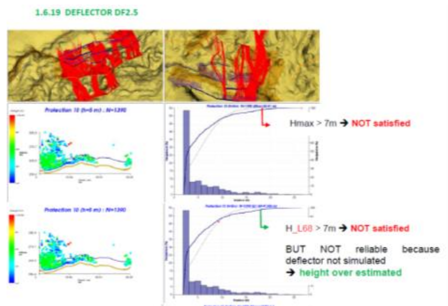
The first step of the modeling was to define the theoretical implantation of the deflector to catch most of the rockfall according to the field topography.



The second step was to define the necessary height and energy level required taking into consideration 90% of the rockfall.



The third and last step was to check the percentage of catching rock and confirm the energy level according to the simulation and on site observations.



While the Contractor checked the feasibility of the structures with its Supplier, it appeared that the long span initially planned would be too complex to implement. It was therefore necessary to divide the structure into several elements.

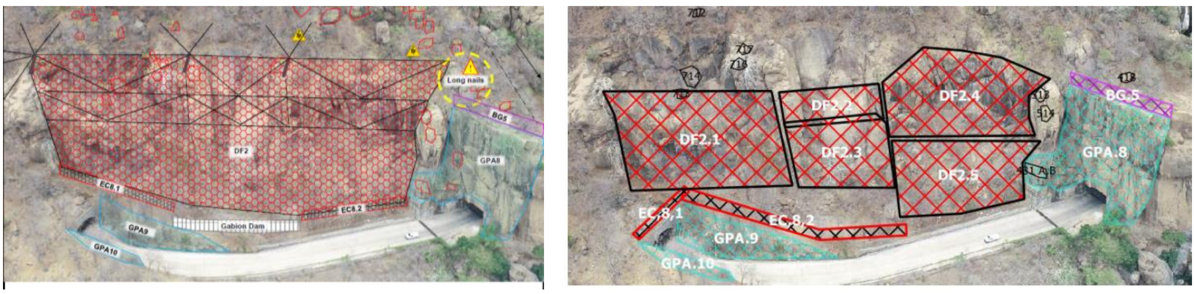


Figure 6. Structures's evolution

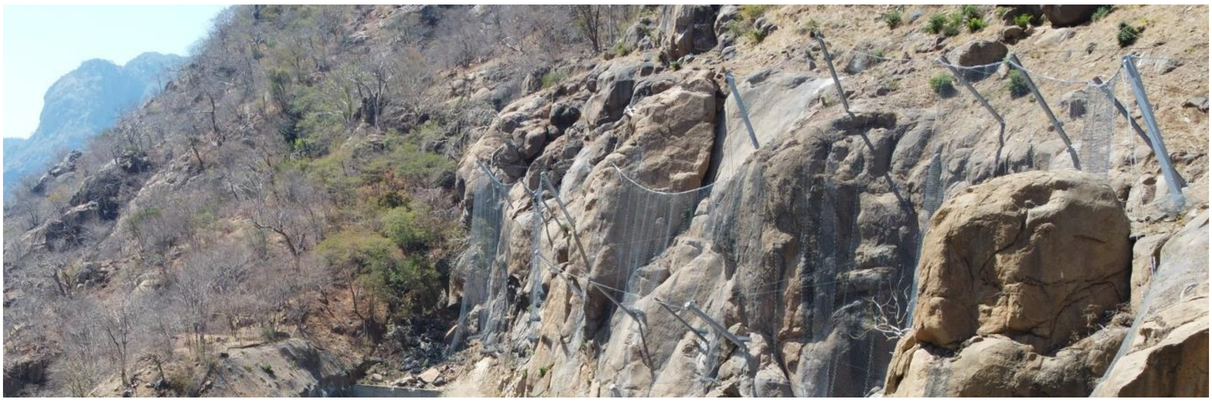


Figure 7. Structures completed

Conclusion:

Field survey is critical in the design of any rockfall protection project. This is even more important for large scale projects in remote locations with all the supply and logistics challenges. The information gathered from site by experienced Geotechnical professionals allow an optimized design of the structures by cross checking them with the outputs of software modelling. A close collaboration between the Geotechnical Engineers, the Contractors and Equipment Suppliers at an early stage of the design is also key in the success of a project.

References

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