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Real scale impact experiments on Bloc Armé® as facing of rockfall protection embankment

Agathe FURET ^{1,2,3}, Stéphane LAMBERT ², Pascal VILLARD ³, Jean-Philippe JARRIN ¹, Julien LORENTZ ⁴, Lucas MEIGNAN ¹

This article presents real-scale experiments aiming to improve the understanding of protection structure facing's response when it's subjected to dynamic loading. Here, we focus on the presentation of the test conditions and measurement methods and we introduce first experimental results.

Keywords: rockfall, protection structure, impact, real scale experiments, Bloc Armé®

1 INTRODUCTION

Rockfall protection embankments protect humans and infrastructures from high energies rockfall (Lambert and Bourrier, 2013). The national project C2ROP is currently conducted to develop tools and methods concerning rockfall hazard, risk management and protection. Part of these researches aims at (1) developing technological solutions with limited footprint and (2) improving rockfall protection embankment dimensioning methods. Experiments, including impacts from 200 kJ to 2000 kJ on innovative facing, were conducted on the testing site of Montagnole in order to provide (1) a better understanding of the dynamic response of the Bloc Armé® structure and (2) a calibration dataset for numerical models.

2 EXPERIMENTAL METHODS

2.1 Layout and equipment

The experimental layout (Figure 1) consists of the tested facing layed on a 2-m thick granular layer, acting as support platform. The support platform is made of rolled gravel 20 to 40 mm in grain size. This material was chosen because it permits displacement while keeping mechanical characteristics rather constant after successive impacts (low sensitivity to compaction).

The facing is composed of concrete blocks joined together with continued metallic frames (Bloc Armé® patent). 19 blocks are positioned in staggered rows forming a bi-pyramid shaped facing which is 4-m large, 8-m long and 0.8-m thick (Figure 1).

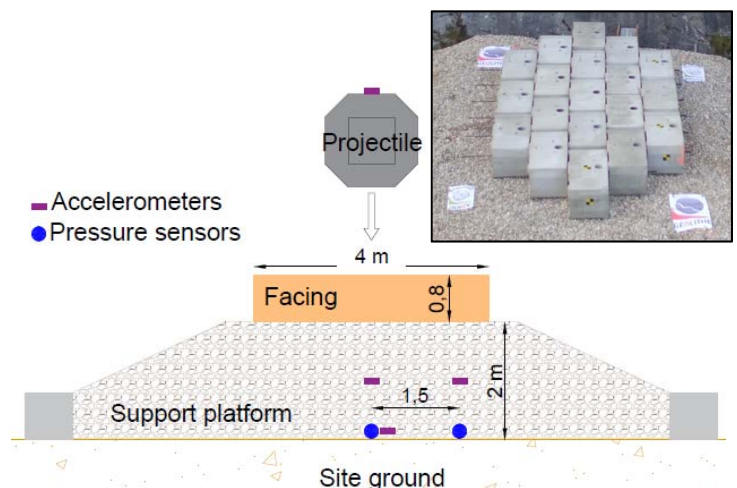


Figure 1: Cross-section of the experimental layout and facing tested

2.2 Impact tests

The experiment included three distinct stages:

1. Impacts were conducted directly on the site ground.
2. The granular platform was impacted.
3. Series of impacts were conducted on the facing layed on the support platform.

The 2 first stages aim to characterize the platform and the soil underlying the tested structures under dynamic loading.

Impacts were performed dropping ETAG27-type reinforced concrete projectiles of varying mass (2580 to 12 490 kg) from various heights (0.83 to 16.54 m.). Most of the impacts concerned the facing center.

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2.3 Measures

Measures were taken to evaluate the impact response of the tested structures, in the different stages:

- In order to evaluate displacement and load transfer in the support platform, acceleration and vertical stress were recorded in different location within the platform. (Figure 1).
- The projectile's acceleration is measured by:
 - o 3-axis accelerometer placed on top of the projectile.
 - o Two high-speed cameras recording images at 500 frames per second in two perpendicular axes at the impact height.
- Three dimensions and one-dimension geophones systems were used to measure ground vibration with the aim to estimate the energy transferred to the ground soil.
- A topographic survey was conducted during all the experiments based on sets of pictures taken by a drone to measure the deformation of the structures.
- In addition, a thermic camera showed heating and point out some element displacements during impact.

3 PRELIMINARY RESULTS

The tests permit to observe the dynamic responses and to compare the whole impacted system response on behavior with or without the facing structures. Measuring devices in the granular support platform showed acceleration at the layer mid-height and stress increment at its bottom (Figure 2).

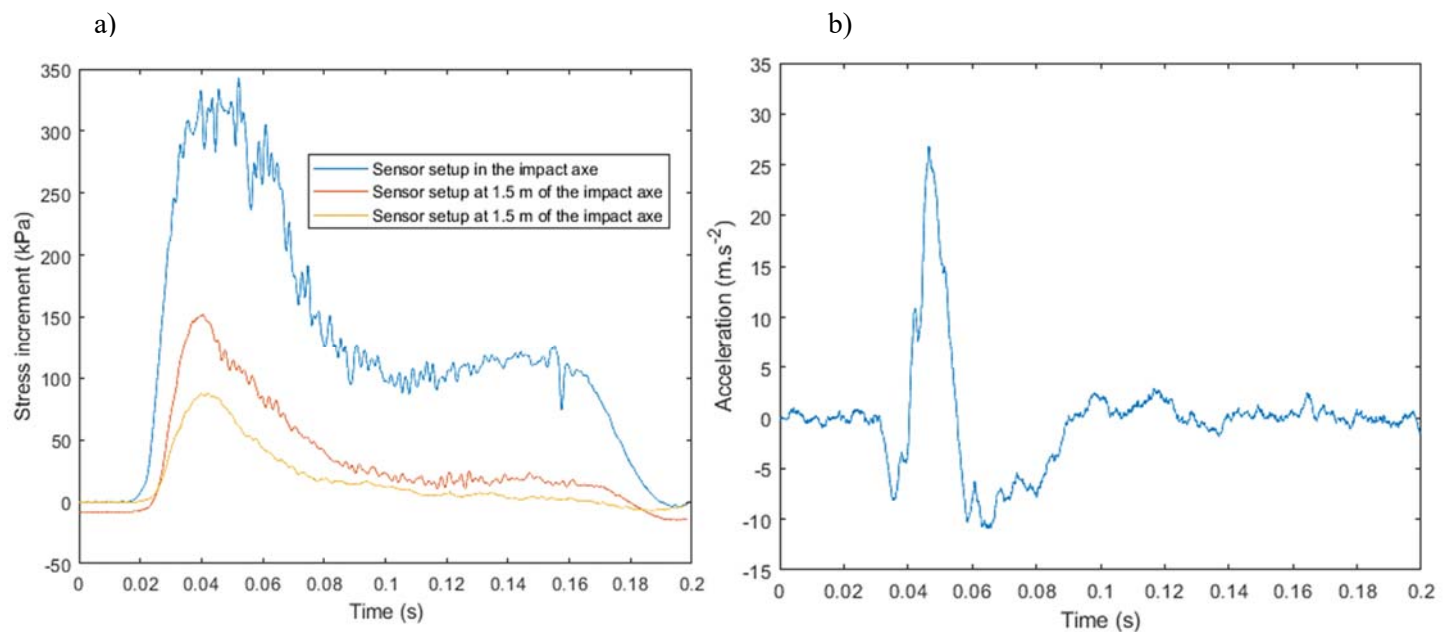


Figure 2: Measured data a) Stress increment in the pressure sensors for a 200-KJ impact test on the support platform b) Acceleration in the granular support platform for a 200-kJ impact test on the facing structure

CONCLUSION

The significant measurement dataset provided by the global experimental campaign will be used to investigate carefully the dynamical response of the facing-support platform system and to calibrate some future numerical models. Data will be analyzed in order to investigate the efficiency of the facing structure in reducing deformation under impact and distribute the loads in the support platform.

REFERENCES

- Lambert, S, and Bourrier, F (2013): Design of rockfall protection embankments: a review. Engineering geology 154 (28), 77-88.