POLITECNICO DI TORINO
Repository ISTITUZIONALE

MONITORING EXTREME ROCKFALL IMPACTS: A 10,000 KJ FULLSCALE TEST

Original
MONITORING EXTREME ROCKFALL IMPACTS: A 10,000 KJ FULLSCALE TEST / Vigna, S., Nadalini, M., Marchelli, M., De Biagi, V., Saltarin, S., Grimod, A., Peila, D.. - (2026). (Rocexs: the 8th Interdisciplinary Workshop on Rockfall Protection Grenoble (Fra) 7-9 July 2026).

Availability:
This version is available at: 11583/3012936 since: 2026-07-10T10:40:26Z

Publisher:
RocExs 2026

Published
DOI:

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

15 November 2026

MONITORING EXTREME ROCKFALL IMPACTS: A 10,000 KJ FULL-SCALE TEST

Vigna Stefano[1], Matteo Nadalini[1], Maddalena Marchelli[2], Valerio De Biagi[2], Simone Saltarin[2], Alberto Grimod[3], Daniele Peila[2]

[1] INCOFIL TECH SRL, Pergine Valsugana (TN), Italy
[2] Politecnico di Torino, Torino (TO), Italy
[3] FRANCE MACCAFERRI S.A.S, Valence, France

OBJECTIVES

Rockfall events pose a severe hazard to infrastructures, residential areas, and human life in mountainous regions. Among passive mitigation measures, rockfall protection embankments (RPEs) are the most energy-dissipative structures, typically employed for impacts exceeding 10,000 kJ. Despite their relevance, full-scale impact tests on reinforced embankments (RE-RPEs) are extremely complex, and literature reports only a few cases, with maximum energies of 4,200 kJ [1] and 6,600 kJ [2]. These tests provided only macroscopic observations about the resisting mechanism, as all sensor measurements failed under impact conditions. This work presents an innovative full-scale impact test on a RE-RPE reinforced with the Terramesh system by Maccaferri at an unprecedented energy level of approximately 10,000 kJ developed in the framework of the PERSEIDI project (CUP: C39J21046780001) (Figure 1). The primary objective was to design and implement a sensor network capable of accurately recording key impact parameters under extreme conditions and to validate its effectiveness during the test.

MATERIALS AND METHODS

- 19-ton block launched at 33 m/s via cableway, impacting the embankment's upper layers.
- Abaqus/Explicit numerical model calibrated on prior tests to predict measurements and prevent signal saturation.
- 32-sensor network embedded in the embankment plus a block-mounted stand-alone system: accelerometers, load cells, strain gauges, and gyroscope.
- High-speed cameras synchronized with sensor data for full impact monitoring.

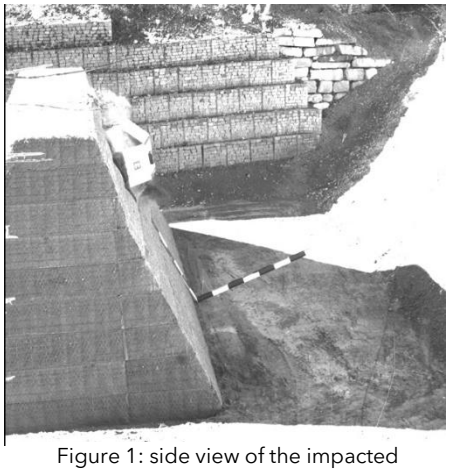


Figure 1: side view of the impacted embankment

MAIN RESULTS AND CONCLUSIONS

- Impact performed as designed, bringing the RE-RPE to near-collapse.
- Sensor network performed reliably under extreme conditions, delivering clean, accurate data.
- Peak block acceleration ~60 g; embankment and foundation load cell readings matched numerical predictions.
- First validated monitoring of a rockfall impact at 10,000 kJ: a new benchmark for RE-RPE research.

REFERENCES

[1] Peila, D., Oggeri, C. & Castiglia, C. (2007), Ground reinforced embankments for rockfall protection: design and evaluation of full-scale tests. Landslides, 4, 255–265.

[2] L. Mongiovi, M. Bighignoli, A. Danzi, and P. Recalcati (2014), An impact test on a reinforced earth embankment. In Proceedings of Interdisciplinary workshop on rockfall protection–Rocexs.