# A robust and cost-efficient design of lightweight rockfall catch fences for railways

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Trains and railway infrastructure are subjected to serious potential hazards from detached falling rock(s) in mountain regions worldwide. This can lead to severe damages, casualties and significant delays. In 2011, a rockfall event at Stromeferry bypass in Scotland caused 4 month railway closure that led to a negative impact on local businesses and the repair work cost was £3.2 million. Other examples are shown in Figs.1 and 2.

**Fig. 1 Rockfall accident at Falls of Cruachan Scotland, June 2010.**

**Fig. 2 Falling Rocks blocked the railway in Bourg St Maurice France, May 2015.**

Rock catch fences are widely used in protecting roads, railways and infrastructure from rockfall hazards. A typical design comprises of a high tensile strength wire mesh that is anchored to the ground by rigid posts and strengthened to the lateral and upslope sides by anchoring tension cables as shown in Fig. 3.

These systems are categorised by the ability to dissipate the kinetic energy of falling rock(s). Due to the lack of a practical design code, these systems are designed primarily by experience and engineering judgement, which makes the design either dangerous or highly conservative. Indeed, engineers found that the current design tend to be highly conservative which makes the costs for materials and construction too high. There is an urgent need to improve the current design based on extensive experimental tests and advanced finite element modelling. This study presents the development of a lightweight rock catch fence design.

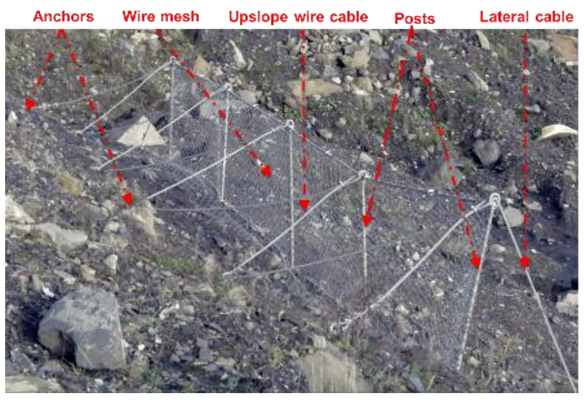


**Fig. 3 A typical design of a rockfall catch fence**

**Fig. 4 A rockfall catch fence on a hillside next to a train line.**

Design development procedure:

I- Modelling of material behaviour

A series of uniaxial tensile tests on a single wires taken from a wire mesh is conducted to accurately model the most realistic material behaviour of the mesh.

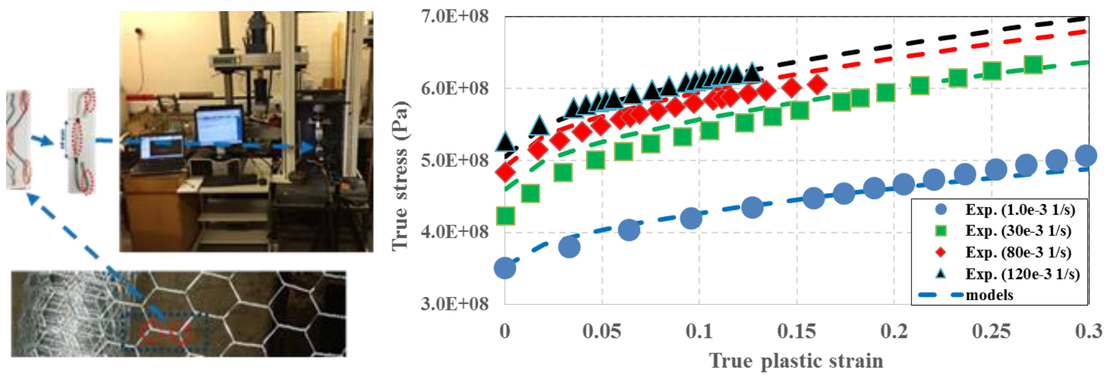


**Fig. 5 Wire samples and uniaxial tensile test setup (left); experimental data and their model representation for various loading rates (right).**

II- Modelling of impact tests

Abaqus/explicit, the finite element analysis software, is used to simulate the impact of a spherical block with various masses and impact velocities on a wire mesh panel.

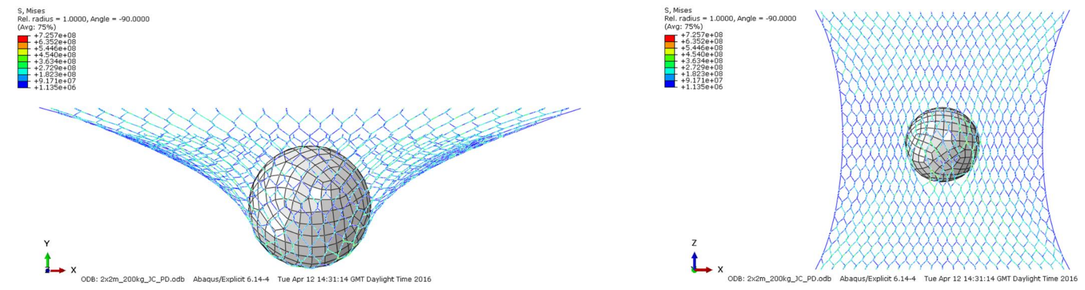


**Fig. 6 Modelling of impact tests of a spherical block on a wire mesh panel.**

III- Validating of impact tests

A test rig is designed and manufactured to validate the calculations of the impact tests.

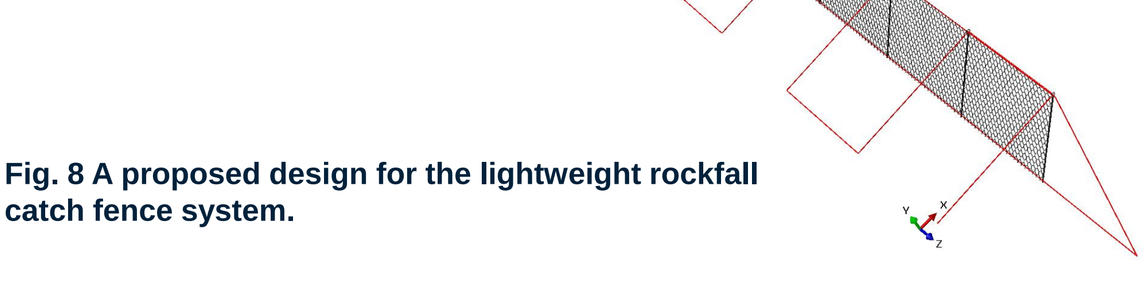


**Fig. 7 Schematic of the impact rig test (left) and the fabricated structure (right).**

IV- Modelling of a complete catch fence system

A model of modified design is currently being investigated. Different rock impact scenarios are simulated to optimise the model parameters and ensure its effectiveness under various impact conditions.

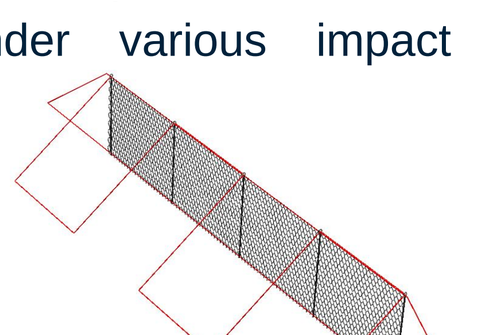

**Fig. 8 A proposed design for the lightweight rockfall catch fence system.**