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New Cushion Concepts for Protective Layers on Rockfall Galleries

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Over-aged rockfall protection galleries, new design guidelines or changing geological situations more often require a posterior strengthening of galleries. In order to keep the costs at a minimum extensive structural works should be avoided. For this purpose the effects of special cushion systems consisting of high-tensile steel wire mesh and cellular glass were tested in large-scale free-fall experiments [1] concerning their suitability as alternative cushion layer. It was evaluated how much energy can be absorbed and how much the impact forces can be reduced. The presentation also shows a qualitative and quantitative comparison to conventional cushion layer.

Normally, granular soil from the surroundings or gravel is used as cushion layer. The cushion layer distributes the contact stresses, reduces the accelerations in the striking body and increases the impact time. Centrifugal research was already performed on different cushion materials [2]. The now investigated systems are developed using high-tensile steel wire mesh (TECCO) and cellular glass (MISAPOR). The wire used for the chain-link mesh has a diameter of $3\ mm$ and a tensile strength of $1770\ N/mm$. The ultimate load of the mesh is about $150\ kN/m$. The cellular glass is produced from recycled glass and has a cube compressive strength of $6\ N/mm^2$. The granulation of the cellular glass amounts ranges from 10 to $50\ mm$ and its density is $2.5\ kN/m^3$ only. Thus, the main advantage of the cellular glass is the low dead load acting on the structure underneath.

The first setup consists of three layers of $40\ cm$ of cellular glass, which means three

times thicker but only half the weight than the gravel layer it was compared to. Between the layers of the cellular glass and on top of the cushion, a layer of high-tensile mesh is installed in order to get an improved load distribution and to activate more cellular glass.
The second setup consists of modular cylinders made from high-tensile mesh and filled with cellular glass. The cylinders have a diameter of $1\ m$ and a height of $0.6\ m$. Seven of them are placed and then covered with a layer of high-tensile mesh, again 7 cylinders and again a top layer of the high-tensile mesh. The cylinders restrict the lateral displacement of the material and create modular energy dissipating systems.

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[2] Chikatamarla, R. (2005). Rockfalls on slopes and structures, Dissertation, No. 16315, Swiss Federal Institute of Technology (ETH), Zurich.