Impact response analysis of rockfall protection fence installed on concrete foundation

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In Japan, a variety of rockfall protection structures have been installed along roads in mountainous and coastal areas to safeguard human lives and transportation networks from falling rocks. One of these structures is the conventional rockfall protection fence, which is constructed by combining materials such as H-shaped steel posts, diamond-shaped wire mesh, and wire ropes. The foundations of these fences are classified into two categories: underground concrete foundations and retaining wall foundations. Currently, the stability verification of retaining wall foundations is conducted according to the Rockfall Prevention Handbook. The stability check of the foundation, as specified in the manual, is conducted under the assumption that the load, when the column base or wire rope yields, acts horizontally and statically at a designated location. As a result, the effects of dynamic loading caused by the impact of falling rocks have not been considered. Against this background, the authors have performed drop-weight impact loading tests on the fences installed on foundations and have examined the stability of the foundations. However, such experimental investigations are both time-consuming and economically burdensome. Therefore, it is essential to develop a numerical analysis method to adequately simulate the impact-resistant behavior of these structures. In this study, a three-dimensional elasto-plastic impact response analysis was conducted with the aim of developing a numerical analysis method to adequately simulate the impact-resistant behavior of rockfall protection fences installed on concrete foundation blocks. The applicability of the proposed finite element (FE) model was investigated comparing with experimental results obtained from full-scale fence models. Here, the fences with both conventional and base-plate anchoring systems for the steel posts. The findings of this research are as follows: 1) the time histories of the impact force and tensile forces acting on the wire ropes, which may be key parameters for designing the fence system considering the dynamic response characteristics, can be more accurately predicted by using the proposed method; and 2) the local buckling behavior of the steel post near the base can also be effectively evaluated.