

Modeling of snow avalanches for protection measures designing

Alla Turchaninova, Anton Lazarev, Ekaterina Loginova, Yuri Seliverstov, Tatiana Glazovskaya, and Anton Komarov

Faculty of Geography, Lomonosov Moscow State University, Moscow, Russian Federation (alla_wave87@mail.ru)

Avalanche protection structures such as dams have to be designed using well known standard engineering procedures that differ in different countries. Our intent is to conduct a research on structural avalanche protection measures designing and their reliability assessment during the operation using numerical modeling.

In the Khibini Mountains, Russia, several avalanche dams have been constructed at different times to protect settlements and mining. Compared with other mitigation structures dams are often less expensive to construct in mining regions. The main goal of our investigation was to test the capabilities of Swiss avalanche dynamics model RAMMS and Russian methods to simulate the interaction of avalanches with mitigation structures such as catching and reflecting dams as well as to reach the observed runout distances after the transition through a dam.

We present the RAMMS back-calculation results of an artificially triggered and well-documented catastrophic avalanche occurred in the town of Kirovsk, Khibini Mountains in February 2016 that has unexpectedly passed through a system of two catching dams and took the lives of 3 victims. The estimated volume of an avalanche was approximately 120,000 m³. For the calculation we used a 5 m DEM including catching dams generated from field measurements in summer 2015. We simulated this avalanche (occurred below 1000 m.a.s.l.) in RAMMS having taken the friction parameters (μ and ζ) from the upper altitude limit (above 1500 m.a.s.l.) from the table recommended for Switzerland (implemented into RAMMS) according to the results of our previous research. RAMMS reproduced the observed avalanche behavior and runout distance. No information is available concerning the flow velocity; however, calculated values correspond in general to the values measured in this avalanche track before.

We applied RAMMS using an option of adding structures to DEM (including a dam in GIS) in order to test other operating catching dams in Khibini Mountains by different avalanche scenarios and discuss the technical procedure and obtained results. RAMMS results were compared with field observations data and values received with Russian well-known one dimensional avalanche models.

In the Caucasus, Russia, new ski resorts are being under the development which is impossible without avalanche protection. The choice of the avalanche mitigation type has to be done by experts depending on many factors. Within the ski resort Arkhyz, Caucasus we implemented RAMMS into the procedure of the structural measures type decision making. RAMMS as well as Russian well-known one-dimensional models were used to calculate the key input parameters for structures designing. The calculation results were coupled with field observations data and historical records. Finally we suggested the avalanche protection plan for the area of interest. The interpretation of RAMMS simulations including mitigation structures has been made in order to assess the reliability of the proposed protection.