DEVELOPMENT OF THE DENSE AND POWDER SNOW AVALANCHE MODEL SAMOS-AT

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INTRODUCTION

An enormous increase in required space in terms of valuable building land in the Alps leads to a high pressure on the alpine environment. In the same order of magnitude the demand for safety is constantly growing. Thus enhancements in risk management are needed to maintain a high level of safety for the exposed society. Avalanche simulation models are one possible component in hazard analysis in regard to a comprehensible and objective estimation of avalanche runout. In Austria the Forest Technical Service for Avalanche and Torrent Control has applied different avalanche models for practical use for many years. In the beginning of 1999 the first 3D avalanche simulation model called Samos (Snow Avalanche Modelling and Simulation) was released by the authorities (BMLFUW) in cooperation with a private company (AVL List). The program enabled both, a dense flow and a powder snow avalanche simulation in 2D and 3D.
New technologies, developments in snow sciences and the demand for a more detailed and comprehensible hazard mapping led to a further step in the development of the 3D powder snow avalanche model Samos. As a result, a new model – SamosAT – was initiated in 2004 and released in 2007. The advanced model provides simulation tools for dense and for powder flow avalanches, depending on the respective settings. The previous Samos simulation platform has been totally altered in order to provide improved results and an easier software handling. In regard of these enhanced technologies the appellation Samos has been adapted by the affix AT for the Advanced Technology.

GOALS AND OBJECTIVES

The Samos model (release 1999) significantly overestimated the total avalanche runout distances. Especially the simulation of the dense flow part resulted in nonsatisfying outcomes mainly due to the friction model. The powder model, which is coupled with the dense flow part, overrated the runout particularly in the pressure zone between 1-5 kPa. Therefore the main emphasis in the development of SamosAT was the proper modelling of the dense flow part und the improvement of the runout behaviour for the powder part.

IMPROVMENTS

Major changes have been done in the calculation of the dense flow part, in the alteration of the simulation environment of the powder part and finally in optimising the resuspension layer, which is responsible for the transition of the dense snow into the powder layer.

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Extensive tests with various friction laws were necessary to find a suitable setup for properly modelling the dense flow avalanche. The SamosAT friction law in the actual setting provides suitable runout behaviour. The bed friction angle $\tan\delta$ still plays the decisive roll in the calculation of the maximum avalanche runout. The term (R_S^0, R_s) increases the bed friction angle at lower avalanche velocities in order to stop smaller avalanches more realistically and to prevent the lateral spreading of avalanches at very low flow heights (under 0,5m depending on the setting). R_S^0 is an empirically determined constant to reduce the spreading of avalanches at very low velocities.
Another step was the alteration of the irregular Delauny triangulation to a constant Eulian grid. This improves the calculation time, increases the stability and reduces random outliers.
The flexible user interface provides extended possibilities in avalanche simulations especially in the data in- and output.
The calculation of the powder snow avalanche in the newly released model is performed on an AVL-Swift V8 platform. The basic formulas have been adapted to the SamosAT model. Additionally a real two phase calculation model of ice particles and air has been integrated to obtain a more realistc simulation of the aerosol. Besides the gain of mass particles this method allows for a supplementary loss of snow particles along the avalanche path. Consequently snow particles can rise and drop within the aerosol especially at strong surface bendings.

CALIBRATION AND VALIDATION OF THE SAMOS-AT MODEL

The Forest Technical Service for Avalanche and Torrent Control collected many data from catastrophic avalanches in the last decades. For the model validation about 20 well documented avalanche events have been chosen to calibrate the various internal parameters. The reference avalanche data pool contains mapped avalanche runout zones, information on measured snow heights, approximated avalanche pressures at damaged buildings and/or recalculated avalanche velocities. These rather punctual information assist, besides the surveyed avalanche events, the calibration of the dense and powder flow models.
The comparisons of simulations and reference data showed satisfying results for the recalculations of the dense parts. The lateral spreading in the runout zone can be minimised by increasing the bed friction angle at low avalanche velocities. Hence the SamosAT dense flow model reacts sensitive in regard to the surface topography.
The simulations of the powder part showed a significant decrease of the spreading in the runout zone in comparison to the reference data. Various tests in this direction are still ongoing to find the optimum setting for the simulated avalanche pressures and maximum runout distances of the powder part.

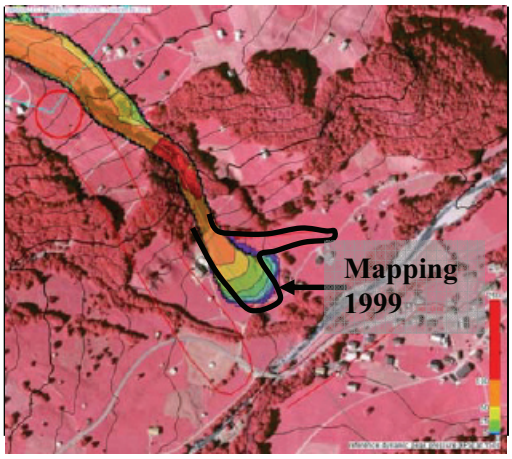

Fig. 1: Mapping of avalanche runout (Kansifluh, Dfa 1999) in comparison to the simulation

Keywords: Avalanche simulation, SamosAT, powder snow avalanche, dense flow avalanche, model validation