Simulations of Dry-Snow Avalanches in the Full-Scale Test Site Ryggfonn, Norway

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Abstract

Twelve dry-snow avalanches measured at the Ryggfonn path in western Norway, featuring a 16 m high dam, were selected for back-calculations. Two analytic models, four 1D hydraulic models, a 1D particle model with snow entrainment, and two advanced 2D/3D two-layer models with entrainment were used. For each model and each avalanche separately, the friction parameters were optimized for reproducing the measured run-out distance and front velocity. These parameters were then applied to a modified path profile without the dam. The main results are:

• All models needed a very wide range of friction parameters to reproduce the measurements.
• None of the models reproduces the deposit distributions of all avalanches satisfactorily.
• The models fail partly because they do not distinguish between the fast, dilute fluidized flow at the front and the slower dense core of the avalanche.
• Predictions for the stopping effect of the dam differ widely. In models that take centrifugal effects into account, the dam shortens the runout by 30–40 m on average; its effect is negligible in models neglecting centrifugal forces.

1. The Ryggfonn avalanches

NGI’s avalanche test site Ryggfonn has been in use for over 20 years. Drop height is 900 m, path length ~ 2100 m. Impact pressures are recorded 320 m and 230 m upstream of the 16 m high retention dam (Figs. 1, 2); from the difference of the arrival times, the front velocity may be obtained.

For this model comparison, 12 dry-snow avalanches were selected that reached the dam and that were surveyed (outline of deposits and deposit profile along one line, Fig. 3). Table 1 lists their main characteristics. These are mostly events with return periods < 5 years. Event 12 is a rare event; it destroyed the steel tower and the wedge with load cells.