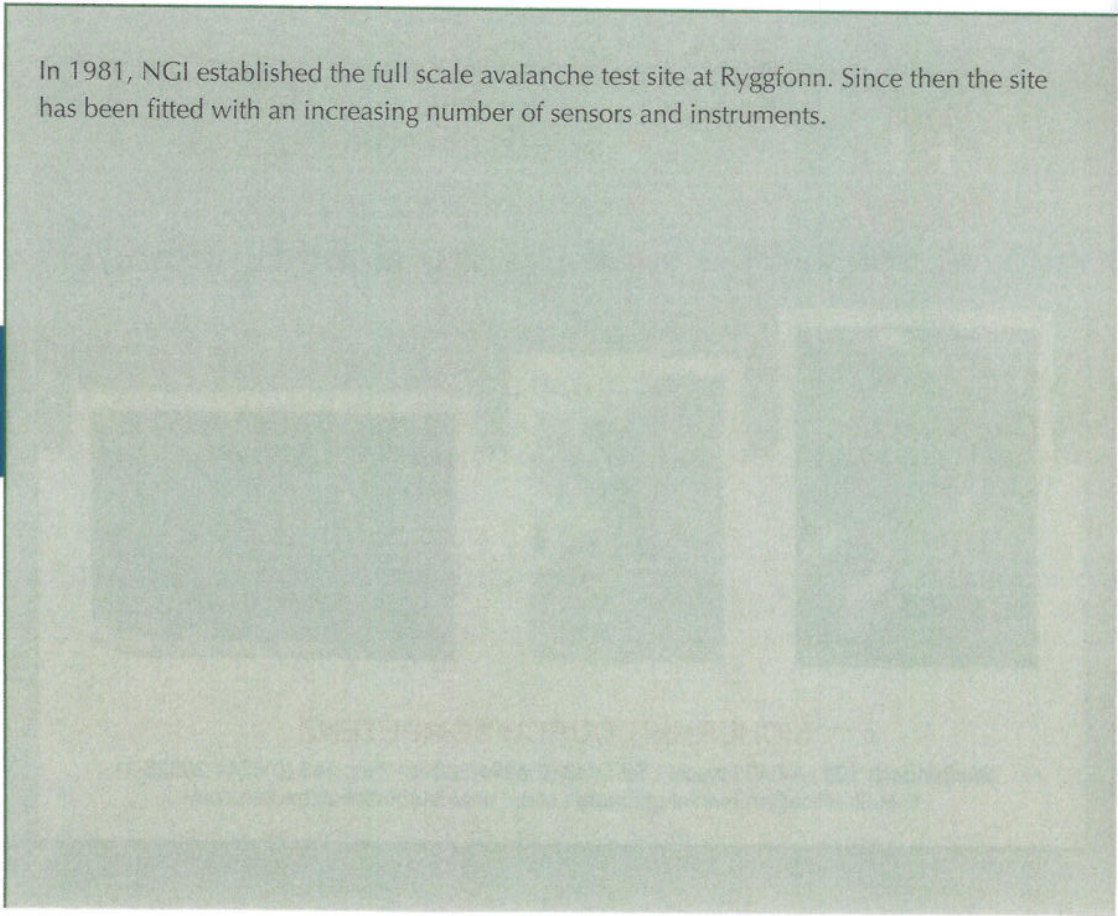


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## The Norwegian avalanche test site - RYGGFONN

In 1981, NGI established the full scale avalanche test site at Ryggfonn. Since then the site has been fitted with an increasing number of sensors and instruments.



The Ryggfonn avalanche is one of the most interesting full scale test sites worldwide due to the avalanche catching dam with an effective height of 16 m. Characteristics of the track are summarized in table 1. A total of about 100 avalanches have been observed over the last 20 years. Both natural and artificial avalanches are observed. For artificial release, explosives are placed before the winter near the upper ridge of the release zone in order to enable 3-5 controlled releases of the cornice.

Internationally the test site of Ryggfonn has become increasingly important due to the numerous avalanche dams that have been established and relied upon as protection measures in the past. However, most have never been subject to

the test of a real avalanche because they are normally placed in low frequency avalanche run out zones. Many questions about the interaction between dams and avalanches with different characteristics like flow type, density, avalanche size, flow height and velocity still need to be investigated and this can be done at the Ryggfonn site on a more or less regular basis.

**Tab. 1: Characteristics of the Ryggfonn avalanche**

Vertical drop:	900 m
Horizontal distance:	2000 m
Mean slope angle:	30°
Volume:	5.000 - 540.000 m <sup>3</sup>
Velocity:	max. observed ~ 60 m s <sup>-1</sup>
Frequency:	2 -10 avalanches per year
Types:	dry dense, dry mixed and wet dense



Fig. 1: Release area of the Ryggfonn avalanche test site



Fig. 3: Deposition of big avalanche in 2000

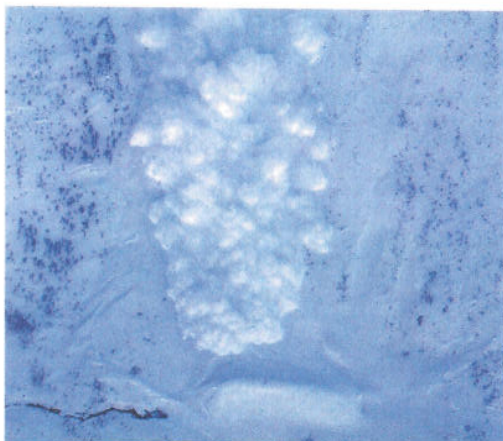


Fig. 2: Avalanche dam (height: 16m) in the Ryggfonn run out area

Numerous measurements are carried out by NGI: weather and snow cover observations, front velocity with FMCV Radar, photo and video, velocity distribution with 2 ground radars and ground vibration with geophones. The impact forces are measured at three sites. Two 0.7 m<sup>2</sup> load cells are placed on a steel tube and three similar ones on a concrete-steel construction in the track. Three additional load cells are also embedded in the uphill dam slope.

In the winter of 2000 a huge avalanche destroyed the two upper constructions. These were rebuilt a year later and NGI will now install

two additional towers with load sensors and LED-indicators. The data acquisitions systems will also be greatly upgraded. In the winter 2008/09, the new measurements will be carried out. Figure 5 shows the existing installations.



Steel tower Pressure gauges



Armed concrete constr. Pressure gauges



Shear and pressure Load cells

Fig. 4: Load cells at the Ryggfjonn test site

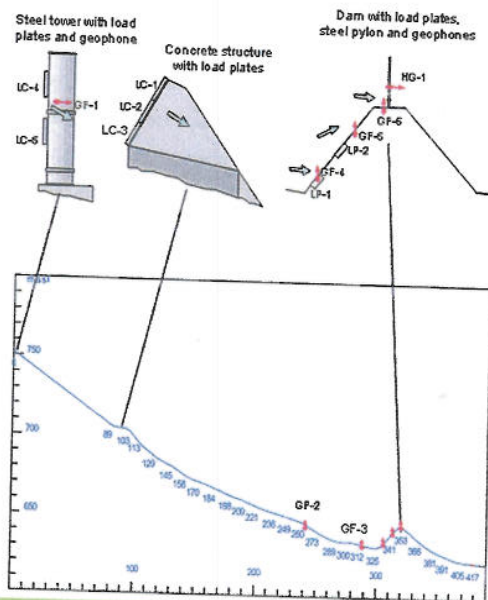


Fig. 5: Overview of the new measurement installations in the Ryggfjonn track

Research activities on avalanche dynamics in Ryggfjonn are carried out by NGI with strong international cooperation. In particular the NGI cooperates with the BFW (Innsbruck) in relation to the development of load cells, radar measurements and laser scanning measurements.

In order to facilitate the numerous field research activities, NGI established a wood cabin which burned down in 2004. The new research centre at Fonnby (Fig.6) is a highly practical building with interesting architectural features. The new centre fully meets all practical and "atmospheric" requirements.



Fig. 6: New field research centre at Fonnby