AVALANCHES; CONTROLLED TRIGGERING OFF BY RADIO BEAMS.

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ABSTRACT

This paper presents a brief introduction of the instruments, the organising and the experiences gained by the road authorites in Norway to control avalanches by the means of radio beams. After a certain period of testing the experiences are positive and so are the recommendations to implement the system when concidering specific conditions. The system might be an alternative to establish conventional expensive constructions.

1 INTRODUCTION.

The county of Sogn og Fjordane is situated in the western part of Norway (see fig 1). The region is mountainous, filled with narrow valleys and deep fjords. In the middle of the region we have the biggest glacier in Europe, Jostedalsbreen.
The climate is influenced by the Golf stream, but in spite of that, the wintertime is rather cold and snowy because of the position to the north.

The prevailing wind comes from south west from the Atlantic Ocean and is accordingly rather moist. When meeting the mountains and the glacier area, this causes a lot of snow normally between Sept./Oct. and March/ April.

When considering the instability of the temperature changing rapidly and often between zero and plus the problems with avalanches are quite common in the region.

One of the main trunk roads connecting the western and eastern part of Norway, trunk road no 15, is crossing this region and partly crossing areas which are exposed by avalanches. The road was upgraded in the middle of the seventies, and then the issue how to solve the avalanche problems was given high priority.

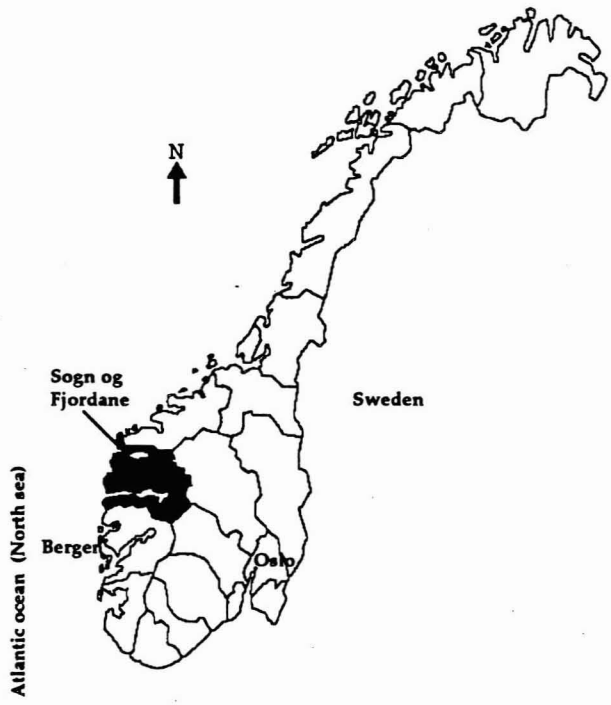

Fig. 1

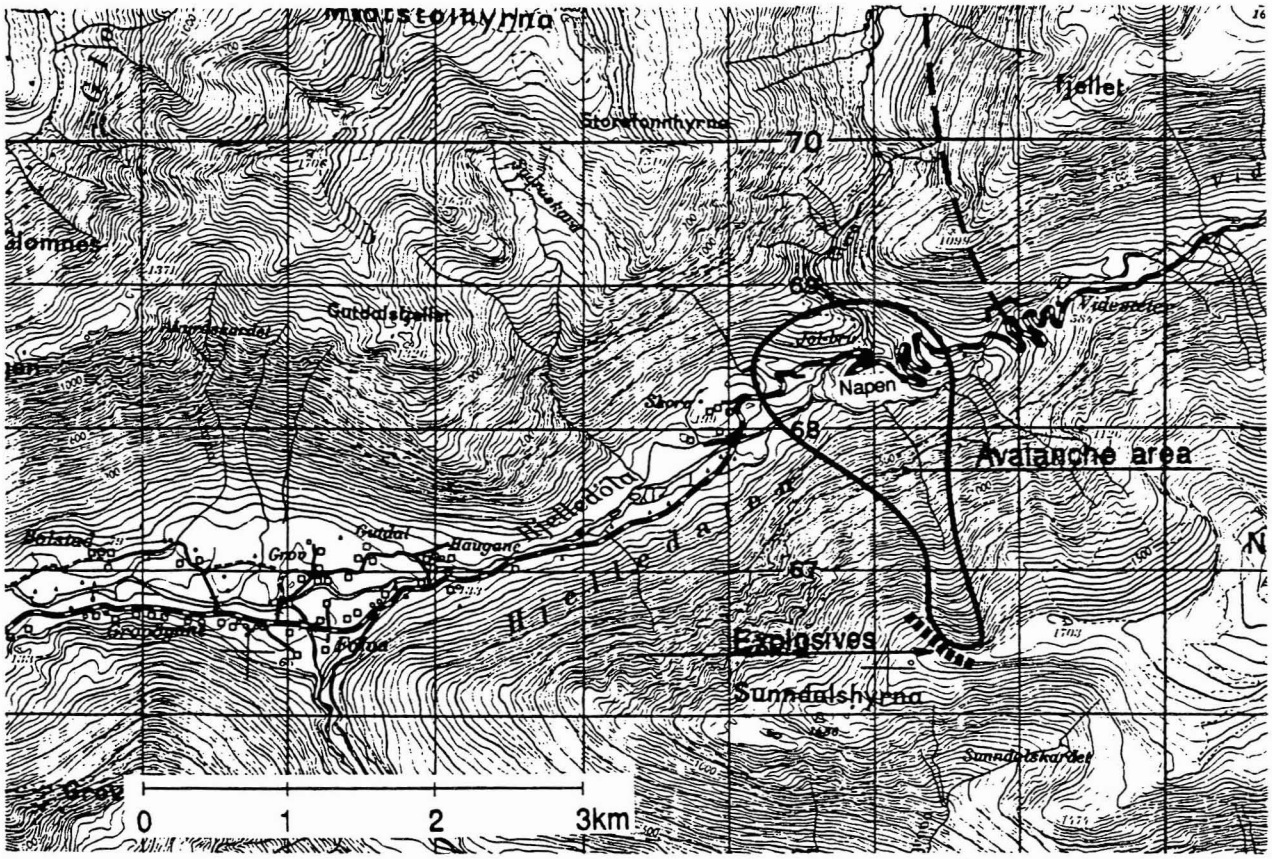

Fig. 2

At the specific site, the road is placed on a hill situated between two river valleys (see fig. 2). From one of the hill sides there normally come huge avalanches several times a year. The avalanche, Napefonn, does not cross the road, but strong winds caused by the avalanches make it extremely dangerous to pass. The cars might be swept off the road with deadly consequences. The wind crosses in a length of 3000 meters. This length, combined with a difficult topographic landscape makes it quite expensive to construct conventional concrete shelters or tunnels. Consequently the authorities started to look for more sophisticated solutions.

The hill side where the avalanches go is a remote area and impossible to pass by foot. Neither is it possible to pass with other traffic items except for helicopter. The top of the hill is covered by snow except for 2 - 3 months during summertime.

The prevailing winds blow the snow out on the edge where it is stored. When the weight is big enough and the temperature is suitable, the edge bursts, and triggers the avalanche by sweeping down the stored snow from the whole hill side below.

The avalanche starts at a height of 1700 m above sea level and goes all the way to the bottom of the valley, approx. 1500 m further down.

After some experiments and failing, the decision was taken to devellop a concept based upon explosives placed in the storing area, which are controlled and triggered by radio beams from long distance.

2 SYSTEM

2.1 Equipment

The system consists of two main units, one reciever unit placed in the outskirt of the snow storing area and one mobile transmitter operated from a suitable area on the road.

The mecanical equipment used and placed in the snow storing area are:

- One radio reciever including an electric and programable clock
- One radio transmitter
- Percussion instrument.
- Battery

Due to practical reasons the electronic equipment in the storing area is placed in a waterproof container. An airiel and cables leading to the explosives are connected to the container. The container is carefully fixed and bolted to the ground. The cables are devided into two parts, one permanent and one which normally will be damaged by the explosion. Much concern is given to prevent disconnections and break downs of the cables. This means that the whole cable, the connections and the explosives are placed underground (see fig. 3).

The operating capasity is based upon 5 possible operations for each season. The explosives are accordingly placed in five different strategic places in the snow storing area.
Each place is loaded with 100 kilos of dynamite.

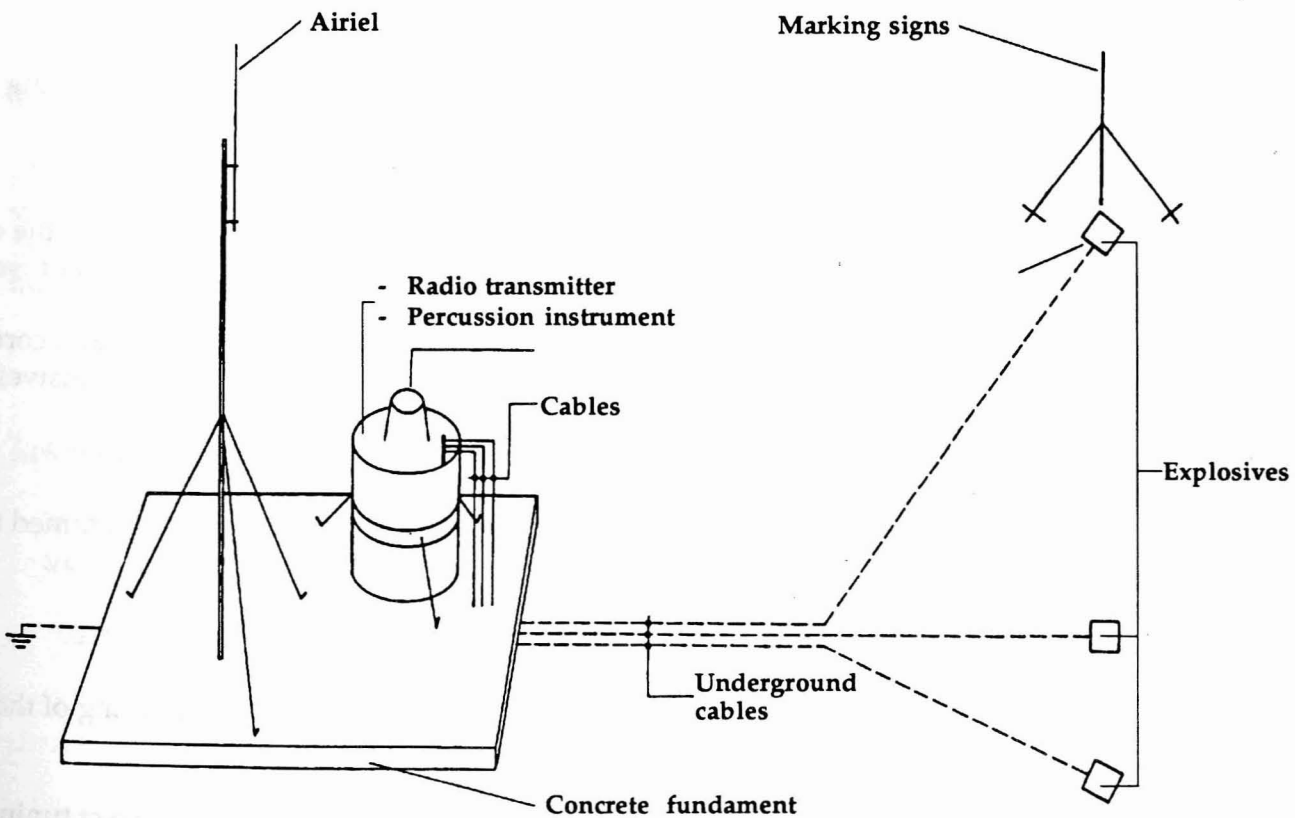

Fig. 3

There is a description of the equipment which is too detailed to be presented in a paper like this.

2.2 Organizing.

The operating of the system is based upon the following procedure:

- The reciever in the storing area is activated by the means of the electronic clock.
  (The reciever can be programmed for a specific and limited time for each day)

- A specific code is sendt from the mobile unit.

- The transmitter in the storing area returns a receipt signal if accepting the code. (All other codes, except for the correct one will be refused)

- The percussion instrument is generated to the necessary energy level. When receiving the accepted return signal, the correct explosive unit can be chosen and the button for exploding is to be pushed.

There is worked out a manual for the procedure.

The whole operation does not need to take more than a few minutes. In addition one has to reckon the time for closing and opening the road for the traffic. All together this can take up to one hour depending on the necessary clearing of the road after the operation.

The explosives are placed in the snow storing area in due time before wintertime, normally in the middle of September.

The transport of people and explosives is done by helicopter. The whole operation is done within half a day, including the testing and possible reinstalling of equipment which might have been broken.

2.3 Time for operation.

The time for starting an operation is build upon experiences and monitoring of temperature and snow.
The storing of the snow in the area and the critical temperature for possible avalanches to go is watched at any time during the winter. This is done by the manpower responsible for the routine maintenance of the road.
They have collected and recorded a lot of experience and statistics about the problem, and are consequently fully capable to decide when action has to be taken.

2.4 Security

When placing armed explosives unwatched in nature like this one has to take highly precautions to prevent accidents.

The danger can be classified into two main risks:

- Danger of unplanned provoking

- Traffic in the area.

Therefore the security aspect of the concept has caused a lot of attention to prevent unplanned explosions.
One has to follow a specific and correct procedure to provoke the explosives.

The procedure is as follows.

- The provoking is programmed to a specific time during the day.

- Choose the correct channel

- Choose the correct tuning of the code for transmission.

- Afterwards, choose correct tuning of the code for the respective percusion cap (charge)

- The button for provoking and

transmission of the signal has to be pushed for at least 30 sec.

If the procedure is not carefully followed the equipment will go back to zero position and the procedure has to be restarted. In addition the percussion caps which are used have built in a considerable resistance against possible unplanned provoking caused by thunderstorms.

The area for such operations have to be remote with a minimum of traffic. The Napefonn area is such an area. One has to use helicopter to enter the area. In spite of this there are placed warning signs in the surrounding areas. Fencing off has no meaning because of the big amount of snow which would cover the fence after a short while.

During the operation the road is physically closed and warning signals are given by sirens.

3 EXPERIENCES

As mentioned the concept was formed and started late in the seventies. After a develloping period of some years the method is now fully accepted and functioning. It has become a part of the normal duties for the manpower responsible for the routine maintenance in the area and is fully accepted by the road users. In the beginning there were some problems with the provoking. In such cases we had to trigger the charge manually by using helicopter for the transport. This is all history now.

There is not recorded any accidents up to date.

The costs a year is recorded to approx. 7000 $ which is mainly due to the helicopter transport.

4 CONCLUSION AND RECOMMENDATION

Under specific circumstances the method of controlling avalanches by radio beams is fully acceptable. It can be an alternative to conventional shelters when the costs with those are too high or the landscape makes it extra difficult to erect any fysical constructions. When concidering the security in all aspects, including the training of the operators, there should be no reluctance to implement the system.

Reference: Report no 885, Norwegian Road Research Laboratory, Oslo