

AVALANCHE DEFENSE SYSTEMS IN THE STARTING ZONE

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Abstract.-- Avalanche Defense Systems in the Starting Zones are common practice in Europe: Several thousand installations have been erected over the last 30+ years by half a dozen specialized manufacturers. A better understanding of their principle is a necessity before they will begin to be used in North America. This paper presents a history of their development and an introduction to one of their manufacturers.

Avalanches happen! They happen in the back-country, away from any human activity, but also, over roads, buildings, ski trails, etc.. The avalanche problem is not new, but its impact on human life has become an increased concern, in particular and more recently, in the United States. This is mainly due to the current development of winter resorts, which bring people by the thousands into close contact with the mountains and their associated dangers, among them the avalanches.

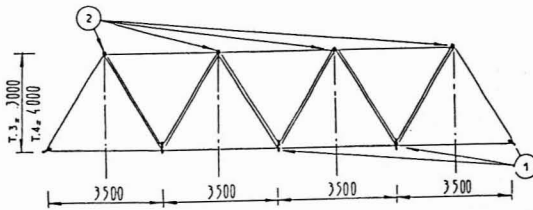
Europeans learned to deal with avalanches a long time ago. Agricultural communities (villages) have existed in the Alps and other mountain regions for centuries. At first the only solution available was to avoid known avalanche paths altogether. Then the villagers began to erect structures to slow down the avalanches (breakers), divert them (tunnel/upward, dikes/ on one side, prows/ on both sides) or stop them (arrestor dams). These "passive" structures can be very effective in specific applications. Their main drawback is that they do not prevent recurrence of avalanches and might therefore allow the avalanche path to deteriorate (to become smoother, cleared of vegetation and thus, even more prone to avalanches).

Instead of controlling avalanches, as the above methods permit, preventing them appeared in many cases to be a more suitable solution. This concept gave birth to Defense Systems in the Starting Zone.

The first methods used were earth benches or platforms erected in the avalanche starting zone. They offered a good control for the base snowslab, but not for the subsequent layers. In the early 50's the Swiss pioneered the "Schneebrucke", a snow rack with horizontal elements. These racks were made out of wood, at first, then out of steel. They are laid perpendicular to the fall line in the avalanche starting zone. The French preferred racks with vertical elements ("rateliers" versus "claires"); "Vive la Difference!" More recently avalanche protection nets have been developed. These rely on the same principle as the racks: Reducing the creep of the snow in the starting zone and therefore preventing the otherwise unstable snowslab to start an avalanche. Nets have numerous noticeable advantages over racks: They are cheaper to install and less visible. They do not create a discontinuity (weakening) in the snowslab as racks do (horizontal racks ("claires) in particular) and are easier to anchor into the slope. The use of epoxy resins (in bedrock) or of exploded piles (in softer soils) allow retentive forces of 1,000 metric tons per acre to be reached.

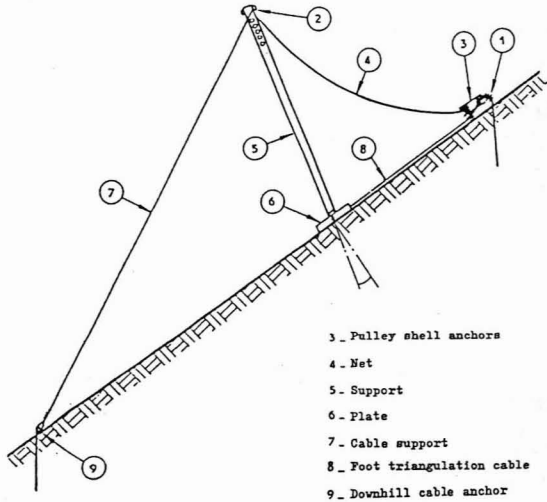
"L'ENTREPRISE INDUSTRIELLE (EI)" is a French civil engineering and general contracting company. It was founded in 1921. It employs 8,500 workers, including 750 engineers. One of its specialties is high and very-high-voltage power transmission lines. EI has erected numerous such lines across the Alps and has run into many avalanche pro-

FIG. A



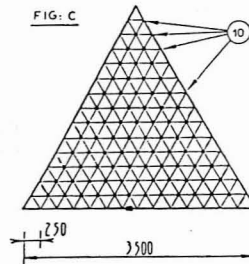
- 1. Anchoring nets to ground (uphill anchor)
 - 2. Fixing net to support
- Support centrelines

FIG. B



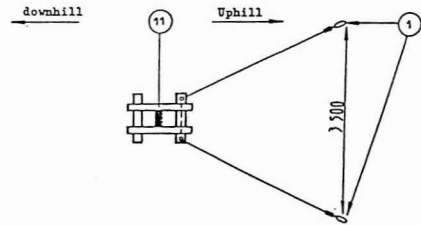
- 3. Pulley shell anchors
- 4. Net
- 5. Support
- 6. Plate
- 7. Cable support
- 8. Foot triangulation cable
- 9. Downhill cable anchor

FIG. C



- 10 Stainless steel collars with stainless steel H-head screw, to hold internal netting cable on edge cable.
- ✕ Stainless steel cable clip, to hold at cable crossings of internal netting.
- Flat junction connectors in galvanized steel with 2 bolts for gripping internal netting cable.
- Steel sleeve crimped on by 150 t press to grip edge cable.
- Edge cable.
- Inner netting cable.

FIG. D



- 11 - Hinge axis at support base
- 1 - Anchoring nets to ground (uphill anchor)

blems. Avalanches were endangering expensive power transmission towers as well as EI personnel. It was for these reasons that EI originally developed avalanche protection nets in 1974. The effectiveness of the EI system had led the company to offer these nets and engineering "know how" to outside customers, such as railroad and road departments, ski resort operators, municipalities, etc.. As of 1986, twelve years later, EI has installed over 90,000 linear feet of avalanche protection nets in 125 sites. This activity has been concentrated in France, but the number of foreign customers is increasing daily: Chile, Iceland, India, Italy.

There is no panacea for avalanche problems. Protection nets are one of the available defense systems. Their application should be considered every time the eradication of an avalanche is preferable to other alternatives. By combining this system with a (re-)vegetation plan, it is possible to permanently stabilize an avalanche path that might otherwise be considered uncontrollable. "L'ENTREPRISE INDUSTRIELLE" is available for any avalanche protection net feasibility studies and for cost estimates or formal bids.

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