A LOOK AT AVALANCHE CONTROL STRUCTURES IN EUROPE

By

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A recent trip to Europe provided a chance to observe avalanche control activities in Switzerland, Austria, and France. In this mountainous section of central Europe the combination of steep terrain, heavy snowfall, and a large rural population create a serious avalanche problem. From the very earliest days the mountain dwellers have tried to protect their homes against avalanches by locating them in places thought to be safe. In spite of these precautions, damage occurred and homes and villages had to be protected by artificial structures. Avalanche deflecting walls built almost 250 years ago in parts of Switzerland are still in good condition.

As a matter of convenience, I have divided avalanche control structures into 3 types based on where they are located in relation to the slide area and the way they are supposed to control the avalanche. Type I structures are those built right in the avalanche path with the idea of "nailing" the snow to the terrain and keeping an avalanche from starting. Such structures actually break up the long, uniformly steep slopes into segments or steps that are not so steep. They also offer support to the snow mantle and reduce the tendency for it to break free and slide under the force of gravity.

A Type I structure must be strong enough to support the mass of snow above it and it must be tall enough so it is never topped by the snow (fig. 1). Many structures fall within this category. Among the oldest are walls, terraces, and ditches. Horizontal wooden platforms, called ramps or bridges were another of the older designs. More recent Type I structures are often in the form of massive steel or aluminum racks built in short sections (10 to 12 feet long) and erected perpendicular to the slope. In other areas, steel fencing material supported by angle iron in masonry foundations is being used. An avalanche slope, such as the one above Davos, Switzerland, which is completely treated with this type of structure represents a tremendous effort and expense.

Not all Type I structures are massive and rigid. In France, for example, nylon nets are being used to stabilize slide paths. Since nylon is subject to abrasion and damage from rolling rock, wooden barriers are often intermingled with the nylon nets to take the abuse from rock. Nylon is also subject to deterioration from ultra-violet rays and must be coated to protect it from the sun's rays. Material in the nets is in the form of flat straps 1½ to 2 inches wide with a tensile strength of 7 tons. Nets are set perpendicular to the slope. They may be erected with steel poles as back braces or they may be supported by an overhead steel cable. The nets are heavily guyed front and back and are securely anchored at the bottom to rocks or to buried logs.

The nylon net system has been modified in some areas by using nets made from steel cables with an overlay of fine mesh wire. This is mostly a modification based on the availability of material rather than a change in basic design. The overlay of finer material is expected to reduce the chance of a small sluff of snow passing through the open weave of the net and starting an avalanche.

It is common practice when using Type I avalanche structures, either rigid or flexible, to completely stud the slide path. Structures should be more numerous in areas of convex terrain and less numerous in concave areas. Five hundred and eighty nets were installed on one moderate size slide path visited near Beaufort, France.

Type II avalanche structures are wind baffles confined to the upper part of the avalanche path or the adjacent ridges (fig. 2). They are designed to create turbulent winds and irregular deposition of snow in the accumulation zone of the avalanche. These structures, called Kolktafeln by the Swiss and parvents by the French, are about 7 to 9 feet tall and about the same width. They look like small wooden billboards. Modifications include some that are broad at the base; others that are broader at the top. The ones with the broad base are more effective before much snow accumulates; the broad topped ones are more effective as the snow gets deeper. Other types of Kolktafeln are built in the form of a cross, a triangle, or of an asymmetric gable roof. These wind baffles are built in the upper part of the actual slide path in the area where the fracture line of the avalanche usually develops.

In addition to the above baffles there are several types of structures that are often built on the ridge along the windward side of well defined avalanche paths. One of these is the snow fence.

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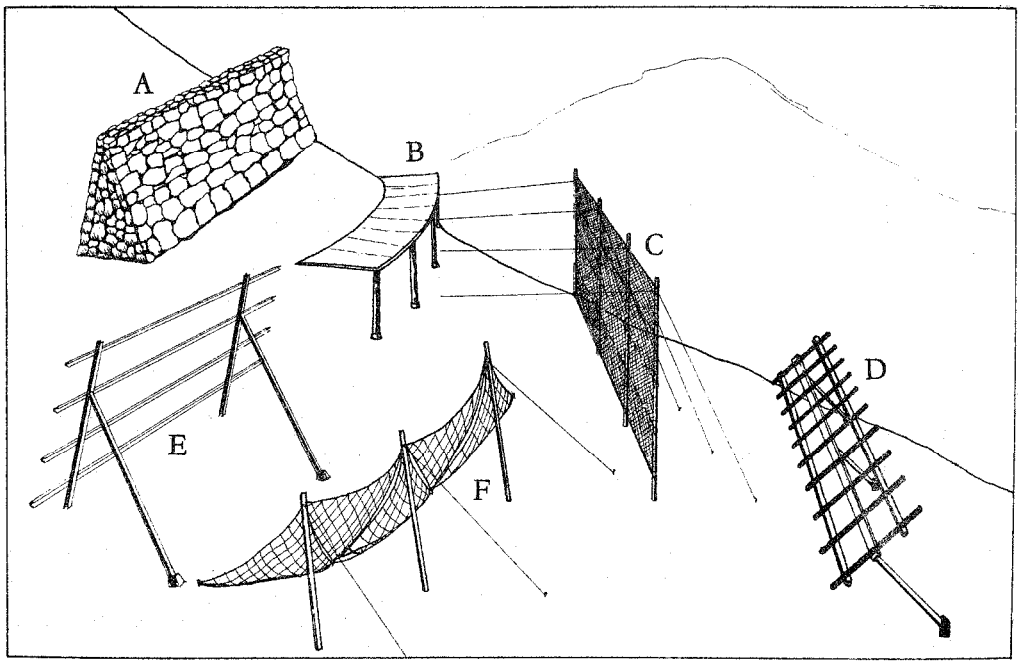

Figure 1 --Avalanche control structures (Type I) used to modify the slope or to support the snow above. A. Wall - masonry or earthen. B. Bridge - wood or steel and cement. C. Vertical fence - heavy wire on steel supports. D & E. Racks - wood, steel, or aluminum. F. Nets - nylon or steel cable and wire.

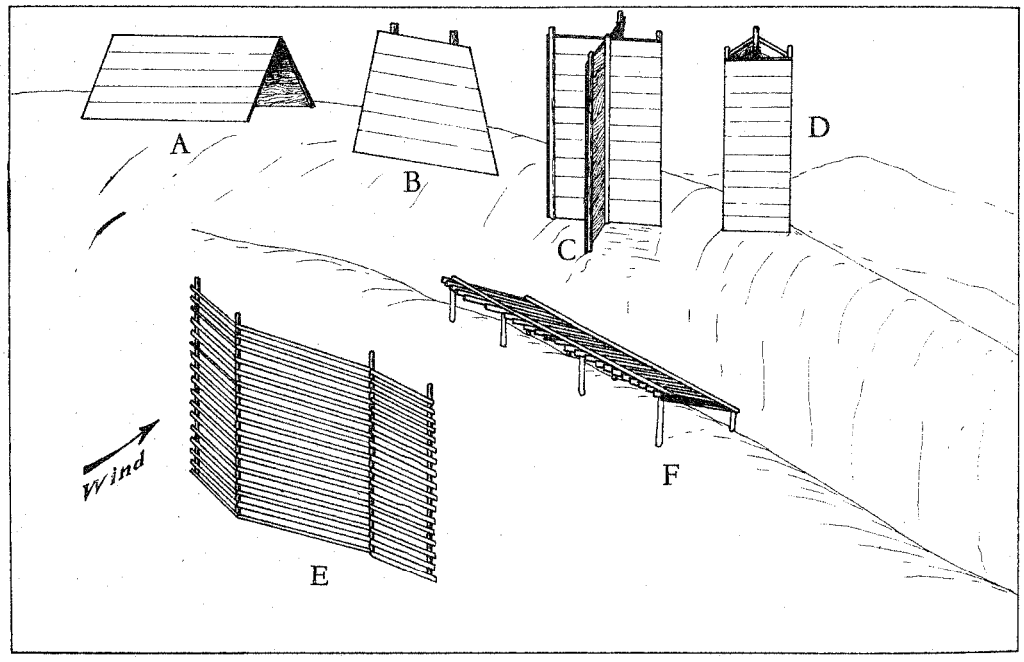

Figure 2 --Wind baffles used as avalanche control structures (Type II). A. "Gable roof" - may be steeper on one side than the other. B, C, & D. Kolktafeln. - These are usually located in the upper part of the avalanche path near the fracture zone. E. Snow fence - slats may be horizontal or vertical. E. Pultdach - several may be used in tandem.

If there is enough room on the ridge to accumulate snow before it gets to the avalanche path, snow fences will help prevent a large buildup of snow in the avalanche path. A less conventional "ridge structure" is the Pultdach. This sloping "shed roof" is designed to prevent the development of a cornice or snow cushion in the lee of the ridge. Wind flowing over the ridge is trapped by the sloping roof and deflected down the lee slope carrying the snow well beyond the avalanche path. Kolktafeln, Pultdach, and snow fences are usually used to supplement one another in this type of avalanche control. Again the idea seems to be to use an abundance of structures when it has been decided to rely on structures for avalanche control.

Type III avalanche control structures are earth or masonry mounds built in the lower part of the avalanche path (fig. 3). Where upper slopes are very steep and barren, avalanche control is difficult and expensive. In such places it is best to concentrate control activities part way down the slide path at a place where the gradient is less steep. On these benches, where the avalanches tend to slow down naturally, earthen or masonry mounds are built to break up the avalanches that come down from the uncontrolled area above.

The first avalanche breakers were angular masonry walls, backfilled with soil. It was observed, however, that mounds of dirt and discarded stone uphill from these structures often broke up the avalanches before they reached the larger structures. This led to the idea of using cheaper and easier to construct earthen mounds to replace the stone structures. Material for these earthen mounds is usually dug and piled by machinery. Final shaping of the mound is done by men with hand tools. The end result is a group of mounds each with a borrow pit in front and behind. These mounds and pits completely fill the avalanche path for a considerable distance. The individual mounds are 15 to 18 feet tall, about 50 feet in diameter at the base, and 7 to 8 feet in diameter at the top. The uphill side is faced with dry masonry and the whole mound is planted with trees, shrubs, or vines. The number of mounds built in such an operation is limited chiefly by the availability of soil with which to build them. In many areas trees quickly become reestablished on the lower part of the avalanche path and add to the productive forest area of the country.

Reforestation of the mountain slopes is an extensive program in its own right in all the countries visited. One important phase of the reforestation program involves planting trees to help stabilize the snow on slopes prone to avalanche. Trees planted on steep, grassy slopes in snow country need protection not only from avalanches, but also from snow creep. Creeping and settling snow strips the limbs from the seedlings, bends them over, or pulls them out of the ground.

Several kinds of structures to protect seedlings from snow creep damage are being tested in Switzerland. These include (1) low fences (about 3 feet tall) made of steel cables or heavy wire mesh; (2) tripods 3 to 4 feet tall made of large aluminum beams; (3) "picket fences" made of large aluminum components. These fences are usually 3 to 4 feet tall and 4 to 6 feet long; (4) wooden posts often used in combination with small terraces.

Where there is a good planting site in an active avalanche zone, plantings are made among the avalanche control structures. Even in areas where avalanches are confined to well defined, steep chutes, reforestation is part of the control practice. In these difficult areas trees are planted first on the ridges beside the avalanche path. After the ridge plantings have become established, plantings will be made along the sides of the chutes. At a still later date the avalanche path proper will be reforested. It is hoped that eventually entire avalanche paths will be stabilized by vegetation.

This report has discussed only the avalanche control structures actually observed in the field. Some of the other types of structures in use but not observed are illustrated in figure 4. They include:

1. Snowsheds (called galerie in French and German). These sloping roofs, usually over roads or railroads, permit avalanches to continue down the mountain without damaging the facility being protected.
2. Deflection structures to turn the avalanche away from the area to be protected. These may be either walls or ditches or a combination of both.
3. Ramps or bunkers are sometimes used on the uphill side of individual buildings. The ramp allows the snow to slide over the top of the building; the bunker or breaker is used on more level terrain to split or divide the avalanche so it will flow around the building.

A great wealth of technical information and practical experience has been developed in Europe concerning the use of structures for avalanche control. To date only limited use has been made of this information in the United States. Undoubtedly there are many places in this country where avalanche control structures could be used to good advantage. As winter sports and general year-around mobility increases, avalanches will again become the serious menace they were during the heyday of the hardrock miner before the turn of the century. It is high time that we start seiously considering the use of avalanche control structures as a means of protecting property and human lives in the mountains of the United States.

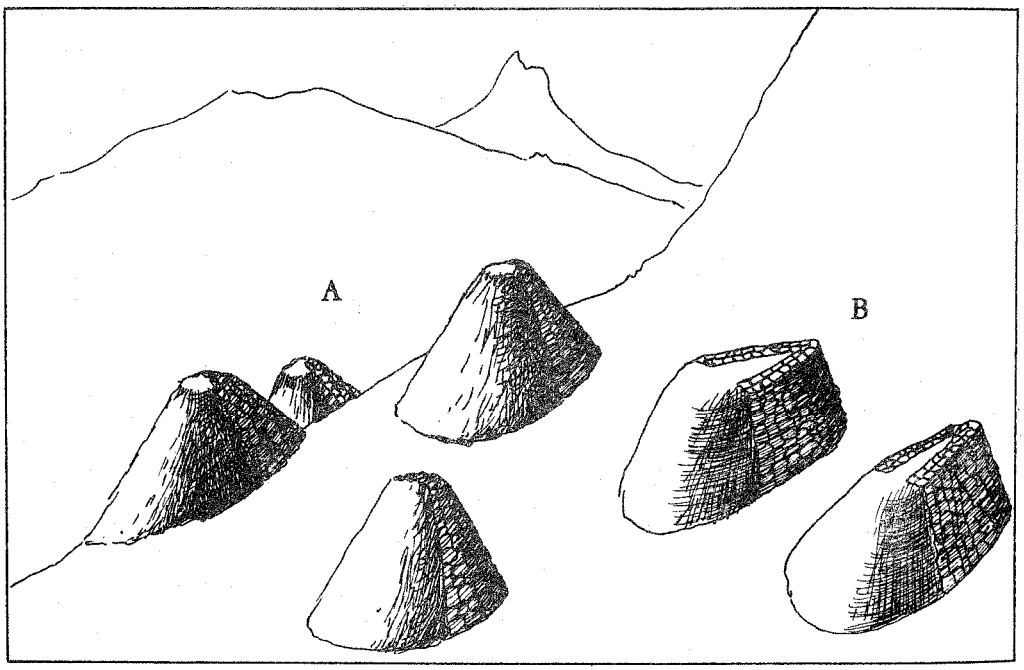

Figure 3 -- Mounds used to break up avalanches that come down from above (Type III). A. Conical earthen mounds faced with dry masonry. B. Angular masonry breakers back-filled with soil.

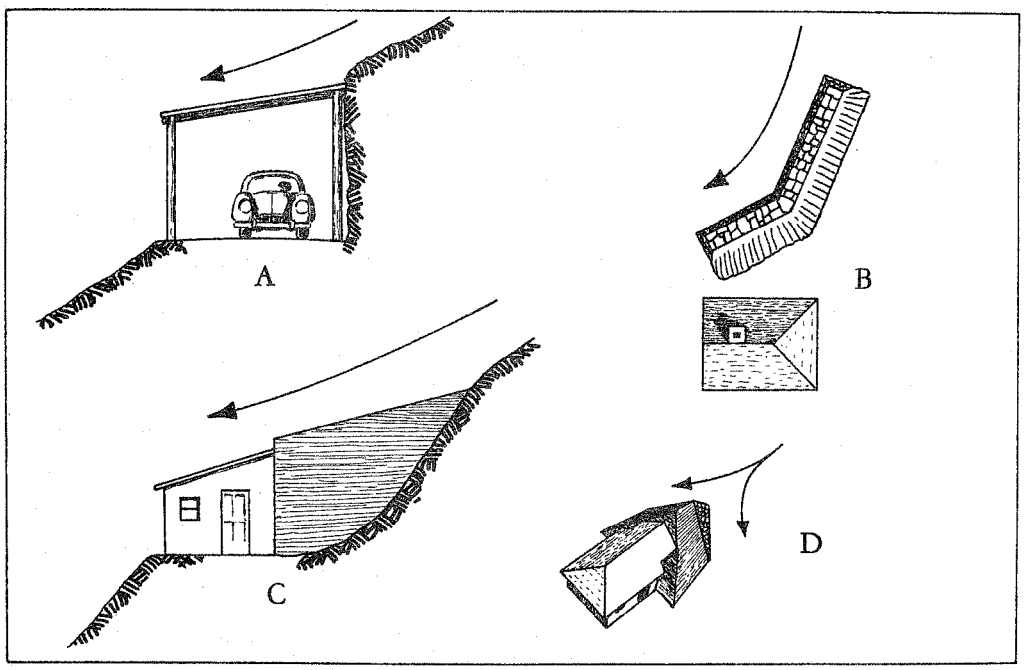

Figure 4 -- Other types of avalanche control structures. These are used primarily to protect isolated installations or buildings. A. Snowshed or galerie. B. Deflection wall. C. Ramp of earth. D. Bunker to split the avalanche.