



## Avalanches

Snow cover on a slope tends to slide down the slope because of gravity. Conditions affecting stability include the gravitational force component of the snow and resisting forces, such as the frictional resistance of the slope or the anchoring effect of shrubs. In general, avalanches are caused when this balance is lost and when the forces exceed the resistance. Avalanches are rarely observed closely since they normally occur during a short time period of one or two minutes. **Major Causes** - Major causes of avalanches can be classified into fixed (prime factors) and variable factors (exciting factors), such as weather conditions and the weight of the snow cover, Avalanches occur when these factors are combined. The types and scale of avalanches can differ depending on the combination of these various factors and their scale. Major prime factors and exciting factors are shown in the following table.

### **Major Causes of Snow Avalanches**

Item	Description	Factor
Prime factors	Topographic factors	<ul style="list-style-type: none"> <li>• Inclination of slope</li> <li>• Shape of slope</li> <li>• Location (ridge line or toe of slope)</li> <li>• Orientation of slope</li> </ul>
	Vegetation factors	<ul style="list-style-type: none"> <li>• Vegetation cover and height of trees</li> <li>• Vegetation cover and its thickness</li> </ul>
Exciting factor	Weather factors	<ul style="list-style-type: none"> <li>• Depth of snow cover</li> <li>• Depth of snowfall</li> <li>• Wind velocity</li> <li>• Atmospheric and snow temperatures</li> </ul>

	Other factors	<ul style="list-style-type: none"> <li>• Increase in weight of snow cover because of snow dropping from cornices or snow covers</li> <li>• Vibrations such as earthquake or the sound of gunfire</li> </ul>
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### Factors Used for classification of Avalanches

Classification Factor	Classification Factor	Definition
Type of occurrence	Loose snow avalanche	Avalanches that flow rapidly, spreading widely from a point normally small in scale
	Slab avalanche	Avalanches that start to move suddenly over wide areas, normally large in scale.
Type of snow	Dry snow avalanche	Avalanches that contain no water.
	Wet snow avalanche	Avalanches that contain water.
Surface layer avalanche	Surface layer avalanche	Slip surface exists within the snow cover
	Full- depth avalanche	Slip surface occurs on the ground surface

### Avalanche Conditions

#### Types of Damage

The following lists typical examples of damage to roads caused by avalanches. The scale of damage can differ depending on the scale and type of avalanche.

- Traffic blocked by snow deposited on road surface.
- Roads damaged by avalanches.
- Road structures, such as retaining walls, overturned.

- Structures damaged by an avalanche during construction of roads occur most frequently.

### **Types and Description of Avalanches**

Dry, loose surface -layer snow avalanche	These often occur in low atmospheric temperature or during snowfalls. This type of avalanche is caused mainly by small masses of snow falling from snow cornices, tree branches or exposed rock. Dry snow moves down in loose layer.
Dry, slab surface -layer snow avalanche	These often occur when new snow with a depth of more than 10cm falls over existing snow cover during low atmospheric temperatures. Avalanches flow rapidly, taking the form of loose snow powder and often reach several kilometers down the foot of the mountain, causing serious disasters.
Dry, slab full-depth snow avalanche	Avalanche occurring in areas with low temperatures can have different mechanisms. In regions of relatively high temperatures, this type of avalanche occurs extensively when the weight of large quantity of snow falls quickly over existing snow deposits on slope at low temperatures. In cold regions, snow layers near the ground tend to become collapsible and can slide in a full depth if severe cold weather has continued for a long time. The dry new surface snow layers tend to slide in the form of snow powder and often reaches further down the foot of the mountain.
Wet, loose surface layer snow avalanche	These can be caused when a 20 to 30 cm layer of new snow layer starts to move, takes a wedge-shaped form and reduces in width. This avalanche flows smoothly as it advances.
Wet, slab surface layer snow avalanche	These can occur when temperature rises in fair weather after a snowfall when the slab snow surface layer contains water. Avalanches do not take the form of snow powder but move in a smooth flow.
Wet, slab full-depth snow avalanche	These can be caused when snow starts to melt in the early spring season and can also result if temperatures rise the winter season. It can occur either on a rainy day or on a warm day. These will not take the form of snow powder, and move in a smooth flow. This type of avalanche often causes serious disasters.

### **Characteristic Feature of Avalanche Movement**

Powder avalanche	This type avalanche often reaches a depth of several tens of meters, taking the form of snow powder moving at a high speed. These most often occur during snowfalls at low temperature.
Flow avalanche	This type of avalanche appears to move as a flow of water over the snow surface. These are seen as full- depth avalanche occurring when atmospheric temperature increases.
Mixed avalanche	Powder type and flow avalanches occurring in combination. This type avalanche can occur quickly when large quantity of snow falls over unstable snow cover.

### **Estimation of Hazardous Slopes**

The following actions are appropriate when avalanche hazard prone slopes are identified;

- Advise residents of avalanche risk areas using published maps.
- Afforestation programmes for areas where there is risk of avalanches.
- Trap avalanches by control measures.
- Dispose avalanche potential snow packs by artificial triggering.
- Predict occurrence of avalanches through stability analysis and issue warnings as and when necessary.
- Guide residents to emergency evacuation shelters.

### **Avalanches Prone Areas in India**

The Himalayas are well known for the occurrence of snow avalanches particularly Western Himalayas I .e. the snowy regions of Jammu and Kashmir, Himachal Pradesh and Western Uttar Pradesh.

- Jammu and Kashmir - Higher reaches of Kashmir and Gurez valleys, Kargil and Ladakh and some of the major roads
- Himachal Pradesh - Chamba, Kullu- Spiti and Kinnaur vulnerable areas
- West Uttar Pradesh - Parts of Tehri Garhwal and Chamoli districts are vulnerable areas.

There are three types of snow avalanche zones;

- Red Zone - The most dangerous zone where snow avalanches are most frequent and have an impact pressure of more than 3 tonnes per square metre.
- Blue Zone - Where the avalanche force is less than 3 tonnes per square metre and where living and other activities may be permitted with connection of safe design but such areas may have to be vacated on warning.
- Yellow Zone - Where snow avalanche occur only occasionally.