Factors Affecting Snow Avalanche

Jitendra Kumar[1] Dr. SriRam[2]
[1]P.G. Student [2]Associate Professor
[1,2]Department of Civil Engineering
[1,2]Madan Mohan Malviya University of Technology Gorakhpur- 273010 (U.P.), India

Abstract— Snow avalanches pose a significant hazard to human populations and infrastructure in mountainous regions. Snow avalanches are the abruptly down slope movement of snow, ice, and associated debris such as rocks, and earth material. The forces generated by large avalanches can damage most man-made structures. Avalanche impacts in India, includes fatilities, is summarize for public and residential area like ski areas, roads, and resource industries. Avalanche hazard methods, in which zoning, explosive control, forecasting. Problems of current avalanche hazard is solving these problem is identified with resources industries, backcountry recreation and residential areas. Snow avalanches are a significant natural hazard that impact roads, structures and threaten human lives in mountain terrain.

Key words: Snow avalanche, Causes of avalanche, avalanche impacts, avalanche prevention

I. INTRODUCTION

An avalanche is a slope failure composed of a mass rapidly moving, fluidized snow that slides down a mountain side. The flow can be composed of ice, water, soil, rock and trees. Snow avalanche is not only the snow cover over the mountain side but also the later snowfall intensity. The snow avalanche, a common occurrence in snow covered mountainous regions, is a slide of snow mass down a mountain side. This is rapid down slope movement of a large detached mass of snow, ice and rocks. The most common types of avalanches are loose snow and slab avalanches. A loose snow avalanches consist of loose crystals of snow admixed with air, the loose aggregate set in motion by snow storms. A slab avalanche is a portion of snow breaks loose as a slab and splits into pieces as it slides. Slab avalanche generally occur when packed portion of snow became loose.

II. FACTORS AFFECTING SNOW AVALANCHE:

Snow cover on a slope tends to slide down the slope because gravity. Conditions affecting stability include the gravitational force component of the snow and resisting forces, such as the frictional resistance of the slope. Avalanches are caused when this balance is lost and when the forces exceed the resistance. Avalanches occur by wind, temperature, snowstorm, heavy snowfall.
There are different causes of snow avalanches:

A. Industries Affected:

Avalanches affect people directly by causing injury or death. Avalanche also cause property damage and affect the environment some of the major industries affected by avalanches are:

1) Transportation:
Avalanches cause interruption of movement on highways and railways in mountain corridors.

2) Construction:
Avalanche is destroying the building and kills or injures residents. The houses and residents is damage through avalanche.

B. Wind Velocity:

Wind velocity is the third and very crucial factor in triggering fresh snow (Powder) avalanches. The wind blows the snow mass to the leeward side; sometimes giving to rise to overhangs and cornices, as very commonly in Laddakh, in upper Sind (between Gagangir and Shitkari) on the other side of the Zojila pass and in the Jhelam basin, where the wind blowing with a velocity of 15 km/hr in the valleys produces eddies and whirlwinds.

C. Slope Gradient:

The mountain slope is the most important factor-The steeper the slope, the greater the potential-but only up to the limit of 60^o, for beyond this limit the slope cannot allow accumulation of snow. In the Ladakh and Himachal regions, the slopes range between 30^o and 45^o and are very prone to avalanches. The vegetal cover has a retaining influence on the moment of snow masses.

D. Air Temperature:

The second factors influencing occurrence of avalanches is the temperature of air and its variation. In Kashmir, where the snow pack is 3 to 5m thick, the diurinal variation is of the order of 6-10^oC, the maximum day temperature in sunny days being 5 to 10^oC.

E. Heavy snowfall:

Heavy snowfall is of the snow is unstable areas and puts pressure on the snowpack. It is create in summer month.

F. Human activity:

Human activity is to start of many avalanches the huge deforestation and soil eroded in mountain region, the snow is little stability in cold season. Natural causes include earthquake and tremors.

G. Snowstorm:

The heavy snowstorms are to cause avalanches. 24 hours later the snow storm is more difficult. The wind generally blows from one side of the mountain slope to another side.

H. Vibration:

Vibration is created by all-terrain vehicles and snowmobiles within the snow. Coupled with the gravitational pull to cause an avalanche.

I. Effects of Snow Avalanches:

This is little damage to ecological system cause by avalanche it is a part of nature, they are natural hazard for human population. Effect of snow avalanche is different types.

1) Flash flood:

Flash flood is to start when the avalanche is occurs, then down all the debris and can cause in low lying areas. Flash flood are seen occur after avalanche, in which a long term problem of many town peoples and villagers to deal.

2) Damage to life and property:

A large number of causalities is take place after the snow avalanche hit heavily populated area. The infrastructure is damage and blockage caused, impact the livelihood of many. A powerful avalanche is to destroy building or houses and power supply can be cut off.

3) Avalanche hazard vulnerability of the state:

The avalanches is also the damages in state Himachal Pradesh in district of Kinnaur, Lahaul and spiti, Kullu and Chamba are particularly vulnerable to the hazard of avalanches.

Year	Location	Damage occur
Jan 1975	Lahaul and Spiti	Earthquake shocks triggered the avalanche of great dimensions damaging road net work
March 1978	Lahaul and Spiti	About 30 people killed, road and property damaged.
March 1979	Lahaul and Spiti	About 237 people killed. Communication disrupted
March 1991	Lahaul and Spiti	Tinku avalanche occurs every year 4-5 times from Jan to March. Road was blocked for 40 days in 1991
16 March 1995	Jammu and Kashmir	Avalanche, killed more than 200 people
Nov. 1997	Lahaul and Spiti	Along the Rani Nala, but fortunately there was no causality
March 2011	Lahaul and Spiti	Pindri Nala, 2 laborers died
16 Dec 2012	Siachen	Avalanche, killed 6 army
3 Feb 2013	Dehradun	Avalanche Disaster, killed 2 people
12 March 2014	Jammu and Kashmir	Avalanche, killed 12 people
18 April 2014	Khumbu Ice Fall, Mount Everest	Avalanche, killed 16 Nepalese.

Table 2.1: Avalanche hazard and the damage occurred
(Source: SASE, DRDO, Chandigarh)

The avalanche in the past in Himachal Pradesh through not widespread is confined to higher reaches only. The prominent events of avalanche damage in Himachal Pradesh are as per Table 3.1 and the District wise breakup of avalanches in Himachal Pradesh is given in Table 3.2.

Sr.No.	District	No. of accidents	Person involved	Person killed	Person injured
1	Chamba	12	59	53	0
2	Kinnaur	32	144	129	9
3	Kullu	6	13	9	4
4	Lahaul & Spiti	21	397	298	53
5	Shimla	2	6	1	5

Table 2.2: Districts wise Breakup of the Avalanche Accidents in Himachal Pradesh:
(Source: SASE, DRDO, Chandigarh)

III. Prevention of Snow Avalanche:

Avalanche control is reduces the hazard avalanches pose to human life, activity and property. Snow avalanche prevented by snow net, Snow Bridge, steel retaining structures, vegetation patterns and drainage. Prevention of avalanche hazard by formulating mitigation plan and prevention which then the executed in the winter season

Prevention of snow avalanches are different types:

A. Snow Net:

Snow net can be changed easily snow supported structure of avalanche prevention is build of nylon, steel or cables held through steel poles, provided with compress an anchors downhill. This is installing in the upper part of avalanche path to the control of snow from initial to slide into an avalanche. Snow net is the prevent of snow avalanche then the avalanche accident is less, Snow net installed in the avalanche zone and the net is made of nylon cables or steel.

B. Snow Bridge:

A snow bridge is a rigid snow supporting structure for avalanche control. They can be made of timber, steel or prestress concrete frames. These structures can be fully enclosed, like an artificial tunnel. Snow bridge is maintain the passage in area where snow removal become almost impossible.

C. Steel Retaining Structures:

Avalanche protection by way of structural measures is two primary strategies, as outlined below. First the avalanche release is prevented by defensive structures and avalanche triggered is continuing and change the direction with structures likely to snow sheds and dams. Preventive measure team conduct and structural avalanche protection

D. Snow Drift Control Structure:

Snow drift control structures help in changing the wind-flow and preventing of snow on vulnerable avalanche slopes. A snow fence is a type of fences that forces wind blows, drifting snow is to collect in a desired areas.

This is primary employee to smallest the amount of snow drift on railway or roadway. The farmers and large farm of a cattleshed is use temporary snow fences and snow fences use in the avalanche.

A permanent snow fence simply builds of pole set into the ground with line of closely spaced shrubs.

IV. Result and Analysis:

Snow avalanches which have been occurred in Uttarakhand, Jammu & Kashmir in the past years were collected from various sites and researches. All the data is in Table form and the Graph of avalanche different parameters are shown.

In the recent past few avalanches occurred in Jammu and Kashmir which are shown in table below:

Year	Location	Event	Deaths
Feb 2005	Jammu & Kashmir	Avalanches	More than 200 people
March 2005	Jammu & Kashmir	Avalanches	150
Feb 2008	Jammu & Kashmir	Avalanches	One family killed
Feb 2009	Jammu & Kashmir	Avalanches	4 people killed
Feb 2010	Kashmir	Avalanches	17 Jawans killed
Dec 2012	Jammu & Kashmir	Avalanches	10
Jan 2012	Kashmir	Avalanches	1 BSF killed
Feb 2012	Jammu & Kashmir	Avalanches	19 Soldiers
Apr 2012	Jammu & Kashmir	Avalanches	100 Pakistani soldiers
Feb 2013	Kashmir	Avalanches	1
Jan 2014	Srinagar	Avalanches	1
Feb 2014	Kashmir	Avalanches	16
March 2014	Kashmir	Avalanches	10

Table 4: District wise Avalanche accidents
(Source: SASE, DRDO, Jammu & Kashmir)

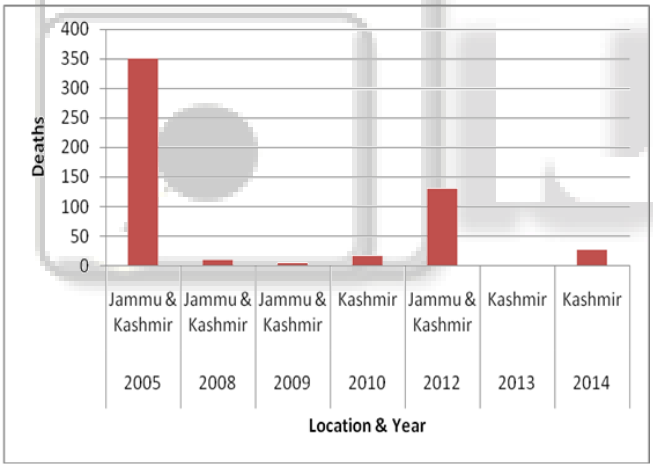

Fig. 4: Graphical representation of District wise avalanche accident

This graph is shows that the maximum number of people is killed in the year 2005 due to the snow avalanche, where more than 200 people is killed and it occurred approx. 4 times in the year of 2012, 46% of avalanche accidents is caused by heavy snowfalls.

V. Conclusions

In this paper, we study of snow avalanche. Snow avalanche is prevented by the snow fences, snow nets, Steel retaining structures and breaking barriers. So that the snow masses do not accumulate to dangerous proportions. Snow fences, retaining walls and avalanche wedges can ward off hazard to building and installations. It is very important for human being because everything that lives on land. Therefore more and more plantation required. We will need better technology and wider adoption of snow avalanches. Snow avalanche vulnerability assessment involves, snow holding capacity of the terrain, seasonal snowfall and cover characteristics. Significant parameters related of terrain, meteorology and snow were assigned weightage towards the accumulation and avalanche event based on reported events in Himalayas.

VI. Scope for Further Study

Large mass of snow moves abruptly down a mountain side. The snow avalanche, a common occurrence in snow covered mountainous regions; snow avalanche is created by wind velocity, slope gradient, air temperature. Snow avalanche is prevented by Snow Bridge, snow nets and steel retaining structures. It is very important for human being because everything that lives on land. Therefore more and more plantation required.

References

[1] Eckert N, Naaim M, Parent E. Long-term avalanche hazard assessment with a Bayesian depth-averaged propagation model. J Glaciol 2010: 56 (198): 563-586.
[2] Fierzand and Gauer (1998), The first attempt to simulate the snow cover on slopes with the snow cover model.
[3] Frutiger, H:1990 maximum avalanche runout mapping: a case study from the central Sier Nevada, Proc. 1950 Int. snow sci. workshop, Bigfork, Mountana, pp. 245-251.
[4] Gaucher (2010), An intense avalanche cycle occurred in Southern French Alps.
[5] Cayan D.R.: 1996 inter annual climate variability and snowpack in the western United states J.climate 9, 928, 948.
[6] Sharma ss and Ganju A(2000) complexities of avalanche forecasting in western Himalya an overview, cold Regions Science and Technology, Vol. 31, PP 95-102.
[7] Schaerer (1984), In Canada experiences at least 1.5 million potentially destructive avalanches.
[8] Stoffel (2008), the morphological criteria examined in tree damaged by snow avalanching.
[9] Takeuchi K. Distribution of information statistics and criterion of model fitting. Urikagaku 1976: 153:12-18.
[10] Voight, B., Armstrong , B.R., Armstrong, R.L., Bowles, D., Brown, R.L., Ferguson, S.A., Fredstone, j., kiusalaas, J., Mc Farlane, R.C., and Penniman, R: 1990, snow avalanche Hazards and mitigation in the United States, National Academy Press, Washington, D.C., 84 PP.
[11] Williams and Armstrong (1998), the avalanches that fail in storm snow are ski areas and may be the most common avalanches worldwide.
[12] De Haan L. A spectral representation for max-stable processes. Ann probab 1984: 12: 1194-1204.
[13] Williams, K: 1985, Nov 1985 avalanche notes, U.S. Forest service west wide Avalanche network, Rocky Mountain Forest and Range experiment.

[14] Gubler and Rychetnik (1991), "How environmental factors likely to wind, topography, vegetation and radiation affect slab avalanche.
[15] Gurer, I,Tuncel, H., Yava, S,O. M., Erennbilge, T., and sayin, A: 1995, snow avalanche incidents in north-western Anatolia, Turkey during December 1992, Natural hazards 11, 1-16.
[16] Holler (2007), The preventive measures of snow avalanche is ski areas.
[17] Hachler P: 1987, Analysis of the weather situations leading to serve and extraordinary avalanche situations, Int. Assoc. of Hydrological Sci.Publ. 162,295-304.
[18] Holler, P: 1999, weather and avalanches in Austria: A brief synopsis of the Austrian Alps, The avalanche Review 17(6), 10.
[19] Mc clung, D. and schaerer, P: 1993, The avalanche handbook, the mountaineers, seattle, Washington, 271 PP.
[20] Arkin, P.A. and Janowiak, J.E: 1987, the global climate for December 1985, February 1986: conflicting ENSO signals observed in the equatorial pacific, Mon. Rev. 115, 297-316.
[21] Ancey (2004), the snow avalanches a type of fast moving mass movement can be considered as weather related natural hazard.

