SNOW SAFETY AND SNOW MANAGEMENT FOR THE 1988 CALGARY WINTER OLYMPIC GAMES[1]

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Snow safety and snow management are important considerations in preparation for the XV Winter Olympics at Calgary, Canada in 1988. Snow safety programmes are being developed for the Alpine and Nordic skiing sites and for the transportation network. Preparation for snow management is being undertaken to ensure that good skiing courses are provided.

INTRODUCTION

The XV Winter Olympic Games will be held in and around Calgary, Alberta, Canada in February, 1988. The Alpine Skiing events will be held at Nakiska, Mt. Allan in the Kananaskis River Valley. The Nordic and Biathalon events will be held at the Canmore Nordic Centre, in the Bow River Valley. Both sites lie within Kananaskis Country, a 4166 km area composed of Parks and Recreation areas in the Front Ranges and Foothills of the Canadian Rockies. Each of the skiing sites is a new development designed both to accommodate the Winter Games and to provide recreation, training and competitive facilities in Alberta.

Two considerations in development of the sites and the surrounding region have been Snow Safety and Snow Management. Avalanche hazard mitigation has been an important consideration in development of the skiing sites, the transportation network and the backcountry area. Snow management has been an important consideration in view of the light snow climate typical of the eastern slopes of the Rocky Mountains. Optimum use of the natural snowcover is desirable to provide the best possible skiing conditions.

CLIMATE AND SNOWPACK

The winter climate of Kananaskis Country combines dominance of cold Polar Continental air masses with periodic intrusions of moist Pacific air. Winter conditions can include cold, clear periods of high pressure, light low density snowfall with occasional heavy snowfall, and short Chinook periods with warm temperatures and strong wind. During the spring period (March - May) heavy snowfall occurs during periodic intense upslope storm activity.

The snowpack is typical of the eastern slopes of the Canadian Rocky Mountains. Potentially unstable depth hoar is observed to develop at the base of the snowpack each winter. The snowcover distribution varies greatly from the deeper snowpacks of the Continental Divide to the thin snowcover of the Foothills region. Wind redistribution of the snowcover results in extreme local variations resulting in a difficult task for snow stability evaluation. Surface formations such as surface hoar and hard wind slab play an important role in avalanche formation.

ALPINE SKIING SITE SELECTION

During the late 1970's and early 1980's several sites were considered for Alpine Skiing Development. A technical review committee was formed by the Alberta Government to review the potential sites which had been identified. The author was present on the committee to provide an initial evaluation of potential avalanche hazards at the various sites.

Each potential development site was reviewed in terms of:

1. potential avalanche hazards on the skiing development terrain;
2. potential avalanche hazards in terms of limitation to structural development;
3. estimated frequency of hazard in the terrain development areas;
4. potential for effective avalanche control including:
   - (a) potential for effective starting zone compaction (in view of the depth hoar climate);
   - (b) potential for effective avalanche control by active explosive means.

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In the final analysis the Mount Allan area was clearly the site with the greatest potential lift serviced terrain area with the fewest constraints in terms of the snow avalanche hazards. Although economic and access considerations played a greater role in the site selection, in the long run Mt. Allan was selected as the skiing development site.

DEVELOPMENT OF THE TRANSPORTATION NETWORK

Studies of the snow avalanche hazard also played an important role in development of the roads in Kananaskis Country. The snow avalanche hazard has been studied extensively on the Canmore Hill, the Smith Dorrien - Spray Trail, and in the Highwood Pass, on behalf of Alberta Transportation and Alberta Recreation and Parks.

The Canmore Hill and Smith Dorrien - Spray Trail ties Canmore to Kananaskis Park via the Spray Lakes and Smith Dorrien Creek, accessing a large backcountry recreation area. An assessment of hazard to traffic at the various avalanche sites was undertaken by Peter Schaerer. He used the Avalanche Hazard Index System developed for British Columbia Highways by the Ministry of Highways Avalanche Task Force, of which he was a member. The factors used in the hazard index calculations are as follows:

1. Estimates of average frequencies and widths of avalanches on the road;
2. Speed of traffic;
3. Average stopping distance for traffic;
4. Waiting time for traffic when avalanches have blocked the road;
5. Average space per vehicle in waiting line;
6. Traffic volume per day;
7. One-way rush hour traffic.

Schaerer describes the hazard indices as numbers which serve for making comparisons. They may be applied:

a) To compare the avalanche hazard with that on other roads;
b) To determine which avalanche paths contribute to the avalanche hazard most and where a control would be most beneficial.

After the initial hazard evaluation, detailed winter observation of the snow, weather and avalanche sites was undertaken. Following the observation period recommendations for avalanche control were prepared and a detailed Avalanche Atlas was prepared for the Canmore Hill and Smith Dorrien - Spray Trail.

The Highwood Pass links the Kananaskis River Valley to the Highwood River Drainage and South-western Alberta. At 7900' above sea level it is Alberta's highest highway pass. At present the route is closed in winter. Initial studies of the avalanche hazard in the area and Avalanche Atlas preparation have been initiated in view of future potential winter use. Relocation of the highway to the centre of the valley from the original mountain side route has reduced the hazard significantly.

SNOW SAFETY OPERATIONS

Snow Safety operations as a whole within Kananaskis Country are the responsibility of Alberta Recreation and Parks. The avalanche hazard in the backcountry and along the transportation network is monitored by a team of snow specialists within the Parks system. Public information programmes and a regional Snow Stability bulletin are the main tools in the backcountry programme. On the transportation network site monitoring, travellers advisory, temporary closure as required, and helicopter bombing are used to mitigate the avalanche hazard.

At the Alpine Skiing site, Nakiska at Mount Allan, the area operator is responsible for snow safety operations. The avalanche hazard at Nakiska is concentrated on a north-east facing ridge above the ski area. The steep ridge is broken by rockbands and contains several small avalanche starting zones of open slope and gully configuration. Lee slope and cross wind effects lead to regular wind-slab formation over weak layers developed by strong temperature gradient action.

During the current 1986-87 winter (the first year of regular operation) the operators will use a system combining avalauncher guns, handcharge routes and temporary closures to minimize the snow avalanche hazard. Regular compaction where feasible in the starting zones, beginning with the first winter snows, has been recognized as an important tool in stabilizing the depth hoar and upper level temperature gradient snow layers.

At the Canmore Nordic Centre the snow avalanche hazard affects only the periphery of the skiing terrain. Several large gullies originate on the north-east face of Mt. Rundle and the runout zones extend to the upper loop of trail development. The hazard to the lower runout zones has been recognized as developing infrequently during major avalanche cycles. Helicopter bombing will be used as an active measure to reduce the hazard from large avalanches.

SNOW MANAGEMENT AT NAKISKA AND THE CANMORE NORDIC CENTRE

A snow and weather monitoring programme was initiated at the Alpine and Nordic sites during the 1983-84 winter by the Alberta Government. The purpose of the studies was to provide the area operators, and various agencies concerned with the coming Winter Olympics, with winter site experience. As the time between operations start up in the 1986-87 winter and the 1988 Winter Games is short, this experience is very important.

At Nakiska a network of five automatic weather stations, seventeen snow courses, and several visual snowstakes was established. At the Nordic Centre eight automatic weather stations and sixteen snow courses were established.

The objective of snow course observations at both sites was to monitor the season snowpack and establish the amounts and distribution of the natural snowcover at both sites. Snowmaking systems have been established at both sites in view of the light snow climate typical of the eastern slope of the Rockies. Effective use of the natural snowcover is important in areas without snowmaking and in reducing costs in areas with snowmaking.

The terrain at the sites was broken down into sub-areas and an analysis of the snowcover distribution in each sub-area has been provided for various dates during each winter of study. Needs in snow management in terms of redistribution of the natural snowcover and snowmaking needs were identified for these various times and sub-areas. In this way site operators gain experience in what it would have been like to operate during the 1983-84, 1984-85 and 1985-86 winters.

At the Nordic Centre studies of varying trail widths on snow accumulation, and studies of compaction and tracksetting techniques to provide optimum skiing conditions, have been undertaken. In the coniferous forest interception of the falling snow by tree crowns greatly reduces snow accumulation on the forest floor. Cutting the trails to a width sufficient to accumulate the majority of the falling snow must be balanced with the need to provide interesting skiing terrain and development at reasonable cost. During the intensive reworking of snow for a major competitive event optimum tracksetting techniques need to be employed to ensure good skiing conditions.

Data from the weather stations on the sites includes wind, temperature, vapour pressure (humidity) and solar radiation. This data has been used to provide operators with detailed information on factors such as:

1. snowmaking conditions;
2. temperature regimes during operating and competitive time frames;
3. wind chill factors;
4. the effect of wind on ski lift operations;
5. the effect of solar radiation over time at various locations on the terrain;
6. chinook effects;
7. affects of climate on the avalanche hazard.

CONCLUSIONS

This paper provides an overview of the process of development of Kananaskis Country in preparation for the XV Winter Olympic Games. Similar studies have and will be applied to future development areas. Effective use of snow safety and snow management programmes are integral parts of mountain winter recreation development.

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