SOME PROPERTIES AND CHARACTERISTICS OF WET SNOW

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INTRODUCTION

Although most seasonal snow falls at sub-freezing temperatures, it eventually is melted by one of several heating processes. When melt water is introduced into the snow cover major changes take place in both the morphology of the snow grains as well as the basic physical and mechanical properties. Typically these changes will occur faster and provide greater variability than is the case with sub-freezing, dry snow.

HEAT SOURCES

How to warm/melt the snow cover.

1) Short Wave Radiation (solar radiation)

2) Long Wave Radiation (from warm air and clouds above the snow surface)

3) Sensible Heat (conduction from warm air in contact with the snow surface)

4) Latent Heat (condensation of warm, moist air on the colder snow surface)

5) Rain

In most climates solar radiation is the primary source of heat available to melt the snow cover but the remaining four sources will increase in importance proportionally as the site becomes more maritime; average air temperatures, atmospheric water vapor, and cloudiness all increase.

CONSEQUENCES OF HEATING

Considerably more heat is necessary to melt a given mass of snow than is required to warm it.

1) Increase the temperature of the snow to the melting point: The amount of heat required to raise the temperature of one gram of ice one degree celsius is 0.5 calories which is termed the specific heat of ice.

2) Melt the snow: The amount of heat required to melt one gram of ice is approximately 80 calories and is termed the latent heat of fusion (or melting).

SHORT-TERM VERSUS LONG-TERM WARMING/ MELTING OF THE SNOW COVER

1) Short-term: brief, moderate warming of the snow may involve only the uppermost few centimeters. Melt layer refreezes at night to become a surface melt-freeze crust. Depending on whether it is in the melt or freeze portion of the cycle the layer is highly variable in terms of texture, strength, and its role as a potential sliding surface for subsequent snowfalls. Layer typically gets stronger, and grains become larger, with increasing numbers of melt-freeze cycles.

2) Long-term: sustained melt occurring through a major portion of the snow cover (surface layers may still be re-freezing at night). Result of prolonged heat input and increased amounts of melt water:

a. Surface tension can no longer hold water at grain surface.

b. Liquid water begins to percolate, flow slowly, downward towards the ground.

c. May encounter colder layers within the snow cover and refreeze; latent heat of fusion is released, which in turn causes the snow layer to warm rapidly.

d. Melt water may pond above a crust or at the base of a fine-grained layer. Restricted flow will cause increase in liquid water in that layer. High liquid water content creates low strength.

MECHANICAL PROPERTIES

1) In wet snow the primary control over strength is the amount of liquid water present.

a. Low liquid content (less than 7% by volume), pendular regime. Ice-to-ice bonds continue to provide strength, air in continuous channels throughout the snow texture. Liquid water has overcome capillarity and is flowing slowly through the snow layers.

b. High water content (more than 7% by volume), funicular regime. Very low strength with water completely surrounding the grains. Typically water drainage has been restricted by a crust or fine-grained layer in order to achieve this high liquid content; thought to contribute to the release of wet snow avalanches.

METAMORPHISM

1) <u>Melt-Freeze Metamorphism:</u> Usually occurs within 10 to 20 cm of the snow surface in response to diurnal heating and cooling.

a. Texture becomes amorphous, individual crystals loose their identity, conglomerates form.

b. As melt-freeze cycles repeat, the number of grains decreases but the average size increases as the smaller grains melt first and then refreeze onto adjacent larger grains; hardness increases with number of melt-freeze cycles.

2) <u>Melt Metamorphism:</u> Occurs in the <u>absence</u> of melt-freeze cycles (but freezing will lead to melt-freeze metamorphism), grain clusters form to minimize surface free energy.

a. Low water content (pendular regime); heat flow from larger to smaller grains results in fewer but larger grains over time.

b. High water content (funicular regime) same process as low water content except grain growth occurs more quickly primarily because liquid area for heat flow is larger. Strength greatly reduced. (Additional water leads to slush, crystals completely immersed in water, no strength, liquid like behavior.)

PROPERTIES OF WET SNOW

Although most seasonal snow falls at sub-freezing temperatures, it eventually is melted by one of several heating processes. When melt water is introduced into the snow cover major changes take place in both the morphology of the snow grains as well as the basic physical and mechanical properties. Typically these changes will occur faster and provide greater variability than is the case with sub-freezing, dry snow.

Heat to warm and eventually melt the snow is available from several sources of energy including radiation, convection, conduction, and latent heat. A much greater amount of heat is required to melt snow than to warm it (160 times more). When liquid water refreezes within the snow cover this same heat (latent heat of melting/freezing) is released and is available for further warming of the snow. Diurnal cycles of melting and refreezing result in relatively thin surface crusts but if warming is prolonged over many days the snow cover temperature increases to the melting point throughout (becomes isothermal). In wet snow the primary control over strength is the amount of liquid water present. When liquid water is percolating downward through the snow cover, the snow structure controls the amount of water which can be held within a given layer. Therefore, just as in the case of dry, subfreezing snow cover, structure and stratigraphy play a very important role in avalanche formation.