Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN UTAH

U. S. Forest Service
Research Note INT-43 1966

SNOW LOADS ON ROOFS IN AREAS OF HEAVY SNOWFALL

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ABSTRACT

This study tested the feasibility of estimating snow loads on roofs from measurements of depth and water content of snow on nearby ground. The water content, and therefore the weight, of snow on the ground proved comparable to that of snow on roofs.

INTRODUCTION

The snow load that a building may have to support in regions where snowfall is heavy becomes an important consideration affecting structural design and requirements for winter maintenance. Sharply pitched roofs and metal roofs that promote snow slippage are commonly used to reduce risks of overload. But for reasons of economy, efficiency, or aesthetics, many buildings have no special provisions for snow removal. For such buildings, it becomes especially important to know how heavy a load of snow the building can carry and how this weight corresponds to local characteristics of snow accumulation. If the maximum probable snow load should exceed designed strength of the building, arrangements must be made to strengthen the structure or to shovel the roof clear before critical conditions develop. Arranging for timely shoveling is difficult, particularly for such unoccupied buildings as summer cabins and forest camp facilities in remote mountain country where roads remain closed during winter.

Two published reports on snow load investigations[2] estimated snow load from standard weather station observations of snow depth and seasonal snowfall. They cautioned users that the data did not reflect conditions typical of western mountain areas. Furthermore, the density and characteristics of retention of snow accumulations on roofs were based upon assumptions rather than actual measurements.

Snow surveys provide bases for estimating on-the-ground accumulation of snow in many localities. However, relations between snow depths measured on the ground and weight of snow accumulated on roofs need to be determined more precisely. Are increases in snow depth similar? How do melting rates and snow densities compare? To answer these and related questions, we measured

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[2] *Housing and Home Finance Agency. Snow Load Studies, Housing Research Paper 19, 19 pp., 1952. Boyd, D. W., Maximum Snow Depths and Snow Loads in Canada. Western Snow Conf. Proc., April 1961, Colo. State Univ., Fort Collins, Colo., pp. 6-16, 1961.*

accumulations of snow on a roof and on the ground nearby at the Priest River Experimental Forest during a 6-week period in February and March 1964.

SITE AND MEASUREMENTS

We selected an unheated, open-front garage as the site for a series of comparative snow measurements on a cedar-shingled roof and on nearby ground locations having less slope but similar exposures (fig. 1). Information on snow loads from other buildings was limited to visual observations. The snow on each side of the garage roof was sampled at points 30 inches below the ridge and 30 inches above the eaves. The snow on each ground location was also sampled at two points. We used conventional snow survey techniques to measure depth and determine water content at all measuring points. Orientation of the sample points was:

Location	Aspect	Slope percent
Roof	N70°E	53
	S70°W	60
Ground	N60°E	27
	S90°W	32

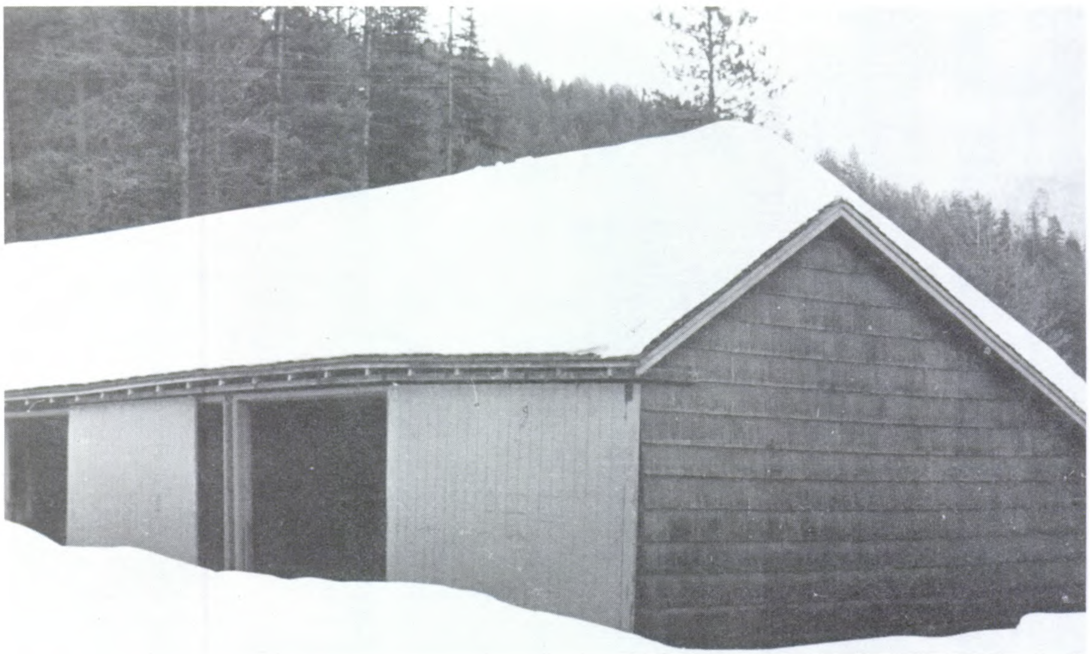

Figure 1.—Garage where snow accumulation was measured. Depth near eaves was about 40 inches on March 12, 1964.

RESULTS AND DISCUSSION

We started measuring snow depths on February 19, 1964. Until then, the seasonal snowfall had been somewhat below average. Several warm days (maximum temperatures exceeding 40° F.) followed by cold nights (minimum temperatures of 10° to 20° F.) preceded the second measurement date, February 27. During the following period snow fell almost every day, and by March 11, 17 inches of new snow had been recorded at the Experimental Forest. From March 12 until the final measurement date, March 31, precipitation was scanty and the temperature trend was upwards.

The properties of accumulated snow on different parts of the garage roof were affected somewhat by aspect, especially on the last date of measuring (figs. 2 & 3). During the period from March 11 to March 31, local air currents apparently caused heavier snow deposit on the west side and a somewhat faster melting rate on the east side of the building. Snow depth increased slightly from ridge to eaves: points near the eaves averaged 2 inches deeper. This difference probably resulted from snow creep down the roof slope.

Depth and water content of snow on the ground were similar to those measured on the roof. Although the depth of snow on the ground averaged about 2 inches less, its density was about 3 percent higher; so the actual water contents were essentially the same.[3] Heat conducted from the unfrozen earth was probably responsible for the increased density.

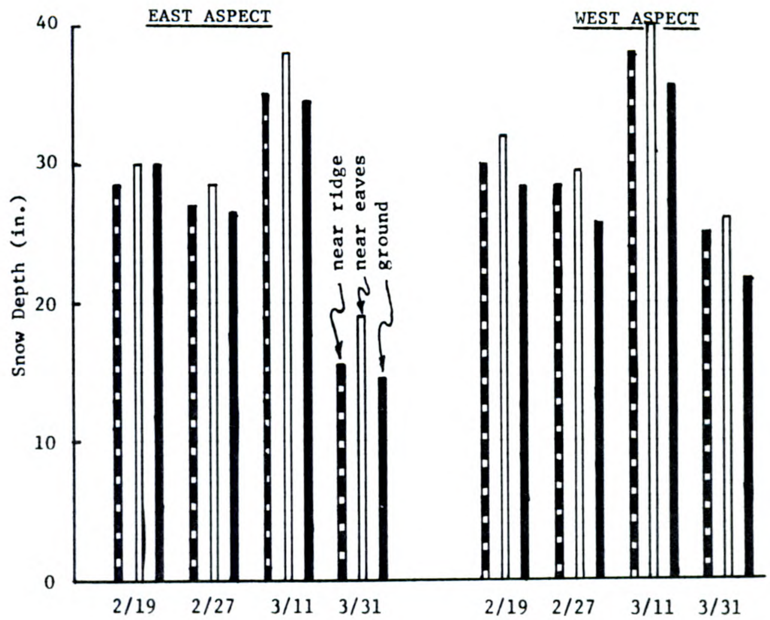

Figure 2.—Depth of snow at ridge and eaves of garage roof and on the ground, by aspect and date of measurement.

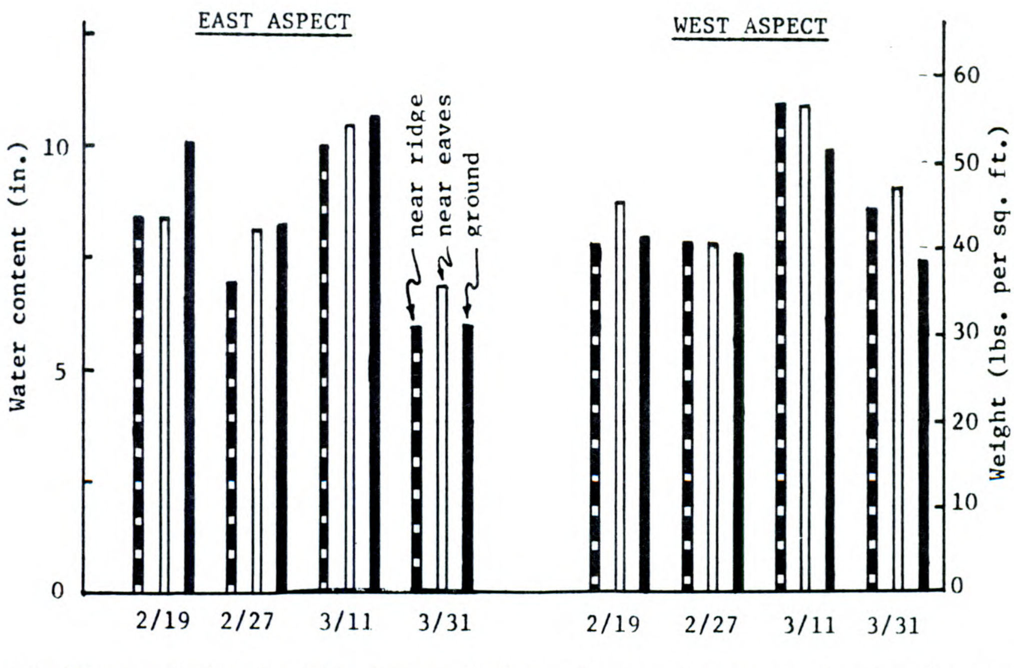

Figure 3.—Water content and weight of snow at ridge and eaves of garage roof and on the ground, by aspect and date of measurement.

[3]*Snow density is computed as the snow depth (in inches) divided by the water content (in inches), and is expressed in percent. Densities during the 6-week period of measurement ranged from 26 to 42 percent.*

Observations of the characteristics of snow retention on the roofs of nearby buildings indicated that wood-shingled roofs of heated buildings also can accumulate heavy loads of snow. Formation of ice at the eaves frequently adds weight stress on the overhang portion (fig. 4).

We also noted behavior of snow on aluminum-shingled roofs of unheated buildings. On these roofs, considerable snow accumulates even where the pitch of the roof is moderate. Cohesive strength of the snowpack over the ridge or over other roof projections tends to hold the snow for extended periods. However, warming temperatures usually cause the snow to slip quickly from aluminum-shingled roofs (fig. 5).

The maximum water content of 10 to 11 inches, reached on March 11, was nearly as great as has been recorded on a nearby snow course during nearly 30 years of measurement. This corresponds to a weight of about 55 pounds per square foot of horizontal area; thus a building having 800 square feet of roof area would need to support a total snow load of 22 tons. This is not especially heavy for many mountainous areas. At a snow course near the Deception Creek Experimental Forest headquarters, for example, snow depths exceeding 6 feet, with water content of more than 30 inches, have been measured.

Figure 4.—Ice usually accumulates at the edge of overhanging eaves of heated buildings (photographed March 12, 1964).

CONCLUSION

Although the depth and density of snow on wood-shingled roofs of unheated buildings may vary slightly from depth and density of snow on the ground, the weight per unit of horizontal area of snow on the roof will correspond closely to that of the snowpack on the ground. Consequently, past records of snow surveys can be useful references for determining the snow load a building may need to sustain.

Figure 5.—Snow slid from the aluminum-shingled roof of this unheated building at Priest River Experimental Forest shortly after a period of warmer weather began (photographed March 5, 1964).

DPSU/66/1791-8