METHODOLOGY USED IN GENERATION OF SNOW LOAD CASE HISTORIES

by

Donald McLaughlin[1] and George Duggan[2]

Introduction

During the 1975-76 winter in the Troy, New York area, a study of snow loads on various types of roofs was conducted. There were three basic objectives of the study. First, the snow configuration on loading on twenty-one structures were to be documented over the winter season. Second, some common winter occurances such as eave icings, drifting and sliding snow, were to be observed to determine how they affect the roof snow load. Finally, recommendations for ground to roof snow load conversion factors were to be derived using the information obtained from the case histories.

Structures

The twenty-one structures were chosen with the three basic variables of slope, exposure and thermal resistivity in mind. Roughly half of the roofs were flat and the exposure level varied from fully exposed to relatively sheltered. The remaining roofs had various slopes from 5 to 60 degrees and were all semi-exposed. The thermal resistivity of the roofs as measured by the 'R' values ranged from 4.25 to 15.8. These R values were calculated and/or estimated values from construction drawings of the structures involved. Table 1 contains a listing of the slopes, exposure levels and R values for each of the structures in the study.

Procedure

In the data gathering procedure itself, it was necessary to know the density as well as the depth of the snow at any location. For this reason, snow samples of a known volume were taken and the weights and locations recorded. This was accomplished by means of snow sampling tubes (500 cc) supplied by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL). In taking sloped roof density samples, it was necessary to obtain all samples within an arms reach of the eaves since all work had to be preformed off a ladder. This restriction did not hold on the flat roofs since safe movement on these roofs was possible. On average, three density samples on each roof were taken on each observation date in location where snow qualities appeared to be typical of the entire roof. In some cases, extra samples were taken to record interesting, unusual or extreme conditions. In a similar manner, ground samples were taken at locations around the buildings which seemed to best exemplify the general ground snow load

1. Lieutenant j.g., U.S. Navy; formerly graduate student, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, NY 12181
2. Engineer, Stone & Webster; formerly graduate student, Department of Civil Engineering, Rensselaer Polytechnic Institute, Troy, NY 12181

TABLE 1

	STRUCTURE	SLOPE	THERMAL RESISTIVITY	EXPOSURE * LEVEL
1	McLaughlin	25°	13.0	2
2	Murphy	16°	13.0	2
3	Lis	27°	13.0	2
4	Powlowski	27°	13.0	2
5	Kinns	15°	13.0	2
6	Sorrel	35°	13.0	2
7	Ensel	27°	13.0	2
8	Aloia	Flat	4.3	3
9	Berdar's	5°	13.5	2
10	Cohoes C.C.	Flat	12.9	2
11	MRC	Flat	15.9	1
12	Cogswell	Flat	14.2	1
13	Science Center	Flat	13.3	1
14	Comm. Center	Flat	13.5	1
15	Renss. Union	Flat	11.0	1
16	Chapel	Flat	11.3	2
17	Burdett	Flat	14.8	1
18	Bray	Flat	14.8	1
19	Sharp	Flat	15.0	1
20	Norton #29	Flat	9.2	1
21	Norton #20,28	Flat	9.2	1

		Sloped Avg	13.1	
		Flat Avg w/o Aloia	12.9	

*EXPOSURE LEVEL: 1 - Exposed (windswept)
2 - Semi-sheltered (some trees or obstructions)
3 - Sheltered

conditions.

In recording the snow depth on the sloped roofs, an extendable wood shaft with a total length of 16 feet was used. A yardstick was attached perpendicular to the shaft at the end. Thus, snow depths at locations as far as 15 feet from the eaves could be measured. The shaft was marked in increments of one foot to help determine the actual yardstick location.

In the planning stage of the project, it was intended that observations would be made at each site at least every two weeks after the first major storm of the season. However, the winter proved to be a mild one with a total snowfall of roughly 50 inches as compared to the historical average of 66 inches. More than half of the total snowfall fell in four major storms. Most of the other storms were either very small in nature (2-3 inches) or were followed by a rainy or warm spell causing rapid melting. As a result, there was no accumulation of snow on the roofs from storm to storm.

The data itself was recorded on a standard data sheet shown in Figure 1 through 6, that were developed for each structure. Pertinent data such as date, weather conditions, snow depths and densities, locations of samples and other general comments were recorded for each visit to a structure.

The special problems of sliding snow and roof icings were also observed at several locations and recorded on the data sheets. Typical examples are shown on Fig. 7 through 11. These phenomenon should be considered in design procedures as their effect on structural loading can be significant.

It is hoped that this work coupled with the data base gathered from the continuation of the study and similar studies throughout the United States and Canada will lead to more representative and standardized snow loading design criteria.

Acknowledgement

The project described in this paper was supported by the U.S. Army Cold Regions Research and Engineering Laboratory under the direction of Wayne Tobiasson and Robert Redfield. Their support and encouragement throughout the project is gratefully acknowledged.

A9-13.5

SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 3/17/76
Weather: Cold, Extremely Windy.

BUILDING: Science Center

Location: RPI Campus, Troy, N.Y.

Building Type: 4 Story Brick

Roof Type: Flat, Built-Up, Smooth

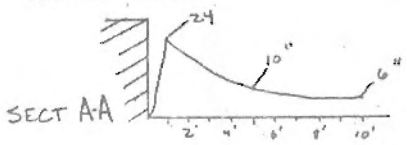
Exposure: Windswept

Heated: Yes

Thermal Rating: R=13.3

Ground Snow Densities:

Total Snow Depth: Avg 9"



Sample	Depth Taken	Weight (gm)	Density (#/ft³)
1V	Full	79	9.88
2V	Full	89	11.13
3V	Full	84	10.50

Roof Snow Densities:

Total Snow Depth

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
4H	2"	87	10.88
5V	10"	84	10.50
6V	10"	92	11.50

Pictures taken:

Comments:

PICTURES
(A) (B) (C)
AC
SHOWN

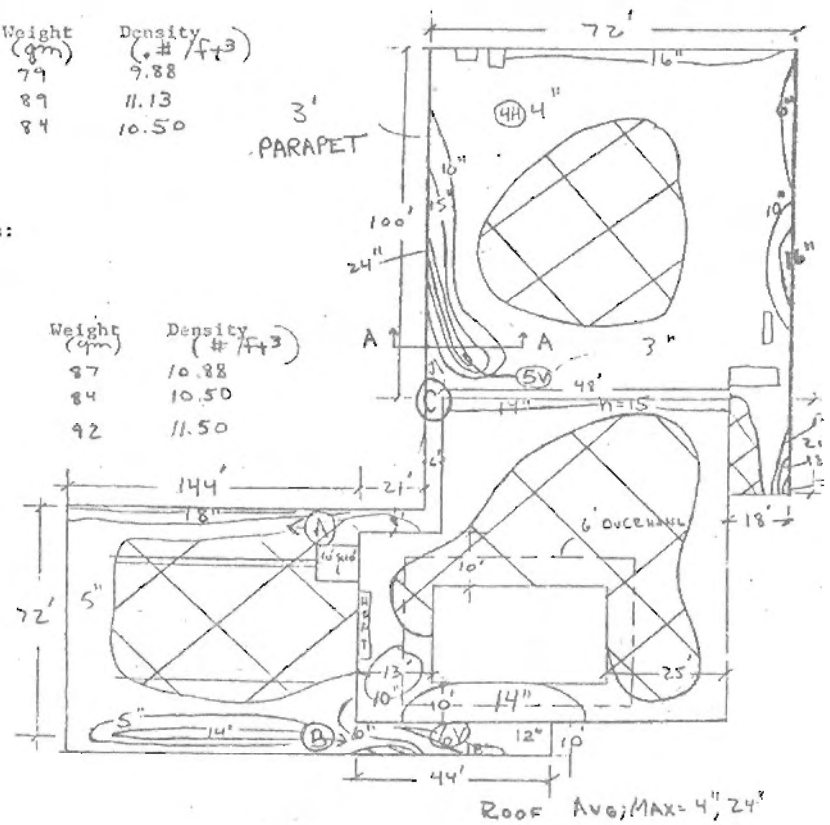


FIGURE 1 Typical Data Sheet

A9-12.5

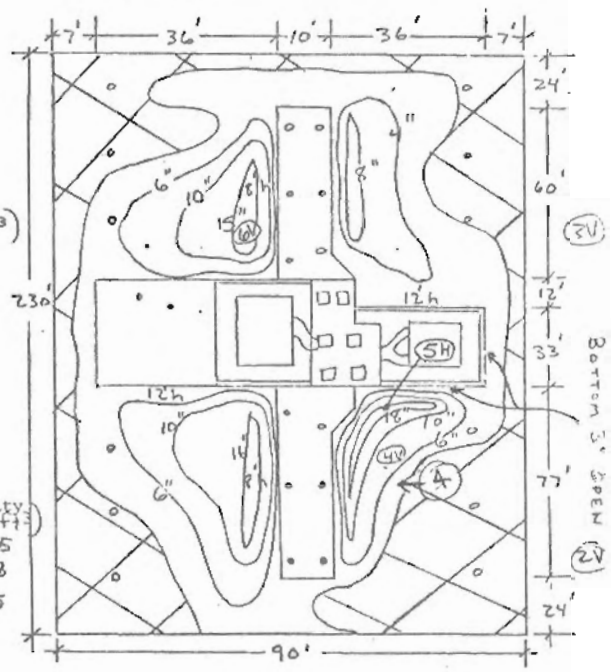
SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 3/17/76
Weather: Cold, Extremely Windy

BUILDING: Cogswell
Location: RPI Campus, Troy New York
Building Type: 3 Story
Roof Type: Flat, Built-Up With Gravel
Exposure: Windswept
Heated: Yes
Thermal Rating: R=14.2
Ground Snow Densities:
Total Snow Depth: ≈9" Avg.

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
1V	Full	74	9.25
2V	7"	87	10.88
3V	Full	79	9.88



Roof Snow Densities:

Total Snow Depth

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
4V	Full	82	10.25
5H	8"	79	9.88
6V	Full	86	10.75

Pictures taken: (1) As shown

Comments:

(10)

Roof Avg, Max = 8", 18"

FIGURE 2 Typical Data Sheet

A9-2.2

SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 12/22/75
WEATHER: 25°, LIGHT SNOW

BUILDING: MURPHY

Location: 19 RUDOLPH CT, COHOES, N.Y.

Building Type: RESIDENCE

Roof Type: SLOPED - 16°, SHINGLES

Exposure: FEW TREES OR OBSTRUCTIONS

Heated: YES

Thermal Rating: APPROX R= ≅ 13

Ground Snow Densities:

Total Snow Depth: 10" AVG

Sample	Depth Taken	Weight (gms)	Density (#/ft³)
1V	FULL	72	9.00
2V	FULL	76	9.50
3V	FULL	98	12.25
4V	FULL	95	11.88

Roof Snow Densities:

Total Snow Depth - VARIES

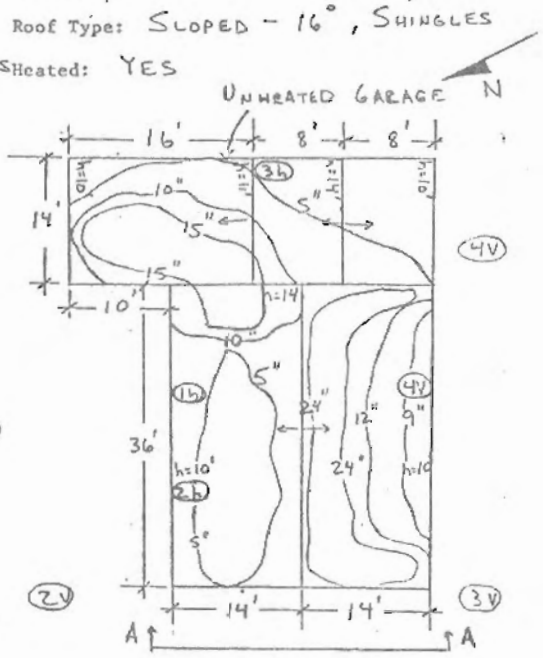
Sample	Depth Taken	Weight (gm)	Density (#/ft3)
1h	3"	71	8.88
2h	3"	70	8.75
3h	3"	79	9.88
4V	FULL	75	9.38

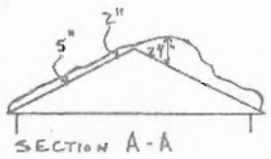
Pictures taken: NONE

Comments: GUTTERS ON ALL EAVES

BUILDUP OF SNOW ON LEEWARD SIDE OF ROOF - REDUCTION OF SNOW ON WINDWARD SIDE

BUILDUP OF SNOW ON UNHEATED GARAGE WHERE GARAGE ROOF MEETS HOUSE ROOF - VERY SMALL SLOPE ON GARAGE ≈ 5°





ROOF AVG; MAX = 10", 24"

FIGURE 3 Typical Data Sheet

A9-12.5

SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 3/17/76
Weather: Cold, Extremely Windy

BUILDING: Cogswell

Location: RPI Campus, Troy New York

Building Type: 3 Story

Roof Type: Flat, Built-Up With Gravel

Exposure: Windswept

Heated: Yes

Thermal Rating: R = 14.2

Ground Snow Densities:

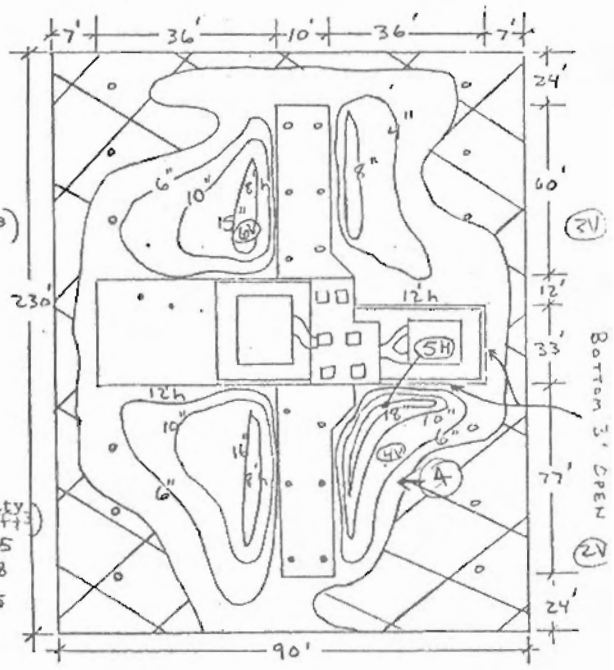
Total Snow Depth: ≈ 9" Avg.

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
1V	Full	74	9.25
2V	7'	87	10.88
3V	Full	79	9.88

Roof Snow Densities:

Total Snow Depth

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
4V	Full	82	10.25
5H	8"	79	9.88
6V	Full	86	10.75



Pictures taken: (1) As shown

Comments:

Roof Avg, Max = 8", 18"

FIGURE 4 Typical Data Sheet

A9-13.5

SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 3/17/76
WEATHER: COLD, EXTREMELY WINDY

BUILDING: SCIENCE CENTER

Location: RPI CAMPUS, TROY, N.Y.

Building Type: 4 STORY BRICK

Roof Type: FLAT, BUILT-UP, SMOOTH

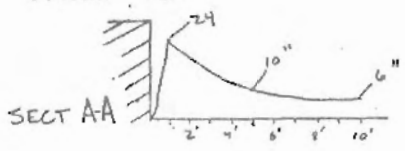
Exposure: WINDSWEPT

Heated: YES

Thermal Rating: R=13.3

Ground Snow Densities:

Total Snow Depth: AVG 9"



Sample	Depth Taken	Weight (gm)	Density (#/ft³)
1V	FULL	79	9.88
2V	FULL	89	11.13
3V	FULL	84	10.50

Roof Snow Densities:

Total Snow Depth

Sample	Depth Taken	Weight (gm)	Density (#/ft³)
4H	2"	87	10.88
5V	10"	84	10.50
6V	10"	92	11.50

Pictures taken:

Comments:

PICTURES
(A) (B) (C)
AC
SHOWN

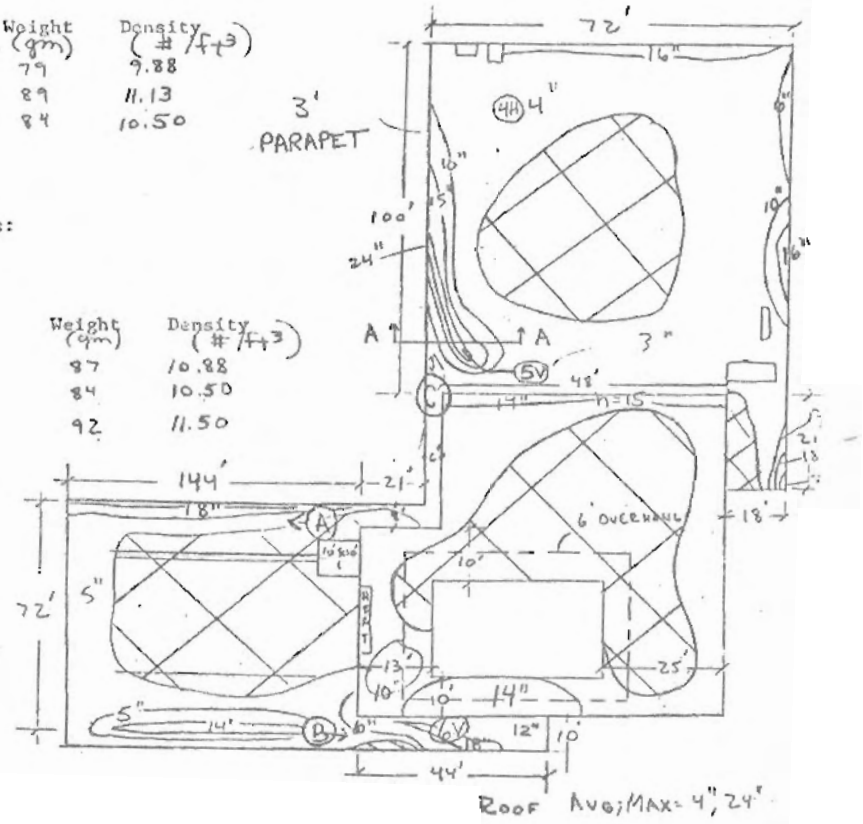


FIGURE 5 Typical Data Sheet

A9-2.2

SNOW AND ICE LOADS

Don McLaughlin, George Duggan
Civil Engineering Department, R.P.I.

Date: 12/22/75
WEATHER: 25°, LIGHT SNOW

BUILDING: MURPHY

Location: 19 RUDOLPH CT, COHOES, N.Y.

Building Type: RESIDENCE

Roof Type: SLOPED - 16°, SHINGLES

Exposure: FEW TREES OR OBSTRUCTIONS

Heated: YES

Thermal Rating: APPROX R= 13

Ground Snow Densities:

Total Snow Depth: 10" AVG

Sample	Depth Taken	Weight (gms)	Density (#/ft³)
1V	FULL	72	9.00
2V	FULL	76	9.50
3V	FULL	98	12.25
4V	FULL	95	11.88

Roof Snow Densities:

Total Snow Depth - VARIES

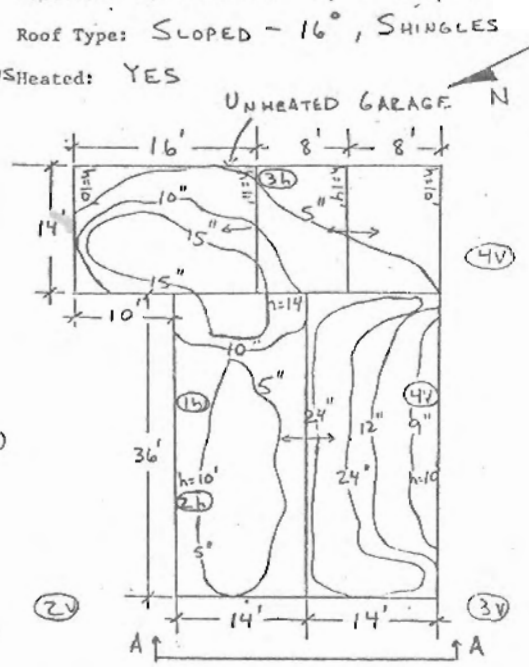
Sample	Depth Taken	Weight (gm)	Density (#/ft³)
1h	3"	71	8.88
2h	3"	70	8.75
3h	3"	79	9.88
4V	FULL	75	9.38

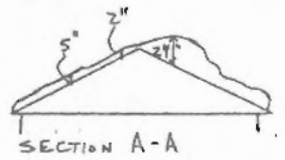
Pictures taken: NONE

Comments: GUTTERS ON ALL EAVES

BUILDUP OF SNOW ON LEEWARD SIDE OF ROOF - REDUCTION OF SNOW ON WINDWARD SIDE

BUILDUP OF SNOW ON UNHEATED GARAGE WHERE GARAGE ROOF MEETS HOUSE ROOF - VERY SMALL SLOPE ON GARAGE ≈ 5°





ROOF AVG; MAX = 10", 24"

FIGURE 6 Typical Data Sheet

FIGURE 7 Snow Sliding Off Arched Roof

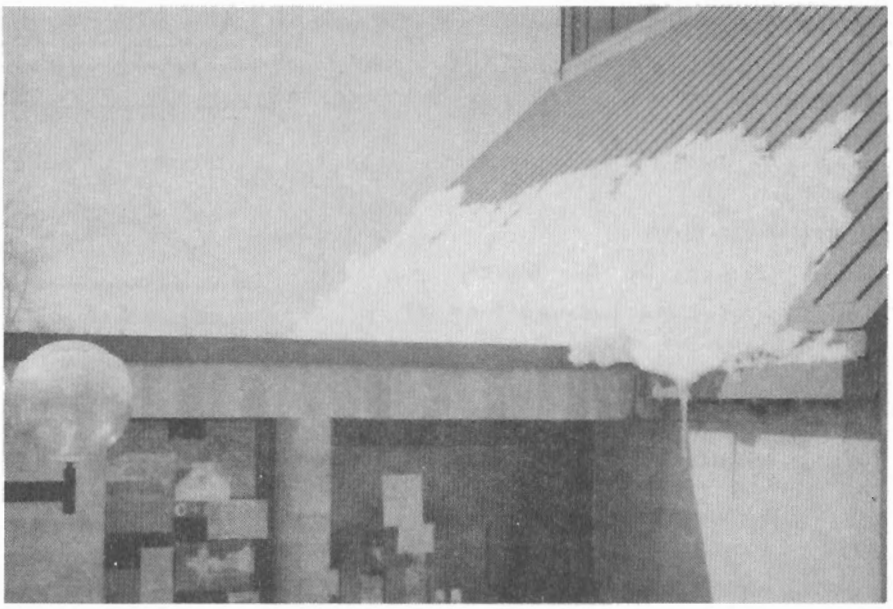


FIGURE 8 Snow Sliding Off Sloped Roof

FIGURE 9
Drifting Snow

FIGURE 10
Drifting Snow

FIGURE 11 Eave Icing