

## Snow Loading

### Understanding the Risk

Each winter, newspapers, radio and television report of spectacular roof collapses due to snow loading.

The loss of the “roof over your head” is bad for apartments and houses, but even worse for plants and warehouses. Whereas affected inhabitants can move into alternative accommodation, affected industries require permits to operate from alternative premises.

Moreover, affected inhabitants can buy clothes as well as other daily essentials and salvage personal belongings later, but affected industries require machines and stocks which are not “off the shelf” and can only start to salvage machines and stocks once the building has been repaired.

Like all risks, prevention is easier and cheaper than control.

Unlike earthquakes, snow seldom arrives unexpected and, although weather forecasts cannot predict everything, warning is ample.

### What causes a roof to collapse?

A roof is designed to carry its own weight as well as the weight of items supported by the roof.

The weight of the roof and the items which are fixed to the roof, such as air-conditioning units standing on the roof or sprinkler piping hanging from the roof, is known as the dead load.

The weight of the items which are not fixed to the roof, such as people, rain and snow on the roof, is known as the live load.

During the design of a roof, the dead load is known, because the weight of the roof as well as all items which will be supported by the roof are known.

The requirements for the live load are usually based on the national building code.

In case the actual dead load plus the actual live load exceeds the designed dead load plus the designed live load, the roof may collapse.

### How can the actual load exceed the design load?

- 1) The dead load could have been increased. Each item which has been fixed to the roof, but was not known taken into account during the design, increases the actual dead load and decreases the allowable live load. Items which are often retrofitted are air-conditioning units and sprinkler piping, but often a new insulation and roof cover is fixed on top of the old insulation and roof cover. In case the snow load exceeds the allowable live load, the roof may collapse.



- 2) The snow load exceeds the live load requirements of the national building code. The live load requirements of the national building code are based on historical snow load data as well as drifting and sliding snow scenarios. Therefore, it is possible that an unexpected prolonged winter results in an unexpected snow load which exceeds the live load requirements of the national building code. However, it is more plausible that a change in the surroundings of a roof has resulted in drifting and sliding snow and, thereby, an unforeseen snow load, which exceeds the live load requirements of the national building code, has occurred.
- 3) The design dead load or design live load is not as required due to a design or construction error. Unfortunately, it is almost impossible to discover a design or construction error. Fortunately, most design and construction errors are discovered and rectified during the design and construction phase.

### Avoiding the Hazard

To avoid the hazard of roof collapse due to snow loading, the snow should be removed before the snow load (plus the weight of the person who removes the snow) exceeds the allowable live load.

### What is the allowable live load of a roof?

The design live load should be available from calculations or drawings.

The allowable live load is the design live load minus the weight of items supported by the roof which were not taken into account by the design.

Different sections of a roof can have different design live loads due to drifting and sliding snow scenarios resulting in different allowable live loads.

In case it is impossible to obtain the design live load, please consult a structural engineer to analyse the roof and calculate the allowable live load.

### What is the snow load?

For rain the calculation is easy:

10 cm of rain equates to a live load 100 kg/m<sup>2</sup>.

For snow the calculation is not that easy, because the density of snow varies:

10 cm of freshly fallen snow equates to a live load of between 5 kg/m<sup>2</sup> and 25 kg/m<sup>2</sup>.

10 cm of compacted snow equates to a live load of between 25 kg/m<sup>2</sup> and 75 kg/m<sup>2</sup>.

10 cm of snow turned into ice equates to a live load of between 80 kg/m<sup>2</sup> and 90 kg/m<sup>2</sup>.

Moreover, the snow on a roof can comprise freshly fallen snow as well as compacted snow, especially because even an insulated roof is warmer than the soil which allows the freshly fallen snow to become compacted snow or even ice.

A snow core can be taken with a plastic or metal pipe and weighed to calculate the snow load.

However, it is suggested to start snow removal as soon as the snow reaches or is expected to reach a depth of 50 cm.

### How to account for the weight of the person who removes the snow?

The weight of a person who removes the snow does not have to be added to the snow load, because the weight of a person is an individual point load instead of a uniform distributed load.

Nevertheless, it is suggested that each person keeps a distance of 5 m to other persons on the roof.

Moreover, a roof should only be accessed for either snow load measurement or snow removal after all necessary safety precautions have been taken.

### Thaw can cause problems

Snow and ice turn into water as soon as it thaws.

Both rain and melt water flows towards the roof drains. In case the roof drains are obstructed, the water forms ponds which can cause a roof collapse.

Therefore, the roof drains should be inspected and cleaned regularly.

However, in case weather forecasters predict thaw during the day and frost during the night, the roof drains should be inspected and cleaned daily.

In areas where thaw and frost cycles are common, it is suggested to install electric heating of the roof drains.

For further information, please contact your local AIG Commercial Property Engineer.

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