ONTARIO RECREATION
FACILITIES ASSOCIATION INC.

Snow Load Analysis For Public Building Roof Systems

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SNOW LOAD ANALYSIS FOR PUBLIC BUILDING ROOF SYSTEMS

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ORFA.COM

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Snow Load Analysis For Public Building Roof Systems

With the types of roofs and ages of most recreational roofs, all business operators and municipalities must be very vigilant in inspecting their roof decks for over-stressing due to heavy snow / and or water loads. Roof trusses are designed to withstand the weight of the roofing materials, HVAC equipment and some snow loading. Snow loading criteria can vary from region to region based on average calculated snowfalls for the region.

Snow can affect buildings, particularly roofs in many negative ways. It can cause the collapse of roofs due to excessive snow accumulations, it can cause ice and ice dams which result in water leakage under shingles and over flashings leading to structural concerns, patron discomfort, ice rink problems and slip and fall hazards (risk management concerns). Snow can slide from sloped roofs onto pedestrians and patrons vehicles and can cause impassable exit doors from facilities. Another large concern is the heavy accumulation of snow surrounding the main gas meter to any building. The bottom portions of the gas meter has a vent which allows the safe release of excess gas pressure to the atmosphere rather than permitting an excess pressure condition at any gas appliance in or on the building.

It stands to reason that the **Building Code** (must check local Building Codes) recognition of "Snow Loading" has changed significantly from the 1950's when snow load on roofs was calculated as the same value as the weight of the snow on the ground, with zero allowance for drifting snow at low to high roof junctions. During the early 1960's, the typical roof snow loads were reduced to 80% of the ground snow loading, but some allowance for additional accumulation on roofs because of shape variations or influence from adjacent building was introduced into the code in 1965. From this information we can comfortably assume that most buildings built prior to 1965 did not likely account for the possibility of increased snow loading as a result of multilevel roofs or roofs with obstructions and parapets where snow will tend to accumulate. In 1985 the Ontario Building Code increased the design unit weight of snow to 15 Pounds per Square Foot (PSF) and in 1990 the code further increased the design unit weight to 18.75 PCF[RR1]. In 1995 further attention was given to accumulation factors for the calculation of snow loads on large flat upper and lower roofs. The Facility Operator should give special attention to any buildings that were constructed prior to 1965 and would be well advised to have a Professional Structural Engineering Study completed on these facilities to determine Snow Loading Abilities of individual facilities. Under the Ministry of Labour it is mandatory that recreation facilities have a structural inspection performed by a certified professional structural engineer a minimum of every 5 years (or sooner if directed by the certified engineer or the Ministry of Labour.) The Ministry of Labour no longer releases reminders to owners to have structural inspections performed and therefore the onus is on the individual to consult with a professional engineer. (MOL Bulletin 4/97)

The most important variable that influences snow loading on roofs is the effect that the wind has on drifting the snow. As the wind speed increases the snowflakes are more likely to be carried horizontally past the higher (exposed) flat roof areas and will be deposited on lower exposed roof areas where the velocity of the wind will usually be significantly less due to a sheltering effect of the building. As wind speed increases (usually 12.5 mph or greater) snowflakes are picked up from the existing snow cover and

carried along the flow until they are deposited elsewhere to accumulate on lower levels of multilevel roofs valleys and on the downwind side of peaked and arched roofs.

Accumulation of snow on any roof should be considered a hazardous condition and should not go without inspection. Though your engineering study may suggest that you are capable of withstanding 8 (eight) feet of freshly fallen snow, we cannot lose sight of the assurance that the weight of that snow will surely change as a result of the compaction of snow due to radiation from the sun melting the surface of the snow and heat losses from the interior of the building from roof decking and exhaust fans etc. When snow melts and freezes on itself it becomes a much more dense substance which is harder to remove and provides an excess of weight prior to any continued snow that fall on to it. For this reason strong consideration must be given to a snow removal policy for the facility which includes regular inspection of snow depths, regular inspection and clearing of roof drains, inspection and clearing of exhaust fan hoods and HVAC units and last but certainly not least the clearing of Natural Gas meters servicing buildings. Strong consideration must be given to studying the type of roofing material utilized on the building as well. Obviously there will be more friction on asphalt and wooden shingle roofs than there will be on glass or steel roof decks, which can certainly affect the potential for snow sliding from the roof onto pedestrians and/or lower roof areas of the building. We must keep in mind that heat loss though the roof may produce melting which reduces the friction and increases the chance snow slides. Areas of sloped roof directly adjacent to pedestrian sidewalks, a building entranceway, vehicle parking areas and building air handling units should be recognized as should sloped roofs that could potentially unload snow loads on lower (adjacent) flat roof areas. **The National Building Code** now recommends that the lower roof should be designed to be able to withstand 50% of the snow load that could potentially accumulate on the adjacent high roof.

Multi-level roofs, which are very common on industrial and commercial buildings and Recreational Facilities often, have triangular drifts on the lower roofs that can become very deep. **The National Building** Code now suggests that these areas of roof should be able to withstand up to three times the specified ground load (as suggested for the area).

Now that we have discussed the need to monitor our rooftops for excess water and snow accumulation, we must consider how to do so in a safe and efficient manner. Most flat roofs present many obstacles and hazards, which impede your ability to remove snow in a safe and efficient manner. Electrical conduits, natural gas lines, roof vents, exhaust fans and rooftop HVAC units are just some of the obstructions.

It is highly recommended that staff responsible for snow removal (including supervisory staff) should familiarize themselves with the engineering studies for your Recreational Facility to plan for the removal of snow and to prioritize the project. A system of marking with flags or light posts should be considered to identify conduits, natural gas lines, vents and equipment. By marking such areas we can prevent any unnecessary damage that may lead to hazards to staff and potential roof leaks. A clear and consistent system of marking should be used where items of similar nature would be flagged and/or coloured alike. Indicate by means of a written procedure (complete with diagram) which areas must be avoided or handled with additional care. The plan must consider where

the snow should be dropped from the rooftop where it won't create another hazard such as burying a natural gas meter, injuring pedestrians or blocking an exit door. If snow must be dropped onto a parking lot be sure to have barricades on hand to protect vehicles and pedestrians. Consider in your plan that equipment such as a loader and dump truck may be needed to remove the extra snow from the parking lot to be hauled off site. Arrangements and necessary approval to dump this snow off site must be secured well in advance.

Any staff involved in snow removal from roof tops must be protected from falling as required by the Occupational Health & Safety Act. This requires the use of fall arrest or travel restraint equipment, which can prove to be very difficult to employ for the task of snow removal. Crews trying to work together using fall arrest lanyards are going to have the additional hazard of tripping over each other's lanyards and catching there own lanyards on roof vents, natural gas lines, conduit and roof top HVAC units. The other problem to contend with is the difficulty in maintaining a constant length of lanyard that will only permit the worker to fall no more than one metre should they fall off of the rooftop.

An alternative to supplying fall arrest equipment to crews involved in rooftop snow removal would be the installation of guardrails to protect the worker from falling off during snow removal operations.

Where flat roofs have been identified as potential Snow Loading Concerns the area must be secured and treated as an elevated work platform to comply with the "Industrial Regulations" as enforced by the Ministry of Labour".

Section 13 & 14 of the Regulations for Industrial Establishments read:

13.(1) there shall be a guardrail
- a) around the perimeter of an uncovered opening in a floor, roof or other surface to which a worker has access.
- b) at an open side of,
  - (i) a raised floor, mezzanine, balcony, gallery, landing, platform, walkway, stile, ramp or other surface, or
  - (ii) a vat, bin or tank, the top of which is less than 107 cm above the surrounding floor, ground, platform or other surface.

14.(1) a guardrail shall,
- a) have a top rail located not less than 91 and not more than 107 cm above the surface to be guarded;
- b) have a mid rail;
- c) if tools or other objects may fall on a worker, have a toe board that extends from a surface to be guarded;
- d) be free of splinters and protruding nails

15.(1) a cover on an opening in a floor, roof or other surface shall be,
- a) secured in place; and
- b) constructed to meet the structural requirements for loads due to the use of floors and roofs as set out in the Building Code, R.R.O. 1990, Reg. 851, s.15

The Ontario Building Code 1997 states that:

4.1.10.1 Loads on Guards

1) The minimum specified horizontal load applied inward or outward at the top of every required guard shall be
   a) 3.0 kN/m (2001b/ft) for means of egress in grandstands, stadia, bleachers and arenas,
   b) a concentrated load of 1.0 KN (225 lb.) applied at any point for access walkways to equipment platforms, contiguous stairs and similar areas where the gathering of many people is improbable, and
   c) 0.75kN/m (50lb/ft) or a concentrated load of 1.0 kN (225lb) applied at any point, which governs, for locations other than described in Clauses (a) and (b).
2) Individual elements within the guard, including solid panels and pickets, shall be designed for a concentrated load of 0.5 kN (113lb) at any point in the element.

The installation of protective guardrails capable of withstanding the weight of 200 lbs. of force every foot can be in form of solid welded steel pipe rails, or can be more economically accomplished by employing the use of 3/8" galvanized steel cable as top and mid rails. The galvanized cable will give you years of maintenance free service and will be more aesthetically pleasing when looking from the ground. Special care must be taken to ensure that each of the posts mounted eight feet apart are both strong enough to withstand the prescribed force, and will not collect water (which could cause corrosion and failure to support a load in an emergency).

ADDITIONAL RESOURCE MATERIAL (see Appendix "A")

http://www.gov.on.ca/lab/ohs/a17e.htm

http://www.orfa.com/facilityalert/SnowLoading.pdf

http://www.ccbfc.org/ccbfc/changes/snow-archedroofs-backgroundpaper.pdf

You can contact the Ontario Ministry of Labour for more information or details on your responsibilities for monitoring snow load of your building.

Ministry of Labour 1-800-268-8013 (Province-wide).

"Appendix A"

Additional Background Resource Material For Snow Load Analysis

Appendix A

SNOW LOADING AND ROOF FAILURES

Hazard Summary
Recently, heavy snow has caused roof failures at a department store in Thunder Bay, a mall and an industrial building in Sault Ste. Marie and a greenhouse in Wawa. Also, structural faults due to snow have been found in two schools and a paper mill in Northern Ontario. The roofs of many other buildings in Ontario may be carrying a greater weight of snow than is allowed for in their structural designs.
A cubic foot of snow can weigh from seven pounds for snow that is new and dry to 30 pounds for old, compacted snow. Rain falling on accumulated snow will add even more weight. Drifting snow may put excessive loads on the areas where it piles up, for example against equipment or penthouses or at walls between roof levels.
When snow removal is necessary, it should be remembered that unsafe procedures may cause a collapse. It should also be remembered that workers on a roof must have adequate fall protection and that workers and others nearby can be injured by snow being dumped from a roof.

Locations and Sectors
All areas where snow has been accumulating. All sectors.

Recommended Precautions
The *Occupational Health and Safety Act* requires an employer to ensure that a roof "is capable of supporting all loads to which it may be subjected without causing the materials therein to be stressed beyond the allowable unit stresses established under the *Building Code Act*" [s. 25(1)(e)]. The Regulations for Industrial Establishments require that materials be moved in such a way and with such precautions and safeguards that the safety of workers is not endangered (RRO 851, s. 45).

The Ministry of Labour makes the following recommendations:

- Owners of workplaces and/or employers at workplaces where there is snow on the roof of buildings should have the roofs assessed by a professional engineer to determine whether
    - the snow load is significant, or
    - there are any visible signs of structural distress, for example, twisting, bending or cracking.
- If snow is excessive or a roof shows signs of distress, the owner or employer should implement a safe snow removal procedure.

- A snow removal operation should avoid producing any uneven or concentrated loading on the roof.
- Areas onto which snow will be dumped from a roof should be secured to prevent access.

Also, workers on a roof must use fall-arrest or travel-restraint equipment in accordance with the fall-protection requirements of the Regulations for Industrial Establishments (RRO 851, s. 85). A civil or structural engineer should be consulted: (1) to determine whether snow loads are excessive; (2) to determine whether there are signs of structural distress; (3) to obtain a removal procedure that will not cause more structural problems; or (4) to reinforce a structure that is overstressed.

Please photocopy Ministry of Labour Alerts, distribute them widely and post them where people will see them.

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ONTARIO RECREATION FACILITIES ASSOCIATION INC.

FACILITY ALERT

SNOW LOADING & ROOF FAILURES ALERT 2002-02

The collapse of the arena in Temagami, Ontario this past week causes the Ontario Recreation Facilities Association to re-issue the following alert.

It is important to note that no cause has officially been identified for the roof collapse but regardless, a reminder of the following information would appear timely.

The Occupational Health and Safety Act requires an employer to ensure that a roof "is capable of supporting all loads to which it may be subjected without causing the materials therein to be stressed beyond the allowable unit stresses established under the Building Code Act" [s. 25(1)(e)]. The Occupational Health & Safety Act, section 9 (23) further requires that "all physical conditions of each building be inspected for safety at least once a month".

The Ministry of Labour (MOL) makes the following recommendations and a local MOL Office should be consulted if additional information and or clarification is required:

• Owners of workplaces and/or employers at workplaces where there is snow on the roof of buildings should have the roofs assessed by a professional engineer to determine whether:

• the snow load is significant, or

• there are any visible signs of structural distress, for example, twisting, bending or cracking.

• If snow is excessive or a roof shows signs of distress, the owner or employer should implement a safe snow removal procedure.

• A snow removal operation should avoid producing any uneven or concentrated loading on the roof.

• Areas onto which snow will be dumped from a roof should be secured to prevent access.

• Also, workers on a roof must use fall-arrest or travel-restraint equipment in accordance with the fall-protection requirements of the Regulations for Industrial Establishments (RRO 851, s. 85).

• A civil or structural engineer should be consulted: (1) to determine whether snow loads are excessive; (2) to determine whether there are signs of structural distress; (3) to obtain a removal procedure that will not cause more structural problems; or (4) to reinforce a structure that is overstressed.

The Ministry of Labour no longer releases reminders to owners of such obligations (MOL Bulletin of Apr. 4/97) and it is therefore an owner responsibility to have structural inspections performed on an as required basis by a structural engineer.

The Professional Engineers of Ontario have also published a guideline entitled, "Arenas: Structural Adequacy" which may be helpful and may be obtained at (416) 224-1100.

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How to Engage a Professional Engineer (P.Eng.)

Engineers may be engaged as consultants or as employees.

PEO's Guideline for the Selection of Engineering Services *(to replace with PDF)* offers selection processes that can be used when choosing a professional engineer. The term "Consultant," or "Consulting Engineer," applied in connection with providing professional engineering services, requires that the person using the term be authorized to do so by PEO. The PEO's Schedule of Fees for Engineering Services lists representative prices for various engineering tasks.

When hiring an employee engineer, the employer may find PEO's Employer Salary Survey helpful . In addition to listing salaries by field of specilization, year of graduation and type of work, the surveys also give details about other forms of compensation and about benefits.

PEO also publishes a guideline on **Qualification-based Selection of Consultants** *(to be a PDF)* to help get the best value for money in professional engineering. The March/April 2001 issue of *Engineering Dimensions*, the associations official journal was also devoted to this subject.

The Guideline for the Selection of Engineering Services should be read in conjunction with the common Foreword and Glossary for PEO guidelines. Its purpose is to assist a user of professional engineering services–the client–to choose the appropriate engineering consultant for a project. It does not apply to design/build projects. Usually, engineering consultants recognize that a project's cost is of paramount importance to their clients. Clients should note that engineering fees amount to a relatively small percentage of the total project cost–especially when project life-cycle costs are taken into account. Selecting appropriately qualified engineers usually results in good engineering designs and can significantly reduce a project's life-cycle costs. Rather than merely meeting minimum standards, the services of appropriately qualified engineering consultants can enhance a project's value to clients through rigorous consideration of alternatives, analyses of long-term operating and maintenance costs, and innovative design. It is therefore in the client's best interests to use a qualification-based selection method, which demonstrates the competence of the engineering consultant in the performance of the required engineering services.

You can access these guidelines by visiting the Professional Engineers of Ontario website or by contacting the PEO office

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T: 416 224-1100 or 1-800-339-3716
P: 416 224-8168 or 1-800-268-0496
Web site: www.peo.on.ca

http://www.peo.on.ca/public/selection_eng_services.pdf

Amendments to the Building Code

Snow Loading on Arched Roofs Background Paper

http://www.ccbfc.org/ccbfc/changes/snow-archedroofs-backgroundpaper.pdf