

# Use Of Snow And Ice Melting Heating Cables On Roofs Of Existing Buildings

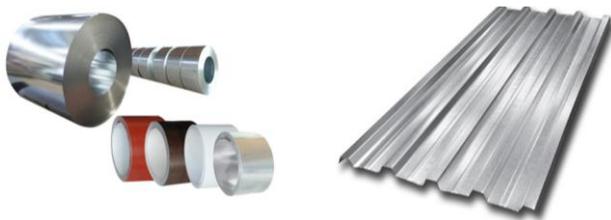
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**Abstract:** Roofs are construction elements which form the upper part of a building and protect it from the all kinds of fall, wind and sun lights. They are made as inclined or terrace shaped according to the climatic characteristics of the area they are located and their intended use. Inclined type roofs are preferred for aesthetic and / or functionality. It is in interest of mechanical engineering that falling snow on long and effective regions of winter conditions accumulate on the roof surfaces with low inclination due to adhesion force between snowflakes and the roof covering. The mass of snow that turns into ice due to cold weather and wind creates stalactites in the eaves due to gravity. This snow mass leaves/breaks off from inclined surfaces due to the effect of the sun or any vibration and can damage to people or other objects around the building. Falling snow and ice masses from rooftops in urban areas where winter months are intense are also a matter for engineering applications of landscape architecture. In order to prevent snow and icing on the roofs of the buildings located especially in busy human and vehicle traffic routes, the use of heating cables is a practical method. The icing can be prevented by means of the heating cables selected according to the installed power to be calculated based on the type of roof and the current country. The purpose of this study is to introduce heating systems to be mounted on the roofs with a lesser workmanship in a short period instead of difficulties and costs that would occur by increasing the roof inclination in present buildings as well as explaining their working principles.

**Index Terms:** Heating Cable, Ice, Inclination, Landscape Architecture, Mechanical Engineering, Roof, Snow

## 1 INTRODUCTION

CONSTRUCTION element that constitutes the upper part of a building, protects it against the effects like snow, rain, wind, cold and hot, and affects its beauty and its stability is called as roof [1]. Roofs are equipped with various coating materials according to the region, climatic conditions and the intended use. One of these coating materials is galvanized sheets. Galvanized sheets are preferred particularly in regions where there is intense snowfall, due to less snow accumulation on them [2]. Corrosion of hot dip zinc coated namely galvanized roof sheets is prevented by protecting them from corrosive environment in a cathodic way (Figure 1)[3].



**Figure 1.** Galvanized roof sheets

In case of low roof inclination, snow accumulation on roof coatings is a frequently encountered situation. Snow and ice masses form in the roofs of the building as a result of the frost events that occur in areas where the winter conditions are very severe and the creeks and drop pipes are blocked due to icing (Figure 2).



**Figure 2.** Ice pendants and snow masses

The decline in mass or stalactite is causing people's lives to be jeopardized, thus limiting the recreational activities of the city's open space in the winter months. In addition to this, trees, shrubs and so on. causing serious damage to the top diameters and branches of plants. This creates additional costs by requiring post-winter revision studies. Sidewalks, roadsides and other urban furnishings (benches, pergolas, trash cans, lighting elements, etc.) are also threatening the urban landscape and visual quality by taking heavy damage with the fall of ice masses. It should be considered that each building can form an alternative irrigation system to its own landscape by storing the descending water from landing pipes. Reducing water consumption in the buildings and rethinking the wastewater strategy used for the building environment considerably expands the available water resources, increases the value to human health, and reduces the threat to the ecological system [4]. In the cases when the sun lights and air temperature are not enough to melt the ice, snow can be rapidly transferred to creeks and drop pipes by means of the heating cables laid on the roof before turning into ice. In this way, the formation and falling of ice and snow masses, often resulting in material damages and even deaths sometimes, are prevented. In engineering applications of landscape architecture, it is obvious that the effect of using heating systems would be great in calculation of the snow and ice load which is one of the loads on the buildings.

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## 2 EXAMINING FORMATION of ICE on the ROOFS

Roofs are divided in three groups in terms of their inclinations; flat (0-5°), moderately sloping (5-40°) and steep roofs (>40°) [5]. In case of choosing low roof inclination (<40°); falling snow begins to accumulate on the surface of the roof coating with the effect of cold weather and wind. The first phase of the adsorption phenomenon can be explained as: The temperature of the roof surface is relatively higher in the weather conditions when the snowfall starts for the first time (depending on the insulation material between the roof and the duration of being exposed to the sunlight)[6]. Therefore, the snowflakes that contact the roof surface quickly become liquid. At this time, due to the adhesion force between the liquid and the solid metal, the liquid begins to adsorb on the surface. In particular if the snowflake can wet the surface fully in other words if it didn't roll and slip by taking the spherical shape due to the tension of the contacted surface, the adsorption occurs more effectively (Figure 3).

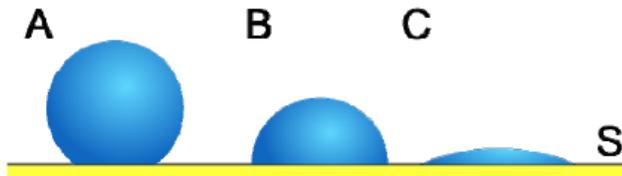


Figure 3. Angle of liquid with a solid surface [7]

A. No wettability B. Partial wettability C. Excellent wettability

Due to the low inclination, liquid snowflakes that do not slip on the roof surface cool down, solidify and accumulate in layers [8]. Because of the cold weather, phase of transformation to ice starts. Due to the heating effect of sun during day, water droplets forming by melting of top parts cause to increase the ice layer density by filtering down. Some of the melting upper snow layers are dragged towards the eaves with the effect of wind and ice pendants form due to effect of the cooling air [9]. These pendants, which start to melt on the days when the air temperature is higher than zero, begin to fall off from their position after they reach adequate temperature and damage the people or objects around them. Another cause triggering the falling motion is the vibrations in the building. For example, constant or harsh opening and closing of the building's door, or vibrations generated by a heavy vehicle passing by the road, can reach up to the roof of the building. Therefore, these vibrations can move ice blocks on the roof.

## 3 USE of HEATING CABLE and ITS TECHNICAL SPECIFICATIONS

From engineering point of view, the most practical and most economical way to get rid of snow falling on the roof is to design a roof with sufficient slope. However, in moderately sloping roofs with inclination angle varying between 15-25° and in case of not using snow crusher-holder elements it will both cause deformation on the roof surface and snow and ice accumulation forms in a way to damage the surroundings. Renovating or completely changing the roof systems of present buildings especially on the routes with busy human and vehicle traffic are very laborious and risky works.

Therefore, the installation of snow and ice melting cables on roof coatings appears as a practical method. Figures 4 and 5 show the images of heating system consisting of various sensors, control elements and the heating cables installed on the roof surface with special clamps.



Figure 4. Forms of application on roof coating

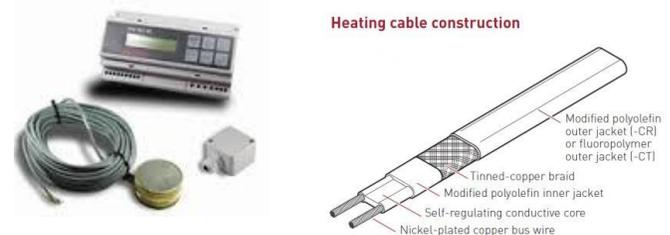


Figure 5. Components of the heating system

The sensors forming the system detect the low temperature and moisture amount in the environment. In this way, the signaled control unit opens the system. Heating cables create a flow path in the valleys and roof by melting the snowflakes. Thus, continuous water flow to the drop pipes is ensured and ice formation is prevented by eliminating the snow accumulation. When it is higher than the air temperature set from the control unit and it is lower than the determined moisture level, the system switches off automatically [10]. If the heating cables are preferred as self-regulating, more electricity will be saved. Because the classical cables connected in series transmit the constant current coming from the control unit. However, self-regulating cables determine the current by itself and increase or decrease the heat output of the unit depending on the ambient conditions. Two temperature and moisture sensors located on both sides of the roof can be connected to the same control unit. By means of the priority zone assignment made through the unit, the current drawn by the cables in the south side would be cut off while waiting for melting of the snow accumulated on the north side of the roof and the system would not work extra [11]. Since there would be no rainfall when there is no moisture in the air, even in very low temperatures caused by wind, the system does not switch on itself and energy saving is ensured. Heating cables installed on the roof have a polyolefin outer sheath that is resistant to ultraviolet rays of the sun. Thus, they can withstand the summer and winter conditions on the roof surface for many years. Polyolefin materials are very lightweight materials resistant to tearing and puncture. They can easily take the shape of the environment in which they are used.

#### 4 ASSESSMENTS and SUGGESTIONS

It has been observed that roof coating materials resistant to intense winter conditions (snow and ice load) experienced generally in eastern regions are sheets and their derivatives. Roof slopes are not sufficient and rusting of the surfaces over time, that is to say due to lack of care, there are frequent material damage, injured / fatal events and problems affecting the urban landscape negatively. The use of heating cable systems in recreational open spaces (parks, passive seating areas, etc.), especially between busy roads with human and vehicle traffic, is a quick and permanent solution. In the building to be built or where the roof renovation will be made;

- Roof designs as steep as possible should be made, otherwise the inclination angle should be chosen wide for moderately sloping roofs. Snow crusher-holder elements must be used on the roofs.
- Within scope of scientific research; hydrophobic materials, which is one of areas of interest of mechanical engineering, for example, lubricant reinforcements such as graphite can be incorporated into composite materials to be developed [13].
- Fully equipped heating systems in which all components work in coordination with each other should be preferred in order to both make saving and extend the life of roof coatings in the case of preferring heating cables.
- The heating cable system should be able to save the irrigation work for urban landscaping by ensuring storage of the descending water from the pipes in the buildings.

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