

Highway Pavement Surface Icing and Traffic Safety: A Review

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Abstract: *Due to the truth that highways are the most used transportation mode in our country and the weather conditions are hard at some point of the winter season, various issues are encountered at the roads wherein terrestrial weather is seen and those problems threaten traffic safety. It poses good sized dangers in particular in road sections including tunnels, bridges and vertical curve and also reasons material loss accidents. The methods used within the problems with icing are divided into training as energetic and passive strategies. Passive strategies are implemented in methods; chemical and physically. Chemical strategies are the utility of a variety of chemicals to the pavement floor with the intention of stopping and casting off icing. These chemical substances appear to motive some damage to environment, roads, metal elements of cars and traffic sign forums and do no longer appear to offer the favored overall performance. Physical methods are executed by means of putting off snow and ice from the coating floor with the aid of using work machines. Using this technique, each equipment staff and time losses are happening. Hydronic heating structures, which can be active methods, flow into a heated fluid via a pipe network placed below the pavement layer to melt snow and ice that collect in the coating layer. By the use of geothermal spring waters, which are clean and less expensive resources as heated drinks, its miles aimed to be prevented without creating snow and ice without inflicting environmental damage, human health and financial loss. In this paper, the traits of anti-icing structures and hydronic anti-icing systems utilized in roads, what type of substances are utilized in such structures and their contributions to traffic protection are cited.*

Keywords: Traffic safety, Anti-icing systems, Hydronic ice melting

1. Introduction

There were critical boundaries affecting the roads as a result of weather occasions consisting of snow fall, icing and snow typhoon inside the iciness months. The friction coefficient de-creases due to icing on important avenue sections together with bridge ramps and tunnels, causing visitors injuries or even inflicting snow and icing to close. It also reasons flight cancellations at airports and causes huge monetary losses (P. Pan, 2014.). Ice melting techniques are examined underneath 2 primary headings. These; lively and passive strategies (Figure 1). Passive strategies consist of using dissolving chemical compounds as chemical materials and mechanical method as physical methods, systems used in ice preventing. In active methods, the usage of conductive asphalt concrete, hydronic ice melting systems and unfrozen asphalt combinations prevents ice formation (GEVREK, Augsut-2018).

Ice and snow at the airport asphalt pavement affect plane takeoff, touchdown, and taxiing in winter due to the fact ice and snow increase the braking distance of the aircraft. The conventional strategies of putting off ice and snow from airport pavement deicing fluid and deicing equipment set off flight postpone and want quite a few manpower, deicing fluid, and machinery. It is vital to conduct well timed and high-efficient elimination of ice and snow to keep away from the unfavorable impact of deicing fluid and machinery at the airport asphalt pavement (Y. Lai, 2018). Some students examine the way to enhance the overall performance of bitumen and asphalt combination to keep away from poor impact (M. Guo, 2020). At the identical time, a few techniques of deicing and melting snow at the pavement had been researched, inclusive of asphalt mixture containing the snow-melting

agent, hydraulic heating gadget, electrically conductive concrete, carbon fiber grille (Y. Lai, 2014), and CFHW. The current study of deicing and melting snow at the pavement especially specializes in the CFHW. Zhao et al. Studied deicing at the bridge deck and urban pavement through the CFHW. In frozen and snowy weather, the outcomes of laboratory and area experiments established the validity of the electrothermal method of deicing and melting snow on the pavement and bridge deck under an appropriate input energy. The authors studied the outcomes of warmth flux, cord spacing, wind speed at the concrete pavement temperature, and deicing on the cement concrete pavement by the CFHW (Y. Lai, 2016). The authors also studied the snow-melting impact, temperature, and energy distribution alongside the depth of the airport cement concrete pavement (Y. Liu, 2015.). Due to one-of-a-kind materials of airport cement concrete and asphalt pavement, the physical properties, production methods, and dimensions of styles of pavement also are different. These determine the difference of deicing and melting snow between airport cement concrete and asphalt pavement. Therefore, the method of deicing and melting snow with the aid of the CFHW calls for a take a look at the application of the airport asphalt pavement. In order to save you ice and snow accumulation, the temperature of the airport asphalt pavement floor have to maintain above 0°C. Finally, the overall-scale experiments of deicing and melting snow are achieved within the actual surroundings of ice and snow (Xin Su, 2020).

Pavement snow melting the usage of geothermal hot water and steam has been validated in several countries, along with Argentina, Japan and the United States. These installations encompass sidewalks, roadways, bridges and runways. Most normally it's far performed with a glycol solution, hot water or steam being circulated in pipes inside or under the pavement, the use of either warmth

Volume 11 Issue 8, August 2022

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pipes or geothermal fluids, however, in a single times hot water has been sprinkled directly onto the pavement. This paper will try to gift the general design requirement for a snow melting machine and then give examples of those in operation the use of geothermal energy. The apparent advantages of those structures are they get rid of the want for snow elimination, provide extra protection for pedestrians and automobiles, and reduce the exertions of slush elimination (GEVREK, Augsut-2018).

2.Literature Review

(GEVREK, Augsut-2018) Due to the fact that highways are the most used transportation mode in our United States of America and the weather conditions are hard during the wintry weather season, numerous issues are encountered at the roads where terrestrial climate is visible and those problems threaten site visitor's safety. It poses extensive risks especially in road sections inclusive of tunnels, bridges and vertical curve and also causes cloth loss accidents. The techniques used inside the war with icing are divided into classes as lively and passive methods. Passive strategies are carried out in methods; chemical and bodily. Chemical techniques are the utility of a variety of chemical substances to the pavement floor with the aim of stopping and eliminating icing. These chemical substances appear to purpose a few damages to environment, roads, metal elements of cars and site visitors signal forums and do no longer appear to provide the preferred performance. Physical methods are carried out by means of disposing of snow and ice from the coating surface via the use of paintings machines. Using this approach, both device personnel and time losses are occurring. Hydronic heating structures, which can be energetic strategies, flow into a heated fluid thru a pipe community located beneath the pavement layer to melt snow and ice that collect within the coating layer. By the usage of geothermal spring waters, that are easy and cheaper assets as heated liquids, it's far aimed to be averted without creating snow and ice without inflicting environmental harm, human health and economic loss. In this paper, the traits of anti-icing systems and hydronic anti-icing systems used in roads, what type of materials are used in such structures and their contributions to site visitor's protection are cited. (Y. Lai, 2018) The method of deicing and melting snow by means of the carbon fiber heating cord (CFHW) embedded inside the airport asphalt pavement is proposed to improve the security of airport operation. The area experiment of deicing and melting snow on the airport asphalt pavement is performed. Deicing and melting snow, asphalt pavement temperature, ice-unfastened area ratio, and snow loose region ratio are analyzed. Electrical energy with 350 W/m² is enter to the airport asphalt pavement for deicing and melting snow via the CFHW. The heating necessities rely upon on price of snowstorm, air temperature, relative humidity and wind speed. Piping substances are both steel and plastic, however, due to corrosion troubles, move-related polyethylene pipe is now usually used in place of iron. Geothermal energy is supplied to systems through the usage of warmness pipes, immediately from circulating pipes, through a warmness exchanger or through permitting water to glide without delay over the pavement,

via using sun thermal garage. Examples of structures in New Jersey, Wyoming, Virginia, Japan, Argentina, Switzerland and Oregon are presented. (Chiasson, September, 2000.)Mathematical models have been evolved to describe the overall performance of a hydronically-heated pavement slab and a water-to-water heat pump unit. The slab version makes use of a finite distinction technique to remedy the transient-dimensional warmth conduction equation with the proper boundary conditions. The warmness pump model makes use of a multi-variable optimization method to decide feature parameters for a particular warmness pump unit after which predicts its overall performance as a characteristic of entering fluid temperatures and glide charges. Existing methods for removal snow and ice at airports include casting off by human beings or using the deicing chemical substances and machines. The efficiency of doing away with snow by means of people is low, and the people's work is very tough. Although the higher layer of snow is eliminated, the decrease layer of snow is compacted whilst the mechanical approach is used. This will make it easier for the lower layer of snow-covered pavement to form a layer of ice, which takes more time to remove and dangerous to the pavement. In addition, deicing chemical compounds were proved which are dangerous to pavement and environment. Therefore, it's far of brilliant importance to increase a brand-new manner of snow-melting at the pavement with the lake of the traditional strategies.

The Snow Self-Melting Pavement is a new form of snow-melting era with important studies and alertness significance inside the field of airport engineering. The Snow Self-Melting Pavement use an inorganic warmness pipe as the warmth transfer medium to transfer the warmth of the floor soil to pavement floor. So that the pavement's temperature is greater than 0°C, with the intention to obtain snow-melting (Qing Ye, 2018).

3.Importance of Road Safety During Freezing of Ice and Snow

In northern regions where wintry weather months are difficult, traffic accidents commonly occur at some stage in snowfall, freezing rain, and icing. Therefore, in everyday road and bridge, removal of ice and snow effectively in terms of smooth movement of traffic is extraordinarily important.

Especially in snowy and icing climate, the friction resistance among the street surface and the wheel bandage at high vehicle speeds drops to very small values. Studies in this place have shown that the reduction in friction resistance will increase traffic accidents ((TNZ), 2005).

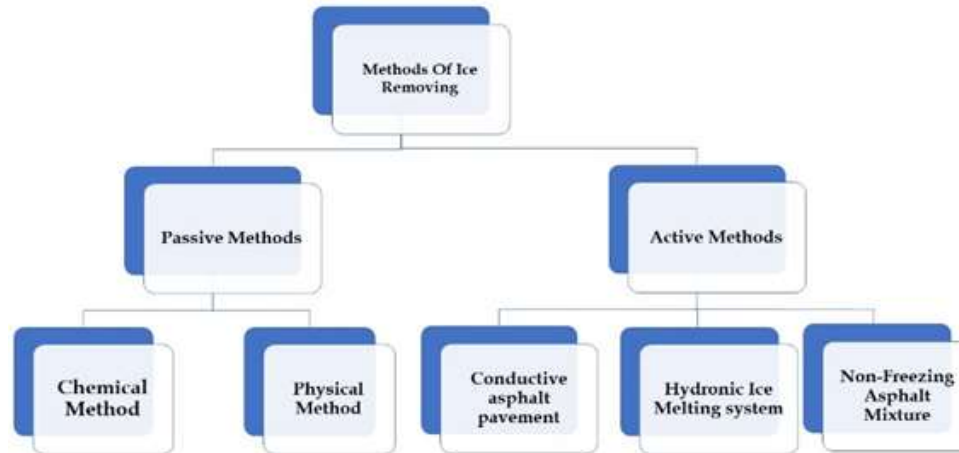
Another, study has shown that a correlation between slip resistance and traffic accidents has shown that road accidents have a 60% reduction in traffic accidents if the street surface slip resistance fee will increase from 35% to 48% (J. Xiao, 2000). In a survey of the World Health Organization, traffic accidents are indexed within the pinnacle 10 causes of loss of life in the global. The use of lively anti-icing structures to lessen accidents due to icing and snowfall in iciness can lead to reduced coincidence

rates (WHO, 2016.)

4. Method of Ice Controlling

The techniques used to remove ice may be tested below under headings: energetic and passive techniques. Passive methods; chemical and physical techniques. In passive techniques, which can be the maximum generally used methods in snow and ice fighting, plowing, salting, sand and chemicals are carried out. However, these techniques

require more materials to be able to dissolve the bond among the coating and ice once they had been carried out after snow or ice. Human health issues and the environment also are affected negatively, because it reasons bottlenecks on road and decreases in running velocity. In energetic methods; structures primarily based at the determination that there's no ice formation because of the system mounted before icing takes place. For this cause active methods are more useful than passive methods.



4.1. Chemical Method

In order to stop or dispose of the formation of ice on the coating layer, numerous chemicals are carried out to the street floor at the start with most used methods in the world (E.K. Allison, 2004.). These chemical substances may be used dry or in solution depending at the moisture content material of the carried-out at pavement. The most used chemical compounds are CaCl_2 , MgCl_2 , CMA (Calcium, Magnesium, Acetate) and NaCl (N. Kuloğlu and B.V. Kök, 2005.).

4.2. Physical Method

For this technique of cleaning snow and ice stack that accumulate after snow fall, work machines together with graders, scrapers, excavators are usually used. After takeoff the snow from the superstructure, it's far a technique that is genuinely costly fuel, employees and equipment cost including transferring snow deposits to the motors to be transported by using the elimination of snow deposits and also damages the superstructure. Also, if the snow mass is not transported after the cleansing procedure applied on the street and the sidewalk, the street turns into very unusable on one aspect, causing traffic congestion and issues (C. Gürer, May 2015,)

4.3. Conductive Asphalt Concrete

The electric conductive asphalt coating machine is based on the precept of changing the implemented electricity into warmth strength through increasing the electrical conductivity of the asphalt aggregate and melting the snow and ice at the floor of the heat coating (D. Derwin, 2003). Ice protection structures building with conductive

asphalt concrete provide many benefits in roads; among the methods that can be used for preventing with icing is the truth that the substances to offer conductivity are similar to the materials forming the pavement and have confined effects at the superstructure performance (L.D. Minsk, 1971). The conductive materials that participate inside the conductive asphalt concrete according to grain length are in three classes: powdered (graphite, carbon black, aluminum powder), fibers (metallic fiber, carbon fiber, steel wool and carbon Nano fibers) and solid particulates (blending of steel slag as coarse or first-rate combination).

The Superior Graphite Company and the American Federal Aviation Administration (FAA) have together labored with the Flood Test Laboratories to broaden the Snowfree System. Snowfree (electrically conductive asphalt coating gadget) the usage of graphite, asphalt and electricity. It is an original coating device which has been examined by using the FAA for a taxi traffic at O'Hare International Airport in the United States, wherein snow and ice are induced extreme hassle (D. Derwin, 2003).

4.4. Hydronic Snow Melting Systems

Hydronic heating structures is a circulating a heated liquid via a pipe network placed beneath the pavement to soften snow and ice that accumulate within the pavement (ASHRAE, 2003.). The pipe network usually consists of structures which can be specified in a wiggly configuration. Pipe material is typically cross-related or excessive density polyethylene. Typical pipe spacing levels from one hundred fifty to 300 mm and intensity stages from 50 to 75 mm. Nominal pipe diameters are usually between 18-and 25-mm. Various fluids which

include salt water, oil and glycol water are appropriate as warmness service fluids in hydronic heating systems. Freezing safety is very important because most systems can be operated intermittently at freezing temperatures. For such structures, a number of warmness resources may be used, which include boilers, electric heaters, groundwater, and ground source warmness pumps (X. Liu, 2004.).

Pipe materials used to deliver hot water are steel or plastic. Steel, iron and copper pipes had been extensively used within the beyond, but proved to be without problems corroded, and plastic pipes are actually more broadly used. The lifestyles of such plastic pipes are extra than 50 years (J.W. Lund, 2000).

5.Conclusion

Ice-preventing in wintry weather is a primary issue for difficult regions. One of the most important of these issues is the site traffic accidents that show up in a row. After the traffic accidents, each cloth and spiritual losses arise and therefore, alternative techniques of ice removing and preventing are needed to remove the negative outcomes. Active techniques are used as opposed to passive techniques in the struggle towards icing in order that they can be avoided before icing takes place and losses consisting of time and money, labor, and so forth. Spent in passive methods may be removed. The Snow Self-Melting.

Pavement machine runs mechanically from past due autumn to early spring. The heat from underground soil is constantly transmitted to the pavement floor, so that the pavement floor continues an excessive temperature for a long time. It can soften the unexpected snow higher. This paper display that the power and bearing ability of Snow Self-melting Pavement also meet the layout requirements. If this era is carried out to airport pavements, it could make sure snow melting on pavement, no need for outside heat sources. It can recognize the use of recent energy resources. Deicing and melting snow by way of the CFHW buried inside the airport asphalt pavement is studied in the paper. It is workable for deicing and melting snow that the depth of the CFHW is 7 cm, and the CFHW spacing is 10 cm in the airport asphalt pavement.

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