Use of Heating System to Clean Roads from Snow

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Abstract. One of the problems of modern road traffic is the problem of icing roads in the winter time, because of this problem the number of road accidents is growing. With this problem every year massively fighting, using different chemical compositions. In addition to this problem, there is also a problem associated with the use of heat supply systems. It consists in the presence of heat energy losses during the delivery of hot water from the heat production site to the heat consumption site. It is also fought, using new thermal insulation materials. All methods of solving both of the above problems are effective for solving these problems in particular, but they cannot be taken to solve them together. For this reason, there is a need to create a method capable of dealing with these problems together. In this article the method allowing to fight against icing of the road by means of increase of temperature of asphalt, using sites of transportation of thermal energy to the consumer will be considered.

1. Introduction
The highest number of road accidents is the winter season, which is confirmed by the fact that 34% of all road accidents occur in this season. One of the main causes of road accidents at this time of year is poor grip of the wheels of the car with the road surface due to the formation of a layer of ice between them. [1-3] Problem can be solved by timely transition of cars from summer type of tires to winter, but such a solution still does not guarantee the full reliability of the coupling of the car and the road. In order to ensure the maximum rate of adhesion of the machine and the road, it is necessary to remove the ice layer located on the surface of the asphalt concrete coating.

Today there is also a problem associated with the use of heat supply systems. It consists in the loss of thermal energy during the delivery of hot water from the heat production site to the heat consumption site. [4-6] Lost heat energy goes beyond the heat supply system into the environment. This leads to a decrease in the efficiency and reduce the useful work done by the system. This problem is solved by the use of thermal insulation materials and shortening of water supply systems. To improve efficiency it is possible to use thermal energy losses on heating the following road construction, the crucial problem with the icing of roads.

2. Construction of the proposed road
2.1. Structure and basic elements of the proposed design
The design of the road is placed under the main layer of road surface heating system in the form of two pipes.

Figure 1 shows a frontal view of the structure. Figure 2 shows the top view of the structure diagram.
Figure 1. Frontal view of the structure: 1 - Iron grate that can withstand the load of a passing car; 2 - concrete; 3 - ledge, on which is mounted the iron grate (1); 4 – drain; 5 - the bottom of a drainage, which drains turned into water, ice; 6 - section of the pipe; 7 - the material that fills the empty space between the 1 and 2 tiers (thermal concrete); 8 - asphalt coating lying on heat-conductive concrete.

Figure 2. Top view of the structure.

When using this design, any concrete with a thermal conductivity of 0.51 W/(m•deg) and above (7) will be used, and reinforced concrete in which concrete with a thermal conductivity of 0.51 W/(m•deg) and above will act as concrete. [7-10] The quality of construction of rebar will be used in the metal structure of high quality structural carbon steel 15.[11,12] The combination of heat-conducting concrete and reinforced concrete will be able to raise the temperature of asphalt above 0 degrees (under ambient temperature 0 <), that is, to a temperature that turns ice into water, while part of the water will turn into steam.[13-15] The water obtained from the melting ice gets to the bottom of the drainage heated by the heat transferred through the heat-conducting concrete pipes. Water flowing through the bottom of the drain will not freeze until it leaves the drain ditch due to the heat generated by the pipes. The grating is planned to be made of steel of a martensite structure that will allow it to
maintain loading of the car passing on it. [11,12] When laying this grating, a ledge of concrete structure will be used, allowing the drain ditch not to change its shape and not to collapse. It should also be noted that the grid is easy to dismantle to replace the damaged segments and also easy to install. This grid has a height equal to the height of the ledge, which leads to the smoothness of the road throughout its length without the appearance of elevation changes.

2.2. Sequence of creation of the proposed road
Creating this design will be divided into the following items:
1. To create this road, it is necessary to excavate the soil to the rocks. At this level, the first tier is created.
2. In the first tier, two pipes are installed, through which hot water will be run from the heat production site to the heat consumption site in the future.
3. Then the first tier is completely filled with concrete.
4. After the first layer hardens. Above it will create a second tier, the bottom of which will coincide with the end of the first tier.
5. The second tier will be filled with reinforced concrete, leaving space for drainage (drainage ditches)
6. After installation of reinforced concrete will be placed the main elements of the road, as well as three drainage ditches, following along the road to a place where you can safely pour it.

3. Advantages, disadvantages and economic efficiency of the design

3.1. Advantages of the design
This design has a number of advantages such as:
1. Road safety – without ice machines will have a more stable grip, which leads to a reduction in road accidents.
2. Increasing the efficiency of heat networks due to the fact that their losses will be spent on heating asphalt and ditches through the material that fills the empty space between 1 and 2 tiers.
3. Profitability. During the construction of roads by this method, the cost of their maintenance will fall, as you do not have to spend resources on cleaning roads from snow.
4. There is no need to re-cut the road surface when it is damaged, as it will be enough to cut out the damaged section of the road, and replace it with undamaged.
5. Convenience of redistribution of water at accident on the pipeline. In the accident you can let the water flow through the second pipe.

3.2. Disadvantages and ways of their elimination
It is worth noting two significant drawbacks that need to be addressed:
1. Because of the temperature difference and overheating of asphalt, it can crack.
2. The appearance of steam in the transition of water from solid to liquid.

The first drawback is eliminated by properly selected, the type of material, the type of base, as well as the technology of creation. At the moment, there are at least several ways to increase the heat capacity of asphalt
1. The first method is to add a variety of natural impurities and additives to the asphalt concrete, which allows the asphalt to withstand the temperature at which ordinary asphalt begins to melt and crack. This is due to the fact that asphalt receives from impurities the properties of thermal conductivity. [16-18]
2. The second method is based on the addition of artificially created materials. [19,20] As an example, we can use the addition of carbon nanotubes, which due to microwave become inductive, which leads to their heating and softening of asphalt so that the cracks are tightened. But this admixture is not economically viable at this stage of the development of science and
technology, and is also not suitable because of the need to heat the asphalt concrete using the microwave.

The second drawback is more difficult to fix. The fact that the equipment is able to eliminate this amount of steam is too cumbersome and energy-consuming. Less energy-intensive and more portable equipment is currently being developed. But since the use of this design is possible only in urban areas, due to the high content of pipelines of thermal networks, and the maximum permissible speed in the city is 60 km/h, the steam fog will not create strong interference with vehicles compared to ice.

3.3. Economic efficiency
To assess the economic efficiency of this design, it is necessary to determine the following indicators: the salary of the road service worker, the cost of fuel and oil cleaning, sprinkling machine for 4 months per m²; the amount of sprinkling material per m²; the cost of equipment, work clothes, the cost of the material. All data are given in table 1.

| Main economic indicators | Minimum costs for the current construction of the road rubles/m² | The minimum cost of the proposed construction of rubles/m² |
|--------------------------|---------------------------------------------------------------|----------------------------------------------------------|
| Payment to crew of workers of road service for fight against natural rainfall | 3.12 | - |
| The cost of fuel and oil cleaning, sprinkling machine | 1.2 | - |
| Cost of clothing and equipment | 1.3 | - |
| Cost of planting material | 0.3 | - |
| Cost of concrete | - | 4.8 |
| The cost of additives and admixtures in concrete | - | 2.5 |
| Cost of asphalt | 5.145 | 5.145 |
| Total | 11.065 | 12.445 |

The data obtained from table 1, allow us to conclude that the minimum cost of creating the proposed design is more expensive at 1.38 rubles/m².

4. Conclusion
Based on all of the above parameters, this design can be described as a new road, the maintenance costs of which will be lower compared to the current design of the road. And security will be many
times higher. It is also worth noting that when using this design, the energy going to heat the asphalt to a temperature above 0°C is the energy of loss of pipelines of heat networks, which means that such a system increases the efficiency of pipelines of heat networks, which in itself is a huge plus.

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