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Icing problems on road in Da Hinggangling forest region and prevention measures

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Abstract

Icing problems on road in Da Hinggangling forest region, northwest of China, are very serious. Many measures (blind ditch, pit for containing ice, fences/dams for blocking ice, insulated drain, etc.) have been used in this cold regions but they were not always effective. This paper analyses the formation reasons of icing and the disabled reasons of the old measures and represented a set of composite measures applied to control the icing problem on road in Da Hinggangling forest region. Results show that the frosty climate and the complex hydrology conditions and the inadequate field exploration are the main reasons that led the prevention measures to be disabled. The innovation of the technique is the "double-drainage openings" insulated drainage system. Practice proved that it had good effect on control icing problem on road, and also it could protect woods resource and ecology environment.

Keywords: Icing; Roads; Cold regions; Double-drainage openings

1. Introduction

Icing is also called aufeis, taryn or naled. In cold regions, icing always occurs on road in winter. It hindrances traffic and causes traffic accidents. It also damages roads after it thawed in spring breakup period. Researchers have made much work on icing. In Russia, many researches on the dynamic properties of icing and numerical forecast have been done. Aliekxiev and Shamoxin (1997) summed up the technological information system of anti-icing and protecting road constructions. In USA, Carey (1973) summarized existing knowledge concerning the occurrence, control, and prevention of icings that develop from surface

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water and groundwater. Slaughter (1990) introduced the formation and prevention of aufeis. Schohl and Ettema (1986, 1990) did some laboratory investigations on the formation properties of aufies. Results presented by Streitz and Ettema (2002) showed that the gravity and wind stag were the main reasons influencing the size and morphology of aufeis. Vinson and Lofgren (2003) summed up some former results and presented a recommendation of strategy on controlling icings. Andersland and Ladanyi (2003) described the icing problem and summarized seven techniques for mitigation icings suggested by Argue et al. Seppälä (1999) cited that engineers have developed several different techniques to drain water along the road bank or through it to minimize the difficulties (Lehtonen, 1991). Saarelainen and Vaskelainen (1988) stated that the groundwater should be collected in drains at a frost-free depth before it reaches the road and then it should be drained into the winter culvert. In China, icing problems are very popular in northwest and northeast areas and some researches were done to control them (Jiao and Chen, 1997; Gao et al., 2001). The phenomena of icing maybe are the same in the world but the formation properties and mitigation options are different. To date, many control measures are not always effective or they are very costly or labor intensive. The work presented herein analyses the formation processing, properties and the damages of icing on road in Da Hinggangling forest region, northeast of China, and presents a set of composite measures to control the icing problems.

2. Natural and geographic conditions in Da Xingganling forest region

The Da Hinggangling forest region (120°12′ E–127°00′ E, 49°10′ N–53°33′ N) has an area of approximately 100,000 km^2 and the elevation ranges from 400 m to 1100 m along the roads. The annual precipitation is about 500 mm. The annual evaporation is much smaller than the precipitation. So the water content of the shallow ground layer is very big. The overlay rate of vegetation exceeds 90%. The annual mean air temperature is about 0.0 to −5.0 °C in this region. The lowest temperature has been −52.3 °C recorded at the locale weather station and the mean temperature in January is about −30 °C. The snow cover is 20–50 cm and its existent time is about 6 months. The rock is heavy weathering and rock cracks are widely distributed because of the long-term congelifraction, cryogenic weathering, etc. The sufficient feed water and the cold weather are the conditions required for icing formation.

There are three types of permafrost in the area. They are the predominantly permafrost (100–50 m in thick, annual mean ground temperature −3.5 to −1.0 °C, permafrost table 1.1–3.5 m), the predominantly continuous-island permafrost (50–20 m in thick, annual mean ground temperature −1.5 to −0.5 °C, permafrost table 2.0 m) and the island and sparsely island permafrost (thickness 20–5 m, annual mean ground temperature −1.0 to −0.0 °C, permafrost table 2.4–3.9 m). On north-facing slopes where vegetation grows well, permafrost table is only 30–100 cm. Permafrost layer is impermeable. So surface water and shallow groundwater cannot seep far into the deeper ground, and they are easy to seep to the ground surface and form icing in winter.

3. Icing problems in Da Hinggangling forest region

The Da Hinggangling forest region is the most severity region of icing problems on road in China. It was incompletely investigated that there were 125 icing sites on the Qi-Yi road (174 km) and the Huang-Niu Road (32 km). The feed water sources of them were different. Some icing areas are shown in Figs. 1–3.

It can be concluded from the above icing problem that there are two main reasons leading to icing problem on road in Da Hinggangling forest region. One is that constructions introduce icing problem, the other is the mistake of planning and designing.

Whether heavy or small the icing is, it may bring many troubles to traffic (Fig. 4). During the spring breakup period, the snow and ice meltwater would damage road seriously (Fig. 5).

Icing covers the road in winter and it begins to thaw when weather gets warm. It will melt completely