

RESEARCH ON CHLORIDE CONCENTRATIONS IN SNOW MELT WATER IN THE ROADSIDE OF HIGHWAY VILNIUS – KAUNAS – KLAIPEDA

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Abstract

Road maintenance in autumn - winter season is essential because of Lithuanian geographical position and climate. Snow sweeping, powdery and ice dissolvent material and their mixture spreading on carriageway are main jobs to vouch for road safety. Chemical materials often used for pavement maintenance are salts (chlorides). Usage of chlorides is direct and indirect pollutant of environment. It originates corrosion of ferroconcrete constructions. By the roadside of highway Vilnius – Kaunas – Klaipėda analyses were made to define concentration of chloride in snow melt water. What is distance of chlorides spreading and in what distance greater stock of chloride is concentrate. Roadside of highway A1 chosen for researches because it is longest highway in Lithuania, which pertains to European road net (E85). Highway from Vilnius to Sitkūnai is maintenance in winter by 1st (superlative) level. Highway crosses all four-climate areas of Lithuania and crosses or borders with seven protected areas. Methodology of deducing concentration of chloride in snow melt water and prevail meteorological conditions (when snow samples were taken) is presented in article. Results are presented in diagram form. Results of analysis pointed that maximal chloride stocks are accumulated along roadside and 1-meter distance from road. The highest concentration of chloride (Cl^-) was 1400-1900 mg/l. Amount of chloride in snow melt water in Lithuania is 3,64 mg/l, the highest permissible level of Cl^- concentration in drinking water is 350 mg/l.

Introduction

For approximately 5 months the roads of the Republic of Lithuania are maintained under the winter conditions. This is predetermined by the geographical situation and the climatic conditions. In winter roads become slippery because of snow collection and ice formation on them. Slipperiness weakens the factor of the adhesion of the vehicles' wheels to the road pavement, reduces speed of vehicles, increases accident rates, impedes road maintenance [1].

The road slipperiness might be reduced with the help of chemical substances, mostly different salts, friction substances and mixes of chemical and friction substances [2]. Under winter conditions road pavement gets covered with a snow or ice crust of different thickness and density, thus for the road slippery reduction different substance spreading norms are set.

A chemical method of slipperiness elimination of the roads in winter is applied using chemical substances (mostly chlorides), which through their interaction with the surface of snow or ice turn it into a solution that does not freeze in the temperatures below zero [3].

To reduce an adverse impact on environment, chlorides should be used taking into consideration the norms of their use, work technologies and other requirements [4].

Chlorides are spread on the ice-covered road pavement with the help of special mechanisms, motor-spreaders that are able of spreading the set amount of a material [3].

Methods

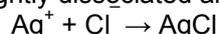
The aim of the research is to find out the concentration of chlorides in the snow melt water on the roadside of the highway Vilnius – Kaunas – Klaipėda; to analyse the distance that chlorides spread away from the road and the distance at which the maximum amount of chlorides accumulates.

Snow samples were taken cross-sectioning them. A cross-section consists of 4 points: Point 1 is located immediately at the end of the carriageway, Point 2 is located 1 meter away from the carriageway, Point 3 is located 2 meters away, and Point 4 is located 3 meters away. Thus, this enables the determination of the alteration in the distribution of chlorides' concentration perpendicularly to the road.

The snow sampling spots are measured with a flexible 10-meter long ruler. Sampling is made at special points of the selected spots with the help of stainless steel scoop; samples are put into clean, disposable, string and plastic bags. Each bag containing a snow sample is marked. Meteorological conditions prevailing during the sampling should be indicated and the location should be described. The snow samples collected are taken to a laboratory and left there for natural melting. Samples are taken from the area of 0,1 m² applying the principle of envelope.

Chloride concentration in the snow melt water is found out applying the titrimetric method.

Chlorides and argentous ions compose lightly dissociated argentous chloride (AgCl):



Potassium chromate is used as an indicator. Due to chloride titration with the help of argentous nitrate solution, all chlorides are compounded into argentous chloride. The resulting excess of argentums ions together with potassium chromate deposits as orange-red sediment of argentous chromate [5].

Results

The highway Vilnius – Kaunas – Klaipėda was chosen for the determination of chloride concentration in the snow melt water. The chosen highway is a national road connecting the biggest towns of Lithuania. The length of the highway is 311,40 km, its marked as A1. The highway is also marked as E85, which means that the highway is a part of the network of European roads. The E85 highway connects Klaipėda – Kaunas – Vilnius – Lyda – Chernovcy – Bucharest – Alexandropol. It is the longest highway of the existing seventeen highways of Lithuania. This highway, the same as the rest ones, has a protective zone of 70 meters. According to the new Law on Roads of the Republic of Lithuania (Official Journal, 2002, No. 101-4492). The A1 highway crosses or borders on 7 preserved areas of Lithuania.

The Republic of Lithuania is in the climatic zone of the middle latitude. The highway Vilnius – Kaunas – Klaipėda is built in all 4 climatic areas and 6 (of 10) climatic sub-areas of Lithuania.

The A1 highway connects the biggest towns of Lithuania and is a part of European road network but in winter only the section Vilnius – Kaunas – Klaipėda from Vilnius to Sitkūnai (104,8 km) is maintained according to the 1st (highest) maintenance level. The rest highways and all country roads and regional roads equated to country roads are maintained according to the 2nd maintenance level.

Snow sampling was carried out on February 13, 2003 at 6 spots. According to the data of Lithuanian Hydrometeorological Department as of February 13, the snow covering was stable and the thickness of the snow covering was equal to the perennial monthly average of February.



Fig 1. Snow sampling spots on the highway Vilnius – Kaunas – Klaipėda (E85)

Indicating chloride concentrations found in the snow melt water, the background amount of chlorides of Lithuania found in the snow melt water (3,64 mg/l) is giving in the diagram. In Europe, the amount of chlorides found in the snow melt water is 0,425-3,94 mg/l. In Lithuania the acidity of the snow melt water is pH=6,75. The data is taken from Lithuanian Geochemical Atlas, 1999. p. 83-84.

Chloride concentrations found with the help of titrimetric chemical analysis method are expressed and given in mg/l.

Snow samples were taken for the determination of chloride concentration on both sides of the road. The obtained results differed only within the error limits, thus the article gives the results only of one side of the road.

The diagrams give the error of 15 %, which might occur during the determination of chloride concentration with the help of titrimetric chemical analysis method.

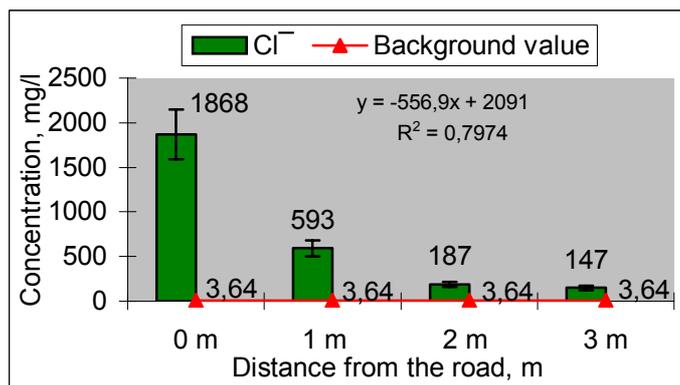


Fig 2. Concentrations of chloride in the snow melt water, Grigiškės

Figure 2 shows that chlorides concentration receding from the road along the cross-section distributes depending on the distance, i.e. it trends to go down. At the first spot near the road the concentrations of chloride is the highest one and reaches 1868 mg/l. This concentration is highest of all concentrations found near the road. The difference among concentrations found 2 and 3 meters away from the road is insignificant. The acidity of the snow melt water used for the determination of Cl⁻ concentration was pH=7.45. The snow covering at the spot of sampling was approximately 20 cm.

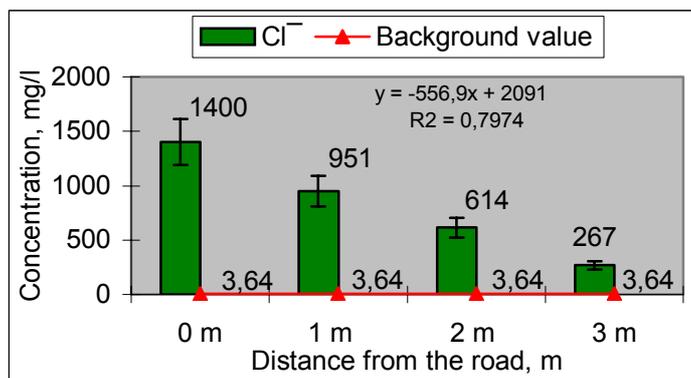


Fig 3. Concentrations of chloride in the snow melt water, Palemonas

Figure 3 shows that the highest concentration of chlorides is found near the road and reaches 1400 mg/l. This concentration exceeds the background value 384 times. Concentrations are distributed in the cross-section proportionally to the distance. pH=7,42. The snow covering at the spot of sampling was 15 cm.

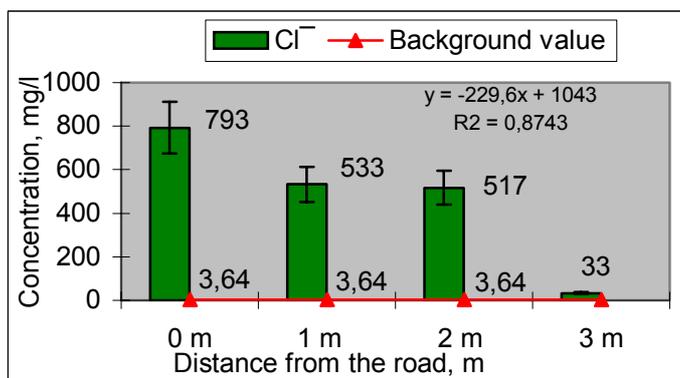


Fig 4. Concentrations of chloride in the snow melt water, Sargėnai

The highest concentration of chloride is found near the road and reaches 793 mg/l. 1 and 2 meters away from the road concentrations are almost equal, and 3 meters away the concentration goes down to 33 mg/l. In Sargėnai, at the sampling spot 1 meter away from the road there is a narrow trench with a sharp opposite slope. Chloride concentration is spread according to the geographical peculiarities of

the location. Cl^- concentrates in the trench. $\text{pH}=7,25$. The snow covering at the spot of sampling was 16 cm.

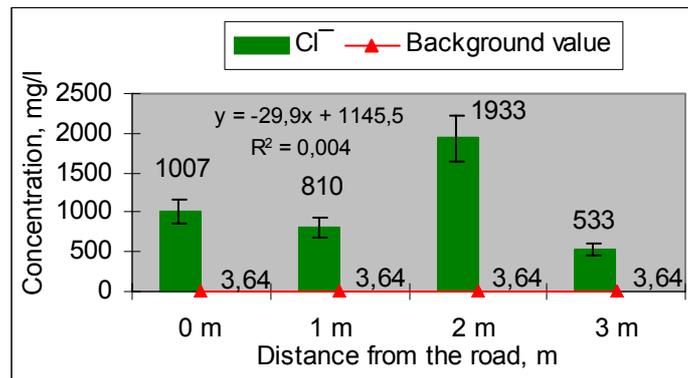


Fig 5. Concentrations of chloride in the snow melt water, Sitkūnai

Receding from the road along the cross-section chloride concentrations is spread very unevenly. The highest chlorides concentration is found 2 meters away from the road and reaches 1933 mg/l. Such concentration is the highest one of all the concentrations found. Such uneven distribution of chlorides is determined by the flows of the passing vehicles, which cause wind flaps and precipitate the salt away from the carriageway. The acidity of the snow melt water used for the determination of Cl^- concentration was $\text{pH}=7.54$. The snow covering at the spot of sampling was 18 cm.

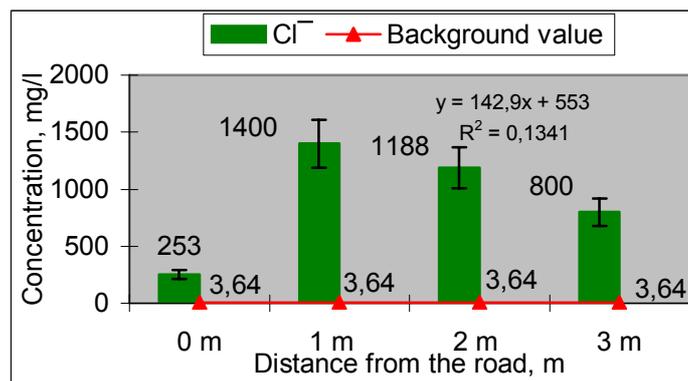


Fig 6. Concentrations of chloride in the snow melt water, Kryžkalnis

One meter away from the road the concentration of chlorides is the highest one and reaches 1400 mg/l. Further, with the increasing distance from the road the concentrations go down. Near the road Cl^- concentration is 3 times lower than that 3 meters away from the road. This could be explained by the wind influence, which is noticed getting closer to the sea (Klaipėda). $\text{pH}=7,40$. The snow covering at the spot of sampling was approximately 5 cm.

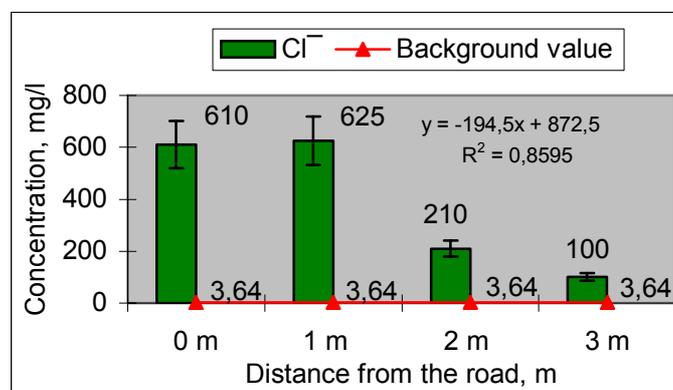


Fig 7. Concentrations of chloride in the snow melt water, Klaipėda roundabout

The highest concentration of chloride is found 1 meter away from the road and reaches 625 mg/l. This concentration differs from the same near the road (which is 610 mg/l) only within the error limits. The concentration 2 meters away from the road is three times lower than concentrations near the road and 1 meter away from the road. Cl^- concentrations at Klaipėda roundabout are insignificant if compared with the concentrations at other sampling spots although the snow covering was stable. This is influenced by the peculiarities of the seacoast climatic area. This climatic area has the lowest number of days without the temperature below zero and with snow covering, thus the amount of chlorides used for the road maintenance is lower than that in the eastern part of Lithuania. $\text{pH}=7.28$. The snow covering at the spot of sampling was 7 cm.

Conclusions

1. The highest concentrations of chloride (1868 mg/l) are found near the carriageway (Figure 2) and 1 meter away from the road (1400 mg/l, Figure 6).
2. The indicator of hydrogen ions of the snow melt water that was used for the determination of chloride concentrations was fluctuating $\text{pH}=7,25$ to $7,54$; making slightly alkaline medium. The background value $\text{pH}=6,75$ (close to the neutral one) was on the average exceeded by 0,6. Salts occurring in soil or water may alkalise them.
3. The highest chlorides concentration (1933 mg/l) was found in the cross-section at Sitkūnai, 2 meters away from the road (Figure 5). The section of the highway Vilnius – Kaunas – Klaipėda till Sitkūnai is the only one maintained at the highest maintenance level where a greater amount of chlorides is used for the road maintenance in winter. Thus, a greater amount of chlorides gets is emitted into the environment.
4. At Sargėnai, 1 and 2 meters away from the road the concentrations are almost equal and differ only within the error limits. 3 meters away the concentration goes down to 33-mg/l. Chloride concentrations is spread according to the geographical peculiarities of the location. 1 meter away from the road there is a narrow trench with a sharp opposite slope (40°). Cl^- concentrates in the trench.
5. At Sitkūnai, receding from the road along the cross-section chlorides concentration is spread very unevenly. The highest chlorides concentration is found 2 meters away from the road and reaches 1933 mg/l. Such concentration is the highest one of all the concentrations found. Such uneven distribution of chlorides is determined by the flows of the passing vehicles, which cause wind flaws and precipitate the salt away from the carriageway.
6. At Klaipėda roundabout concentrations near the road (610 mg/l) and 1 meter away from the road (625 mg/l) differ only within the error limits. The concentration 2 m away from the road is 3 times lower than the concentrations near the road and 1 meter away from the road. Cl^- concentrations at Klaipėda roundabout are insignificant if compared with the concentrations at other sampling spots although the snow covering was stable. This is influenced by the peculiarities of the seacoast climatic area. This climatic area has the lowest number of days without the temperature below zero and with snow covering, thus the amount of chlorides used for the road maintenance is lower than that in the eastern part of Lithuania. Lower amount of them is emitted to the environment.
7. The determination of chloride concentrations in the snow melt water is the first step observing their amount in the soil and soil water. Monitoring should be performed in the preserved areas having their own specifics, as the highway crosses them or borders on them.
8. To reduce a negative impact on the environment, chlorides should be used taking into consideration the norms of their use, work technologies and other requirements in order to avoid overspending.

References

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