

The Use of Video Surveillance for Research of Snow Accumulation on the Highways

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ABSTRACT

The observations were made on the experimental sections of roads during two winter periods. Experimental road sites have crash barriers with different scheme placements. Video surveillance during the winter allowed to reveal that the crash barriers have an effect on the snow distribution on the road surface. Two possible variants of crash barrier works during blizzards were identified. The process of snow accumulation on the highway was studied on the analysis of the collected video and snowsurvey results on experimental sites. The schemes of snow deposits for four-lane roads and four rows of crash barriers were updated.

Keywords: Video surveillance, snow accumulation, snowsurvey, crash barriers.

1 INTRODUCTION

The improving of operational management of road winter maintenance is moving towards the development of intelligent transportation systems (ITS). Subsystems of weather monitoring and video surveillance are part of ITS. The information obtained in these subsystems, allows to select the optimal strategies of road winter maintenance.

The management of road winter maintenance in Russia is a difficult task for road service because Russia is a large country with regions which differ in weather conditions during winter. The practical experience in managing of road winter maintenance based on the use of weather information from road information systems is available in Russia today. In addition to the solution of practical problems the RWIS information can be used for scientific research.

One of the actual problems of road winter maintenance in Russia is ensuring the prevention of snow deposits on the roads during blizzards. The modern highways have several rows of crash barrier on the entire road to ensure traffic safety. In the winter, this leads to the fact that all roads embankment which are not protected from snow blizzards with forests, are blocked by snow. A large amount of snow is accumulated during blizzards on the road with crash barriers. The special models for the calculation of snow amount on the road surface were developed [1, 2].

One of the main stages of research is checking the accuracy of the solutions obtained with the help of mathematical models. The solution of this problem was made by using the information of video surveillance systems.

2 THE OBSERVATIONS ON EXPERIMENTAL ROAD SECTIONS

The observations were made on the experimental sections of roads during two winter periods on the site of the federal highway M-4 "Don" Moscow - Voronezh - Rostov-on-Don - Krasnodar – Novorossiysk. The road connects the central and northern regions of the European part of the country with the North Caucasus, the Black Sea coast and the port of Novorossiysk. Highway M-4 "Don" has a length of 1,589 kilometers.

The part of the federal highway M-4 "Don" Moscow - Voronezh was taken for the study. It has a length of 536 km. The experimental site crosses the territories of Moscow, Tula, Lipetsk and Voronezh regions. The federal highway M-4 "Don" Moscow – Voronezh has 4 traffic lanes, divided reverse traffic and road crossings on different levels. Characteristics of the highway site are shown in the Table 1.

<i>The name of parameter</i>	<i>The characteristic of parameter</i>
Road category	I B
Length, km	536
Number of traffic lanes	4
Subgrade width, m	27,5
Road surface width, m	7,5 x 2
Shoulder width, m	3,75
Dividing lane width, m	5÷11,0

Table 1. Characteristics of the federal highway M-4 "Don on the site Moscow – Voronezh.

Experimental works include:

- The observation by video cameras placed on the highway
- The special snow surveys, measurement of the snow height after the blizzards and snowfalls
- Analysis of data from automatic road meteorological stations located on the highway

Road weather stations and video cameras transmit the information in real time about the situation on the road through the video surveillance system [3]. The collection of information about the weather conditions are made with automatic road meteorological stations [4].

18 complex stations were installed on the experimental site. They consist of automatic road meteorological stations and video cameras. The scheme of the federal highway M-4 "Don" on the site Moscow - Voronezh with indication of complex stations placement is shown in Figure 1.



Figure 1. The scheme of the federal highway M-4 "Don" on the site Moscow - Voronezh with indication of complex stations placement.

Some video cameras allow to observe road sites which have the same geometric characteristics and direction, therefore, 11 road sections were taken for research.

The collection of videos and photos is made with the help of video cameras during the all winter. The special attention during observations was paid to condition of road surface during the passage of blizzards and heavy snowfalls.

The video materials collected during the separate blizzard allow to analyze snow accumulation on the road and in the roadside. The example of the collected photo material showing the process of snow accumulation on the experimental road section during a blizzard is shown in Figure 2.



Figure 2. The process of snow accumulation on the road experimental section during blizzard.

3 EXPERIMENTAL SNOW SURVEY WORKS ON THE ROAD SECTION

Experimental snow survey works were conducted in three phases:

- In summer – the tacheometry of embankment cross sections in relative or absolute heights on experimental road sites was made; embankments marks, ditches bottom marks, marks on the embankments slopes and the land marks at a distance of 15-20 m from the embankments ditches were determined; the location of the crash barriers was defined.
- Embankments cross sections were drafted on the base of survey results.
- In winter – measurement of the snowdrifts thickness after intense blizzards, snowfalls and in the end of the winter was made; measurements of the snowdrifts thickness in the characteristic points of the land cross-section; in the points where the snow shape and thickness change; as well as measurements of snowdrifts on the subgrade were done [5].

During winter the collection of weather information from state meteorological stations and automatic road meteorological stations is produced. The list of weather parameters is shown in Table 2.

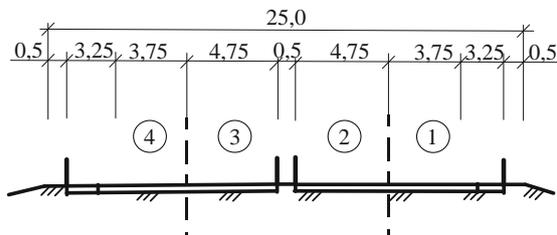
<i>Name of parameter</i>	<i>Unit</i>
atmospheric phenomenon (type of precipitation)	
time of beginning of the phenomenon	hour
time of finishing of the phenomenon	hour
wind speed	m/sec
maximum wind speed during the phenomenon	m/sec
wind direction	compass point
temperature of air	°C
precipitation intensity	mm/hour
average precipitation for 30 minutes	mm

Table 2. The weather parameters from automatic road meteorological stations.

The weather parameters allow to calculate snowbring and snow deposits volumes on the road surface taking into account the snow accumulation dynamics [6].

Experimental road sites have crash barriers with different scheme placements. The example of variants of crash barriers placements on experimental sites and the results of video observations are shown in Figure 3.

a)



b)

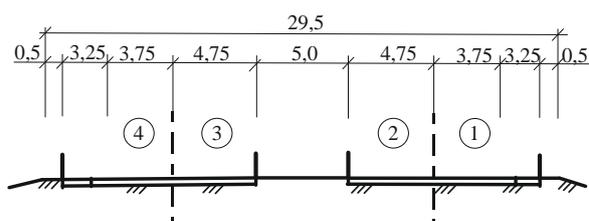


Figure 3. Variants of crash barriers placement on experimental sites.

4 THE SCHEMES OF SNOW DEPOSITS ON THE HIGHWAYS DURING BLIZZARDS

Video surveillance during the winter allowed to reveal that the crash barriers have an effect on the snow distribution on the road surface. In the winter, this leads to the fact that all roads embankment which are not protected from snow blizzards with forests, are blocked by snow. A large amount of snow is accumulated during blizzards on the road with crash barriers.

Two possible variants of crash barriers works during blizzards were identified [7]. The variants depend on the scheme of snow removal next to the barrier. At the first variant, a condition of complete removing of crash barrier from snow must be implemented. In this case crash barrier will work as blow-snow fence. At the second variant, snow is not removed from the crash barrier. So, crash barrier will work as entire, snow accumulation fence.

The process of snow accumulation on the highway was studied on the analysis of the collected video and snow survey results on experimental sites. The schemes of snow deposits for four-lane roads and four rows of crash barriers were updated. The schemes of snow drifts on highways are shown on the Fig. 4.

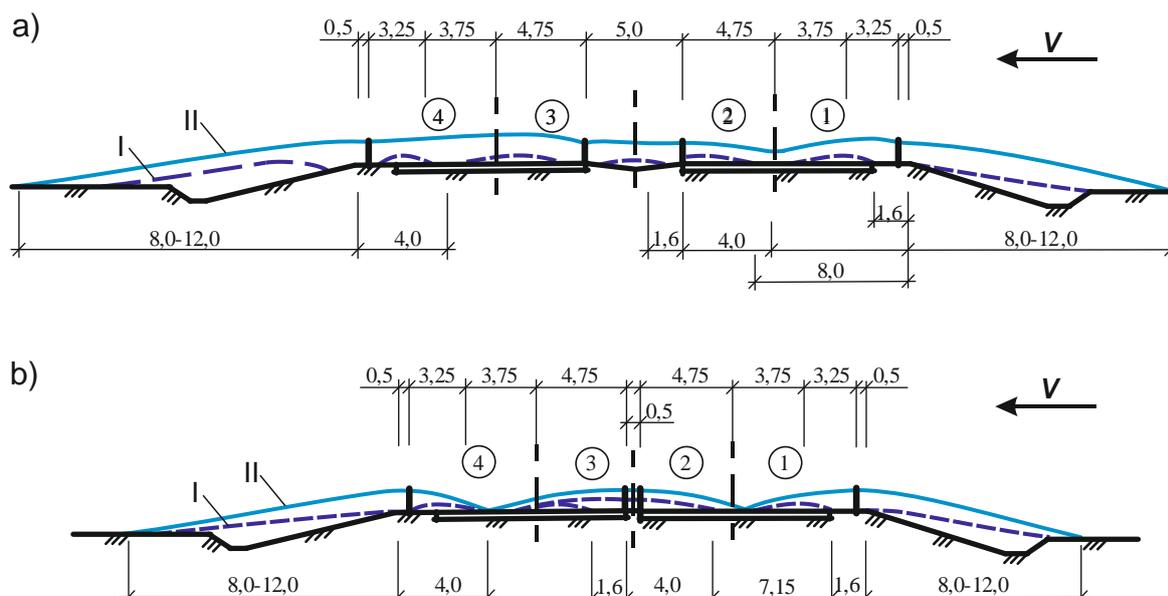


Figure 4. Schemes of snow drifts on highways: a) dividing line width of 5,0 m; b) dividing line width of 0,5 m; 1, 2, 3, 4 are numbers of traffic lanes; I – the surface snow cover after the passage of previous blizzard; II – the surface snow cover after blizzards with volume of snowbring more $30 \text{ m}^3/\text{m}$ and without snow removal.

The Figure 4 shows that three lanes (1, 2 and 3), shoulder and dividing lane are located in snow deposits zone. The main reason for their formation is the presence of crash barriers working as blow-snow fence. The first snow deposits are formed in the windward ditch, on shoulders, then the second and the third lanes, as well as on the dividing lane. The snow accumulates less only on the fourth lane.

The snowdrifts schemes on the road surface when crash barriers are filled with snow are shown in Figure 5. In this case, the snow accumulates primarily near crash barriers. The first snow drifts are formed before the first crash barriers row on the embankment slope, then in the barrier area, then behind the barrier on the shoulder, and only then snow deposits are formed on the road surface. The first snow deposits are formed in the windward ditch, on shoulders, then the second and the third lanes, as well as on the dividing lane. The snow accumulates less only on the first and the fourth lanes.

Snow drifts will not form on the highway if snow is not removed from the crash barrier during blizzards with small snowbring volumes, in contrast to the case, when crash barriers are completely cleared from snow. But during intense blizzards with large snowbring volumes all traffic lanes can be filled with snow at the crash barriers height.

Thus, if highways have 4 rows of barriers, the entire road surface is in the snow deposits zone during a blizzard.

When the number of crash barriers rows and their scheme placements change the process of snow deposits formation on the road surface will change too.

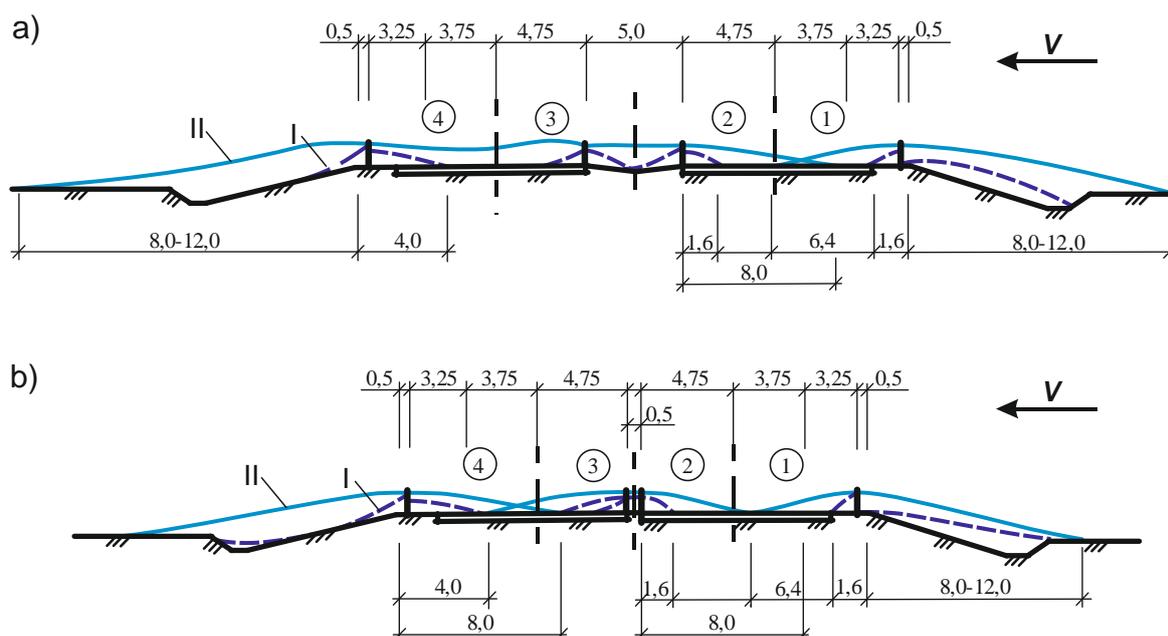


Figure 5. Schemes of snowdrifts on the road surface next to crash barriers filled with snow: a) dividing line width of 5,0 m; b) dividing line width of 0,5 m; 1, 2, 3, 4 are numbers of traffic lanes; I – the surface snow cover after the passage of previous blizzard; II – the surface snow cover after blizzards with volume of snow more than 30 m³/m and without snow removal.

Therefore, the presence of barriers and their effect on the snow accumulation on the highways must be considered when road winter maintenance. The road sections with crash barriers must be under constant surveillance during blizzards, and decisions on works technology should be made according to analysis of information from video surveillance.

5 CONCLUSION

1. Crash barriers can work as blow-snow fence or as entire, snow accumulation fence.
2. Crash barriers work as blow-snow fence in the beginning of blizzard until snow removal starts or all winter if the full cleaning of barriers from snow is constantly made. In this case, the snow begins to deposit immediately on the road surface that interferes with the traffic.
3. Crash barriers begin to work as entire snow accumulation fence after the first snow removal when the snow fills the lower open part of barriers. In this case, snow drifts begin to form next to barriers and then gradually accumulate on the road surface.
4. The availability and placement scheme of the crash barriers on the highways should be considered when planning the snow removal.

6 REFERENCES

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