EXAMINATION ABOUT SNOW MELTING EQUIPMENT WITH WATER SPRINKLING ON POROUS ASPHALT PAVEMENT

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1. Abstract

When snow melting equipment on porous asphalt pavement is considered, on the conventional normal asphalt pavement, it is assumed that the water which was flowing the pavement surface flows the pavement inside in porous asphalt pavement, and it is expected that a big difference appears in the effect.

We inspected the effect of snow melting equipment with water sprinkling on porous asphalt pavement by performing indoor examination, outdoors examination, and examination construction in expressway. Consequently, even if it compared the snow melting effect in porous asphalt pavement with it of normal asphalt pavement, it became clear that there is almost no difference.

2.Intoroduction

In Japan Highway Public Corporation, porous asphalt pavement (high function pavement[1]) effective in the run safety at the time of rain or noise reduction adopted extensively from 1998. In connection with it, it is necessary to verify whether about the snow melting equipment which was being conventionally carried out on normal asphalt pavement, there is any effect sufficient on porous asphalt pavement.

About snow melting equipment with water sprinkling on porous asphalt pavement is reported in Kojima･Maruyama(1997), that pavement temperature is rise by means of letting water inside pavement. But the problem that is not solved is left, whether to melt snow is actually possible, if possible there is what effect. Then, it experimented to inspect snow-melting effect by various examinations. This report is collected, model examination by the interior of a room, model examination by the outdoors, and examination construction in the expressway, and even verification of the snow melting effect. The flow of the whole investigation is shown in Fig. 1.

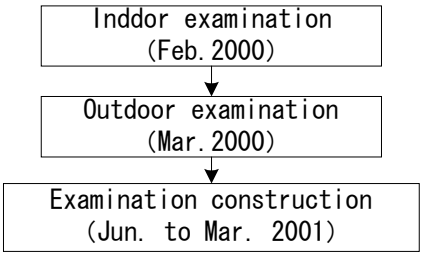


Fig.1. The flow of investigation

[1] In the Japan Highway Public Corporation, porous asphalt pavement is called high function pavement as effective pavement also not only about drainage but about prevention of noise etc.

3. Indoor examination

Specimen, which buried 18 temperature sensors, was created and change of the road surface temperature when pouring water to porous asphalt pavement was recorded. In addition, the slope of specimen was made into 2%. An examination outline figure is shown in Fig. 2 and photograph 1.The indoor examination was carried out under the temperature conditions shown in Table 1.

Table 1. Examination pattern

Temperature / Amount of water	0℃	-2℃	-6℃
None	○	○	○
250 [ml/min・m]		○	
600 [ml/min・m]		○	
1000 [ml/min・m]	○	○	○
1500 [ml/min・m]		○	

It is Fig. 3 which expressed temperature change which all the temperature sensors in this examination show to the transition figure. At the time of an experiment, temperature is rising by supplying heat from water. Conversely, in the situation without supply of water, temperature falls. In the situation that temperature is higher than room temperature, Specimen radiates heat, and is cooled to even room temperature.

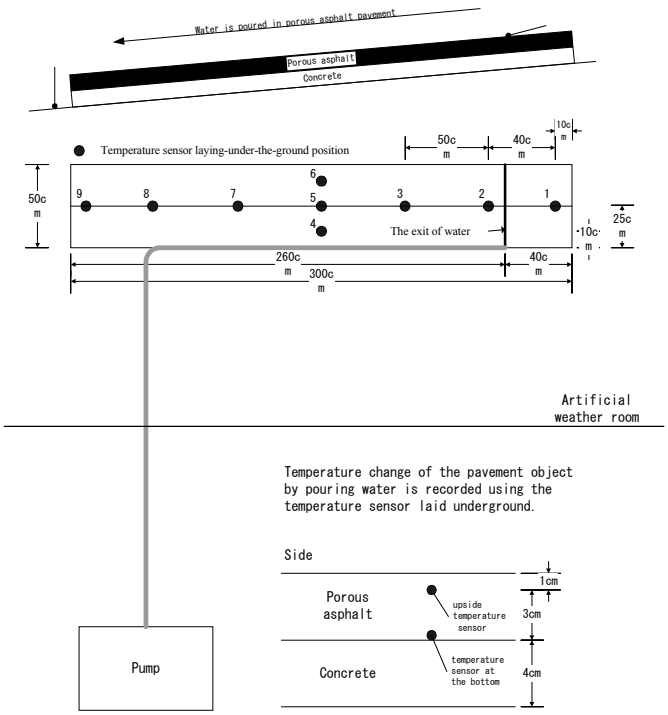


Fig. 2 Examination outline figure

Photograph 1 indoor examination scene

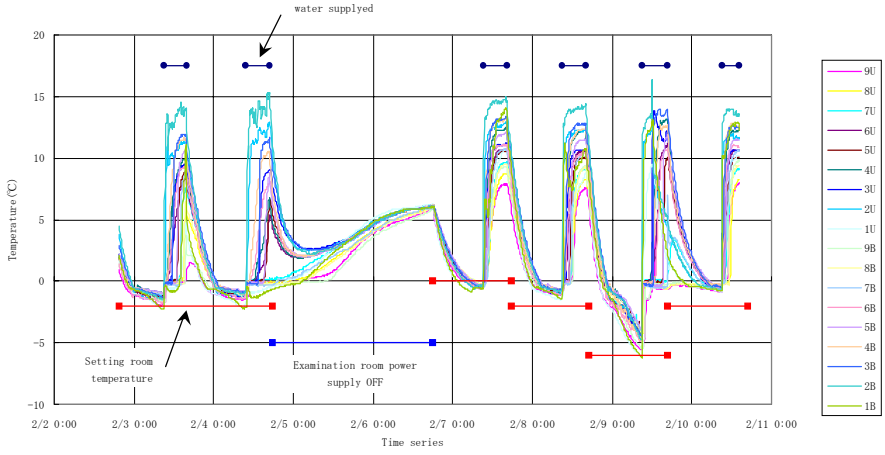


Fig. 3 It is series change at the time of a temperature sensor.

Graph which collected the temperature which all temperature sensors show When water is supplied, it turns out that temperature is rising.

Road surface temperature comes to show the fixed value according to the distance from watering for every sensor, when a certain time is passed. Transition of road surface temperature and distance in the room temperature of -2 degrees C for every examination flux is shown in Fig. 4. In addition, although some difference was looked at by the initial temperature of watering with the experiment day, on graph, initial temperature was unified and displayed on 10 degrees C.

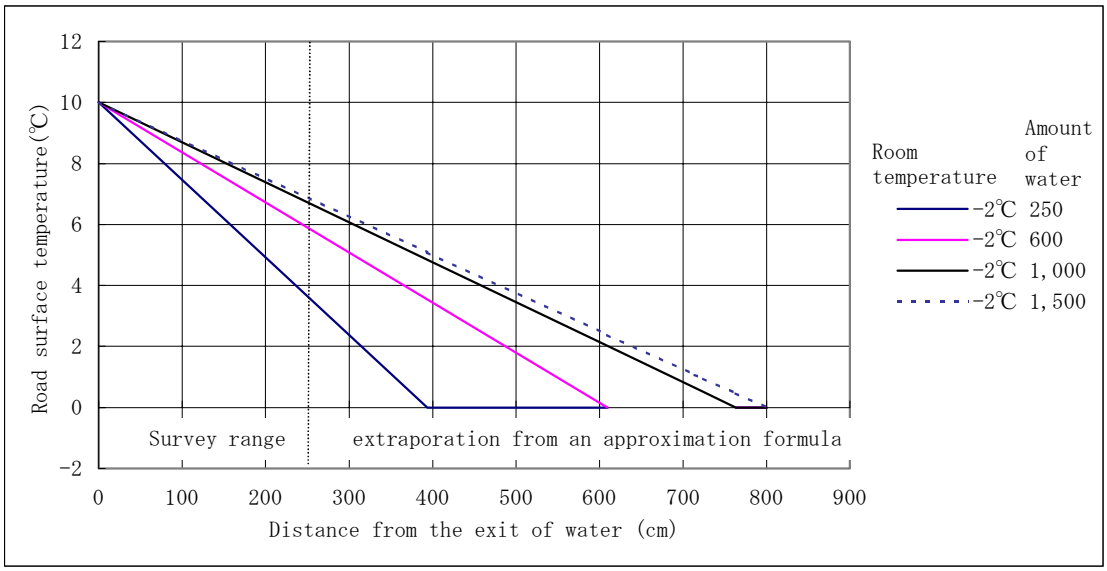


Fig.4 Relation between amount of water and road surface temperature (An experiment with a room temperature of -2 degrees C)

Table 2 Amount of water for maintaining

Amount of water in an experiment (ml/m·min)	The maximum road width which can hold plus temperature(m)	Amount of water per unit area(ml/㎡·min)
250	3.9	64.1
600	6.1	98.4
1000	7.6	131.6
1500	8.0	187.5

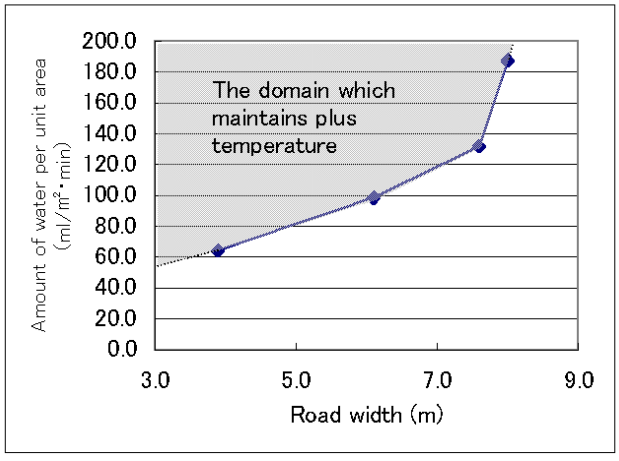


Fig. 5 Amount of water for maintaining right temperature, and relation of width

Temperature falls as it becomes farther than the supply part of water, and the rate of the temperature fall is dependent on the quantity of water. In order to maintain all of road width 7m at plus temperature (plus side), about 1000ml/min of amount of water is needed. On the basis of this result, the relation between a width and the amount of water per unit area was shown in Table 2 and Fig. 5. Therefore, under a -2-degree C situation, in order to maintain road surface temperature at plus, it turns out that the amount of water of the net credit part in a figure is needed. The amount of water at the time of considering road width of 7m as assumption is set to about 120ml/min per unit area. It is reported by the existing investigation that road heating in the electric heat generally used

will take comparatively long time by the time the heating element itself has heat, even if it turns ON the switch of heating. On the other hand, in the examination carried out this time, since the water with temperature flows the direct inside of specimen, if no less than 5 minutes pass from watering start, in the position at the bottom (it is 4cm from the surface) of porous asphalt pavement, it will have the heat exceeding 10 degrees C, and it can be said that the early temperature rise is very early.

4. Outdoor examination

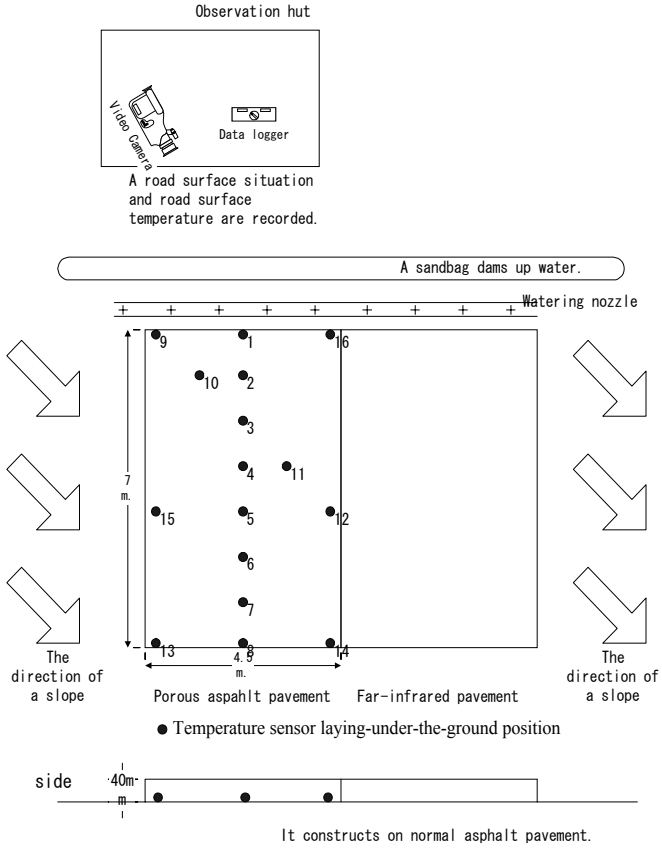


Fig. 6 Examination construction yard outline

Photograph 2 Outdoors examination scenery (Time-lapse video picture)

In the indoor examination, the examination which put emphasis on road surface temperature was carried out. However, in road management, the snow melting effect becomes more important. Since the examination about melting snow was indoors accompanied by difficulty, it carried out the examination about melting snow in the outdoors. An examination outline is arranged to Table 3.

Table 3 Outdoors examination conditions

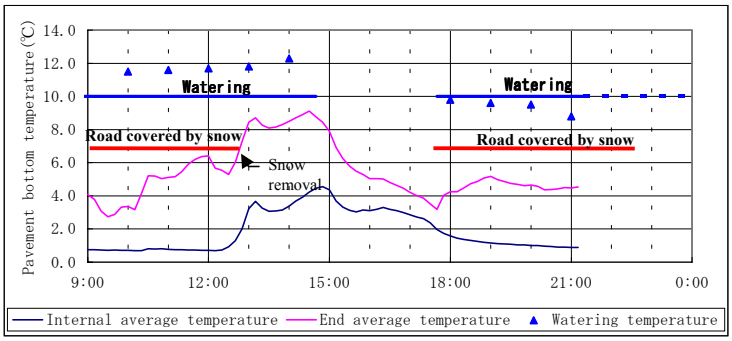
Place	Kan-etsu expressway Tsuchitaru PA
Percentage of void	20%
Amount of water	0.3 l/m^2
Water temperature	8-12 degrees C
Examination implementation	March, 2000
Road condition observation	Time-lapse video is used.
road surface temperature observation	16 temperature sensors is buried.

The day when watering was carried out by measurement apparatus recovery from the amount adjustment of watering will be for seven days on 3/25,26,27,4/11,1516,17.

A monned observation was carried out on March 25, and data, such as road surface temperature, and various weather data, a heat image of a road surface, was acquired. The graph, which arranged the condition of observation day, is shown in Fig. 7.

The road surface average temperature in a figure is divided into two, end average temperature and internal average temperature, and is shown.

On the investigation day, there was snowfall from the morning and it had watered. However, since snow cover was carried out to the road surface by 3cm / hr thing heavy snow around 11:00, the snow was once removed to 12:40. Subsequent transition of a snowfall and road conditions are as follows.



An end average is average value of a thermometer (1, 9, 13, 16) located in the end of pavement. An internal average is the average value of the other thermometer. Since the difference was seen by both temperature, it divided and displayed on it.

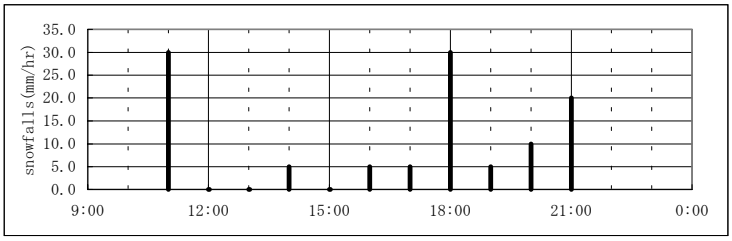


Fig. 7 Situation of field survey day (3/25)

1. Although the snowfall about 0.5cm/hr was seen at the 14:00, snow did not covered on the road surface.
2. Watering was stopped to 14:40. Although there was snowfall about 0.5cm / hr after that, snow cover was not seen on the road surface. In the meantime, the road surface temperature inside porous asphalt pavement shows 3-6 degrees C, and it is thought that snow melted with the heat of a pavement.
3. Since it began to snow from 17; 40 from which the road surface changed to the snow coverage state at a stretch. The snowfall at this time was 3cm in 20 minutes. Although a porous asphalt pavement part was not melted in the meantime even if it watered, the surrounding normal asphalt pavement part was melted nearly completely.
4. When the snowfall on an examination yard was measured in 19:35, the difference was seen, 2cm at the watering nozzle side (upstream side), 0.5cm at the pavement terminus part (downstream side).

The total snowfall of 2 hours from 17:40 to 19:40 as which snow coverage came to be regarded by the road surface is 4.5cm. Supposing the whole of this snowfall changes to snow coverage, it means that the nozzle upstream side had had the snow melting effect of 1.2cm/hr (it is 2.5cm in 2 hours) by the 2cm / hr (it is 4cm in 2 hours), and downstream side. Next, according to the record on 16-April 17 by video photography, If time snowfall is about 1cm / hr, the road surface which changed into the snow coverage state extensively is also checking melting to a "thinly white" grade immediately.

If it consists of the above thing a time snowfall 1cm/hr grade when groundwater is watered by 0.3 $l/m^2 \cdot min$, it will be thought that melting snow is sufficiently possible for road width 7 m.

5. Examination construction in expressway

The result to the preceding paragraph was received and examination construction was carried out in the expressway actually opened for traffic.

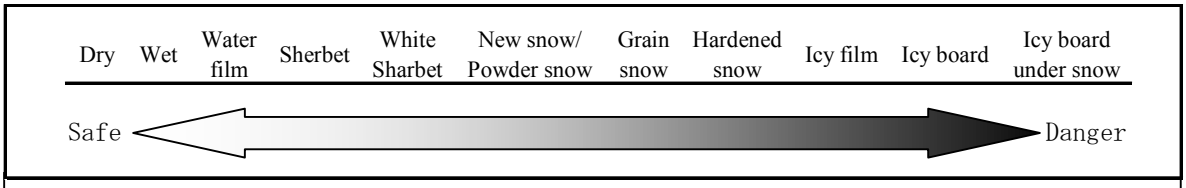
The spot for investigation is eight in a Hokuriku expressway and the Tokai Hokuriku expressway in the Hokuriku branch pipe. In order to know whether the difference in the road surface temperature of how much will be seen at the watering and end side at the time of watering melting-snow implementation, road surface temperature was measured. Road surface temperature was measured by burying a temperature sensor between a pavement surface layer and subbed. And, observation value was recorded by data logger, between in the beginning of January, - beginning of March at the interval for 10 minutes.

Moreover, the field survey was carried out 3 times on the snowfall day in the meantime. In the field survey, at each observing point, the investigator has been stationed one person and weather conditions, such as temperature and snowfall, and road condition, were observed.

The road condition was indicated as 11 classifications which divide into a track and a non-track and are shown in Table 4. In addition, a track is a tire run part and non-tracks are portions other than a track.

Table 4 Road condition classifications

Road condition classification	*Road condition definition*
Dry	The state which does not have moisture in a road surface
Wet	The state where the road surface has got wet
Water film	The state which has film of water on a road surface
Sherbet	A liquid, the thing into which ice melted, the state a road surface looks black
White Sharbet	The state carries out snow coverage to the sherbet upper part, and a road surface looks white
New snow/Powder snow	The snow just behind the shape of powder, and snowfall, the state which soars after vehicles passage
Grain snow	The shape of powder, the snow which vehicles stirred or was grain-ized by medicine spraying, the state which does not soar after passage of vehicles
Compacted snow	The shape of a board, the state pushed by passage of vehicles
Icy film	That in which water film froze
Icy board	That to which snow sank in and froze in the shape of a board, and hardened snow
Icy board under snow	The state up to which snow piled up on Icy board



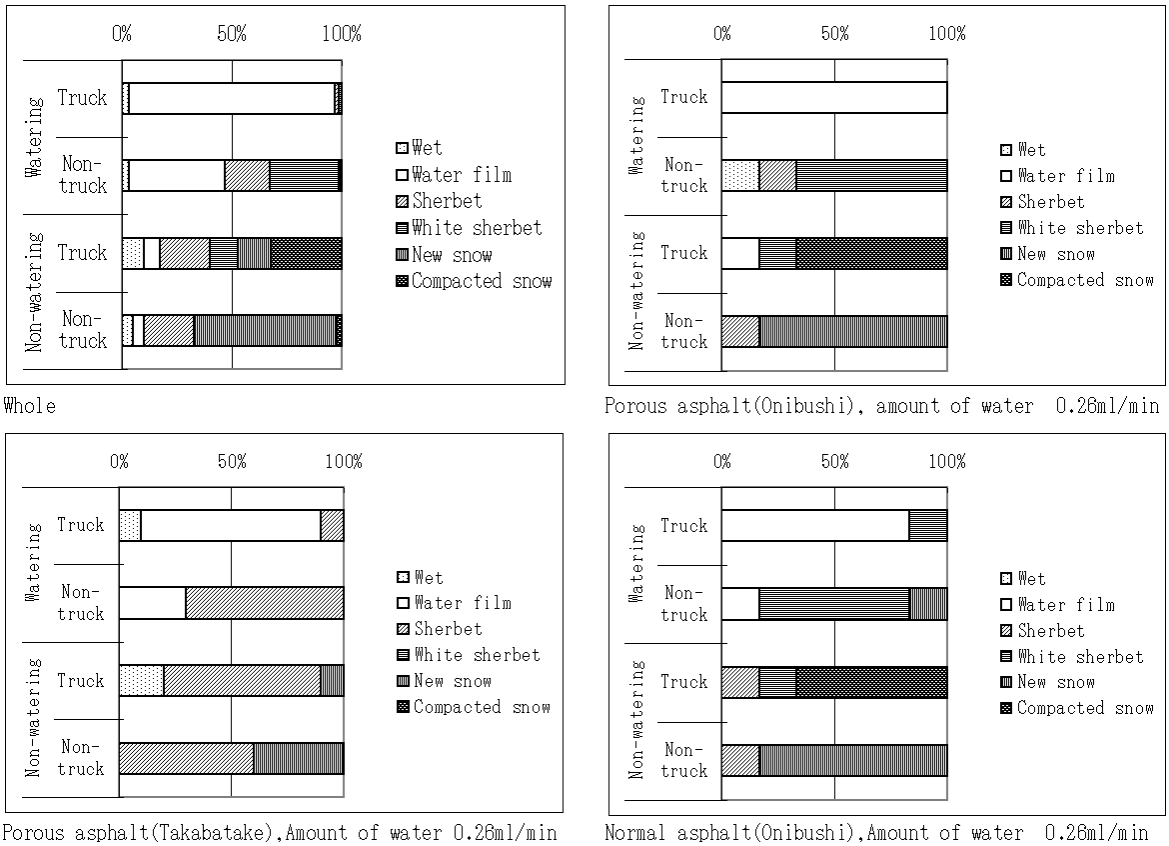
Truck : The portion the tire of a car runs
Non-Truck : Portions other than a track

The snow melt situation by watering is shown in a photograph 3. In a watering portion and a non-watering portion, a difference is clearly looked at by road surface snow coverage, and it understands that the effect by watering has appeared.

Onibushi TN **Kanayama TN**

Photograph 3 snow melt situation by snow melting equipment with water sprinkling

It is Fig. 8 which arranged the road surface situation of a watering part and a non-watering part from the result of the road condition in field observation.



Onibushi and Takabatake are an observation point name.

Fig.8 Comparison of the road surface situation of a watering part and a non-watering part

Fig. 8 shows the appearance rate of a road surface. As for the track of a watering road surface, most serves as water film. In a non-track, it is more than a half, and sherbet and white sherbet remain and the road surface under watering can also be said for having come to

melt all the snow of a road surface only by watering melting snow. However, compared with the non-watering road surface, the road condition of a watering road surface is good.

The road condition photograph is shown in a photograph 4 on the same day and same time of a watering melting-snow operation day. It turns out that there is no difference in the road condition in a watering portion also from these both photographs.

Nou TN Ups side pithead
Porous asphalt pavement

Nou TN downs side pithead
Normal asphalt pavement

Photograph 4　The road condition on melting-snow operation day

Next, the road condition at the time of watering operation is arranged, and it is shown in Fig. 9.

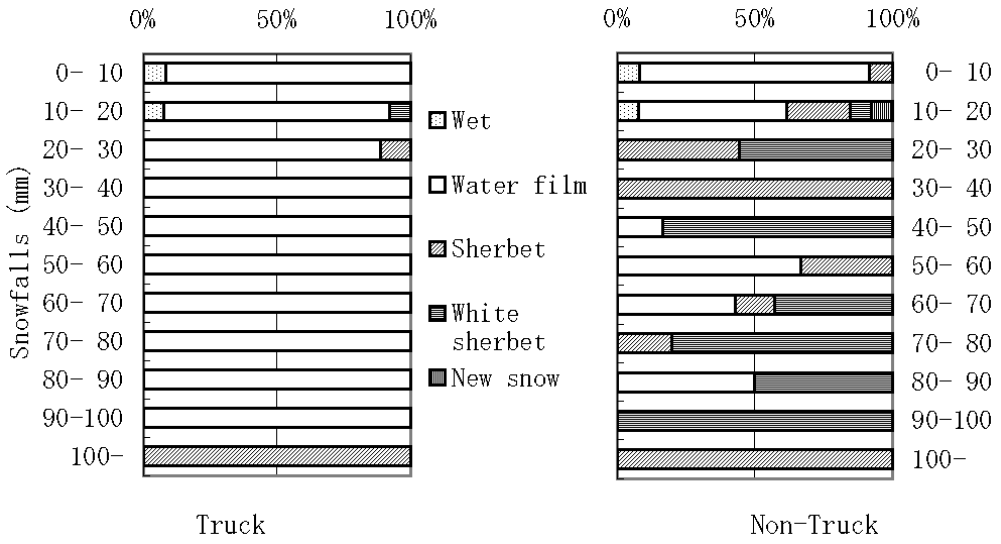


Fig. 9 Road surface snow cover situation by time snowfall intensity of watering

Since other snow and ice work is carried out in parallel, although it is not the effect of only watering melting snow, if snowfall exceeds 20mm/hr, snow cover will remain in a non-track, and if 100mm/hr is exceeded, also in a track, snow coverage can be referred to as remaining.

From this field survey, even if pavement differs from normal asphalt and porous asphalt, there is almost no difference in the road condition of a watering part and a non-watering part, and it can be said that snow melting with water sprinkling on porous asphalt pavement occurs the snow melting effect of the same grade as normal asphalt pavement.

6. Consideration

It is as follows when the examination result about each is summarized.

Indoor examination	In porous asphalt pavement, it can count upon a temperature rise enough.
Outdoor examination	Although the snowmelting effect is small compared with normal asphalt pavement, to melt snow is possible if snowfall is to 1cm/hr.
Examination construction	The snow melting effect of the same grade as normal asphalt was seen.

In snow melting with water sprinkling, the principles that melt snow differ by the conventional normal asphalt pavement and porous asphalt pavement. To the conventional normal asphalt pavement melting snowfall using the thermal energy and the flow velocity of water which watered the road surface, or passing, porous asphalt makes a heat source thermal energy which watering has, and has melted snow by warming pavement. Therefore, in porous asphalt pavement, it can consider that heat loss in the process decreases the snow melting effect by heat resistance which a pavement has. From this, it was expected by watering melting snow on porous asphalt pavement at the beginning compared with normal asphalt pavement that the effect becomes small.

By outdoors examination, although porous asphalt pavement had the snow melting effect smaller than normal asphalt pavement, by examination construction, the snow melting effect of hardly changing with normal asphalt pavement was acquired.

When the situation of watering melting snow in field was seen, it seems that the water, which assumed that the pavement inside of porous asphalt pavement flowed, was flowing the pavement surface in fact. This is considered to be the greatest factor that was effective also in porous asphalt pavement. As a cause by which water flows a pavement surface, snowfall or the melted snow is pressed fit in the crevice between pavement by the tire of run vehicles, and it is expected by it, whether the drainage function fell. It is a future subject to acquire these data from now on and to conduct further investigation.

This time, it was able to pass through an indoor examination, an outdoors examination, and examination construction, and the validity of snow melting with water sprinkling on porous asphalt pavement in the Hokuriku area was able to be shown. It is necessary to also repeat and verify acquisition of data etc. from now on.

Bibliography

1) Hironobu Kojima, Teruhiko Maruyama,1997 : Research about temperature fall control of the drainage nature pavement by groundwater、The Nagaoka University of Technology master paper