

SNOW REMOVAL DISPATCH AND LOW-SPEED LEADING SNOW REMOVAL ON EXPRESSWAYS IN THE HOKURIKU REGION

Hiroshi Nakao* and Muneyoshi Kiyosawa**

* Maintenance Planning Division

Hokuriku Branch, Japan Highway Public
Corporation

TEL: +81-25-243-4106/FAX: +81-25-243-4237

E-mail: Hiroshi_Nakao@gw.japan-highway.go.jp

** Civil Administration Division

QUEST ENGINEER Co., Ltd.

TEL:+81-25-287-5221

FAX:+81-25-287-5232

E-mail: m_kiyosawa@questeg.co.jp

1. Introduction

The Hokuriku Branch of the Japan Highway Public Corporation (JH) manages an extended total of approx. 680 km of five expressways including the Hokuriku expressway, which runs parallel to the Japan Sea coastline in the middle of Honshu, the main island in the Japanese archipelago, and the Kan-etsu, Ban-etsu, Tokai-Hokuriku, and Joshin-etsu expressways, which run across Honshu and are connected to the Hokuriku expressway. The area under the Branch's jurisdiction is characterized by meteorological conditions which are extremely harsh and highly variable. Cumulative annual snowfall ranges from over 20 m in the Yuzawa district, which lies in a zone that has some of the heaviest snowfall in the world, to only about 1 m in the Komatsu district. The Branch is in charge of removal of snow and ice from expressways in this area. For this purpose, a total of 48 snow/ice operation bases (at a rate of one for every one or two inter-interchange sections) have been set up under the jurisdiction of the Branch's eight operation offices, which is also in charge of a fleet of about 500 pieces of removal machinery, including about 200 snowplows. In this way, it works day and night to ensure the safety and soundness of the flow of traffic.

Even under this arrangement, however, the area sometimes receives snowfall in excess of its removal capacity. In such cases, it is not unusual for expressways to be closed to traffic over many sections and for long hours owing to the heavy snowfall and resulting traffic accidents. Given the importance of the role played by expressways, there is a vital need for improvement of removal capabilities in light of the immense impact of expressway closure on society as a whole.

In response, a manual was prepared for a setup that will offer the highest possible prevention of closure due to snowfall by improving removal capabilities in sections affected by snow emergencies (defined herein as weather conditions in which snowfall heavy enough to result in closure is anticipated). This is to be done by broadening the use of removal machinery including snowplows, which has thus far been confined to the operation office in question, to the interoffice level in the event of snow emergencies through provisions for its dispatch to support removal (i.e., Snow Removal Dispatch). The manual includes provisions for another system (Low-Speed-Leading Snow Removal) when closure could be expected in spite of Snow Removal Dispatch. Under these provisions, which are premised on assurance of a minimum-speed flow of traffic, snowplows would, while removing snow, lead a group of ordinary vehicles packed between them and the following warning vehicle.

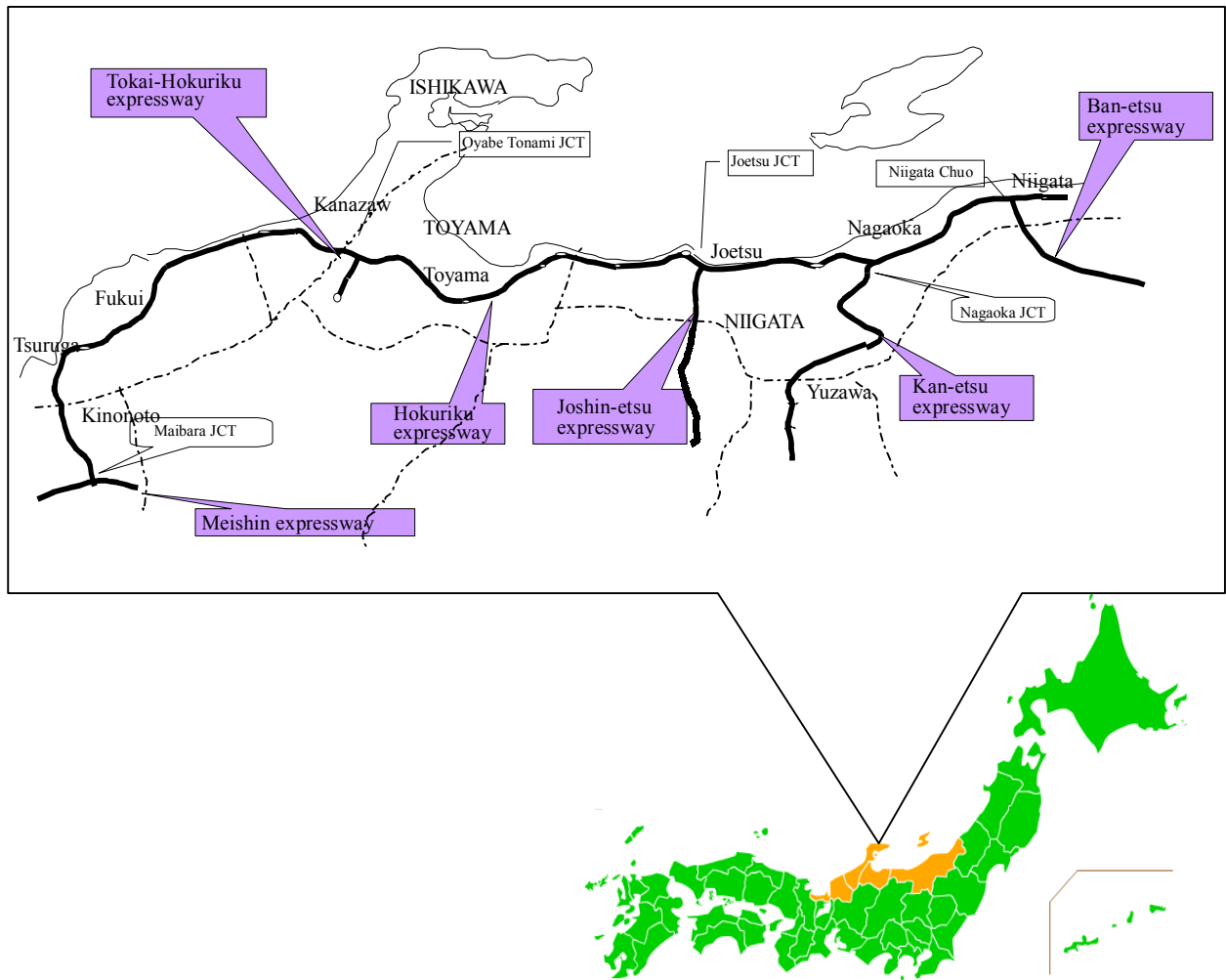


Figure 1 Map of the JH Hokuriku Branch Area

2. Measures at the JH Hokuriku Branch for Removal of Snow and Ice

Based on historical meteorological data, the Branch has made provisions for snow and ice control for a period of 152 days, from November 15 to April 15. Operation for removal work have been set up at a rate of one for every one or two inter-interchange sections, based roughly on the distance that can be covered in an hour. The 48 bases under the jurisdiction of 8 operation offices stand ready around the clock to initiate control measures.

There are two major types of control work: 1) removal of new snow by teams in order to keep road surfaces clean of snow and ice, and 2) work for prevention of surface freezing.

The basic work flow is as follows.

- 1) Start of preparations for control work when weather forecasts indicate conditions of substantial snowfall or freezing temperatures
- 2) Start of spreading anti-freezing agents and removal work as appropriate for the snowfall and temperature
- 3) In the event of heavy snowfall and very low temperatures: imposition of speed restriction and tire-chain requirements (in addition to snow removal work) to secure traffic flow
- 4) In the event of snowfall beyond removal capacity or occurrence of many accidents: closure of sections to traffic

3. Flow of Snow and Ice Countermeasures in the Event of Snow Emergencies

The term "snow emergency" is defined as meteorological conditions in which heavy snowfall that could force road closure is anticipated. The basic perspectives on the implementation of control countermeasures in such snow emergencies is as follows.

- 1) The decision on declaration of a snow emergency is based on meteorological forecast information. In the event of a decision in favor of declaring a snow emergency, the offices in question must work to make full use of their snowplows and bolster their capabilities for removal (by more frequent runs, for example).
- 2) If the office in question does not have enough snowplows, motor graders, etc, it makes a request for Snow Removal Dispatch to the Branch head office in order to bolster its removal capabilities. If the snowfall is extremely heavy and there is a risk of closure due to the worsening surface condition in spite of the dispatch, Low-Speed-Leading Snow Removal is executed to maintain the flow of traffic and avoid closure.
- 3) As the meteorological conditions improve, the offices make efforts for prompt recovery of the surface condition through removal operations while carrying out Low-Speed-Leading Snow Removal, and a transition is made to the ordinary control work when the weather forecast indicates the end of the emergency situation.

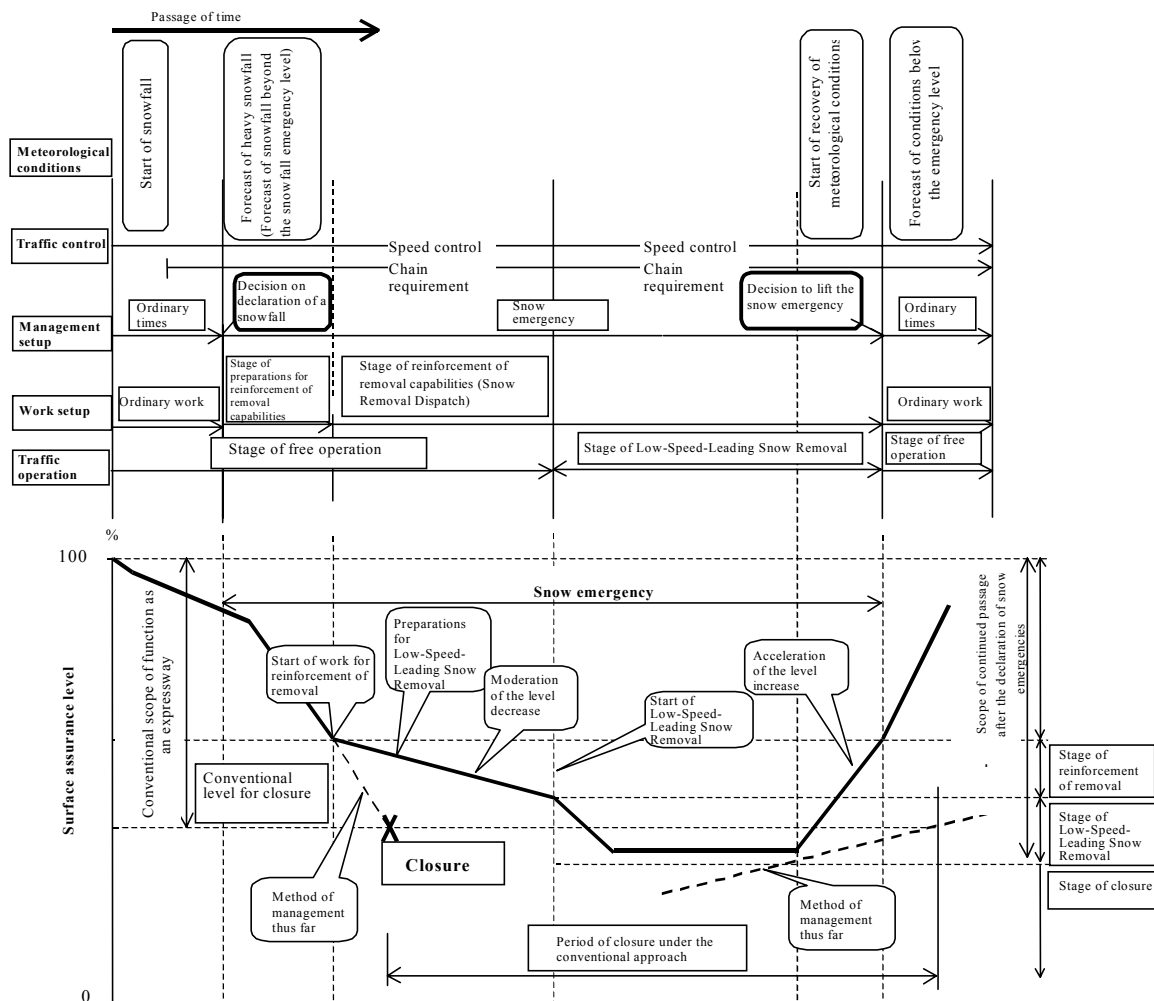


Figure 2 Flow of Snow and Ice Control in Snow Emergencies (in the case of Low-Speed-Leading Snow Removal as well as Snow Removal Dispatch)

4. Basic Judgmental Standards for Snow Emergencies

4-1 Snow Emergencies ~ Snow Removal Dispatch

This section describes the judgmental standards applied in decisions on matters such as the declaration of snow emergencies, request for Snow Removal Dispatch, provision of Snow Removal Dispatch, and priorities in the event of requesting for dispatch from more than one office.

(1) Decision on snow emergencies

In light of historical snowfall data and the mechanism culminating in closure, it was decided to apply the following criteria in decisions on whether or not to declare snow emergencies.

- 1) In many cases, snowfalls that cause long-term road closures begin about 24 hours earlier. Snowfall intensity begins to increase once the point of time 24 hours before the start of the closure has passed. As such, the forecast amount of snowfall over a 24-hour period was taken as one of the criteria for decision.
- 2) Snowfall in excess of removal capacity can worsen the surface condition and cause accidents that lead to long-hour closure. For this reason, the hourly amount of snowfall was also taken as a criterion. Because a heavy hourly snowfall rarely continues for many hours, the amount of snowfall forecast for the next three hours was taken as another judgmental criterion.

On this basis, standard levels for snow emergencies were established for each inter-interchange section. Table 1 shows the levels for two sections.

Table 1 Standard Levels for Declaration of Snow Emergencies

Expressway	Section	Forecast snowfall (cm)	
		24-hour snowfall	3-hour snowfall
Hokuriku expressway	Kinomoto IC ~ Niigata Airport IC	50~80 cm or more	15~25 cm or more
Kan-etsu expressway	Yuzawa IC ~ Nagaoka JCT	60~130 cm or more	20~30 cm or more

(2) Decision on request for Snow Removal Dispatch

Once snow emergencies are declared, the offices in question basically make a request for Snow Removal Dispatch to the head office. However, the office may not make such a request if it decides that it can cope with the emergency through mobilization of motor graders and other vehicles under its jurisdiction, reassignment of removal vehicles, etc. Essentially, the requisite number of vehicles is calculated from the forecast snowfall and the posting of removal machinery at the time. In addition, in machinery posting, priority is accorded to sections which past experience indicates are liable to become bottlenecks.

(3) Decision on provision of Snow Removal Dispatch

The following basic perspectives were applied in decisions on whether or not to dispatch vehicles from the office in question in response to requests forwarded from the head office.

- 1) Normally three snowplows are allocated to each snow removal team. It was judged that dispatch teams could be formed by taking one vehicle from each team.
- 2) As a result, each remaining team would consist of only two trucks. This would result in a decrease in the frequency of removal in order to widen shoulders so as not to reduce in the capacity for removal on lanes. As such, a calculation is made of the three-hour forecast snowfall amount permitting dispatch from the capacity for shoulder-widening removal.

3) The amount of snowfall forecast over the next 24 hours is obtained from the correlation with the three-hour forecast.

On this basis, standard levels are set for each inter-interchange section. Table 2 shows the levels for two sections.

Table 2 Snowfall Forecast Levels Permitting Snow Removal Dispatch

Expressway	Operation office	Forecast snowfall (cm)	
		24-hour amount	3-hour amount
Hokuriku expressway	Tsuruga - Niigata	Not more than 20 cm	Not more than 5~10 cm
Kan-etsu expressway	Yuzawa	Not more than 20 cm	Not more than 10 cm

(4) Order of priority in destinations for Snow Removal Dispatch

When a request for Snow Removal Dispatch is received from more than one office and there are not enough vehicles in response to all of them, dispatch is made in order of destination priority (A → C).

The order of priority was determined with overall consideration of the following factors.

- Stretches which have frequently been closed in the past
- Volume of traffic during winter
- Road conditions as regards alternative routes, etc.

Table 3 Ranks of Stretches as Regards Priority in Snow Removal Dispatch

Rank	Expressway	Offices	Sections		
A	Hokuriku, Kan-etsu	Tsuruga	Kinomoto	~	Tsuruga
			Tsuruga	~	Imajo
		Kanazawa	Kanazawa-Higashi	~	Oyabe
		Yuzawa	Minakami	~	Tanikawadake
			Tsuchidaru	~	Yuzawa
B	Sections other than those in ranks A and C				
C	Tokai-Hokuriku	Toyama	Fukumitsu	~	Oyabe-Tonami

4-2 Low-Speed-Leading Snow Removal

When special speed limitation is set during winter season, the expressway speed limit is 50 km/h. Low-Speed-Leading Snow Removal is carried out when it is anticipated to be difficult to assure the flow of traffic even with the aforementioned measures to reinforce capabilities. Between the snowplows and following warning vehicle is a pack of from about 250 to 300 ordinary vehicles, traveling at speeds in the range of 20~30 km/h. The aim is simultaneous removal of snow and assurance of the flow of traffic (i.e., avoidance of closure).

Figure 3 shows a standard placement of vehicles for Low-Speed-Leading Snow Removal.

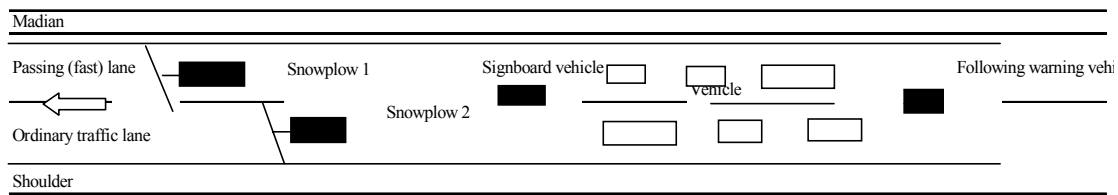


Figure 3 Placement of Vehicles for Low-Speed-Leading Snow Removal (Standard)

Study taking account of structural constraints identified the following two sections as enabling execution of Low-Speed-Leading Snow Removal at present.

- Under the jurisdiction of the Tsuruga office: Kinomoto IC ~ Imajo IC (Nanjo SA)
- Under the jurisdiction of the Kanazawa office: Kanazawa-Higashi IC (Morimoto base) - Oyabe IC (Oyabe SA)

5. Snow Removal Dispatch - Case Study and Practice

To investigate the effectiveness of the manual for operations in snow emergencies, a study was made on the frequency and possibilities of Snow Removal Dispatch by reproducing past meteorological conditions.

5-1 Snowfall Patterns in the Hokuriku Region and Possibilities of Snow Removal Dispatch

In Snow Removal Dispatch, snowplows are basically dispatched from districts for which relatively little snowfall forecasted to those expecting heavy snowfall. For this reason, a study was made on snowfall patterns in the Hokuriku area. This study identified the following three patterns, which derive from the typical distribution of low-pressure systems in the area.

- 1) Pattern A : Mountain side
 - Trend toward heavy snowfall along the foot of and in mountains, and light snowfall in the plains (common to the district where the Ban-etsu expressway runs through under the jurisdiction of the Yuzawa and Niigata offices)
- 2) Pattern B : Plain region
 - Trend toward heavy snowfall in coastal areas and plains, and light snowfall in the mountains (common in many districts on the Hokuriku expressway)
- 3) Pattern C : Hybrid type
 - A hybrid of the mountain and plain types (most common type throughout the area under Branch jurisdiction)

In this mix of patterns, there are possibilities for Snow Removal Dispatch between the mountain and plain types. This raises the prospect of dispatch between sections of the Kan-etsu and Ban-etsu expressways, which traverse mountainous areas, and sections of the Hokuriku expressway, which traverses mainly plain areas. Conversely, there is little possibility for Snow Removal Dispatch between sections of the Hokuriku expressway. Nevertheless, even in the plain area, there have been occurrences of heavy snowfall in Niigata prefecture and light snowfall in the neighboring Ishikawa prefecture. It was consequently decided to make a further study of snowfall patterns appearing in past data.

A study took up 42 cases of heavy snowfall over a recent five-year period (1994 ~ 1998). The snowfall patterns appearing in the data are shown below. From this study, it was assumed that there would be possibilities for Snow Removal Dispatch even between sections of the Hokuriku expressway

in the event of heavy snowfall in a single prefectural area, for example.

- 1) Heavy snowfall in the entire area under Branch jurisdiction: seven cases (17%); little possibility of dispatch
- 2) Heavy snowfall in eastern Ishikawa prefecture and all of Niigata prefecture: nine cases (21%); some possibility of dispatch
- 3) Localized snowfall (heavy snowfall in a single prefecture): 26 cases (62%); some possibility of dispatch

A simulation was made to find out the possibilities of dispatch in these cases under the rules described in this study. This simulation found that dispatch would have been possible for 13 of the cases over the five-year period in question, for an average of two to three per year. The study also found that there would have been enough temporal margin for the Snow Removal Dispatch in these cases, and proved that the proposed scheme is realistic.

5-2 Results

Snow emergencies occurred three times during three winters from 1999, when the manual for operations in snow emergencies began to be applied, to 2001 as shown in Table 4.

Table 4 Snow Emergencies Cases

Date	Office	Section	24-hour forecast snowfall (cm)	Response	Result
Feb. 15, 2000	Fukui	Takefu ~ Maruoka	50 (50)	Dispatch of one team from the Etchu-sakai base	No disruption of the flow of traffic because the actual snowfall (17 cm) was lower than forecast
Jan. 13, 2001	Joetsu	Nakago ~ Shinano-machi	110 (80)	No dispatch because there was no office forecasted to receive snowfall below the level permitting dispatch	No disruption of the flow of traffic because the actual snowfall (58 cm) was lower than forecast
Jan. 14, 2001	Fukui	Tsuruga ~ Takefu	64 (60)	No dispatch because there was no office forecasted to receive snowfall below the level permitting dispatch	Long-term closure due to continued snowfall (although the actual snowfall (50 cm) was lower than forecast)

In each case, the difference between the forecast and actual snowfalls prevented the situation from reaching one of functional avoidance of abnormally heavy snowfall. This result underscored the needs for an improvement of forecasting accuracy.

6. Conclusion

Conventionally, on routes with a comparatively low traffic volume, have emphasized and road closures in heavy snowfall were regarded as unavoidable. Recently, however, assurance of passability under extreme meteorological conditions is considered as an integral part of the mission of expressways. Organic mobilization of removal machinery for Snow Removal Dispatch and Low-Speed-Leading Snow Removal entails a considerable cost but also serve for smooth traffic flow. The related effects, which include not only the direct one of preventing reduced toll revenue but also the indirect one of preventing the interruption of socioeconomic activities, suggest that the benefit is fully commensurate with the cost. In addition, assurance of transport especially under bad weather conditions is one of the advanced services of expressways. Through this effort, expressways could obtain the trust of expressway users. Moreover it works to solidify status of expressways as infrastructural elements that are indispensable to the areas they serve.