Feasibility study of an automatic system of spreading of sodium chloride brine in the North of France

Luc Duriez
CETE North-Picardie, in charge of studies winter viability, France
Luc.duriez@developpement-durable.gouv.fr

SUMMARY

A feasibility study of automatic spreading of sodium chloride brine was carried out in 2008 by Interdépartementale Management of the Roads of the North of France which manages the winter exploitation of part of the French road network, more than 1100 kilometers of network of first level.
It aims at the automatic intervention of release of sodium chloride brine spreading on a bidirectional slope a 1000 meters length having a declivity of 8% and one specific way dedicated to the heavy lorries in the direction of the rise.
This slope is located at 35 kilometers on both sides of two maintenance centers and is in consequence at the end of the processing winter circuit. The intervention of winter service is thus carried out on this slope one hour after the starting of the treatments on the circuit.
The ways being separated from a broad wooded area, it easily allows the installation of a system of command of spreading on the high end of the site.
Several choices are binding to the building owner which must decide to treat either only the way dedicated to the heavy lorries, or to treat the bidirectional way, or to treat the whole of the ways.

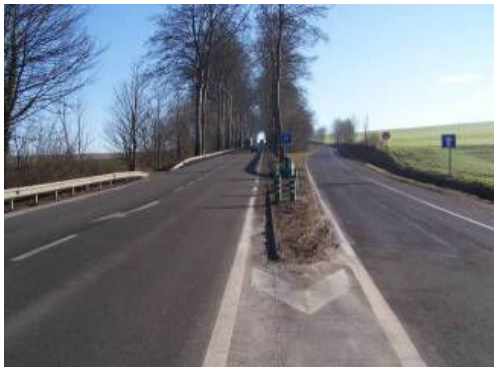
Key Words

SPREADING/BRINE/SODIUM/

1. INTRODUCTION

Interdepartementale Management of the Roads of North of France (Northern DIR) exploits and maintains more than 1100 kilometers of roads and motorways of first level.
Located in the north of France, it profits in winter from a wet oceanic climate in north and the west from its territory, and of an oceanic climate with continental nuance in the south and east.
Based on a non-mountainous but undulating territory intersected with plains, the varied climate offers in winter some snow-covered precipitations, but the Northern DIR (interdepartemental road direction) is mainly confronted with the various formations of ice.
The commune of Doullens which is located in the valley of Authie, is with approximately 35 kilometers on both sides significant cities of Amiens and Arras.
Established on a route which connects these two cities, it has at its end a slope of 1000 meters having a declivity of 8 %.
This bidirectional slope is doubled on its end of right-hand side of a specific way heavy lorries, in the direction of the rise [photography 1].
The daily traffic is 7215 vehicles/day for the 2 directions with a traffic heavy lorries of 18% is approximately 1300 heavy lorries per day.

A wooded space and a broad ditch separate the bidirectional way and the way heavy lorries.
The section is bordered of large trees on both sides of the ways.
The services of maintenance and interventions of the Northern DIR which intervenes on the route find with more than 35 kilometers. This section is at the end of the circuit of interventions of winter maintenance and has a high level of service.
The slope of Doullens is thus treated approximately 1 hour after the starting of the processing circuits of the center of interventions.
There is not automatic collection of weather-road information in this sector. The closest weather-road stations are at approximately 60 kilometers.
In order to ensure a better safety and to offer an equivalent level of service on the whole of the roads of the Northern DIR to the road users, an automatic equipment for a sodium chloride brine spreading was carried out.

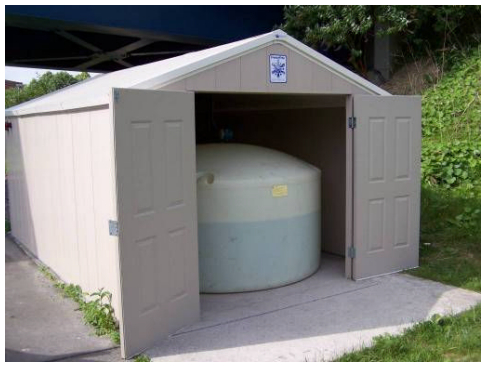


« photography 1 - Sight of the ways of the low point with vegetation and ditch separating the ways »

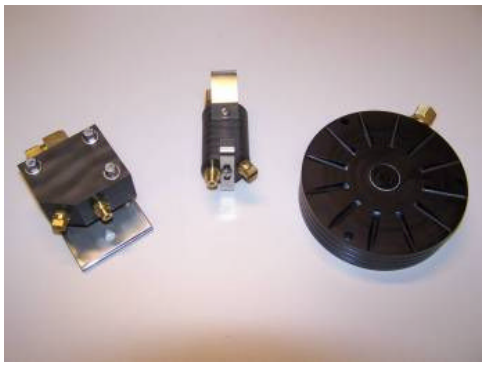
2. DESCRIPTION AND OBJECTIVES OF THE AUTOMATIC SYSTEM OF BRINE SPREADING

The automatic brine spreading is a system of ejection of de-icer or anti-icer liquid and water under pressure.
It allows the fast spreading of de-icer or anti-icer liquid on the totality of the roadway or in a partial way, and keep residual salinity of the roadway so necessary.
Spreading is easy to realize and is carried out either in an automatic way or in a manual on the spot or remote way.
The system does not replace the means of traditional snow clearance (snow removing with a blade) in the case significant thickness of snow. Once engaged, the system avoids not-precipitating ice formation and allows the traffic in the case of low thickness snowfalls.
It is made up mainly of storage units of brine, cupboard flushing water of command, a weather-road station, of piping, electromagnetic sluice gates, accumulators of pressure and jets. The whole of the storage units, the cupboard of command and the weather-road station requires a solid stabilized adjustment of the type paves concrete and can be protected in a room or a latticed surface [photography 2 and 3].
The brine under constant pressure is released by the electromagnetic sluice gates either in a way manual (on the spot or remote) or in an automatic way according to the road weather parameters collected by the road-weather station.
The spraying is carried out either using plates made up of tubes of ejection sealed in the bituminous mix, or by heads of spraying posed on supports or crash barriers, or by micro

tubes of spraying which pulverize the brine and which are sealed in the bituminous mix in axis of roadway [photography 4].



« photography 2 and 3 - Example of installation of spreading »



« photography 4 - Example of tubes and plates of ejection »

The spreading of the brine can be carried out on one or more ways following of the cycles of ejection and preset quantity of brine. When a cycle of spraying is carried out each jet opens with the continuation one of the other and the operation starts again so that the complete cycle includes at least two sprayings.
The number of electromagnetic sluice gates, of heads of spraying and jets is variable according to the type of installation and surface to be treated [notice board 1].
Currently two companies one from Switzerland and one from American installed in France the three systems of spreading.
These systems of spreading all are established on motorways.

	System by plates	**System per capita**	**System of pulverization**
A number of jets per jet	7	5	2
Outdistance between jets	20 meters	12 to 15 meters	5 meters
A number of treated ways	2 and more	2	2
Consumption by jet and spreading	2,5 liters	2,5 liters	1,2 to 2 liters
Type of spreading	Type of spreading 20 to 30 centimetres above ground-level		Shaving fine jets
Time of spreading	Variable 3 seconds at 3 minutes		

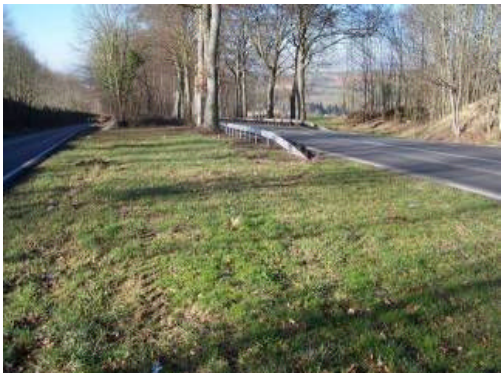
“notice board 1”

3. FEASIBILITY ON THE SITE OF DOULLENS

The length to be treated is approximately 1000 meters.
The realization of a system of brine spreading can be carried out on the whole of the ways or the way heavy lorries or the bidirectional way.
An automated system is preferable because of a share of the distance of the site from maintenance centers of and intervention and in addition to the absence of close weather-road stations.

3.1 - localization of the installation

Contrary to space available to the lowest point, broad space between the ways located in high end of the slope allows the installation of a spreading platform (concrete flagstone) and the adjustment of an access of service to carry out the provisioning of the brine and the maintenance of the site. This brine can be manufactured in a maintenance and intervention center having a manufacturing unit of brine.
This space [photography 5] being at the highest point of the slope is most favorable because it will make it possible the vehicle to be able to carry out all the necessary operations in full safety, on the other hand an arrival of electrical current as well as a telephone line coming from the low point, meadows of the entry of the agglomeration, will be necessary for the operation of the system and the transmission of the data towards the management computer.
The adjustment of space can be the specific market object for realization of roadway.



« photography 5 - Platform suitable »

3.2 - system per capita of spraying on crash barriers

This system allows the diffusion of the brine on several ways.
The heads of spraying are fixed on the amounts of crash barriers and the drain is located behind the section of the slide.
A head of spraying and its electromagnetic sluice gate are located approximately all the 12 to 15 meters. An accumulator of pressure is necessary for 2 or 4 heads maximum.
Of course, for this type of system one needs a support which can be either a metal slide, or a reinforced concrete slide.
This process has the advantage of allowing a maintenance and an easy maintenance of by manager.
It has as a disadvantage of having to lay out over the entire length to treat slides or other supports. Thus on the slope of Doullens, it is necessary to add slides and to prolong the existing slides.
These slides also allow the protection of the electromagnetic sluice gates and associated accumulators of pressure.

3.3 - system of spreading per plate

On the principle, this system does not require the installation of crash barriers.
However the electromagnetic sluice gates and accumulators of pressure must be able to be protected. They can either be laid out behind the crash barriers, or buried in a box.
On average a plate is needed every 20 meters. An electromagnetic sluice gate is associated each plate. The accumulators of pressure correspond to two or four plates maximum.
The advantage of this system allows the brine sending at longer distances and surfaces, and can be on the sides of the roadway or in axis of this one.
The disadvantage is that it is necessary to carry out bleedings and to carry out sealings. The raising of the plates also poses a problem during the renewal of the wearing course. The maintenance of the plates is more difficult to realize because that requires a significant indication and the closing of a way.
In other, this system is more expensive because of the plates and it requires more electromagnetic sluice gates and accumulators of pressure.

3.4 - micro ejection system:

This system allows the pulverization of the brine in axis of roadway.
The spreading of the brine is carried out in a more discrete way, and it is possible to vary spreading more.
The advantage of this system allows the reduction of the electromagnetic sluice gates and accumulators of pressure. One needs an electromagnetic sluice gate for 100 meters of brine pulverization. The jets are laid out every 5 meters and are assembled in series in factory by 100 meters length. The road users are less disturbed by this system than by that of more significant ejection.
The disadvantages are as for the system by plate, it are necessary to carry out bleedings and sealings in the roadway, to raise the heads of spraying during the renewal of the wearing course, and require the closing of a way for the maintenance and the maintenance of the jets.

3.5 - synthesis of the various systems of ejection of the brine [notice board 2]

System of spraying	Advantages	Disadvantages
Heads of spraying on slides	maintenance and easy maintenance	- poses slides - 1 electromagnetic sluice gate and 1 accumulator of pressure for 2 or 4 heads
By plates	brine ejection on great surfaces	- sawing and sealing fitted - maintenance and maintenance by closing of way - more significant cost - 1 electromagnetic sluice gate and 1 accumulator of pressure for 2 or 4 plates - raising of the plates during the renewal of the wearing course
Micro ejection	more discrete ejection of the brine a number of limited electromagnetic sluice gates	- sawing and sealing fitted - maintenance and maintenance by closing of way - raising of the heads of spraying during the renewal of the wearing course

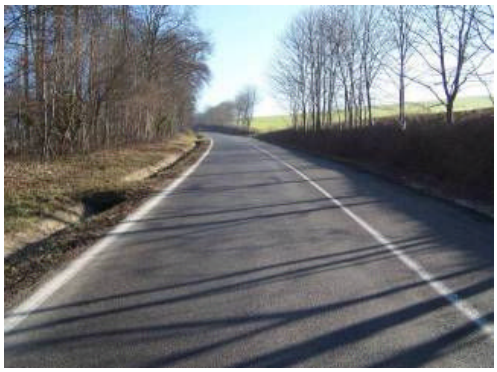
« notice board 2 »

3.6 - supply brine

The provisioning of the brine and the flushing water can be carried out by a center of maintenance and interventions which manufactures sodium chloride brine. This brine can be used because the temperatures in the area of the north of France are not extremely low.
This provisioning can be carried out using a cistern is to be envisaged at the market or quite simply to use an existing cistern.
The brine is supplied approximately two to three times per winter season according to the of the winter hardness.

3.7 - a number of ways to be treated

The total number of the ways being able to be treated is of 2 ways on the bidirectional section and of one way on the section heavy lorry sees.
According to the defined objectives, it is necessary to choose if spreading must be carried out on the whole of the ways or only on the way heavy lorry [photography 6] or the bidirectional roadway.



« photography 6 - Single track Heavy lorries feel gone up »

4. FINANCIAL ESTIMATE

The realization [notice board 3] of work of the automatic system of brine spreading can break up into several parts:
- the installation for operations surface of provisioning and flagstone concrete for storage of brine and water, cupboard of command and weather-road station.
- installation of crash barriers and barriers of closing of the surface to the vehicles.
- powerlines and telephone.
- the installation of the automatic system of brine spreading.

The coarse estimates of the various parts correspond to:
- the installation of the surface: 13 000 €/including all taxes
- installation of slides (1000m) and barriers: 30 000 €/including all taxes
- powerlines and telephone (1000m): 42 000 €/including all taxes
- the automatic system of spreading (2 ways bidirectionnelles+ 1 way PL)
: 550 000 €/including all taxes
- the automatic system of spreading (1 way bidirectional PL or 2 ways)
: 420 000 €/including all taxes

	1 way heavy lorry	2 bidirectional ways	1 way heavy lorry + 2 bidirectional ways
Installation of the surface	13 000 €	13 000 €	13 000 €
Pose slides and barriers	30 000 €	30 000 €	60 000 €
Powerlines and telephone	42 000 €	42 000 €	42 000 €
Automatic system of spreading	420 000 €	420 000 €	550 000 €
Total	**505 000 €**	**505 000 €**	**665 000 €**

« notice board 3 »

5. CONCLUSION

The owner must choice to treat the whole of the lanes or only the lane affected for the lorries. The overcost for the treatment of the whole of the lanes represents an increase of 32%.
The objective is to treat this slope as soon as possible in order to ensure a better safety of the road users, It is not possible to choose only one type of road user. and by consequence the treatment of the whole of the lanes proves to be necessary.

The automatic system of brine spreading must be perceived like an objective of safety for the user and comfort in organization.

Profitability cannot be calculated compared with less equipment or organisational modification. One will always need manpower and equipment to avoid the failure of an automated system, more especially as it is integrated in a network maintained and exploited by the man.
The taking into account by the company of an annual preventive maintenance including the setting in safety at the end of the winter and the starting at the beginning of winter is of primary importance if one wishes to keep the installation in good condition .

REFERENCES

[photography 1 to 6] Photography Luc DURIEZ