

DIFFERENTIATED WINTER SERVICE IN CITIES

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1. Introduction

The law stipulates that the public road construction departments are responsible for the winter service in Germany, according to which the snow will have to be removed from all public roads, roadways, pathways and squares, while important traffic areas and danger spots will have to be gritted.

The relevant local authorities are in charge of these duties, while specific laws are concerned with individual types of roads and differentiate between them: the Federal Long-Distance Road Act applies to the federal superhighways and highways, the roadway and pathway laws of the individual federal states apply to the state roads and additional regulations and bylaws apply to the community roads.

The overall objective of all these regulations and of the relevant winter service is to ensure that the traffic is sufficiently safe in snowy and icy conditions. This means that a good trafficability of the roads and a possibly slightly reduced traffic frequency must be ensured. The actual requirements will vary and depend on the type and significance of the road as well as on the traffic frequency.

Previous talks have already focused on the special aspects concerning the country roads and the winter service outside the municipalities, so that this talk will specifically deal with the winter service in larger cities.

2. General requirements concerning the winter service in cities

In accordance with the above statutory regulations, the winter service would normally only be required to clear the roads from excessive quantities of snow and to grit danger spots.

However, jurisdiction constantly re-defines and updates the duties of the winter service. An example of this development are court decisions in which the operating time, the beginning and the duration of the snow clearing operations, the type of gritting material etc. are fixed in great detail.

In addition to clearing the roadways, the snow must also be removed from the sidewalks and cycle paths in the cities, while pedestrian crossings, bus and tram stops, traffic islands, stair cases and other danger spots require particular attention.

While it initially sufficed to clear the roads from snow and to grit the main roads and danger spots, the gritting service had to be expanded and improved in line with a drastically increasing motorization. While sand or grit have been the traditional skid-proofing materials for a long time, the introduction of de-icing salt has resulted in a considerable improvement for the road-users. As a consequence of an initial euphoria too much salt was applied to far too many roads and the detrimental effects it had on the vegetation, buildings and vehicles became quickly obvious.

The application of de-icing salt has been considerably improved by further developments in the vehicle and equipment technology during the following years. By introducing wet salt, the material could be spread in fine doses as well as depending on the road type and width. It was thus possible to achieve an optimal effect with a minimum of salt quantities. The quality of snow removal could be further enhanced by upgrading the equipment. The often massive criticism voiced by the general public and the rather controversial discussions about the winter service have now been more or less silenced.

A sub-division of the roads into three performance classes as regards the winter service has proved to be most expedient in the meantime:

1. Salt spreading routes - black road surfaces by using de-icing agents,
2. Gritting routes - gray road surfaces by spreading skid-proof materials,
3. Snow-cleared routes - white road surfaces because they will not be gritted, with only the snow being removed.

This differentiation means that the standard strategies can no longer be applied to all roads and during all weather conditions. The use of gritting material rather depends on the significance of the road concerned, its routing and the concrete operating conditions applying. The objective is to restrict the use of de-icing substances to the necessary minimum and to use skid-proofing materials wherever the requirements of traffic safety and of the traffic flow are lower. gritting ought to be avoided at all, where the traffic situation allows for it.

This strategy, called "differentiated winter service", was described in detail in a code of practice issued by the "Research Society for Road Traffic and Management" in 1985 and has been widely applied in many cities and communities since.

3. Increasing requirements caused by the changes during recent years

But even this winter service strategy, which may be called traditional, does not meet the expectations of the road users, citizens and tax-payers any longer. The winter service is now expected to provide such a wide scope of services in the cities which is far beyond the statutory duties but comes close to the individual expectations of the citizens. The demands made on road safety and environmental protection have also increased considerably. The trafficability of the roads is not supposed to be restricted a great deal during wintry conditions. And last but not least, the winter service is expected to operate as economically as possible.

The implementation of all these far-reaching requirements will quickly lead to personal and financial dimensions which exceed the budget of the community. Their room for maneuvering is rather limited, especially in times of scarce public funding. This, in turn, makes it necessary to restrict everything to what is absolutely necessary, especially since everybody complains about the high costs for the winter service and demands that savings are made. However, the options to make such savings are limited if one takes into consideration that the number of motor vehicles registered in Germany has doubled during the last 20 years. Take Munich as an example, where some 800 000 vehicles are registered in a city with 1 200 000 inhabitants. The mobility of the citizens has also increased considerably. In addition, it has been observed for some years now that considerably more people use their bicycles in the cities also during the winter. Consequently, the citizens and the business world expect a fully functioning road network available in a large city to which they are accustomed during the rest of the year. A well functioning, effective and speedy winter service is therefore of the essence.

It therefore became necessary to critically review the winter service in the way it has been organized and operated until now. The improvements looked for were to make it possible to respond quickly, flexibly and efficiently to the relevant weather conditions, for which a considerable amount of research work was necessary. The technical developments in several sectors of the winter service had to be further advanced.

After new research results have been received and the development of vehicles and equipment has been completed, new recommendations for developing a differentiated winter service were published in a code of practice issued by the "Research Society for Road Traffic and Management" (FGSV) at the end of 1997. Fortunately, a large part of the recommendations have already been tested and implemented in practice.

4. New scientific findings for the winter service in Germany and Switzerland

In recent years, a number of investigations have analyzed the following subjects:

- The winter service on cycle paths
- The winter service on pedestrian crossings
- A definition of the winter service
- Quality requirements as regards the gritting material
- The influence of de-icing salt on the ground water
- The application of skip-proofing materials by the winter service
- Salt spreading or gritting in winter? An optimizing the cost-benefit-ratio by taking into consideration environmental and safety-relevant factors
- The emphasis on the mechanical snow removal
- The road and weather information system in the municipal winter service
- Skid reporting systems
- Optimizing the doses of spreading materials and the spreading process

Further subjects are still being processed or will be updated shortly, such as

- The information of road user about the road conditions in winter
- The storage and treatment of gritting materials
- Information about and training for the winter service

A presentation of all individual research results would exceed the scope of this paper. The most important items necessary to optimize the winter service in the cities have therefore been summarized below.

4.1 Improving the observation of the road and weather conditions

Having knowledge of the expected weather conditions as early as possible is a vital factor when it comes to providing an environmentally-friendly, economical and effective winter service. The close co-operation with the meteorological service is therefore of the essence. General weather forecasts can satisfy the specific requirements of the winter service providers only to a limited extent. Interconnected measuring points for obtaining data about the road and environmental conditions have therefore been installed along the trunk roads and the measuring results obtained from there are made available to the German Meteorological Service. The road condition and weather information system (SWIS) which is fed with these data is in a position to generate road condition and weather forecasts for separate areas at different times which, in turn, helps the local winter service managers in their decisions-taking process.

Big cities with larger differences in the elevation, with an extensive road network that covers a large area or with meteorological peculiarities should set up their own meteorological stations and skid warning systems, in order to complement these forecasts. This provides further and complementing short-term and trend forecasts about individual road network sections to the highway maintenance depots and building yards as well as accurate records for the weather and road conditions in these sections, which need to be documented for later assessments and for the records.

Giving all that, the winter service can be organized well in time and with an economically justifiable effort, so that icy conditions can be avoided or their effects on the traffic at least be minimized.

In the case of large road networks it is also recommended to use one or several meteorological centers for establishing a competent surveillance system for the road and weather conditions. These centers are supposed to organize and control the winter service operations in an optimal way, help saving costs and improve the quality of the operations. As they are staffed with highly qualified and competent personnel the centers can be equipped with the most sophisticated technology, such as precipitation radar screens, satellite weather maps, data lines to meteorological stations and to skid warning systems in neighboring surveillance areas as well as with the devices for the communication with the local heads of operation, with the operating forces, with the road clearance and gritting vehicles, with the police, with the meteorologists etc.

4.2 Emphasis on the mechanical snow removal

So far, hardly any scientific facts have been known about the quality of the mechanical snow removal. This is why the Technical University of Darmstadt has carried out measurements and made analyses in this respect as part of a research project assigned to it by the Federal Ministry of Transport. The quality of the snow removal operations has been compared in field tests with different clearance systems under constant operational conditions. After the snow removal operation was completed, the remaining snow quantity has been measured with a gauge on three different cross-sections determined within the standard test fields and the skid-proofness of the road surface was also established.

It has been found that the modern-type snow ploughs are not only the ones most widely used but also the most effective ones. The best results have been achieved with this type of snow plough when medium-sized and large quantities of snow had fallen or when the snow had already become hard. However, a combination of snow ploughs and sweeping attachments (the latter either directly behind the snow plough or between the axles of the tractive unit) can further reduce the remaining quantities of snow to a considerable extent. The skid-proofness of the road surfaces was also clearly better after the treatment with a snow plough in combination with a sweeping attachment. This leads to a better road safety and probably to a lower salt consumption.

The employment of such kind of combination is only useful on routes which are to be prepared for spreading salt and especially in cities located at a medium altitude, where predominantly wet snow falls and where the layers of fresh snow are low. Please note that operations might take longer than with snow ploughs alone.

At higher altitudes, aggressive snow removal operations with special blades still prove to be most expedient. The guiding principle for any snow removal operation must be to clear as much snow from the road surface, in order to do with a minimum of gritting material during the subsequent gritting operation.

More knowledge must be gained in practice, whether the above combination of a snow plough with a sweeping attachment, which has also been offered for narrow-gauge vehicles in the meantime, will meet the high expectations placed in them on cycle paths and in pedestrian zones and whether they can repeat the good results under the confined conditions there.

4.3 Application of wet de-icing salt with a high thawing effect

As gritting is mandatory on important and dangerous road sections, the winter service must prepare a detailed gritting schedule for each municipality in which the gritting materials used in each location need to be determined. For reasons of traffic safety, only high-quality de-icing substances should be used on roadways. As there are undoubtedly quality differences between the commercially available types of salt, and as the market offers a wide variety of products, some of them frequently recommended as "all-purpose agents", it is necessary to set certain criteria for the gritting material. The expert committee of the "Research Society for Road Traffic and Management" (FGSV) has drawn up a Technical Delivery Standard for Gritting Materials ("TL Streu") for this purpose, which is currently undergoing the notification procedure of the European Union and is expected to be

introduced shortly. Apart from skid-proofing agents, the standard also lists de-icing substances and the quality requirements applying to them. This includes the additions to the deicing salt, its chemical composition, the proportion of de-icing substances, the permitted sulfate content, the grain size and the particle-size distribution curve, the permitted proportion of fine and coarse grains, the heavy metal content etc. The details must be provided by the manufacturer in a product description together with the offer. The Technical Delivery Standard does not, however, specify the de-icing effect as such, since the fairly expressive test procedure which is commonly applied in Germany cannot be reproduced in other places so that it cannot be used as a means of specification. However, bidders making offers with new or unknown products should generally be asked to furnish proof of the de-icing capacity. The de-icing capacity is of considerable significance to the user, since a number of influential factors have a great effect on the salt quantity required and eventually on the cost-effectiveness of the winter service as a whole.

The distribution technique of the de-icing salt has a great effect on the consumption as well. Analyses made with wet salt have shown that the effect has been improved although the quantities used were lower than those of dry salt. Losses of salt caused by snowdrifts have been avoided and wetting the salt itself triggers off the de-icing process much faster. In general, the wet salt technique FS 30 is used, which means that the proportion of the saline solution amounts to 30 weight per cents of the dry material (salt) placed on the distributing plate and discharged from there.

Spraying or gritting vehicles of the latest generation can distribute the de-icing salt in precise doses, in accordance with the road conditions and width as well as with an equal distributing pattern. Older vehicles should therefore not be employed any more for these operations. The quantities distributed or to be distributed can be adjusted to the individual requirements, which helps to save salt while the effect is maintained. A prerequisite for precise operations of that kind is that the head of operations and the operators themselves have a profound knowledge of the routes to be de-iced and can assess the weather situation, the road conditions and the required quantities correctly. Measuring instruments for the surface temperature installed on the vehicles, thermal maps for the entire area of operations and the intensive training of the staff will bring further improvements.

If all these prerequisites have been created and the weather forecast is good, the preventive distribution of de-icing salt in good weather conditions may also help to minimize the salt consumption. The early operations of the winter service prevents a hardening of the snow on the roadways and the formation of crusts in the ice.

4.4 No gritting on roadways at all

The effects of different gritting materials on the flow of traffic and the road safety have been analyzed in-depth by the Technical University of Darmstadt for the first time ever. Subsequently, recommendations for the use of gritting materials during the operations in practice have been derived from this analysis. It has shown that the winter service cannot do without the de-icing salt on important and dangerous road sections and that the salt is the most economical de-icing material as regards the material costs and the cost of spreading.

Contrary to that, the effects of gritting on the traffic conditions are negligible, since the frictional connection between the vehicle's tires and the road pavement improves only slightly. Re-gritting ever so often and at short intervals becomes necessary as only a few hundred vehicles can throw the grit completely off the road lanes and render it ineffective. The problem is that car drivers are let to assume that the gritting has improved the frictional connection and do not adjust their speed to the actual road conditions. Hence, the accident figures rise again, namely in line with the increasing time distance to the most recent gritting operation.

The gritting operations thus incur considerably higher costs due to the higher grit quantities and the

more frequent gritting operations required, but also later on when the grit has to be removed from the road and disposed or reprocessed. A comparison of the gritting operations on the same routes and based on the same standards has established that gritting is about 5-10 times more expensive than spreading de-icing salt.

An investigation commissioned by the Swiss Federal Office for Road Construction has analyzed the cost/benefit ratios of using de-icing salt and grit for the winter service by taking into account the relevant environmental and safety factors. When comparing all operational costs of the winter service in practice including the follow-up costs, gritting proved to be 6 times more expensive than spreading de-icing salt.

The spreading of anti-skid materials may also cause environmental problems. The slag and the granulate which are often used for this purpose contain heavy metals that will contaminate the ground. Moreover, the dust loads whirled into the air by the traffic or during the sweeping operations pose a health risk to the operators, residents and passers-by. Another problem is the disposal or the reprocessing of the mineral material used. As the new waste laws do not allow dumping them any longer, the re-processing techniques are very expensive, require a high energy input and contaminate the water and the air.

Although it has been previously assumed grit is environmentally-friendly because it does not contain salt, this is no longer true. Quite the contrary, the ecological effects of grit must be assessed much more detrimental to the environment than those of salt. Jurisdiction has also changed during recent years and does not consider gritting itself as a discharge of the gritting duty.

In view of these new findings, the use of grit on roadways must be basically questioned and reduced to the absolute minimum. This means, of course, that gritting should be avoided at all wherever justifiable under the given traffic conditions. In general, routes only cleared from the snow (without gritting at all) are economically and ecologically more advantageous than being gritted and afford reasonable safety standards on side roads (in residential areas) without any particular danger spots. Here, road users will tend to move slower and even more cautiously.

The new recommendation for the differentiated winter service as far as gritting materials are concerned is therefore: use de-icing salt on all roads where a higher frictional connection between vehicle and road surface is necessary for reasons of the traffic safety and the flow of traffic. This applies to all major and arterial roads, to roads accommodating means of public transport and special forms of traffic (such as rescue services etc.) as well as to special danger spots, such as slopes, bottlenecks, junctions, intersections, important crossroads, bridges and areas where black ice forms. Zero-gritting is recommended for all other roads which need not be treated with de-icing salt, i.e. these routes are merely cleared of the snow.

As a consequence of these considerations, the road network in cities will be sub-divided into only two categories henceforth: the roads where de-icing salt is applied and all other roads which are only cleared from snow. The winter service must therefore be operated flexibly so that it is possible to distribute de-icing salt also on some road sections or on entire roads which are not normally treated with salt, if exceptional weather conditions or the local circumstances require it.

As far as sidewalks, cycle paths and pedestrian zones are concerned, the recommendation to distribute skid-proof materials above all for environmental reasons has not changed at all.

4.5 Further organizational improvements

In order to comply with the recommendations for the new differentiated winter service, some further organizational measures need to be introduced. They are intended to utilize all possible ways of reducing the consumption of gritting material, especially de-icing salt, in the sense of optimizing the environmentally-friendly winter service.

One of the measures to be implemented is the proper recording of the operational data for all winter service activities. They need to be assessed and compared at regular intervals. This makes it possible to establish not only the cost of material and the personnel costs, but also the quantities of the material distributed by each vehicle and during each operation. This, in turn, allows to control and compare the dosing, the distribution patterns and the quantity of the material distributed by each vehicle under different weather conditions.

Based on the experience thus gained and the improved information about the weather and road conditions, the routes for the snow clearing and gritting operations will have to be continuously optimized, as a result of which a strategic operations plan can be drawn up so that the winter service can respond quickly and flexibly to any situation.

The equipment of the vehicles used for the winter services will have to be optimized for the relevant operation. Especially gritting vehicles should be equipped in such a way that the quantity of the gritting material as well as the width and direction of operations can always be adjusted to the relevant situation or that these parameters can be determined by an automatic measuring device. The control unit should monitor the details concerning the route and document all operational data automatically. This frees the driver largely from the paper work involved and allows him to concentrate even better on his job and the driving.

The storage and loading facilities for the different materials need to be optimized as well, so that the required operational and loading hours can be reduced to a minimum.

Most of the above items can only be successfully implemented when the existing personnel receives regular and intensive training. The success of the modern and environmentally-friendly winter services depends decisively on the training and motivation of the staff as well as on the quality of their work. Old habits will have to be abandoned, which may prove to be a real change for some employees. They will therefore have to be properly instructed and familiarized with their work before each winter season and be given the opportunity of acquainting themselves with all installations and attachments of the vehicles and to gather experience in practice. Compliance with the instructions must be permanently checked, as will the operational data have to be submitted to individual checks.

Public relations is another contributing factor to the success of the winter service. The citizens and road users need to be informed about the different duties and responsibilities of those involved in the winter service, and the names of the people in charge will have to be made known. This information, which helps prepare the general public for the changed traffic situation on the wintry roads, shall be released to the press before the winter season and once again when winter strikes the first time. These publications should particularly focus on the changed routine of the winter service. It has been found to be expedient to inform the press constantly about the development of the costs for the winter services. Precise figures about the costs, the kind and the scope of operations as well as details about the personnel and the vehicles involved should be released especially after larger assignments. A citizens' service line should be set up for complaints and suggestions in order to ensure that they can be passed on speedily to the operations management and be dealt with.

5. Summary

The latest research findings and investigations show indeed that the way in which the winter service is conducted has changed. The materials to be distributed on the roads are looked upon and assessed differently from the way it used to be a few years ago. Grit, originally being assessed much more environmentally-friendly than salt, proved to be hardly effective as a skid-proofing material on road surfaces, if at all. When considering all aspects of using grit, i.e. the production, the storage, the quantities required, the subsequent sweeping and the re-processing as well as the side effects, it turns out that this material is by no means environmentally-friendly. On the other hand, de-icing salt, originally in disrepute because of its detrimental environmental effects, may have great advantages and loses much of its danger potential (i.e. the detrimental effect), provided it is applied and distributed correctly, selectively, well dosed and only in absolutely necessary places.

This is not meant to be a complete volte-face and a recommendation to use de-icing salt indiscriminately. Quite the contrary, it is suggested to use less salt altogether. The use of de-icing salt is to be restricted to main and arterial roads, bus lanes and danger spots so that the trafficability of these roads and the requirements of urban traffic will be ensured in combination intensive mechanical snow-clearing operations. The consumption of gritting materials to be spread can thus be minimized. A further and considerable savings potential is gained in the side streets which need no longer be gritted at all and will only have to be cleared from snow. This does by no means affect the road safety in these areas.

The general public will have to be involved in the implementation of this winter service strategy by giving them all the information required. This helps preparing the general public for the new situation during wintry conditions.

Another fundamental prerequisite for the success of the project is to provide regular and intensive training for all members of the staff assigned to the winter service. If all factors are sufficiently taken into account, we will be on the best way to an effective, environmentally-friendly and economical winter service.

The experience gained so far from the new differentiated winter service justifies the hope that the objectives set in this respect will be attained for the benefit and the safety of the road users and of all citizens.