

FOLLOW UP STUDY OF WINTER STANDARD AS A R&D PROJECT

Torgeir Vaa
SINTEF Transport Research, Trondheim, Norway
torgeir.vaa@sintef.no

Ivar Hol
Norwegian Public Roads Administration, Central Region, Molde, Norway
ivar.hol@vegvesen.no

ABSTRACT

In Norway winter maintenance is now on contract on all National roads. One of the consequences of the competitive tendering is a decrease in the R&D projects involving the contractors. This is why the Public Roads Administration has found it necessary with challenging measures to maintain a required level of research within the area of winter maintenance. In one of the contracts starting in September 2006 there has been set aside 100.000 US\$ per year in the seven year contract period to stimulate research projects.

The main project focuses on a follow up study of the winter standard on E136 which is a trunk road and the most important road in the contract area. The main reasons for the choice of contract and the road section in the follow up study are:

- The area is very exposed to snow avalanches.
- The area is an important route for trailer trucks and is of high national importance.
- Many complaints from the public.
- In addition to the functional requirements in the contract there are also special demand regarding the readiness and equipment.

The results from the project so far are very positive both from a professional and an organizational point of view. R&D within the area of winter maintenance is already included in several of the contracts renewed in 2007 and later.

One of the important results from the project is that there has been a measurable improvement in the driving conditions in the winter time with fewer complaints and improved traffic flow. One of the lessons that can be learned from this is that reinforced supervision is a mean to achieve a winter standard in accordance with the contract.

KEYWORDS

WINTER MAINTENANCE / CONTRACTS / STUDY / REQUIREMENTS

1. INTRODUCTION

1.1. Background

Norway is divided into 103 winter maintenance contracts – first ¼ on bid in 2003 and last ¼ on bid in 2006. The contracts are performance based (friction, snow depth etc.). One of the consequences of the competitive tendering is a decrease in the R&D projects involving the contractors. This is why the Public Roads Administration has introduced challenging measures to maintain a required level of research within the area of winter maintenance. In contract 1503 Indre Romsdal southwest of Trondheim, see Figure 1, which started in the autumn 2006 there has been set aside 100.000 US\$ per year in the seven year contract period to stimulate research projects.

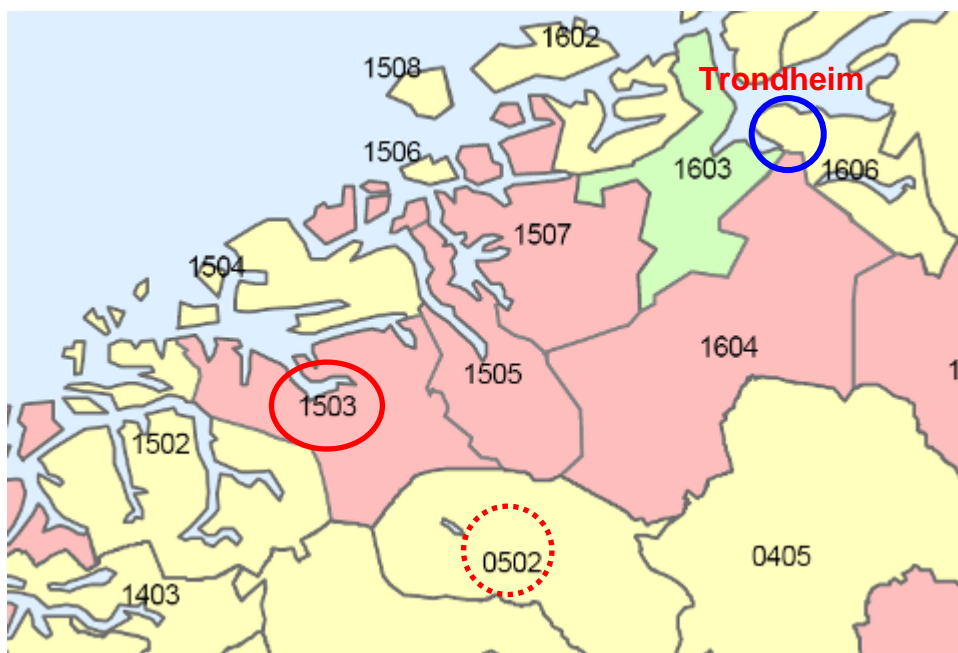


Figure 1 - Contract 1503 and 0502 is included in the study area

The main project focuses on a follow up study of the winter standard on E136 which is a trunk road and the most important road in the contract area, see Figure 2. The main reasons for the choice of contract and the road section in the follow up study are:

- The area is very exposed to snow avalanches.
- The area is an important route for trailer trucks and is of high national importance.
- Many complaints from the public.
- In addition to the functional requirements in the contract there are also special demand regarding the readiness and equipment.

The AADT on E136 in Romsdalen is 1500 with winter traffic slightly above 1000 vehicles per day. The share of trailer trucks is approximately 40 %. The road standard varies a lot and the road width is narrow compared to the traffic volume and proportion of trucks. The road is also bendy and has steep hills with a mean gradient of 6 % on the last part of the way from Åndalsnes to the County line.

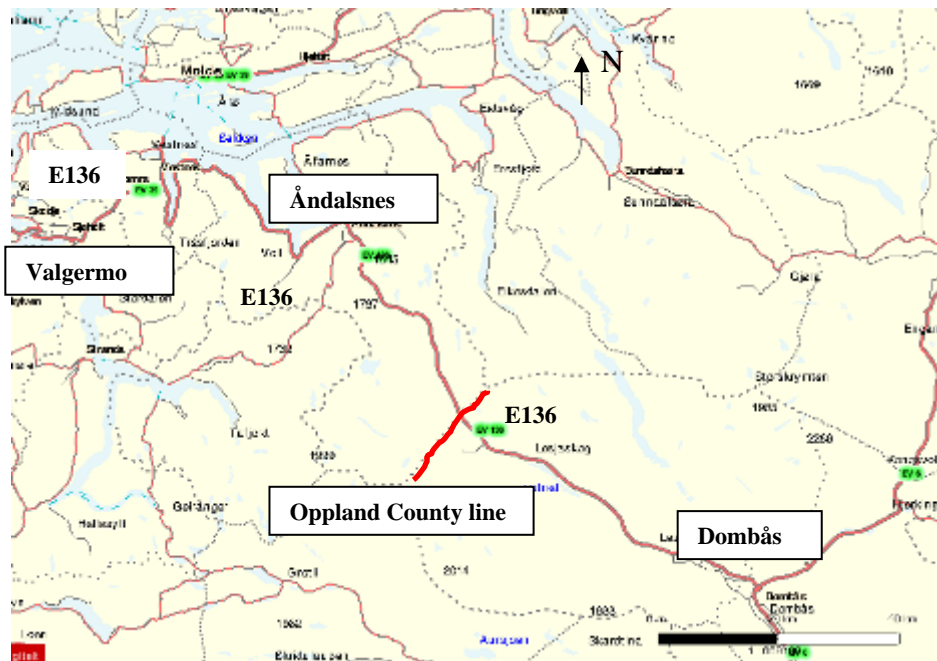


Figure 2 - Map showing E136 in the follow up study

1.2. Goal

The goal with the project is to improve the traffic safety and trafficability with correct use of resources and it has been decided to focus on documenting the winter standard by frequent follow up of the road conditions. The purpose with this is to:

- Give a good basis for the contractor to carry out the correct measures to the correct time.
- Give good and updated information to the public regarding the driving conditions through the winter.
- Supply the road keeper with good documentation of the winter standard and driving conditions on the road.

1.3. Organization of the project and expected results

The follow up study is organized as a joint effort between the contractor and road keeper and it is expected that the collaboration in the project will initiate other important R&D projects. The project is expected to give benefit on short term:

- Better basis for decisions and faster reaction time for execution of winter operations will result in better driving conditions and increased traffic safety and trafficability on the road network.
- Better information will be of service to the road users and make it possible for the transport industry to plan their deliveries in a better way.

On long term systematic documentation and analysis of the actual winter standard will provide knowledge that can be used as a basis for improvement of routines and methods both locally and in general:

- Overview of difficult road sections and places demanding extra effort.
- Overview of time and periods when it from experience can be expected difficult driving conditions.
- Overview of how different weather conditions influence on driving conditions and the need for actions.

- Better basis to assess the effect of different methods, equipment and materials.
- Better basis to evaluate standard requirements and contract descriptions.

In addition the area covered by the project has been chosen to test new requirements developed as a part of an ongoing revision of the Norwegian winter standard (Handbook 111). The following questions are addressed:

- What is the friction when measures in form of plowing and sanding and salting are carried out?
- What is the friction when the driving conditions are experienced as difficult?
- How do the friction conditions vary throughout the whole road section?
- Is it possible to measure direct impact on the driving speed when actions are carried out?
- How much precipitation as snow is necessary to reduce the trafficability in such extent that the traffic flow is reduced?

2. PROJECT DESCRIPTION

2.1. Study area and maintenance strategies

The follow up study covers a 180 km long road section on E136 between Valgermo and Dombås with the following characteristics:

- The project covers two regions.
- Two different contractors are involved in the project.
- The follow up study covers contracts with different terms of settlement; one with fixed price (contract 0502) and one with variable winter costs depending on the severity of the winter (contract 1503).
- The road section in the follow up study includes three different winter maintenance strategies; “Strategy winter road”, “Strategy almost bare road”, and “Strategy active salting”.

The friction requirements for different strategies are summarized in Table 1 and Table 2. For comparison the requirements for Strategy bare road is similar to Strategy almost bare road except for that the whole roadway shall be bare within the same time limits and anti-icing shall be done when friction is expected below 0.40.

Table 1 - Friction requirements, Strategy winter road

Class of road	AADT	Local sanding		Continuous sanding	
		Start at	Finished within	Start at	Finished within
Trunk Roads		$\mu < 0.30$	1 hour	$\mu < 0.20$	2 hours
All other roads	> 1500	$\mu < 0.25$	1 hour	$\mu < 0.20$	2 hours
	501 – 1500	$\mu < 0.25$	2 hours	$\mu < 0.15$	3 hours
	0 - 500	$\mu < 0.20$	2 hours	$\mu < 0.15$	4hours

μ is the friction factor before spreading is started.

Table 2 - Friction requirements, Strategy almost bare road

Tasks	Triggering criteria and maximum time for action in regard to different AADT		
	< 3000	3001 – 5000	> 5000
Anti-icing	If expected friction value < 0.30	If expected friction value < 0.30	If expected friction value < 0.30
De-icing. After snowfall: Bare in tracks before	6 hours	4 hours	2 hours

The road section Valgermo - Oppland County line is operated after “Strategy winter road” with a shorter section of 12 km operated after “Strategy almost bare road”. I.e. salt is being used when the conditions are appropriate for using salt.

The road section Oppland County line – Dombås is operated after a strategy with so called active salting. The definition of this strategy is: Snow or ice cover is acceptable. Friction requirements according to strategy winter road. The contractors are allowed to use salt in their daily operations if use of salt makes it easier to meet the friction requirements. This strategy is being used on trunk roads and other roads with high traffic where it is difficult to achieve the friction requirements by use of sand or salt blended sand.

The different strategies for friction measures give the follow up study an interesting dimension regarding both the actual standard gained and the amount of actions carried through.

2.2. Data recording

A registration vehicle is provided for the follow-up study. The main instrument on the vehicle is a friction device of the type Traction Watcher One (TWO) which is a continuous measuring device; see Figure 3, with fixed slip test wheel. TWO is mounted on a tow bar. The test wheel is equipped with a standardized friction measurement tire according to ASTM E-520 (grooved tread) with 8 inches diameter. The test wheel is normally positioned in the left wheel track.

Data is transferred to a laptop mounted on the dash and there is a new recording every second. The friction value recorded is the mean value of the readings the last second (100 readings per second). Data is stored in a database.

The TWO friction device has three different modes of doing the measurements:

- Normal mode. Measurements with standard 60 kg ground pressure.
- Inspection mode. When the coefficient of friction exceeds a set value e.g. 0.60 over a distance of 100 meters the ground pressure is automatically lowered to 30 kg and the ground pressure is raised again to 60 kg when the coefficient of friction falls below a set limit over a distance of 100 meters.
- Spot mode. Friction measurements are made with 60 kg ground pressure on a 70 meters long road section at fixed intervals. The operator chooses the measuring intervals between one and five kilometers. All data except for the friction value is logged continuously.



Figure 3 - TWO friction measuring device

On days with winter conditions there is made one – two trips per day in both directions in the hours between 4 am to 10 pm. Other data is also recorded like the extent of plowing and salting/sanding, weather conditions and traffic flow and speed. The follow up study includes the following routines:

- Friction measurements with TWO friction measuring device. The road is divided into 10 sections.
- Air temperature, road surface temperature, relative humidity.
- Calculation of dew point.
- Pictures in fixed points triggered by position registered by use of GPS.
- Road weather data from RWIS stations.
- Registration of car rescue actions by use of pocket PC.
- All measures carried out registered by use of automatic data collection system.
- Programmable pocket PC used to register additional information about the road conditions.
- Drivers on busses and trucks filling out a form to have their opinion on the driving conditions.
- Automatic registration of driving speed by recognition of vehicles using piezoelectric cables to register number of axles and weight.

3. RESULTS

3.1. Friction measurements

There are great differences in friction conditions between different roads sections both the winter season 2007/2008 and the winter season 2008/2009, see Figure 4. With exception of the road section Brøstvegen – Seterbø the route between Dombås and Valgermo is

principally operated after strategy winter road. The variations in friction conditions must therefore to a great extent be explained by the differences in climatic conditions.

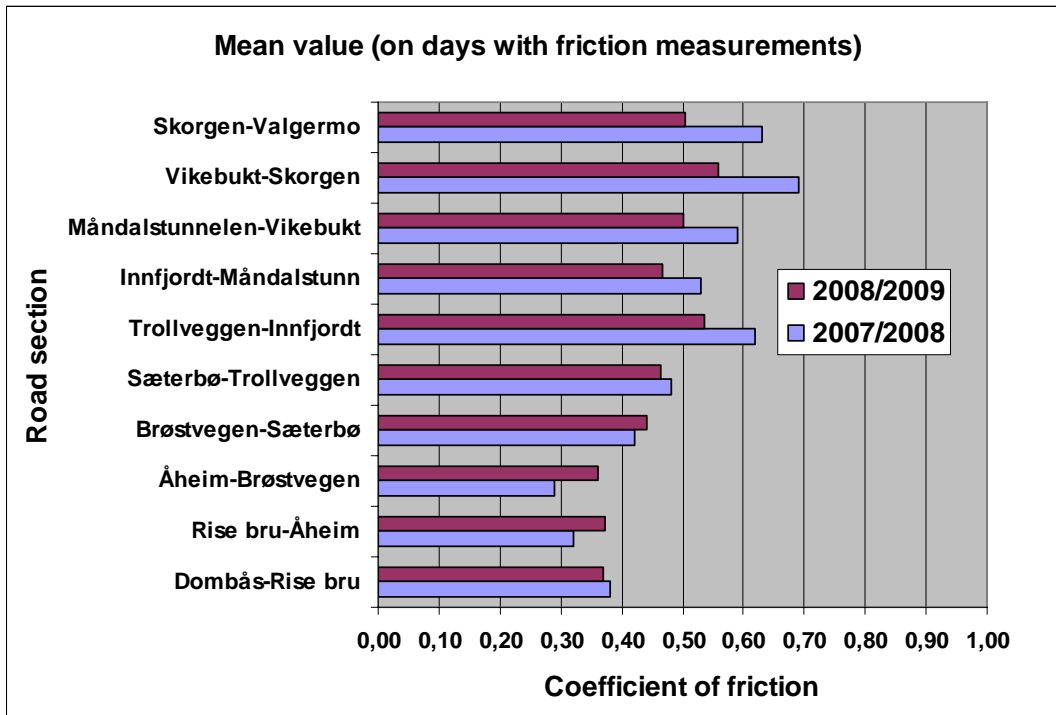


Figure 4 – Mean coefficient of friction on road sections

Some days there can be even greater variations in the driving conditions between different road sections than Figure 4 indicate. Some examples of that are shown in the following figures. Figure 5 shows RWIS data during a snowfall in February 2007 and Figure 6 and Figure 7 shows friction measurements made the same day at 08:36 and 9:46 a.m. respectively.

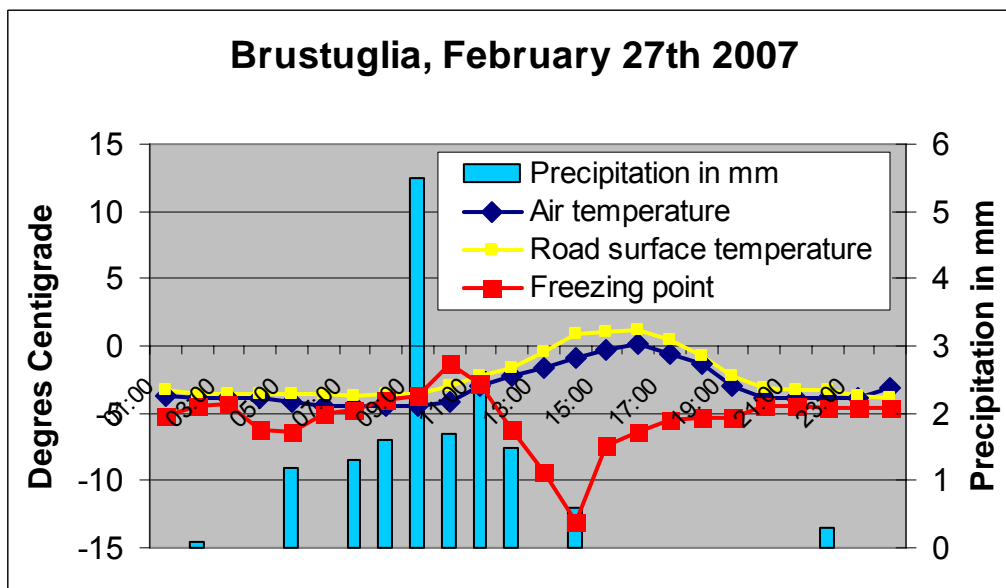


Figure 5 - Data from Brustuglia RWIS station February 27th 2007

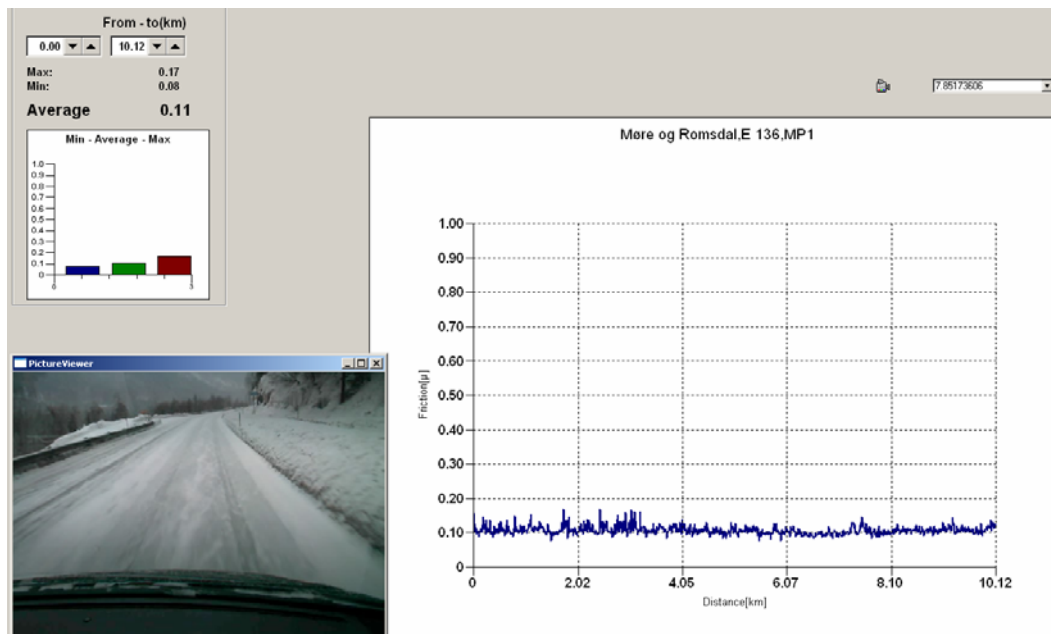


Figure 6 - Friction measurements past Brustuglia RWIS station February 27th 2007 8:36 a.m.

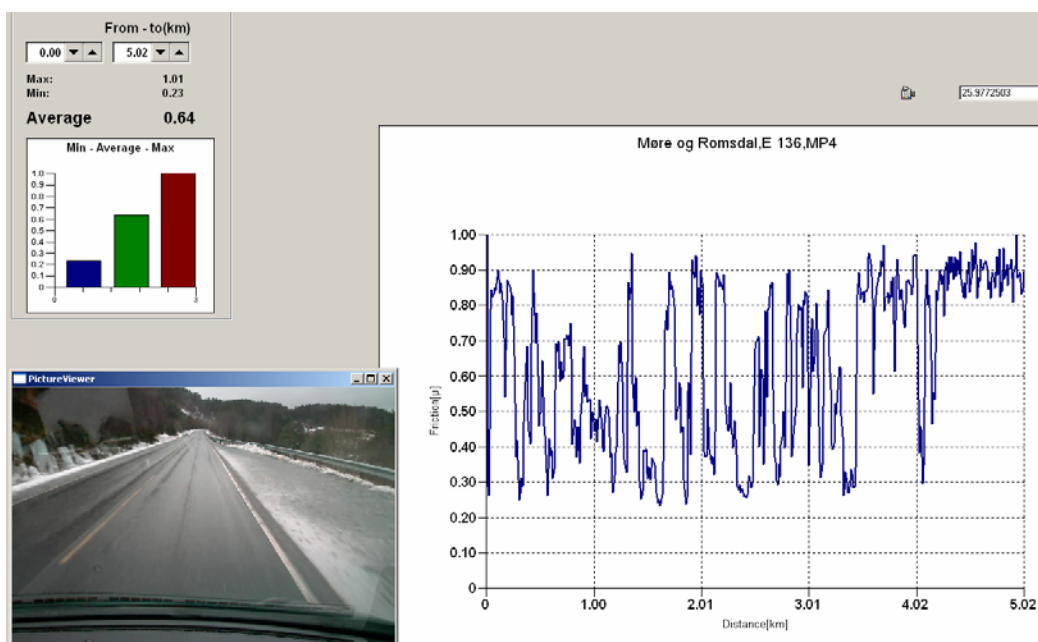


Figure 7 - Friction measurements 60 km vest of Brustuglia RWIS station February 27th 2007 9:46 a.m.

Figure 7 shows the results from the friction measurements approximately 60 km vest of the section presented in Figure 6. The variation will in this case mostly probably be caused by variations in the climate.

3.2. Road conditions

Manual registrations simultaneously with the friction measurements show great variations in observed road conditions. This is obvious when comparing the road sections Vikebukta – Skorgen and Skorgen – Valgermo, see Figure 8. The observations shows great variations

in the proportion of bare road and snow and ice cover on these adjacent road sections. On the road between Skorgen and Valgermo it is reason to raise a question whether the salting practice in sufficient extent is reflected by the proportion of bare road. With the amount of salt reported it is reason to expect a greater share of bare road between Skorgen and Valgermo.

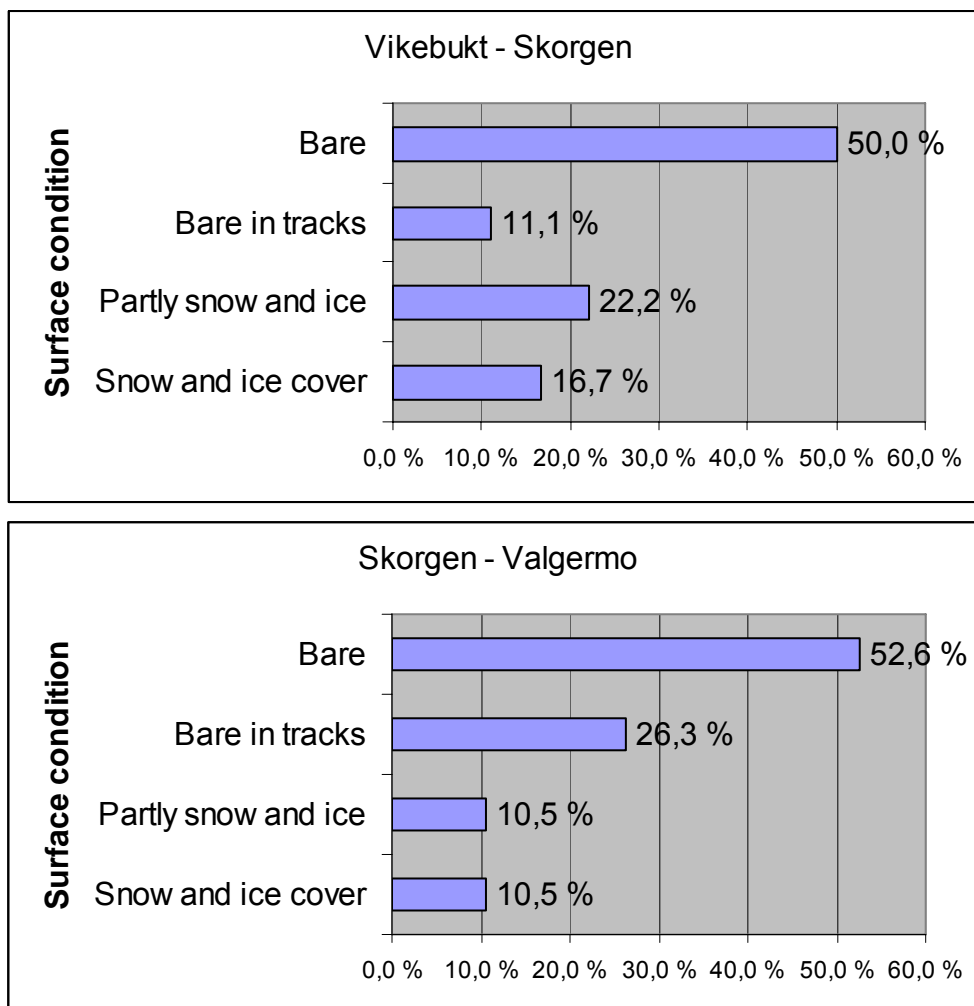


Figure 8 – Observed conditions on two neighbouring road sections, winter season 2007/2008

3.3. Operational statistics

The operational statistics on a seasonal basis show greater effort on the trunk road than on national roads in contract area 1503. This is valid both for plowing, salting and sanding. The differences are probably greater than the variations in standard requirements should imply, and this fact indicates that operational effort can be influenced by increased attention on follow up of the winter standard.

Figure 9 shows the amount of plowing and consumption of salt and sand on trunk roads in the two contract areas in the winter season 2006/2007.

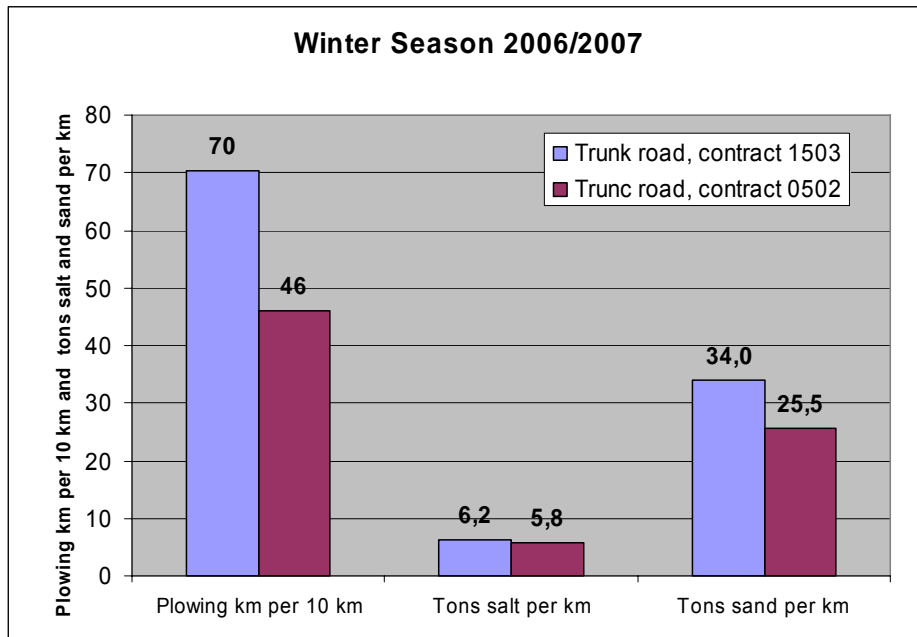


Figure 9 - Amount of plowing and consumption of salt and sand the winter season 2006/2007

Both the extent of plowing and use of sand indicate that there is a major difference between the two contract areas. There can be several explanations to this: difference in the climate, difference in the road geometry, difference in the interpretation of the contract regulations and difference in the terms of settlement. It is too early to draw conclusions on the differences in the total winter maintenance effort in the two contract areas, but there are some indications that the payment system can be a factor influencing on the contractors input of labor, see Figure 10.

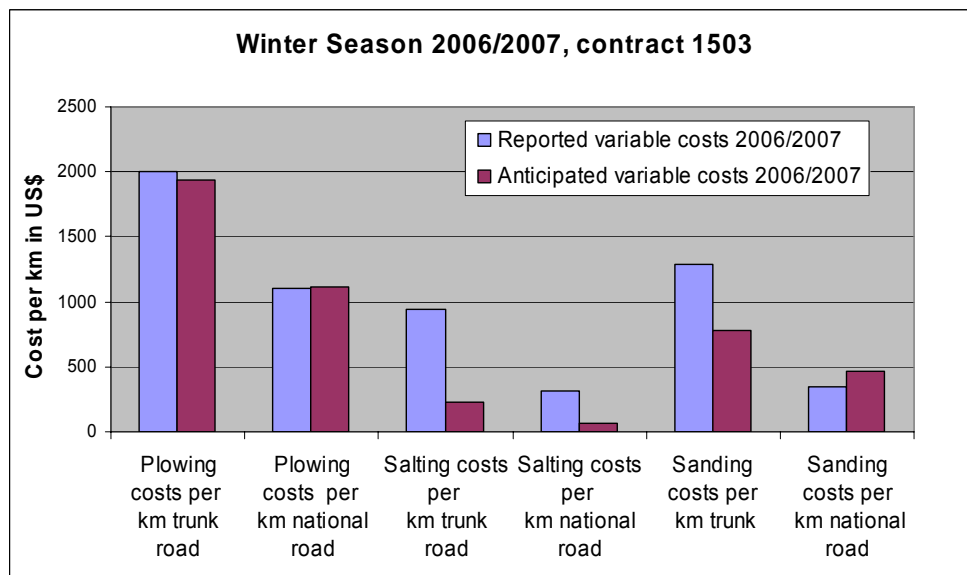


Figure 10 - Reported and anticipated variable costs on trunk roads in contract 1503

From Figure 10 one can see that both for the salting costs and the sanding costs the reported variable costs in contract 1503 is substantially higher than anticipated costs based on empirical data.

3.4. Rescue actions

Overturn/off road driving constitutes clearly the greatest amount of incidents both for trucks and passenger cars.

Snow and ice cover is the dominating road condition for rescue actions on trucks, while more of the rescue actions on passenger cars are noted on a bare road surface.

3.5. Driving conditions reported by bus and truck drivers

In the winter season 2006/2007 a total of 7 drivers on busses and trucks participated in the reporting activities to get their subjective view on the driving conditions. The main reporting period was from January 8 to March 26 2007. The drivers were asked fill out a form and note travel time and their view on the driving conditions and need for friction improvement actions on the two road sections Valgermo – Åndalsnes and Åndalsnes – Oppland County line. The following alternatives were listed in the form:

- Driving conditions: Very good, Good, Slightly difficult, Very difficult.
- Need for friction improvement actions: Yes, No, Partly.

Figure 11 and Figure 12 show the statistics based on the reported driving conditions and need for salting and sanding for the road sections Valgermo – Åndalsnes and Åndalsnes – Oppland County respectively. It is a bit surprising that the driving conditions are reported to be poorer on the road section Valgermo – Åndalsnes than on Åndalsnes – Oppland County since the road eastwards from Åndalsnes traditionally is most problematic. One reason for this can be that the contractor has given higher priority to this part of the road since most of the complaints earlier winter seasons are related to the road section Åndalsnes – Oppland County.

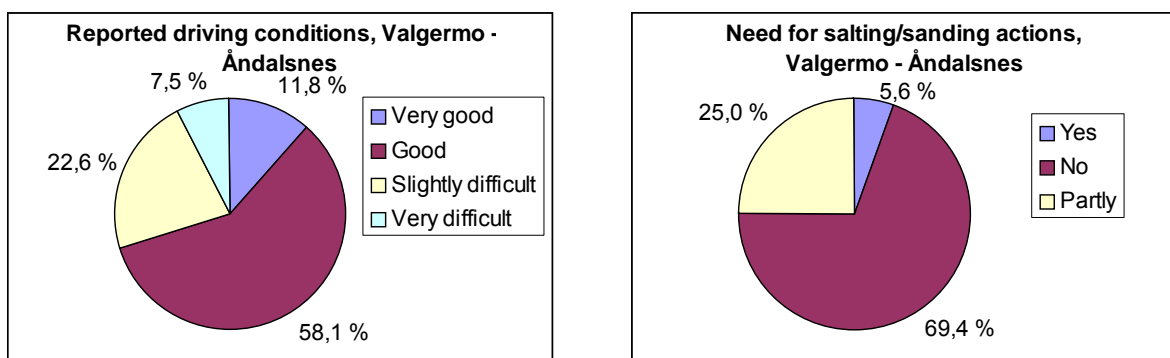


Figure 11 - Driving conditions January 8 – March 26 2007 reported by bus and truck drivers, Valgermo – Åndalsnes

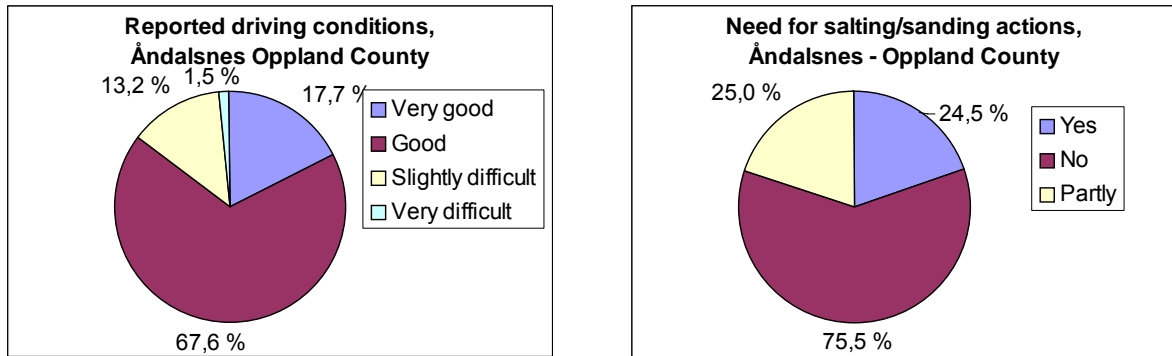


Figure 12 - Driving conditions January 8 – March 26 2007 reported by bus and truck drivers, Åndalsnes – Oppland County

4. CONCLUSIONS

The results from the project so far are very positive both from a professional and an organizational point of view and the results give support to the main idea behind the project that incorporating R&D in maintenance contracts is of value both to the road keeper and the contractor. The project helps in increasing the general knowledge about factors influencing on the driving conditions, the importance of doing the correct actions and also the benefit of having a system to follow up the standard on winter roads.

REFERENCES

[1] Torgeir Vaa (2009). R&D Indre Romsdal. Follow up study of winter standard the seasons 2006/2007 and 2007/2008. SINTEF report A11557, April 2009.