

A Weather Model for Variable Speed Limits

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ABSTRACT

By use of a weather model it is possible to reduce the speed limits along the roads according to prevailing weather and road conditions. The model considers the variations in local climate along the road stretches which is processed together with input from the RWIS. The speed limits are set according to the severity level produced in four classes by the model.

Keywords: road climatology, variable speed limits, RWIS

1. INTRODUCTION

Severe weather and icy road conditions are problems which repeatedly occur every winter in Sweden. These situations result in great impact on traffic and society. Maintenance activities, delays and accidents cost a lot of money for society as well as for companies and individuals. It is obvious that there is a potential for savings if the impacts of these weather related disturbances and impacts could be reduced. By use of the road weather information system, RWIS, it is possible to see several approaches for improvements that could be successful. Firstly it is fundamental to develop RWIS with regard to the winter maintenance task. The development of forecast tools and maintenance support models is crucial for the possibility to have the proper information to take the right decision when it comes to preventive maintenance activities avoiding the risky situations to occur and also to do the right activity during the ongoing situation.

Secondly, but not less important, is to develop models providing the drivers with information and knowledge of the potential dangers of a given situation resulting in enhanced risk for road slipperiness. Giving the drivers information about the road weather and risk of slippery conditions can be performed in several ways. However information only is not enough to influence the drivers' behaviour in an effective way. Studies regarding drivers behaviour show that drivers generally have a poor judgement when it comes to consider risk of slipperiness and what driving speed that might be safe avoiding skidding and reducing the risk of accidents [1-2].

A possible approach to address this problem is to use dynamic variable speed signs that are regulated by the actual road conditions and the present risk of slipperiness along the road. By this approach the driver is "forced" to reduce the speed accordingly to the risk level. If there is a risk of slipperiness along a road during a given occasion a lowering of the speed limit has the potential to reduce the risk of accidents and also the severity of an occurring accident [3].

The Swedish Road Administration has initiated a project testing the idea with dynamic speed signs regulated by a weather model. The model is developed by the Road Climate Centre at Göteborg University and it has been implemented at three test stretches located along the coastal roads E6 and E22 in the southern part of Sweden and along E18 in the inland county of Västmanland. The weather model for regulating the speed limit has been in operation along the test roads since the winter of 2004/2005.

2. RESULTS

Studies have shown that for Swedish winter conditions slipperiness can be divided into different categories according to rain, snow, rime and ice formation. The occurrence and distribution of typical slipperiness situations during winter time varies according to location within the country and prevailing weather. During the winter about 24% of the days are associated with risk of slipperiness. However the dominating type of slipperiness that is occurring in the southern part of Sweden is in association with snow or rime, table 1, [4-5]

Type of slipperiness	Frequency (%)
Ice	1,0
Rain	0,4
Rain cold surface	2,4
Rime	8,9
Snow cold, $T_s < -3^\circ\text{C}$	2,0
Snow warm, $T_s \geq -3^\circ\text{C}$	8,8
Snow, strong wind	0,6
Total	24,1

Table 1. Frequency distribution of days with different types of slipperiness during a typical winter in southern Sweden based on 182 winter days.

The idea with the weather model is that it should capture these different kinds of slipperiness situations related to weather that might occur during the winter time in Sweden. Tests of the weather model during the winter 2004/2005 resulted in a number of slipperiness occasions varying between 25% to 32% of the time depending on test stretch which is in agreement with the general winter statistics. The model shall also be able to classify the occurring different slipperiness occasions into risk categories depending on the potential reduction of friction of the upcoming situation. The resulting output delivered from the model is a classified warning that corresponds to a speed level which can be displayed on the variable speed signs along the test roads. The classified warning is divided into four risk levels or severity levels where level four is the most serious level which calls for major reduction of speed, table 2.

Severity level	Speed limit (km/h)
No risk	120
Risk level 1	110
Risk level 2	100
Risk level 3	80
Risk level 4	60

Table 2. Speed limits shown by the variable signs on the test stretch, E6, at different severity levels delivered by the weather model.

Basically the weather model is feed by RWIS-data every 15 minutes which is processed and integrated with information about the local climatological variations along the road stretches. The output from weather model is delivered for different parts of the road stretch making it possible to consider the small scale variations determined by for example topography, vegetation or constructions that might influence the road conditions and risk of slipperiness. It is also important that the model is based on the local climatological variations along the road stretches since these often are large, figure 1. This approach is necessary since the climate and road conditions can vary considerably within a short distance along the roads. The benefit of this is that a road stretch can have different speeds according to the output from the model.

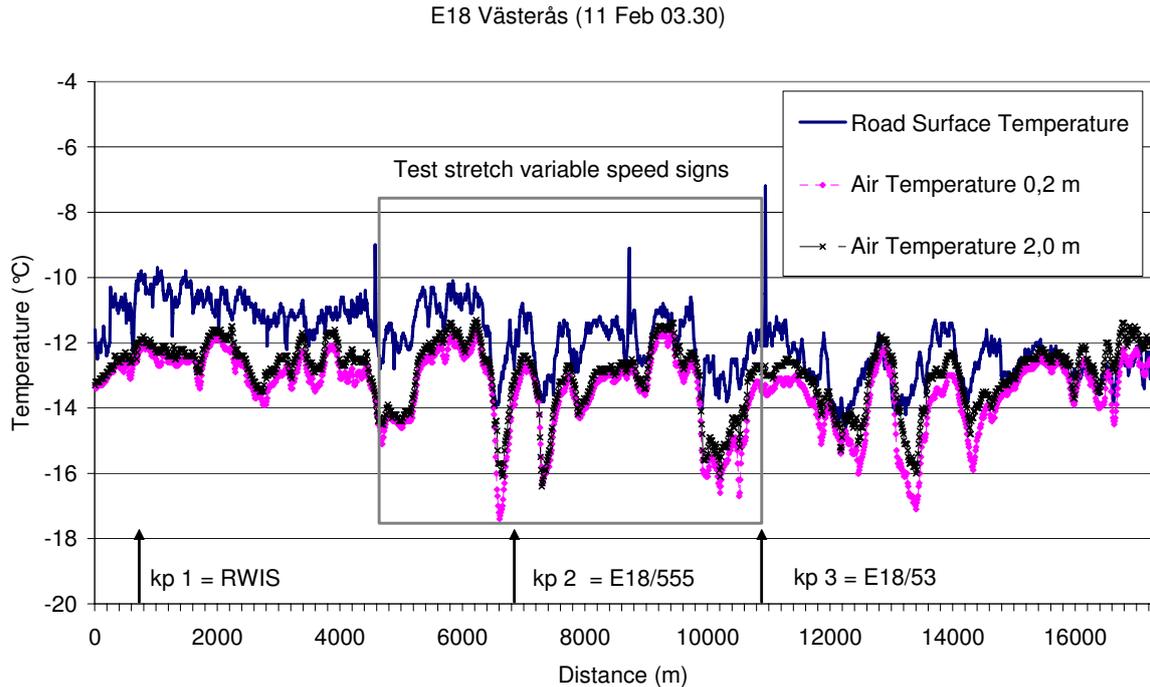


Fig. 1. Thermal mapping along E18 showing large temperature variations within a short distance. This information is integrated in the weather model for a high spatial resolution of variable speed segments.

3. DISCUSSION

The weather models for speed regulation at the test sites in Sweden have shown to respond well to the variations in types of slipperiness occurring during winter time in Sweden. Compared to the fixed speed signs the dynamic variable speed signs can provide the driver with a speed that is in accordance with the prevailing road conditions, figure 2.



Fig. 2. Variable speed signs give up to date speed according to the prevailing road conditions along the road compared to the fixed speed sign.

Further work with the model will be focused on how to integrate the effect of maintenance activities automatically into the model. Today the maintenance activities are delivered to the traffic information centre (TIC) together with the output from the weather model. The personnel in the TIC manually take decision on how to change the speed limits according to the information from the weather model and the maintenance activity. Another important task is to further analyse the effect of variable speed signs on the amount of accidents related to severe road conditions. Today it is obvious that there is a lot to gain by reducing the amount of accidents related to slippery road conditions. Studies show that the amount of accidents increases rapidly when the severity level of the road condition is high, figure 3.

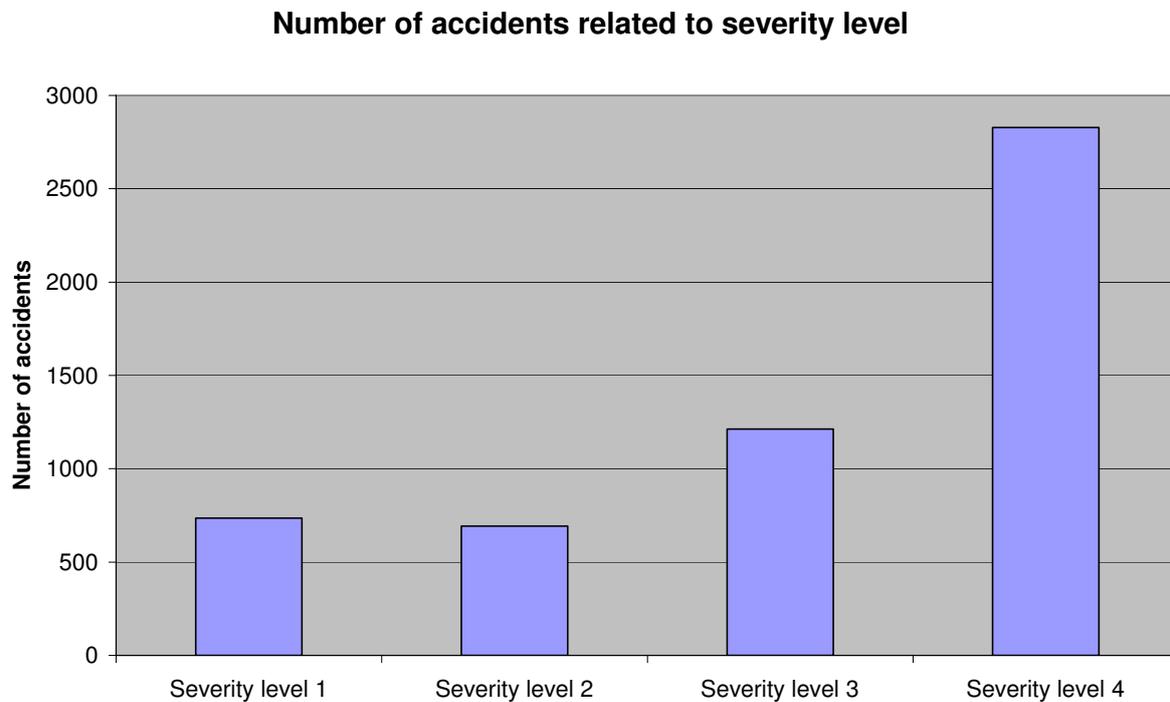


Fig. 3. Increased number of accidents when the severity level of slipperiness increases

4. CONCLUSION

By use of the weather model it is possible to reduce the speed limits along the roads according to prevailing weather and road conditions. The model provides the drivers, through the signs, with information about speed limits that are reflecting the road conditions which gives the potential for a safer travel than with fixed speed limits. On average the road conditions call for speed reduction during the winter in approximately 25-30% of the time (not including the effect of maintenance which will reduce the number significantly) which means a considerable difference compared to fixed signs. A reduction of speed during situations with risk of slipperiness has a great potential for reducing accidents.

5. REFERENCES

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