DO WE NEED TO MONITOR ROAD FRICTION IN SUMMERTIME?

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ABSTRACT

A work has started to investigate the importance to monitor friction on Swedish roads in summertime. In a Nordic country like Sweden it is a fact that the friction is low in wintertime due to the weather situation and icy roads. In summertime it has been the understanding that friction has not been an issue. Modern brake systems and few incidents have implied that tire/road friction is in control. This has now been questioned. New road materials that has longer durability and the reduction of studded tires has given the effect that roads are not loosen anymore, on the contrary the pavements are polished giving a lower friction. New building techniques with re-cycling have increased the number of bleeding areas which normally indicates lower friction. All this has given rise to the question if the rules have to be improved for summer time control of friction performance on Swedish roads. Included in this work is to investigate the need for friction measurements, update technical documents and suggest how to do more effective scanning of friction in summertime.

INTRODUCTION

Friction is the only road surface characteristic exclusively connected to safety. It is controlled and monitored in different stages and for different safety related purposes. Three main purposes can be identified;

- material control and performance,
- monitoring of roads in service
- and real-time support for driver assistance safety systems.

This document discusses the need and use of friction monitoring of roads in service during summer road conditions. The main focus of friction monitoring development in Sweden has been in combination with road maintenance and operations during winter road conditions. In Sweden, the activities and development regarding friction measurements had a peak in the seventies and a lot of equipment was developed at that time. The so called skiddometer principle was developed. The principle uses a slightly braked longitudinal aligned measuring wheel (17% slip), as compared to the free rolling support wheels. Equipment with tires of various sizes was used depending on the application, e.g. airport run ways, heavy truck or light vehicle handling. The equipment was used both in winter and summer time. In the summer time a water film was included to prepare the surface for wet friction measurements. In the initial trials using contracts with functional requirements, friction was an equally important factor among all other road surface conditions such as longitudinal and transversal evenness. With time this has changed. As mentioned above, friction monitoring is a major issue in the wintertime management. In summer time very subjective or proxy methods are used, although there are advisory thresholds in the technical documents of road management. Only in exceptional cases summer road condition is measured with more sophisticated equipment. Due to this low demand very few companies, if any, can or have equipment to measure according to the Swedish standards.

STANDARDS, EQUIPMENT AND EUROPEAN PROJECTS

The European standardisation organisation, CEN is working on a common standard for dynamic or traffic speed friction. As for now the suggestion is to include a number of equipment (>10) divided into three main principles, longitudinal block, longitudinal controlled slip and sideway force principle. A number of international projects have been done such as HERMES (4), to create a European Friction Index, EFI. This was not successful and a project called Tyrosafe (5) was started. One part of the Tyrosafe project was to support the European harmonisation safety and policies regarding tyre road interaction by giving advice and suggest a strategy how to go on with a common view on tyre/road friction. It was found that there are big divergences in strategies and many systems to measure friction exist in Europe. The Swedish system uses the longitudinal controlled slip principle. The equipment is called Saab Friction Tester, when built into a Saab car or BV11 when used as a trailing device, see *Figure 1*. The car contains a 400 litres water tank to supply a 0.5 mm water film in front of the measuring wheel during measurements.

Figure 1: The BV11 and Saab friction tester used in Sweden

Most of the major projects have focussed on the real-time support for driver assistance or real time information. The INTRO project (3) (finished in 2008) investigated stopping distances and also tested the design of human interface displays using a driving simulator. FRICTION (1) aimed at systems for vehicle to vehicle communication and driver information. SKIDSAFE (2) is looking on the tire-pavement interface and development of micromechanical tools for prediction of loss of skid resistance. SRIS, Slippery Road Information System (6) is a national project finished in 2009. The project aimed to combine the activity from the brake systems in cars with road weather information systems (RWIS) to predict and inform traffic of sections for low friction in winter road conditions.

THE PROBLEM

It has been shown (7), especially in urban areas, that polishing of the surface have led to lower friction. New road materials that has longer durability and the reduction of studded tires has given the effect that roads are not loosened anymore, on the contrary the pavements are polished giving a lower friction. New building techniques with re-cycling have increased the number of bleeding areas which normally indicates lower friction. All this has given rise to the question if the rules have to be improved for summer time control of friction performance on Swedish roads. The use of modern winter tires without studs and tires with more pavement friendly studs is initiated to save pavement wear without losing safety. Using studs also creates a problem with particulates generated from the pavement leading to health problems. The pros and cons are therefore heavily debated at the moment. The use of new road marking materials and methods is also important to include in the skidding monitoring. For the user, safety should be the same on the pavement and the road marking. Using intermittent road marking and new materials has made it even more difficult to reliably measure friction (8). Development to make less noisy pavements and the use of recycling methods has created new situations. A low noise surface often involves a macrotexture design leading to lower friction. The use of recycling and new construction methods, in combination with a changed more extreme weather situation (very rainy and very warm weather) has led to bleeding surfaces; see *Figure 2*, which indicates low friction. In media more and more reporting of bleeding pavements has been observed. The discussions are if the weather has changed with more very warm days can be a reason. Other factors discussed are the change in pavement maintenance to use more and more recycling that can lead too wrong proportions of bitumen and aggregates. Maybe the aim to be more and more effective in production lead to that the traffic is allowed to early on new surfaces?

Figure 2: New paved "bleeding" pavement

An investigation was made to find out if the number of accidents due to low friction has increased over the years. In the accident database STRADA, all police reported accidents including personal injuries and at least one vehicle involved is reported. Unfortunately there are very few obligatory fields and attributes that give information on the road surface condition at the accident occasion. One field divides the road condition in 5 categories, dry, wet or three types of winter road conditions see *Figure 3*.

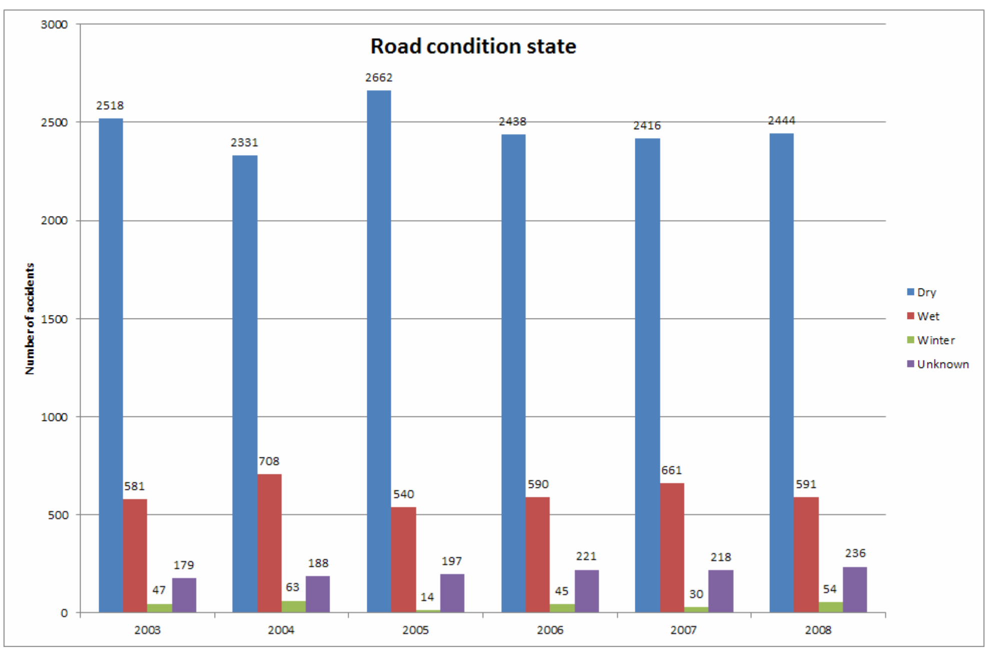

Figure 3: Road condition state

In this investigation only accidents that occurred during summer and with at least one private car are investigated. There is a text field available for description of the accident pattern that has been used for this investigation. An investigation on how many times the use of the words *aquaplaning, friction, slippery, slide* and *skid* is used in the description field has been done. From this an indication of the number of friction related accidents and possible trends over the years could be assessed. The years investigated is 2003 to 2008 and only on rural roads. From the *Figure 4* it can be concluded (statistical proved) that there are no proofs for any trends or changes during the years on rural roads. For urban areas it is shown that polishing of pavements has increased. One reason is the less use of studs and more pavement friendly studs. Another reason is the use of more strong aggregates (Porfyr), (7).

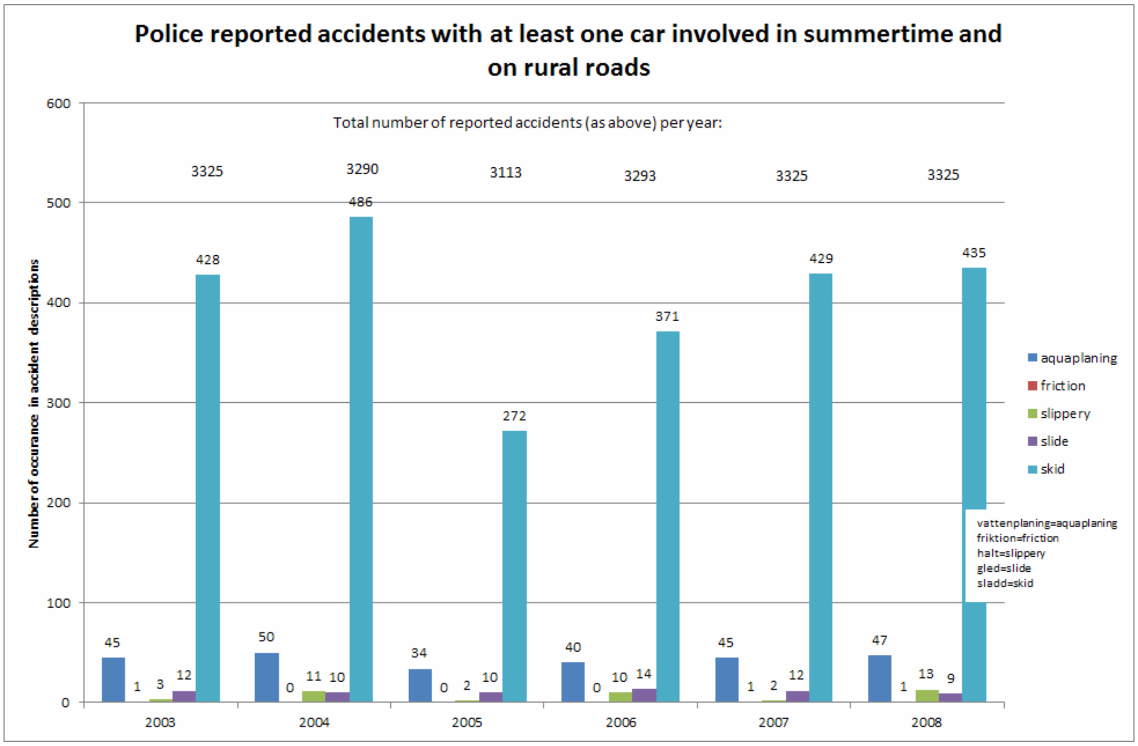

Figure 4: The use of skidding related words in the accident database

SOLUTION

In Sweden all governmental paved roads are controlled and measured regularly by profilometers (road surface testers). Included in those measurements, beside the traditional unevenness measures, is macrotexture. The macrotexture is measured as MPD (Mean Profile Depth) (10). It is measured in the two wheel tracks and between the wheel tracks. It is found that macrotexture and friction have a relationship. This has been shown in a number of projects e.g. the work that TRL limited have done in UK on road surface texture on local roads (9), have shown and concluded that *"Texture depth is related to high speed skid resistance in wet conditions, but not to low speed measurements"*. The friction measured by traditional equipment (Saab friction tester, SCRIM etc.) is mainly related to the fine scale microtexture. Currently this is not measured by routine profilometers. In Sweden the traffic safety vision is expressed as Vision Zero, aiming to achieve a highway system with no fatalities or serious injuries in road traffic. It is known that the fatal accidents occur at high speeds. With this as basis the suggestion is to use macrotexture (MPD) as an indicator to identify risk sections that may have low friction at high speed in wet condition. This suggestion is taken well aware that this does not replace traditional friction measurements but complement it. By using MPD it is possible to get an overview of the road network status regarding the amount of low MPD sections and secondly detect risk areas for low friction. From 2010 this data is saved for every travelled meter (earlier this was 20 meter). Main roads are monitored more frequently (each year) than smaller roads. From the pavement management data base the variation of MPD is found to be between 0, 40 (5 percentile) and a median just below 1, see table 1.

Table 1: MPD variation on Swedish roads

Average daily traffic /Mean MPD per 100 metres, 5 percentile and median													
0-249		250-4999		500-999		1000-1999		2000-3999		4000-7999		>8000	
0,52	1,03	0,45	0,89	0,41	0,80	0,42	0,76	0,46	0,85	0,50	0,88	0,53	0,85

A standard for in service roads are suggested. The figures (limits) have been established from international sources (9, 10, 11 and 12). In *Figure 5* measurements from MPD and friction equipment (Saab ft) are compared. As can be seen the sections with low MPD, below suggested standard (0.3) correlate well with the measured low friction sections using the friction limits. This is just an example from other measurements done. More work is going on to confirm the relationship.

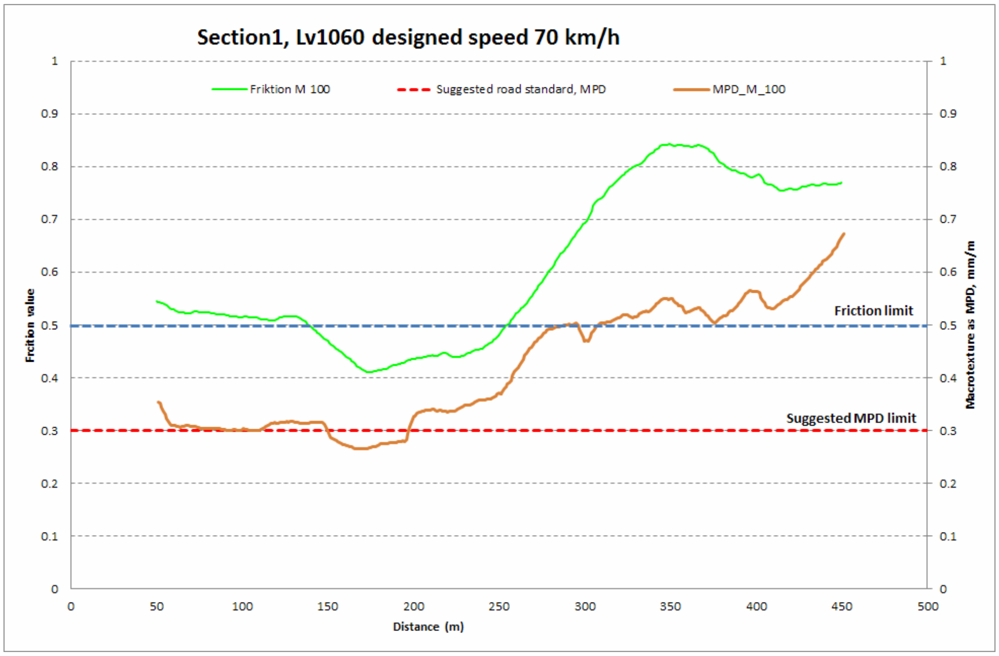

Figure 5: Friction and MPD comparison

The method to measure friction uses a special measuring tire that might not give the same friction as from a normal modern car. Probably the actual friction is underestimated from the test equipment. Therefore the minimum limits in the suggested MPD standard should be higher? The thresholds in the standard are divided by traffic and signed speed, see table 2. By using the MPD as an indicator, potential risk sections can be detected. The detected areas will then be assessed considering if they are situated in a place that should be prioritized for further investigations (e.g. friction measurement). The assessment and prioritization should look at factors such as if the sections are exposed for risks and considered more important, e.g. traffic amount, signed speed, in the shadow, exposed for warm weather, built with new material, newly resurfaced, sudden warm weather, situated in sharp curves with etc.

Table 2: Macrotexture minimum values for a suggested standard

Traffic flow (vehicles/day)	Signed speed (km/h)							
	120	110	100	90	80	70	60	50
0-250	-	0,20	0,20	0,20	0,20	0,20	0,20	0,20
250-500	-	0,25	0,25	0,25	0,25	0,20	0,20	0,20
500-1000	-	0,30	0,30	0,30	0,25	0,25	0,25	0,25
1000-2000	-	0,33	0,33	0,33	0,28	0,28	0,28	0,28
2000-4000	0,35	0,35	0,35	0,35	0,30	0,30	0,30	0,30

4000-8000	0,35	0,35	0,35	0,35	0,30	0,30	0,30	0,30
>8000	0,40	0,40	0,40	0,40	0,35	0,35	0,35	0,35

REFERENCES

FRICTI@N, http://friction.vtt.fi/presentation.html

The objective of the FRICTI@N project is to create an on-board system for estimating friction and road slipperiness to enhance the performance of integrated and cooperative safety systems like vehicle-to-vehicle communication, and driver information. Friction was finished in 2009.

Skidsafe, http://www.skidsafe.org/index1.html

Skidsafe is ongoing. The main objective and the novelty of the SKIDSAFE project is the development of a micromechanical, multi-physics computational tool for prediction of the progressive loss of skid resistance at the tyre-pavement interface as a function of the composition of the pavement surface and the deterioration of its characteristics with traffic loading.

INTRO, http://intro.fehrl.org/?m=1

INTRO (“Intelligent Roads”) is developing innovative methods to increase the capacity of road infrastructure and to maximise the safety and well being of drivers, passengers, crew and pedestrians. These involve the use and combination of existing technologies as well as combining them with developing technologies

Model for estimating expectable stopping distance

HMI friction warning, simulator study

HERMES, http://www.fehrl.org/?m=32&id_directory=614

Tyrosafe, finished in 2010, http://tyrosafe.fehrl.org/?m=1

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AUTHOR BIOGRAPHIES

Leif is a Senior Researcher at VTI (The Swedish Road and Transport Research Institute). He has been employed at VTI since 1980. His main fields of research cover the area of road surface characteristics including measuring techniques, quality assurance, control and testing and other research related to assessment of road condition and surface characteristics. He is a member of PIARC group, Road Surface Characteristics and active member in the European standardisation work, CEN TC227 WG 5 Surface characteristics of road and airfield pavements. He is also active in many EU projects.