Cooperation in the field of skid resistance between Germany and the Netherlands

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ABSTRACT

The Netherlands is on the way to change its existing skid resistance measuring method for its highway network from the Dutch RAW 72, a longitudinal force method, to the Sideway Force method. This method is described in the Technical Specification 15901-8 (SKM device) as well as 15901-6 (SCRIM device) and is in use in 9 European countries. The CEN TC 227 WG5 on Surface Characteristics is currently working on combining of these two technical Specifications into a European standard for Sideway-Force (SWF) measurement devices.
The idea of this change in the Netherlands was perceived in 2013 and since then a lot of meetings have been held with the different Dutch decision makers as well as with countries which currently operate SWF devices. There was an intensive exchange of knowledge about these devices and their corresponding quality assurance systems, because the Netherlands wanted to incorporate and rely on an existing system of a neighbor country without losing their present level of quality. The Netherlands has therefore decided to incorporate the German SKM approach. The network monitoring with the new system will start in 2017.
To ensure the quality of skid resistance measurements and further cooperation in this field, it has been decided to initiate an alliance between BASt and the Dutch road owner Rijkswaterstaat (RWS). This alliance will facilitate an exchange of research activities, calibration of the Dutch systems according to the existing German Standard as well as control measurements with a BASt-device on the Dutch network during the network monitoring.
During 2016 also comparative measurements will be performed on a network level with the current Dutch device and with an SKM device to determine a conversion between the two and to be able to define new threshold values.

Keywords: Comité Européen de Normalisation, Friction, Maintenance, Porous asphalt, Skid Resistance

1 INTRODUCTION

The asphalt road surfaces of the European network need for the sake of safe traffic sufficiently skid resistance. This is necessary in order to balance the horizontal friction forces, by which vehicle movements like acceleration, braking and steering are transferred in the contact area between the tyre and the road surface.

In the Netherlands Rijkswaterstaat (RWS) and the provincial and municipal road authorities measure the wet skid resistance using the RWS-skid trailer, see Figure 1. This measuring device was introduced in 1959 by Rijkswaterstaat and is an evolution of a system originally developed by Rijkswaterstaat and the Delft Technical University in 1930.
Typically for the measuring method is that the skid resistance is measured in the longitudinal direction with a slip ratio of 86% (almost blocking) at prescribed wet conditions and with a standardized non-profiled PIARC test tyre.
In the present Dutch normalization standards this method is referred to as RAW 72.

Figure 1: Example of a skid measuring device (RAW 72) for measuring wet skid resistance in the longitudinal direction as is in use in the Netherlands

Till 1985 Rijkswaterstaat was the only party which had measurement devices for wet skid resistance and conducted therefore all necessary measurements on the main road network itself. At this moment there are two active market parties in the Netherlands which have in total five RWS skid trailer devices at their disposal. The measurements are used in the annual network monitoring campaign, approval of construction contracts, assessment after warranty period of these sections, assessment of accident black-spots, as well as for various research topics.

For quality control Rijkswaterstaat compares periodically (about 10 times per year) all operational measurement devices together in a comparative testing. This includes not only the approval of a specific measuring device, but also the acceptance of the individual test tyres in use.

Meanwhile since about 2010, the two market parties have taken over almost all measurements for the annual monitoring of the main road network, as well as for acceptance control of new roads and assessment of warranty on the main road network.

As a result of this, Rijkswaterstaat is increasingly pulled back in the area of the measurement of skid resistance. What remains now is focused on the general quality assurance aspects of the method, both on the short and the long term. In the following of this paper this will be referred to as “the ownership” of the method. Apart from the already mentioned periodic quality control of the measurement devices of the market, this includes the supervision on the specifications for skid resistance measurements in the Netherlands, every two years the organization of the delivery and acceptance of new test tyres and the acceptance of any new RWS skid trailer measurement devices. For this purpose Rijkswaterstaat still owns one operational measurement device unit.

An extended overview of the way how skid resistance is implemented in the various processes of Rijkswaterstaat can be found in [1].

The objective of this paper is to give information on the following issues:

- state of the art of European harmonization on skid resistance
- background and preparation for the change of skid measurement method in NL
- cooperation between Germany and the Netherlands
- transition programme 2015 - 2016
- outlook for 2017 and later.

About 90% of the European Network is made of asphalt pavements. In the Netherlands as well as in Germany the network also consists of a higher percentage of asphalt pavements than of concrete pavements. Due to these facts mentioned above there will be an active exchange of knowledge and research results about skid resistance on asphalt pavements between Germany and the Netherlands and even on specific topics since in the Netherlands nearly 85% of the network is made of porous asphalt. There are some differences expected with regard to skid resistance between the behavior of dense asphalt and porous asphalt.

2 STATE OF THE ART OF EUROPEAN HARMONIZATION ON SKID RESISTANCE

When in Europe in the previous century the first national main roads were constructed, many countries developed measurement methods to assess the skid resistance of the road surface under traffic flow conditions. These developments were mainly done independently from each other.

The measurement methods differ much in measuring principle, dimensions, loading and measuring conditions. Some measure the friction properties in the transversal direction, the other in the longitudinal direction. The first group uses test tyres which are mounted with an angle of 20 degrees with the travel direction, therefore Sideway-Force (SWF) method called. Slip ratio is fixed at 34%. The second group uses test tyres running in line with the travel direction. Quite a lot of different test tyres (diameter, rubber type and profile) are used, different slip ratios ranging from ca 15 % (near ABS conditions) to 100% (locked wheel conditions) and with different loading and measurement conditions.

> definition skid resistance
> the skid resistance of a road surface is defined as the friction coefficient under standardized conditions

In the literature [2] no convincing evidence is found which measuring principle (transversal versus longitudinal) is more linked to traffic safety. From a theoretical point of view it can be expected that the transversally measured values would be linked more to sliding of vehicles during steering and longitudinally measured values skid resistance would be linked more to braking distance.

Since almost all existing measurement methods determine the friction properties at many different conditions it can be expected that this leads to very different outputs which are not easy to compare. This complicates the exchangeability of measurement data.

The first initiative for European harmonization of skid resistance was carried out in 1992 – 1996 with the international PIARC experiment [3]. This was more than 10 year later continued in the European HERMES project in the period 2002 – 2006 [4]. These both projects aimed at defining a common scale based on a kind of average of all device types and finding a (magic) formulae suitable for conversion of the individual device types into this common scale.
In both projects comparative tests with more than 10 different device types were carried out. Unfortunately this approach failed due to a worse accuracy when using the derived conversion formulae.

An evaluation of the approach of deriving a common scale was carried out in the TYROSAFE project (2008- 2010). It was concluded that the major stumbling block in this approach is the difference in measuring principle, transversal versus longitudinal. Also the above mentioned differences in device specifications, as well as the fact that the calibration was not always done correctly, were denoted as reasons why a sufficiently reliable and accurate translation via conversion formulas was not found.

As a first further step in the harmonization process of skid resistance TYROSAFE advised in their final report to the European body CEN Technical Committee 227 Working Group 5, to draft Technical Specifications (TS) for all relevant skid measurement device types. This working group is in charge for drafting a single European standard on skid resistance. This encompasses the uniform description of the technical aspects including the operation conditions of all the different device types which are in use in Europe. A following step would be to draft one single standard on skid resistance.

This idea was adopted by the CEN working group and nowadays there are 15 TS on skid resistance available. Three TS deal with device types that measure skid resistance in the transversal direction (SWF) and 12 TS deals with device types that measure skid resistance in the longitudinal direction.

Table 1 shows some relevant information of the three device types for transversal skid resistance, the SCRIM (Sideway force Coefficient Routine Investigation Machine), the SKM (Seitenkraftmessverfahren) and the Odoliograph. Comparing the TS of these three device types it is found that the SCRIM and the SKM are almost identical devices, whereas the Odoliograph is much more different in respect to size and type of test tyre and tyre load. The very high level of conformity of the SCRIM and the SKM is due to the fact that the SKM is a further development of the SCRIM.

The twelve TS dealing with device types that measure the longitudinal skid resistance are mostly used in one or two countries. As already mentioned these device types use quite a lot of different test tyres, slip ratios and different loading and measurement conditions.

Table 1: Overview of skid device types for measuring transversal skid resistance (SWF)

device	application	countries in use	number of devices
SCRIM	monitoring, warranty approval new surfacings research	United Kingdom, Belgium, France, Spain, Portugal, Italy, Slovenia	about 30
SKM	monitoring, warranty approval new surfacings research	Germany, Switzerland	about 20
ODOLIOGRAPH	research	Belgium	1

In 2013, after many discussions, the CEN working group decided not to pursue on a route of a single European standard on skid resistance, but to distinguish principally skid resistance in the transversal direction from skid resistance in the longitudinal direction. Almost at the same time a new European project called ROSANNE was initiated dealing with pre-normative research on noise, rolling resistance and skid resistance measurement methods.
For skid resistance the focus is to prepare two draft standards:

- one for transversal skid resistance. This will be done by mainly a merge of the TS of the SCRIM and the SKM, keeping some options in an Appendix to include also the Odoliograph. An historic moment was in spring 2015 when a first draft standard on skid resistance with the SWF method was discussed and commented in the CEN working group.
- and one for longitudinal skid resistance. This will be done by using the idea of the common scale, based on new measurement series.

In the course of the ROSANNE project comparison tests on the test track of IFSTTAR in Nantes took place in spring 2014 and 2015. In the category of transversal skid resistance a total of 8 SWF measurement devices from 6 European countries were used. The measurements were carried out on 10 different sections of road surfaces and with five different measuring speeds. In addition measurements on real road sections were carried out as well. The ROSANNE project will terminate in the end of 2016.

Figure 2: Comparison tests on the test track of IFSTTAR in Nantes

3 BACKGROUND AND PREPARATION FOR THE CHANGE OF SKID MEASUREMENT METHOD IN THE NETHERLANDS

3.1 Exploration for a change to measuring device type like SWF

In 2012 RWS started an exploration study into the possible transition to a new measurement device type [5]. The reason was that Rijkswaterstaat signals a long term risk for the necessary ownership activities of the skid resistance method. This is because specialized RWS employees, especially operators, will retire in the coming years and it was also doubted whether because of prioritizing of all activities new employees would replace them. This could no doubt have a negative effect on the necessary ownership activities, which will lead to a quality problem in the field of skid resistance measurements.

To get the necessary input for the exploration study many parties have been consulted, such as colleagues from the road authority from the German Federal State Northrine Westphalia (Straßen.NRW), from the Transport Road Laboratory (TRL) in the UK and from the Federal Highway Research Institute (BASt) in Germany.

Based on this input and many discussions with experts of RWS internally it was decided to study two variants more in detail:

1. keeping the current measuring method according to RAW 72 and improving the temperature correction to increase accuracy,
2. make a change to measuring devices based on the SWF method, like the SCRIM or the SKM. These are almost identical measuring device types and have a widespread use in nine European countries.

Figure 3: Example of a Sideway Force device (SKM) for measuring skid resistance in the transversal direction

3.2 Risk session

The first activity, a risk session, was held in June 2013 with about twenty experts and users on skid resistance in the Netherlands. Amongst them were also employees of the two Dutch measuring market parties who carry out all the skid resistance measurements. Using an electronic board room session a large number of possible risks for the two variants were identified. For the main risks the measures to control the risks were formulated.

For the variant change to measuring devices based on the SWF method the following main risks were formulated:

1. will there be a sufficient correlation between the current and the new method,
2. possibly high costs of the transition,
3. how to ensure the general quality assurance aspects of the method, both the short term and the long term stability,
4. how to judge the quality of specific measurement series,
5. almost all knowledge of other devices is on dense surface, porous surfaces might behave differently.

The first issue is studied in detail in a pilot project, see next subchapter 3.3,
The second, third and fourth issue are discussed in the business case, see subchapter 3.4. The last issue needs more research to be carried out before the actual change will be done. This will be discussed in chapter 5.

3.3 Pilot project of comparison measurements of current RAW 72 method and SWF method

The second activity, the pilot project, was held in July 2013, see [6]. In this pilot project in the region of Arnhem a road network of about 326 km was measured both with the current method RAW 72 and with the SWF method, for which a SKM device was used. Figure 4 shows the relation between the measurement values of both device types.

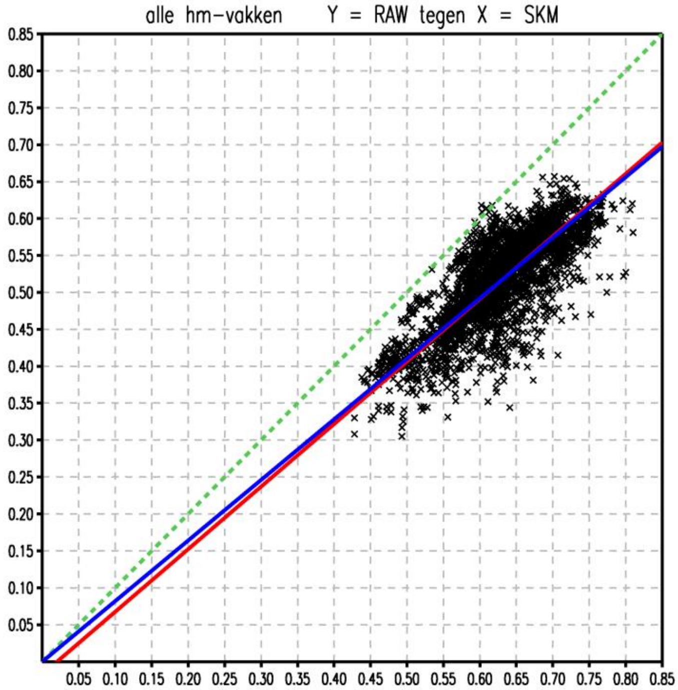

Figure 4: Relation Current method (Y axis, "RAW") and SWF method (X axis, "SKM") on 326 km road network with 71% porous surfaces and 29% dense surfaces

A statistical analysis of the pilot results showed that the accuracy of the current RAW 72 and SWF method are very similar. With one conversion factor for all surfaces, the differences between the measured values of both measuring methods give an increase in the normal accuracy by a factor of 1.65. A separate conversion factor for open surfaces gives no increase in the normal accuracy, whereas a separate conversion factor for dense surfaces gives an increase by a factor larger than 1.65. These differences, however, will only result in a one-off transition and will not harm on the general safety levels.

3.4 Business case report and decision

The third activity, the preparation of a business case report, took place in autumn 2013 [7]. In this report a possible transition approach was developed, see for more detail chapter 5, and financial calculations were performed. Also a qualitative judgement was given on both two variants. The following criteria were used: personal consequences, continuity, quality, market aspects, relation with European harmonization, annual costs, transition costs and transition risks.

The business case report has been discussed with many parties within Rijkswaterstaat. This has led to a special discussion note for the Board of directors of Rijkswaterstaat with the advice to make indeed the change to the SWF method.

The main reasons for this advice are:

- this fits better within the RWS policy of more market and less self-executing,
- due to the widespread use in Europe cost savings can be foreseen for the annual monitoring of the main road network,
- decrease of number of employees at RWS on skid theme of about 2 per year,
- more in line with European harmonization and improved compatibility of measurements with other countries.

In August 2014 the Board of directors of Rijkswaterstaat made a positive decision to make the change to the SWF method per 2017 for all wet skid measurements on the main road network in the Netherlands.

The main consequences of the decision are:

- the future quality of the measurements of the wet skid resistance should be well guaranteed, as a first realistic option a cooperation with the BASt in Germay should be explored,
- from the beginning of 2017 the SWF method is the exclusive method for measuring wet skid resistance on the main road network and the current RAW 72 is not valid anymore,
- new threshold values needs to be determined for the different applications and agreed upon with market parties,
- all existing contracts with road contractors have to be changed accordingly,
- Rijkswaterstaat will no longer have its own measurement equipment for wet skid resistance.

To be well prepared for the change it was decided to launch a structured transition program to be executed in 2015 and 2016. On the first issue, cooperation, the following chapter 4 will give more details; the other issues will be dealt with in chapter 5.

4 COOPERATION BETWEEN GERMANY AND THE NETHERLANDS

4.1 Short introduction about skid resistance measurements in Germany

In Germany devices with the SWF-principle for measuring wet skid resistance are used for nearly 30 years in the network monitoring process, investigations and assessment of accident black-spots, approval of construction contracts and also after warranty period of these sections as well as for various research topics.
Due to this fact it was necessary to develop technical descriptions for the device and also establish a quality assurance system to prevent any problems due to implausible results during the measuring campaigns.
The first technical description for the devices with a SWF-principle was published in 2001. Within this context before but mostly after this publication a lot of research projects were initiated to investigate the various (external and internal) effects on the measured values. The projects were for example about impact of different speeds as well as various temperatures on the measured values. Also the accuracy of the measurement values in terms of repeatability and reproducibility was analyzed. The results of these projects were one of the aspects which lead to a new version of the technical description in 2007 with improved correction formulae and a specified description of how to make sure that the results of the measured sections are valid.

Within the process of an European harmonization and standardization process a Technical Specification of the German SWF-device (called: SKM) was developed as part 8 of the TS 15901series among nine other European devices for measuring wet skid resistance in 2009. In 2013 a development of a common SWF-Standard which combines the TS of the SCRIM and the TS of the SKM began. At the end of 2014 the first draft of this document was circulated among the members of CEN TC 227/WG 5 for comments.

For advanced analysis in the field of skid resistance and its changes over time BASt has been conducting a database with skid resistance values for more than 10 years. To ensure this the Federal States report to BASt the results of each skid resistance measurement in connection with contraction contracts – new work approval as well as at the end of warranty period.

Figure 5 shows two cumulative frequency curves of SMA (stone mastic asphalt) at two different points during the lifetime of this surface – at new work approval (left) as well as at the end of warranty period (right). The required values for skid resistance are defined in the Supplementary Technical Conditions of Contract, Specifications and Guidelines for asphalt as well as for concrete roads. These values depend on the measuring speed and for new work approval it is $\mu_{SKM,80}$ = 0,46 and at the end of the warranty period it is $\mu_{SKM,80}$ = 0.40. About 2% of new SMA-surfaces and about 0.7% of SMA-surfaces at the end of warranty period don't meet these limits. Due to this fact measures to improve the skid resistance are necessary.

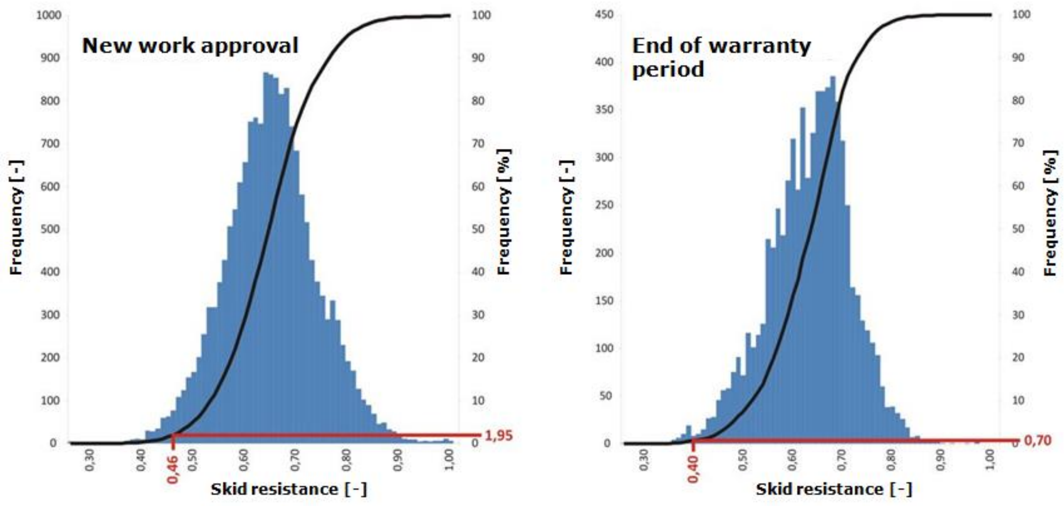

Figure 5: Cumulative frequency curves of skid resistance of SMA-surfaces at new work approval as well as at the end of the warranty period

Based on this database also the changes of skid resistance limits in the technical documents can be demonstrated. At the moment there are investigations ongoing about the impact of changes in the asphalt mixture on the skid resistance levels at new work approval.

4.2 Quality assurance process in Germany

The German transport network is substantially used and burdened caused by its central location within Europe. For a systematic maintenance management in the first instance the condition of the road is detected by using of a standardized procedure. Since 1991 road monitoring and assessment has been playing a major role in the registration and assessment of skid resistance, evenness/roughness and substance characteristics of road surfaces.

The measured data are used to calculate condition variables. Grades ranging from 1 (very good) to 5 (very poor) are used to characterize an investigated road's condition. The ratings are made up of utility and consistency components in accordance with a defined weighting scheme. The utility component indicates the level of safety and comfort for road users. The consistency component mainly indicates road maintenance results. Both components together form the overall rating.

Individually determined condition parameters and associated values are displayed on special maps, for instance – see Figure 6. This provides an overview of road network conditions and serves as a basis for planning road maintenance measures.

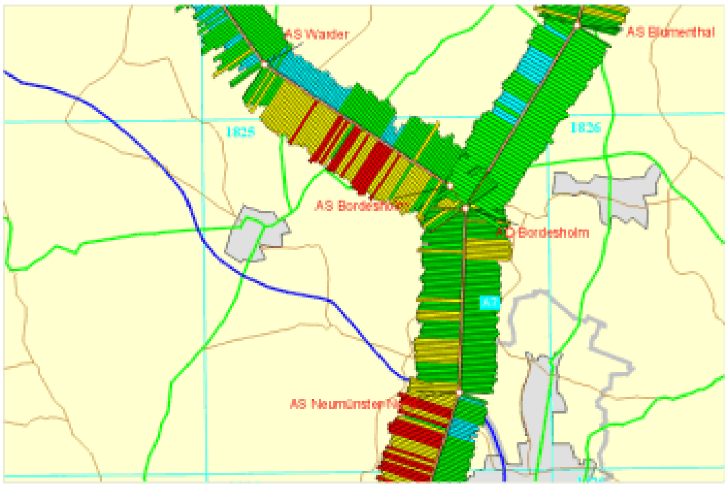

Figure 6: Road surface conditions - network overview

To ensure the quality of the data, the BASt has installed a quality management. It covers the technical examination of measurement vehicles, to monitor the acquisition process and the quality control of the measured data.

The quality assurance process for the SKM-devices in Germany is based on a three level system – calibration, external checks and internal checks which will be described in more detail in the following paragraphs. Figure 7 gives an overview of the existing quality assurance system (QA-system) for SKM-devices in Germany.

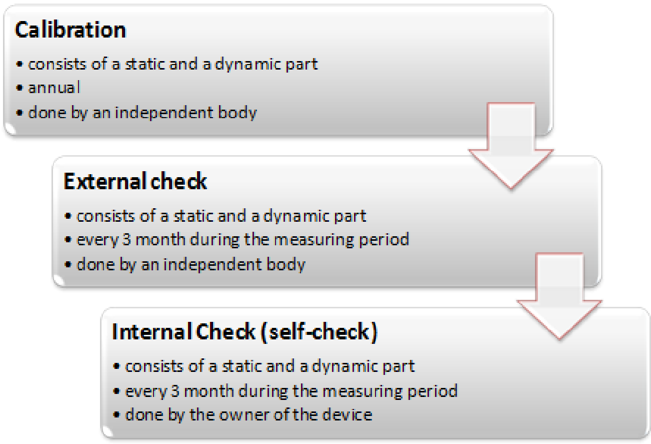

Figure 7: Overview of the QA-system for SKM-devices in Germany

The so-called lowest level of the QA-system is the internal check ("Eigenüberwachung"). These checks have to be done by the owner of the devices on their own responsibility every month during the measuring period. It always consists of a static and a dynamic part, that means during the static part the system itself will be checked like the free movement of the bearings and some other things of the measuring unit itself, while the dynamic part comprises measurements on two different sections which fulfill the given requirements.

The external check ("Fremdüberwachung") represents the second stage of the QA-system. This check also consists of a static and a dynamic part. This means that during the static part further tests, additional to the one which are executed during the internal check will be done these are for example checks of the line guidance system. The dynamic part comprises comparison measurements on only one section which fulfill the given requirements. But in contrast to the internal check the external check has to be done by an independent organization – in Germany its BASt which is doing this job. That means that the owner of a device has to arrange a date within a three-month period during the measuring season and then he brings his device to BASt where all the necessary checks will be executed.

The Calibration is the most comprehensive check of the SKM which comprises all necessary checks of the device, like the measuring unit, all temperature sensors, line guidance system and all safety installations. The calibration also consists of a static as well as dynamic part. During the dynamic part there are comparison measurements on three different sections necessary which also fulfill the given requirements. Like the external check the calibration has to be done by an independent body – in Germany it's also BASt. The calibration has to be done once a year.

There are publicly available descriptions of process for all three levels of the QA-system for SKM-devices in Germany. These documents describe all the checks which have to be done and also the requirements which should be met.

For the process of the network monitoring there is an additional column of the QA-system – it's the so called control check. This check is used to check the quality as well as conformity of the device used by the company which is responsible to do the measurements for the network monitoring and will be done depending on the progress of the measurements in situ by BASt. Due to the fact that the wet skid resistance can be effected by the weather conditions these control checks should be done with only few days delay to the measurements of the contractor. To ensure that the contractor has to report the measured sections on a daily basis via an internet page. Based on these information an appropriate section will be selected and measured by BASt. The results will be compared with the results from the contractor and the difference between the two devices should be within given limits, otherwise there will be sanctions inflicted.

4.3 Aspects and content of the Memorandum of Agreement (MoA)

Based on the fact that RWS is in a process of changing its present skid resistance standard from a longitudinal skid resistance measuring method to the sideway force method, RWS was very interested to gain any information and support in the field of this measuring method. While Germany has been using the skid resistance measuring method for decades and BASt as an independent Federal highway research institute has a central role in the German quality assurance process of the SKM-Standard in Germany, RWS wants to cooperate with BASt on the quality assurance of the SKM-implementation in the Netherlands. This was the basis for Memorandum of Agreement (MoA) between RWS from the Netherlands and BASt from Germany.

This MoA contains different topics these are among other things sharing of knowledge and cooperation in the area of measurements of surface characteristics especially in the field of porous asphalt in this stage mainly focused on wet skid resistance and BASt will also take over a special part of the quality assurance system during the network monitoring process in the Netherlands. This part consists of control measurements and periodical measurements of preselected sections. The control measurements are used to check the compliance with the existing quality specifications and to assess the measurements executed by the contractors of the network monitoring in the Netherlands, due to this random control sections of the network will be selected and measured by BASt with a minimum time difference to the measurement of the contractor. Furthermore BASt will support this RWS-transition to SKM-measurements with its technical expertise and mutual support as well as cooperation in research field of the wet skid resistance issues.

4.4 Importance of the Memorandum of Agreement

This MoA gives an unique chance of a cross-national collaboration in the field of surface characteristics, while one country adopt more or less the national regulations of another country and both countries will work close together in the field of quality assurance as well as in the field of knowledge exchange and research on various skid resistance issues. Due to this it will be much easier to establish common harmonized standards also in cooperation with other involved countries.

The first step within the MoA will be in the field of skid resistance, like exchange of knowledge, support the RWS-transition to SKM-measurements with technical expertise by BASt, mutual support and cooperation in the field of research needs as well as support of the quality assurance process of the network monitoring in the Netherland by regularly control checks. But in future this MoA can be extended to other pavement surface characteristics like evenness/roughness, raveling and cracking.

5 TRANSITION PROGRAMME 2015 – 2016

5.1 General

In this chapter the major activities will be explained which will take place in the transition to a full implementation of the SWF method for the main road network.
The main activities are:

1. European tendering for the annual network monitoring with SWF method of the complete road network,
2. carrying out a full scale trial campaign with SWF in 2016,
3. changing all existing contracts with road contractors
4. specific measurements on selected topics.

5.2 European tendering for annual monitoring campaign whole main road network

In this activity first the specifications have been drawn for executing SWF measurements. Since there is not yet an approved European standard of SWF, see chapter 2, for the time being a practical choice had to be made between the technical specifications of either the SCRIM or the SKM. As it is explained in chapter 4 of this paper, the quality assurance will rely fully on the BASt approach developed for the SKM, so it is a logical choice to use the German specifications for the execution of the wet skid measurements [8]. This definitely may not be interpreted as a value judgement on the SCRIM specifications.
The next step was the launching of a European tender procedure at the end of January 2015. The scope was the monitoring in 2017 of the complete main road network of about the 6.000 lane-km including about 900 km of passing lanes. Optional in the scope is continuation with a maximum of three years till 2020. The work was split in two parts of about equal size and end of July 2015 the final choice for two bidders was made.

5.3 Full scale trial campaign in 2016 road network including statistical analysis for determining the conversion

In the scope of the European tender also the full scale trial campaign is included. In this trial the wet skid resistance of all right hand lanes of the complete road network will be measured with the SWF method. There are two reasons for this trial campaign:

- the first reason is to determine the conversion of measurement values of the RAW 72 method with those of the SWF method. For this purpose all the measurement values of the SWF method will be compared with the values gathered in the most recent annual monitoring campaign with the current RAW 72 method. In a similar way as has been done in the pilot project, see subchapter 3.3, but now on much more data, in a statistical analysis the conversion for measurements with a measuring speed of 80 km/h will be determined. Once knowing the conversion the approach is that for the respective threshold levels as used in annual monitoring, for approval of construction contracts and at the end of the warranty period, the conversion is balanced around the current one. Therefore the conversion will have neutral effects at network level, and so no impact on traffic safety and maintenance costs. On project level however there might be some deviations and it is also one of the specific goals of the analysis to study whether some systematic effects can be found which need attention for.
- the second reason is to serve as a general rehearsal for the first year of monitoring in 2017. This both with respect to the capability of the measuring firms and the quality of the work they can deliver but also for checking the internal Rijkswaterstaat procedures including the used software.

5.4 Changing existing contracts

Once the new threshold levels have been fixed all existing contracts with road contractors need to be adapted. This deals with changing threshold levels for new road approval and warranty levels ultimately by the end of 2016. An important factor of success in this activity is the willingness of the road contractors. To gain their collaboration the road contractors are invited to participate fully in the process of determination of the new threshold levels.

5.5 Specific measurements on selected topics

On three specific topics some gap of knowledge exists which needs to be filled in to ensure a successful implementation of the SWF method.
These are:

- *seasonal and temperature effects*. From the current RAW 72 method it is known that measurements in the summer time, July and August, are not always as stable as necessary. The reason is most probably a combination of both seasonal as well as temperature effects. Therefore in the regulations of the annual monitoring campaign with the current RAW 72 method measurements in July and August are not allowed. In SWF method, as implemented in the SKM, corrections are adopted in the software for effects of both the road surface temperature as well as the water temperature. The corrections are based on research of the BASt carried out about 12 years ago on common dense surfaces in Germany. These corrections improve the stability of the measurements during the summer time as well. In the SWF tender of the annual monitoring campaign the usual restriction in the Netherlands of not measuring in July and August is therefore skipped. In planning now is to perform comparative measurements with both current RAW 72 and SWF devices on about ten road sections with porous surfaces. The measurements will be carried out once a month in the period autumn 2015 till end of 2016. Purpose is to check/demonstrate the validity of the temperature corrections for the road surfaces used in the Netherlands, which are dominantly porous surfaces. When unexpectedly disappointing results would be found than appropriate measures should be defined.

- *behavior in curves.* In the analysis of the measuring data of the full scale trial campaign for the conversion it is foreseen to distinguish between straight road sections and right bends and left bends including the possible effect of the radius of the bends. In the ultimate case, this could lead to different threshold values for right and left bends and a dependency of the radius. However it cannot be argued that the thresholds for curves belonging to the current method are sufficiently representative for the assessment of the safety level in bends. It is expected that the polishing of the tyres in bends and consequently the relative loss in wet skid resistance, mainly takes place in the transversal direction and not in the longitudinal direction. In planning is to select a small number of right and left bends with the most critical radius which happens to be between 150 and 300 m. From these bends the skid resistance will be measured with both wet skid resistance methods. On top of that also measurements with a Skid Resistance Tester (SRT) will be carried out, see Figure 8. This is a portable instrument. SRT values will be determined in several positions in the bend and in several orientations (transversal and longitudinal).

Figure 8: Skid Resistance Tester (SRT)

- *low measuring speed*. Additional to the conversion at 80 km/h, as it will be determined based on the full scale trial campaign in 2016, there is a need to study the conversion at lower speeds in the 30 – 60 km/h range. Application is for connecting roads in the main road network with reduced speeds and also for provincial roads and roads for municipalities. The planning is to carry out comparative measurements with both methods on typical road surfaces for these types of roads.

6 OUTLOOK FOR 2017 AND LATER

The outlook for 2017 and later can be summarized as follows:

- the skid resistance measurement method RAW 72 will terminate for use on the main road network,
- consequences for the provincial roads and the roads of municipalities has to be decided by those road owners,
- RWS will withdraw its own measurement device and will terminate the ownership of the RAW 72 method,
- BASt will watch over the quality control of measurement devices used on Dutch main road network,
- BASt will perform on a regular basis control measurements,
- annual monitoring campaign by SWF,
- acceptance control new surfacings by SWF,
- assessment warranty/guarantee by SWF,
- evaluation after two full years of operating production measurements.

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