Road surface labelling

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From: Dutch working group on road surface labels: Johan Sliggers (Ministry of Infrastructure and Environment), Theun Stoffels (RDW the Netherlands Vehicle Authority), Berry Bobbink, Remco Hermsen and Harco Kersten (Province of Gelderland public works department), prof.dr. Dik Schipper and dr.ir. Henny ter Huerne (Technical University of Twente), dr.ir. Arian de Bondt and dr.ir. Frank Bijleveld (Contractor Strukton Civiel), Cees van Oostenrijk and Michiel van Koeverden (NVR Dutch Association of Rubber Industry / Association Tyre and Environment), dr.ir. Jacob Groenendijk (Kiwa KOAC pavement research and consultancy)

Contact: Johan.Sliggers@minienm.nl; mailto:FBijleveld@Ooms.nl

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1 Introduction

Road surface labels encourage the road construction industry to develop, build and manage safe, liveable, sustainable, durable and economic roadways. Such labels could be the basis for discussions between local, regional and national governments/road authorities and road builders regarding the quality of road surfaces. Road surfaces labels would increase transparency in road building, initiate innovation and allow for a better understanding between road builders and tyre manufacturers. The draft road surface label in this document consists of four performance indicators of which three correspond with the three performance indicators on the tyre label.

Labels are a categorisation of requirements and guidelines, often from class A (good) to G (bad). Examples include energy labels for washing machines, buildings and cars, but the labels may also concern properties other than energy. For example, tyre labels on which the wet skid resistance and noise properties of tyres are displayed in addition to rolling resistance (influencing fuel consumption).

The direct purpose of road surface labelling is easier, transparent communication between the client and contractor, between road authorities and road users, taxpayers and residents. Moreover, it promotes a recognition towards society and politics and promotes a better public awareness of road surface performance. The deeper purpose of road surface labelling is to stimulate the development and application of better road surfaces with less cost to society.

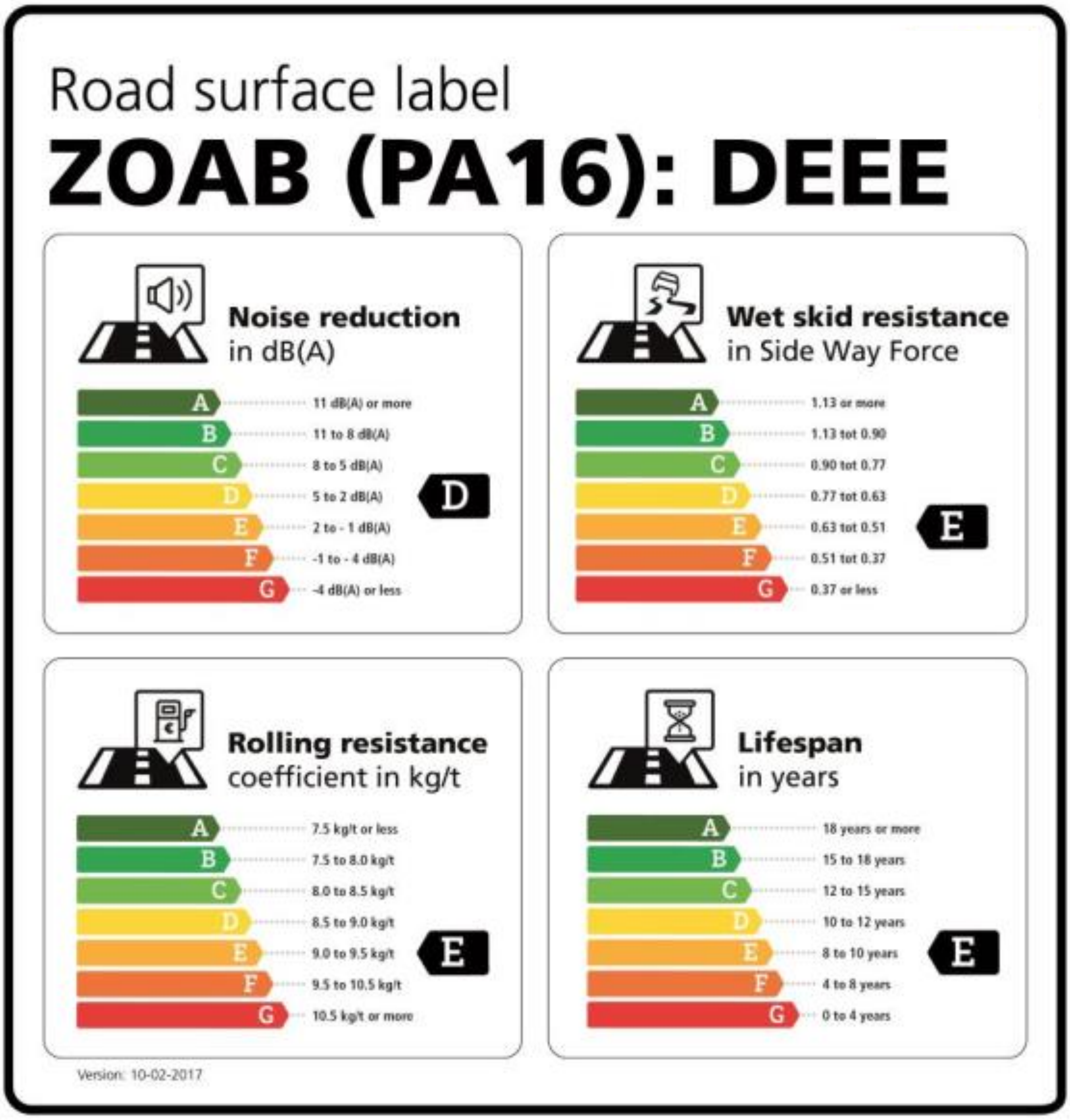
The goal of this document is to propose a guideline to make a label for road surfaces (wearing courses) with the following four performance indicators:

- Traffic noise reduction
- Wet skid resistance
- Rolling resistance
- Lifespan

The first three indicators of road surface performance are all indicators of tyre-pavement interactions, and therefore influenced by tyre properties and ambient conditions. Therefore standard tyres shall be used to measure these indicators of road surface performance. Where possible, relevant conditions (e.g. temperature or measuring speed) shall be standardised as well, or limited in range, or variations should be corrected for.

The goal is to develop a road surface label and not to change the tyre label.

The figure below gives an example of such a label for a Porous Asphalt (16 mm nominal grain size), showing the label scales and label classes for the four performance indicators.



All characterisation methods, and boundaries for label classes (A to G inclusive), mentioned in this document, are proposals of the Dutch working group, to make the subject more tangible, The working group advocates the use of harmonised European characterisation methods, such as are being developed by CEN TC227/WG5, a.o. in the recent ROSANNE project. However, at present such harmonised methods do not yet exist, but the Dutch working group is already initiating pilot projects using road surface labels in contracting road works. Therefore, specific methods and values had to be chosen, which were suitable in the present Dutch context, relating to European practice as much as possible.

The main preconditions for road surface labels are:

- Compatible with the existing tyre label;
- Compatible with existing international standards and measuring methods;
- Suitable for current and future vehicle fleet;
- Includes (only) essential road surface features - for both new and existing roads;
- Allows for (meaningful) innovation (product and process).

2 Benefits and necessity (long term): Accessibility, safety, liveability, sustainability, durability and economy

Roads exist to facilitate the mobility of people and goods. Important political and social issues concerning roads include accessibility (and therefore availability), safety, liveability, sustainability, durability and economy. These themes are related to road surface performance indicators as shown in the table below.

Themes from politics and society	Performance indicator to address from a tyre-road surface perspective
Safety	Skid resistance
Liveability	Noise reduction, Rolling resistance
Sustainability	Environmental Cost Indicator
Accessibility, availability	Lifespan
Economy	Rolling resistance, lifespan

For the safety of a road the skid resistance performance is key, for the liveability (theme) the tyre-road surface noise, and for both durability and economy (and CO_2) the rolling resistance is very important. For accessibility and availability, the lifespan of the road, both mechanically and functionally, is an important parameter. This lifespan can be further worked out in, for example, resistance to crack formation, resistance to rutting and ravelling. Finally, sustainability can be expressed in an Environmental Cost Indicator of a road surface.

How does it benefit society?

Road surface labels encourage the optimisation of road surfaces, e.g. for tyre-pavement noise, skid resistance, rolling resistance and lifespan, and help to make choices between different road surfaces. Such improvement of road surface performance will reduce the road-related costs of mobility for society and environment, in reducing fuel consumption, CO_2 emission, accident costs and noise nuisance.

For example, reducing rolling resistance by approximately 10-30% yields fuel savings of 2-6%, and the risk of accidents at good skid resistance is 2-5 times less than with a very poor skid resistance. Silent road surfaces reduce nuisance, noise-related sleep problems, and the need and costs for visually less appealing sound barriers.

Benefits for the whole of Europe have yet to be calculated. For the Netherlands 4% fuel savings yields about 1Mton CO_2 reduction annually (for national roads + provincial roads) and approximately €325 million social benefits (for national roads alone). Better skid resistance could save significantly on the annual €8 billion of Dutch traffic accident costs. Lower noise can save €400 million for heightening the present 400 km of noise barriers in the Netherlands.

The road surface label can easily be used in the management stage in order to more accurately determine the replacement time in advance and to be able to communicate with society. It encourages road builders to develop products with enhanced rolling resistance, optimum skid resistance, less noise, and an increasing lifespan. Road surface labels stimulate road authorities to tune requirements to specifics situations. Importantly, road surface labels enable the tax payers that finance the road, the road user and local residents to easily appreciate what road surface quality they are getting.
In addition, it facilitates the cooperation between the road industry and tyre industry and other relevant partners, resulting in faster innovation cycles (shorter turnaround of new products) and makes the optimisation of tyre-road interaction really possible. Indeed, a tyre can be optimised for a particular type of road surface, but might be less optimised for another type. Alternatively, a road surface can be optimised for a particular type of tyre, but might be less favourable for a different type of tyre. If these two sectors - the tyre industry and road construction industry - understand each other better, tyre-road interaction can be optimised as a whole. Road surface labelling should lead to the recognition of a road as a product that is industrially designed, built and maintained.

3 Context

The road surface label is intended to be used in multiple ways within the road construction contracting process:

- Specification for road construction tenders: Enabling road authorities, or other legal entities, commissioning pavement works, to specify functional performance of pavement surfacing, by specifying performance classes of important functional characteristics.
- Corroboration ("creating trust") for contractor bids for tenders;
- Works approval, by providing the framework against which the delivered characteristics can be compared;
- Threshold value during warranty period or maintenance period.

4 Scope & Exclusions

The label only considers the road surface. For example, for the topic of safety the skid resistance is included, but the layout of the road (i.e. limiting visibility) is not. Presently, the label is limited to road pavements, later it could possibly be extended to airfields or other types of pavements. The label is intended to cover all types of road surfaces: asphalt mixes, Portland cement concrete, natural stone tiles or blocks, fired clay brick, concrete paving blocks, etc.

The road surface label is voluntary and preferably self-regulating. Labelling road surfaces is primarily the responsibility of the producer.

The road surface label is not intended to change or replace tyre labels, although it concerns the same phenomena. The road surface label is complementary to tyre labels:

- Tyre label: How does a particular tyre model perform on a standard road surface?
- Road surface label: How does a particular road surface (type) perform under standard tyres?

It is not intended to prescribe minimum requirements in the labelling system itself. Minimum requirements should be prescribed by parties using labels in tendering requests for road works.

Road surface characteristics may differ widely between different types of pavements, and required values may also differ much between different applications (e.g. motorway vs low-volume rural road). Therefore, with only 7 label classes (A-G), the range of characterisation values within one label class needs to be rather large. Therefore, contract specifications need not be limited to label class boundaries. Of course, additional requirements can be set in the contract besides the road surface label.

No check of compatibility between specifications is built-in within the road surface labelling system, as it is mainly intended for professional road agencies and road contractors. Also: specifications that today are impossible to realise, individually or in combination (e.g. >15 dB noise reduction and >30 years of lifespan under heavy traffic) may be possible in the near future.

5 Description of proposed road surface labelling concepts and examples

5.1 General

The proposed labelling system is deliberately kept as simple as possible and still tries to stimulate improvement and optimisation (seeking balance between stimulating improvement and clarity / simplicity), similar to the tyre label. Therefore, only one set of scale values is chosen for each of the four considered most essential road surface performance indicators. For each indicator there exists more than one method to measure or determine a value. The proposed characterisation methods are chosen to match existing regulations and practices as well as possible. In the future, these can be replaced by harmonised European standards when these become available.

The proposed boundaries of the label classes are chosen such that F or E are common now, D and C represent current good practice, B is a challenge and A is not attainable at present, but should pose a realistic challenge for the next 5-10 years.

The proposed label scales are based on in-situ properties, measured using different concepts for different properties: standardised tyres under standardised conditions (for skid resistance, rolling resistance), representative traffic (for tyre noise reduction), or actual traffic (for lifespan). Laboratory tests on laboratory-made surface specimens may be used to predict in-situ behaviour for purposes of road surface product development. However, “the proof of the pudding is in the eating”, so the in-situ values are decisive. For noise reduction, skid resistance and rolling resistance, i.e. properties that can be determined within a year after construction of a road surface, the label class for innovative products should preferably be based on a set of pilot sections. For lifespan, this is not practically feasible as the actual performance of the in-situ road surface only shows after many years. By necessity, this label class therefore has to be based on predictive laboratory tests.

For measuring in-situ properties of road surfaces, methods were chosen that can be executed in the run of traffic, to avoid traffic disturbance or unsafe measuring.

It is recognised that e.g. wet skid resistance and tyre-pavement noise are highly dependent on vehicle speed, and that the speed-dependency may differ strongly between pavement types or categories. Nevertheless, for simplicity it is proposed to base the label scale on only one speed, 80 km/h. Similarly, the proposed label scale is only based on passenger cars, not considering vans, trucks, motorcycles or others. If desired, alternatively a composite value could be based on e.g. 10% trucks and 90% cars.

It is also recognised that road surface characteristics often will change over time. Skid resistance will decrease due to aggregate polishing and tyre-pavement noise may increase as surface texture roughens and sound-absorbing pores get clogged. For noise reduction and skid resistance, “young” values are used, and the decline may show by the road surface “dropping out of its label class”. Limiting such a drop is not proposed to be part of the road surface label, but to be covered in road construction contracts.

5.2 Noise reduction

5.2.1 method

The proposed characterisation of road surfaces is the correction term for the influence of the pavement on the tyre rolling noise, as defined in sections 2.2.3 “Rolling noise” and 2.2.6 “Effects of the type of road surface” of the environmental noise directive 2015/996/EC, for m=1 (light motor vehicles) and A-weighted over all octave bands i.
As reference road surface, described in section 2.2.2 “reference conditions” of 2015/996/EC, the Dutch reference is proposed, described in [1]. This is a numerical equation (“virtual road surface”) based on measurements on several sections of asphalt concrete, similar to the IS0 10844 reference surface, averaged over a typical lifespan[1]. The measurements are done according to ISO 11819-1:1997 Statistical Pass-By method (SPB), but with a microphone height of 3 m, to avoid in-situ measuring problems caused by guard rails,

As discussed earlier, the label scale for noise reduction is based on the noise reduction values at 80 km/h.

[1] The advantage of a numerical reference, over a physical reference such as the ISO 10844 reference surface, is that differences between actual sections of that reference surface are averaged, just as variations over time, e.g. due to wearing.

5.2.2 Label scale proposal for noise reduction

Noise reduction in dB(A)	
A	More than 11 dB(A)
B	11 to 8 dB(A)
C	8 to 5 dB(A)
D	5 to 2 dB(A)
E	2 to - 1 dB(A)
F	-1 to - 4 dB(A)
G	-4 dB(A) or less

Noise reduction (a few months after construction), relative to the reference for light motor vehicles at 80 km/h.

5.2.3 Remarks / discussion / motivation

It is recognised that the EC has asked CEN TC 227 Road materials, WG 5 pavement surface characteristics (Convenor: Manfred Haider, Austrian Institute of Technology AIT) to develop a harmonised European method for acoustic characterisation of road surfaces, to be used in 2015/996/EC. As that method is not yet available, a non-harmonised method is proposed in the meantime.

In general, dense asphalt surfacings such as Asphalt Concrete (EN 13108-1) and Stone Matrix Asphalt (EN 13108-5) with nominal grain sizes of 5 to 16 mm typically will have label class E, whereas coarse surface dressings and brushed PCC may be F, and two-layer Porous Asphalt (PA5) may be C, sometimes reaching B.

In-situ monitoring of road surfaces can be done by CPX method (ISO 11819-2:2017), which can be converted to rolling noise reduction values.

As the label scale is based on “initial” values, the noise reduction at the end of road surface lifespan may be lower than the label class value. This should be kept in mind when using the label in long-term contract specifications.

5.3 Wet skid resistance

5.3.1 Method

The proposed characterisation method is the determination of wet sideways force skid resistance coefficient at 80 km/h, using German SKM (CEN/TS 15901-8), according to the German “TP Griff-StB 07 (SKM)”.

5.3.2 *Label scale proposal for wet skid resistance*

Wet skid resistance in friction coefficient	
A	More than 1.13
B	1.13 to 0.90
C	0.90 to 0.77
D	0.77 to 0.63
E	0.63 to 0.51
F	0.51 to 0.37
G	0.37 or less

Wet Sideway Force Skid Resistance Coefficient at 80 km/h (a few months after construction).

5.3.3 *Remarks / discussion / motivation*

As mentioned earlier, European harmonisation of characterisation methods is being worked on by CEN, but has not yet been achieved. This necessitates non-harmonised choices at present.

The friction coefficient is the ratio of horizontal force over vertical force, hence its physical dimension is Newton/Newton or dimensionless.

The German SKM and British SCRIM device (CEN/TS 15901-8 and -6) are very similar and the most commonly used in Europe. However, procedures for measurement (and correction for temperature and season) differ between the UK (Design Manual for Roads and Bridges (DMRB) - HD 28/15 Skidding Resistance) and Germany (TP Griff-StB 07 (SKM)).

Many other devices and procedures exist to measure wet skid resistance, but on road pavements in Europe, none are more widespread than SCRIM/SKM.
Unfortunately, the measurement procedure for determining wet grip of tyres for the tyre label is not suited for in-situ assessment of road pavements, as it requires deceleration of the test vehicle from 80 to 20 km/h and is therefore not applicable in in-traffic conditions.

For conversion between different traffic speeds, a constant loss of 0,05 per 20 km/h speed increase can be used for practical purposes, although not being fully correct.

For several types of pavements, especially asphalt mixes but also Portland Cement Concrete, wet skid resistance may fluctuate significantly in the first weeks or months of traffic loading, because of the traffic wearing off any cement coat, grittings, and/or bituminous mastic covering the surface of the mineral aggregate. The label scale for skid resistance is based on the skid resistance value obtained after 3-6 months of traffic, after the initial fluctuations, and at the beginning of long-term skid resistance decline due to polishing. The initial fluctuations are outside the scope of the label, and should be covered separately in contract specifications, e.g. by minimum requirements, if desired.
Over time the skid resistance of the road surface may decrease to in-situ values below the label class. This should be kept in mind when using the label in long-term contract specifications.

Prediction of in-situ wet skid resistance, based on laboratory-made road surface specimens, is still very challenging. However the Friction after Polishing test (EN 12697-49:2014) provides a relative ranking of road surfaces that correlates well with in-situ ranking. Also, previous European research (project SKIDSAFE) developed a laboratory machine to characterise skid resistance in the laboratory (SR-ITD, skid resistance interface testing device).

5.4 Rolling resistance

5.4.1 Method

The proposed characterisation method is to first determine the road macrotexture data MPD (Mean Profile Depth), RMS (Root Mean Square) and skewness, according to ISO 13473-1:1997 and ISO 13473-2:2002. Then to determine the rolling resistance coefficient from these texture data, using the model described in [M+P.PGEL.17.06.1].

5.4.2 Label scale proposal for rolling resistance

Rolling resistance coefficient in kg/t	
A	Less than 7.5 kg/t
B	7.5 to 8.0 kg/t
C	8.0 to 8.5 kg/t
D	8.5 to 9.0 kg/t
E	9.0 to 9.5 kg/t
F	9.5 to 10.5 kg/t
G	10.5 kg/t or more

Rolling resistance (a few months after construction)

5.4.3 Remarks / discussion / motivation

The rolling resistance coefficient is the ratio of horizontal force over vertical force, hence its physical dimension is Newton/Newton. For ease of comprehension it is expressed here as kilogramforce/tonforce (kg/t).

Rolling resistance is influenced by many factors:

- Tyre parameters (load, size, structure, composition, etc.)
- Conditions (a.o. temperature of air, pavement and tyre, …)
- Pavement parameters
  - Pavement texture: microtexture, macrotexture, megatexture, evenness (ISO 13473-1 and -2)
  - Pavement deflection under (heavy) traffic load
  - Elasticity (or contrarily: visco-plastic energy loss) of pavement under loading

For a road surface label the tyre parameters and conditions should be kept constant. Of the pavement parameters, deflection and elasticity are excluded, as these are probably more related to the entire pavement (sub)structure, and less to the wearing course. Furthermore, the influence of microtexture, megatexture and unevenness is considered to be of minor importance, relative to macrotexture, and therefore ignored.

It is recognised that the chosen model is not perfect, and that further research is desirable to improve the model. Still, is was chosen instead of measuring the rolling resistance directly in-situ, as only two measuring devices exist in Europe: the trailers of TU Gdansk or the Belgian Road Research Centre. Furthermore, texture measurements are much easier and cheaper, much more widely available, and also possible on laboratory-made road surface specimens.

As the label scale is based on “initial” values, the rolling resistance at the end of road surface lifespan may higher than the label class value. This should be kept in mind when using the label in long-term contract specifications.

5.5 Lifespan

5.5.1 General

The lifespan encompasses all types of surface distress

- Unevenness;
- Cracking;
- Ravelling;
- Abrasion by studded tyres;
- …

The distress type that first reaches the serviceability limit values (defined in contract or in national or international regulations) is critical, i.e. defines lifespan. For different types of road surface, different distress types may be critical. Also, each distress type is influenced by many factors, such as traffic loading and climatic conditions.

5.5.2 Method

This has to be further elaborated. The label scale for lifespan is proposed to be based on a virtual reference specifying:

- Serviceability limit values, no distress source below the road surface layer
- Straight road section, no junction, no grade, adequate surface, drainage
- Traffic loading: wheel loads spectrum, average daily traffic, traffic speed,
- Climatic loading: maximum and minimum temperature, daily temperature variation, number of freeze/thaw cycles per year, number of frost days.

5.5.3 *Label scale proposal for lifespan*

Lifespan in years	
A	18 years or more
B	15 to 18 years
C	12 to 15 years
D	10 to 12 years
E	8 to 10 years
F	4 to 8 years
G	0 to 4 years

5.5.4 *Remarks / discussion / motivation*

- Lifespan in-situ may seem obvious, but depends on the limits that are set to pavement condition (distress levels, such as rut depth, amount and severity of cracking or ravelling, etc.) that define "end of life". In the same situation, acceptance of higher distress levels will give longer lifespan. Acceptable distress levels will often differ between road categories (from motorways to rural roads) and may differ between countries, regions or road authorities. Furthermore, lifespan of a specific pavement quality is dependent on traffic (intensity, weight, manoeuvring). If one set of condition limits (e.g. appropriate for medium-traffic provincial roads) defines the lifespan used in the label scale, the resulting lifespan values overestimate real lifespan for high-quality, high-traffic motorways. Likewise the label scale will underestimate real lifespan for low-volume roads. Instead of introducing multiple label scales for different road classes or traffic classes, one may use conversion factors to account for a shift in characterisation value for deviations in traffic and road class from the standard conditions for the label scale.
- Lifespan prediction just after pavement completion, or in the lab in the pavement design phase, is even more challenging. Presently no methodology (e.g. test methods or prediction model) exist that can accurately predict pavement distress development over time and cumulative traffic. Neither for individual distress types, nor for interacting combinations of distress, or to determine which distress type will be critical (i.e. first reaches the serviceability-limit set for that distress type). There are several ways to produce affirmation of lifespan claims, such as: long-term performance of reference pavements, numerical modelling, combinations of lab tests, etc. However, these are mainly indicatory, not real "proof".

6 Implementation schedule and further outlook

This document will be submitted as an informal document to the 66th meeting of the GRB (UNECE), 4-6 September 2017. The Dutch working group proposes to provide more background on the technical proposals and the underlying discussions and choices in an oral presentation at this meeting. Comments on the document are invited from all stakeholders, particularly CEN TC227/WG5. If the UNECE GRB is positive towards the concepts and choices in this document and the presentation, the Dutch working group proposes to elaborate this document, incorporating the comments received, into a working document for (optimistically) the February 2018 meeting of the UNECE GRB.

In parallel with the above schedule, the Dutch province of Gelderland will perform a pilot project in autumn 2017 for a real road works project, using this draft of the proposed labelling system in tender and contract specifications. Experience from this pilot project will be incorporated in future versions of this document.

7 References

2015/996/EC: Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council

CEN/TS 15901-6:2009: Road and airfield surface characteristics - Part 6: Procedure for determining the skid resistance of a road surface by measurement of the sideway force coefficient (SFCS): SCRIM®

CEN/TS 15901-8:2009: Road and airfield surface characteristics - Part 8: Procedure for determining the skid resistance of a pavement surface by measurement of the sideway-force coefficient (SFCD): SKM

Design Manual for Roads and Bridges (DMRB) - Volume 7 Pavement Design and Maintenance - Section 3 Pavement Maintenance Assessment - Part 1 HD 28/15 Skidding Resistance; Highways England et al.

EN 12697-49:2014 Bituminous mixtures - Test methods for hot mix asphalt - Part 49: Determination of friction after polishing

ISO 10844:2014 Acoustics - Specification of test tracks for measuring noise emitted by road vehicles and their tyres

ISO 11819-1:1997: Acoustics - Measurement of the influence of road surfaces on traffic noise - Part 1: Statistical Pass-By method

ISO 11819-2:2017: Acoustics - Measurement of the influence of road surfaces on traffic noise - Part 2: Close-Proximity method (CPX)

ISO/TS 11819-3:2017: Acoustics - Measurement of the influence of road surfaces on traffic noise - Part 3: Reference tyres

ISO 13473-1:1997 Characterization of pavement texture using surface profiles - Part 1: Determination of mean profile depth

ISO 13473-2:2002 Characterization of pavement texture using surface profiles - Part 2: Terminology and basic requirements related to pavement texture profile analysis

M+P.PGEL.17.06.1: Enhancements of texture vs rolling resistance model, M+P consulting engineers, Vught (NL) June 12th, 2017

RMG2012: Regulation for calculation and measurement of noise [in Dutch: Reken- en meetvoorschrift geluid 2012], Ministry of Infrastructure and Environment, The Netherlands, 2012.

TP Griff-StB 07 (SKM): Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau; Teil: Seitenkraftmessverfahren (SKM), Ausgabe 2007, FGSV Köln DE