CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

CEDR KPI Report 2023: Data Definitions

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Document Control Sheet

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CEDR Working Group Performance (3.5)

Document History

Version	Description	Author	Reviewed	Date
0.1	First Draft for internal review	CS	AP	Oct-23
0.2	Second Draft for review by WG Performance	CS	WG Performance	Nov-23
1.0	Issued Version	CS	AP	Dec-23

Contents

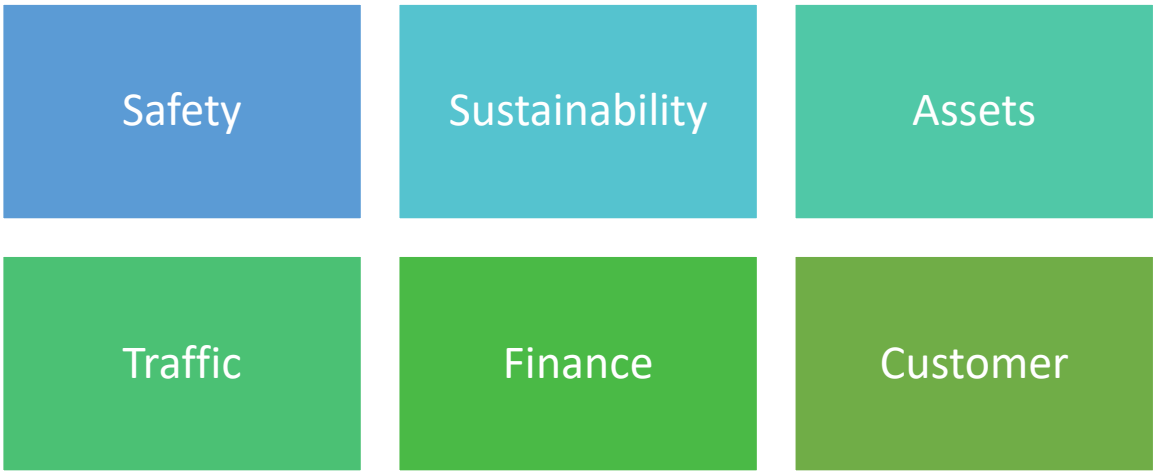
1 Introduction

Since 2009, CEDR has published a biennial report on the performance of the Pan European Road Network (PERN) within participating CEDR countries. These reports have previously focussed on the network of the European Union's TEN-T roads but, since 2021, have been extended to include other strategic national roads of CEDR members.

In 2020, CEDR's Governing Board asked Working Group Performance to develop a new high-level report which looked at the performance of individual NRAs in managing their road networks. The intention being that this report would supplement the ongoing PERN performance report and that it would:

- Align with the strategic challenges facing NRAs.
- Be aimed at senior decision makers rather than technical specialists.
- Cover all roads for which NRAs are responsible.
- Enable NRAs to compare their performance and share good practice.
- Provide information to support CEDR's strategic plan and the activities of the various Working Groups.
- Provide high-level information about European roads that may be useful to third party organisations.

In consultation with other CEDR Working Groups and other specialists, WG Performance has designed a new high-level performance report based covering the following six strategic themes:



A range of KPIs and supporting PIs have been defined to measure NRAs' performance against each of these themes and these indicators have been reviewed and tested.

WG Performance is now ready to produce the first version of this new 'KPI Report' and have produced this Data Definition Document to assist NRAs in the provision of data.

2 Scope of Report

As described in the introduction, there are differences between the new KPI Report and the ongoing PERN Performance Report:

The new KPI Report will cover all roads that the NRA have responsibility for and therefore NRAs should provide data covering all these roads, segmented as described in this document. It is noted that this will vary between NRAs and therefore background information is requested that will enable NRAs to identify suitable comparators.

The first version of the new KPI Report will cover 2023**, NRAs should therefore provide data for 2023 or the most recently completed fiscal year.** NRAs can provide notes against individual data items to provide context.

3 Instructions for Data Collection

3.1 Data Collection Workbook

An MS Excel Workbook will be issued alongside this document that should be used to provide the required data.

KPI Data Collection Workbook 2023_v1.0.x

The completed Workbooks should be sent to the support consultant at cedr@hyperion-uk.com by **1st March 2024**.

Please contact the support consultant if you have any questions about the data collection exercise.

3.2 Robustness Measure

In order to aid interpretation of the final report, KPIs will be reported along with a robustness measure which will give an indication of robustness of the data that they are based on.

When completing the workbook, NRAs are therefore requested to provide a robustness score of 1-4 for each data item provided to indicate the degree of conformity with the definition and level of confidence in the data (e.g. whether they are based on measured values or are estimated):

	Data Confidence	
Conformity with Definition	High	Low
High	4	3
Low	2	1

NRAs can also provide notes against data item to provide more information.

The individual robustness response will be combined to derive an overall robustness score for each reported KPI.

4 Background Data

4.1 Organisational Description

Code	**ORG_SUM**
Domain	Background Data
Description	Brief textual summary of the organisation including its status, scope of responsibilities, size, funding model, etc.
Calculation	Free text
Segmentation	None
Unit	None
Permitted values	Free text
Purpose	Provides a brief summary of the organisation to enable identification of comparators for benchmarking.

4.2 Network Length by Road Type

Code	**LEN_M; LEN_P; LEN_S; LEN_O**
Domain	Background Data
Description	Total length of road network for which the NRA has responsibility by road type
Calculation	The indicator is the sum of the length of the sections measured in one direction only per road type. This means that for dual carriageways the length is included once only and is the average of the distances of each carriageway. The length does not include the length of ramps or junctions.
Segmentation	Motorways; Primary Roads; Secondary Roads; Other Roads
Unit	Kilometres
Permitted values	Real number to one decimal place
Purpose	The purpose of this indicator is to provide an overview of the extent of the different categories of roads in the different countries. Used to normalise other indicators.

5 Safety

5.1 Fatal Collision by Road Type

Code	**FATAL_M; FATAL_P; FATAL_S; FATAL_O**
Domain	Safety
Description	Number of fatal collisions on different road types over the last year
Calculation	Based on NRA's internal statistics of fatal collisions
Segmentation	Motorways; Primary Roads; Secondary Roads; Other Roads
Unit	Number
Permitted values	Integer
Purpose	The purpose of the indicator is to provide an overview of the relative level of safety on different road networks. Will be normalised by network length and traffic flow.

5.2 Fatal Collisions on Divided and Non-divided Carriageways

Code	**FATAL_D; FATAL_N**
Domain	Safety
Description	Number of fatal collisions on high-speed roads with divided and non-divided carriageways over the last year
Calculation	Based on NRA's internal statistics of fatal collisions
Segmentation	Divided High-speed Roads; Non-Divided High-speed Roads
Unit	Number
Permitted values	Integer
Purpose	Provides an overview of the relative level of safety on divided and non-divided carriageways. Will be normalised by network length and traffic flow.

5.3 Road Worker Safety

Code	**WORKER_KSI**
Domain	Safety
Description	Number of road workers killed or seriously injured as a result of incidents at road works on the whole network over the last year, including direct and indirect staff.
Calculation	Total number of road workers killed or seriously injured over the last year per 100,000 hours worked.
Segmentation	None
Unit	Number
Permitted values	Real number to two decimal places
Purpose	Provides an indication of the relative safety of road workers on the network. Will be normalised by network length and traffic flow.

6 Sustainability

6.1 Total Energy Consumption

Code	**ENERGY**
Domain	Sustainability
Description	Total energy consumed by the NRA over the last year (e.g. buildings, service areas, toll plazas, road lighting)
Calculation	Based on NRA's internal data
Segmentation	None
Unit	Gigajoules
Permitted values	Integer
Purpose	Provides an indication of the total energy consumed by the NRA over a year. Will be normalised by network length.

6.2 Green House Gas Emissions

Code	**GHG_1; GHG_2**
Domain	Sustainability
Description	The NRA's total Scope 1 and Scope 2 GHG emissions over the last year
Calculation	Based on NRA's internal data
Segmentation	Scope 1; Scope 2
Unit	Tonnes of Carbon Dioxide-equivalents (tCO_2e)
Permitted values	Integer
Purpose	Provides an indication of the direct and indirect GHG emissions consumed by the NRA over a year, excluding emissions from road traffic. Will be normalised by network length.

6.3 Electric Vehicle Charging Points

<table>
<tr><td>Code</td><td>EV_1a; EV_1b; EV_1c; EV_2a; EV_2b; EV_2c; EV_2d</td></tr>
<tr><td>Domain</td><td>Sustainability</td></tr>
<tr><td>Description</td><td>Total number of recharging points for electric vehicles on, or associated with the network, categorised according to the proposed Alternative Fuels Infrastructure Regulations (AFIR).</td></tr>
<tr><td>Calculation</td><td>Based on NRA’s asset data</td></tr>
<tr><td>Segmentation</td><td>
<table>
<tr><th>Category</th><th>Sub-category</th><th>Max Power Output</th><th>Definition pursuant to Article 2 of AFIR</th></tr>
<tr><td rowspan="3">Category 1 (AC)</td><td>Slow AC recharging point, single-phase</td><td>P < 7.4 kW</td><td rowspan="2">Normal power recharging point</td></tr>
<tr><td>Medium-speed AC recharging point, triple-phase</td><td>7.4 kW ≤ P ≤ 22 kW</td></tr>
<tr><td>Fast AC recharging point, triple-phase</td><td>P > 22 kW</td><td rowspan="5">High power recharging point</td></tr>
<tr><td rowspan="4">Category 2 (DC)</td><td>Slow DC recharging point</td><td>P < 50 kW</td></tr>
<tr><td>Fast DC recharging point</td><td>50 kW ≤ P < 150 kW</td></tr>
<tr><td>Level 1 - Ultra-fast DC recharging point</td><td>150 kW ≤ P < 350 kW</td></tr>
<tr><td>Level 2 - Ultra-fast DC recharging point</td><td>P > 350 kW</td></tr>
</table>
</td></tr>
<tr><td>Unit</td><td>Number</td></tr>
<tr><td>Permitted values</td><td>Integer</td></tr>
<tr><td>Purpose</td><td>Provides measure of deployment of EV recharging points. Will be normalised by network length and traffic flow.</td></tr>
</table>

7 Assets

7.1 Pavement Condition

Code	**PACO_M (VG, G, S, P, VP)** **PACO_P (VG, G, S, P, VP)** **PACO_S (VG, G, S, P, VP)** **PACO_O (VG, G, S, P, VP)**
Domain	Assets
Description	The proportion of pavement asset in each of five condition bands for each road type.
Calculation	See Appendix A
Segmentation	

	Motorway	Primary Roads	Secondary Roads	Other Roads
Very Good	●	●	●	●
Good	●	●	●	●
Satisfactory	●	●	●	●
Poor	●	●	●	●
Very Poor	●	●	●	●

Unit	Percentage
Permitted values	Percentage to one decimal place
Purpose	Provides an indication of the condition of pavement assets

7.2 Number of Bridges

Code	**BRIDGE_NUM**
Domain	Asset
Description	Total number of bridges greater than 0.1km in length on the network that are the responsibility of the NRA to maintain.
Calculation	Based on NRA's asset data
Segmentation	None
Unit	Number
Permitted values	Integer
Purpose	Provides contextual information for other indicators

7.3 Average Age of Bridges

Code	**BRIDGE_AGE**
Domain	Asset
Description	Median age of bridges greater than 0.1km in length on the network that are the responsibility of the NRA to maintain
Calculation	Median age of bridges since construction or last reconstruction, expressed in years
Segmentation	None
Unit	Years
Permitted values	Integer
Purpose	Provides an indication of the condition of bridge assets.

8 Traffic

8.1 Total Traffic Flow

Code	**AADT_TOT**
Domain	Traffic
Description	Average daily traffic flow for the whole network over the last year
Calculation	Sum of length weighted average AADT in both directions on all sections of the network, rounded to the nearest integer. This includes all vehicle types. If traffic count data is not available, estimated values can be used.
Segmentation	None
Unit	Number
Permitted values	Integer
Purpose	Provides an overview of the traffic demand on each national road network and is used to normalise other indicators.

8.2 Traffic Flow by Road Type

Code	**AADT_M; AADT_P; AADT_S; AADT_O**
Domain	Traffic
Description	Average daily traffic flow for each road type over the last year
Calculation	Sum of length weighted average AADT in both directions on all sections of each road type, rounded to the nearest integer. This includes all vehicle types. If traffic count data is not available, estimated values can be used.
Segmentation	Motorways; Primary Roads; Secondary Roads; Other Roads
Unit	Number
Permitted values	Integer
Purpose	Provides an overview of the traffic demand on each national road network and is used to normalise other indicators

8.3 Vehicle Movements on Divided and Non-Divided Carriageways

Code	**VKM_D; VKM_N**
Domain	Safety
Description	Number of vehicle movements on high-speed roads with divided and non-divided carriageways over the last year
Calculation	AADT x Length
Segmentation	Divided High-speed Roads; Non-Divided High-speed Roads
Unit	Vehicle Kms
Permitted values	Integer
Purpose	Provides a leading indicator of safety measures that NRAs have put in place to reduce the number of collisions and used to normalise other indicators

8.4 Average Speed

Code	**SPEED_AVG**
Domain	Traffic
Description	Harmonic average speed over the whole network over the last year
Calculation	See Appendix B
Segmentation	None
Unit	Kilometres per hour
Permitted values	Real number to one decimal place
Purpose	Provides an indication of average traffic delay on the network

8.5 Network Availability

Code	**NW_AVAIL**
Domain	Traffic
Description	Network availability over the last year
Calculation	See Appendix C
Segmentation	None
Unit	Percentage
Permitted values	Percentage to one decimal place
Purpose	Impact of planned closures on network availability over the last year

9 Finance

9.1 Total Income

Code	**INC_TOT**
Domain	Finance
Description	NRA's total income over the last year, including public and non-public funding
Calculation	Average figure over the number of years for which budget is set.
Segmentation	None
Unit	Local currency
Permitted values	Real number to one decimal place
Purpose	Provides an indication of the annual level of funding provided to each NRA and will be used to normalise other indicators.

9.2 Proportion of Non-Public Funding

Code	**INC_NP**
Domain	Finance
Description	Proportion of annual income from sources other than non-public funding (e.g. toll revenue)
Calculation	Average figure over the number of years for which budget is set.
Segmentation	None
Unit	Percentage
Permitted values	Percentage to one decimal place
Purpose	Provides an indication of an NRAs sources of funding

9.3 Total Capital Expenditure

Code	**CAPEX_TOT**
Domain	Finance
Description	Annual average expenditure directly related to construction of new assets (i.e. network enhancements) and renewal of existing assets
Calculation	To be provided on basis of NRAs in house accounting principles and covering cost categories identified by each NRA's as capital expenditure
Segmentation	None
Unit	Local currency
Permitted values	Real number to one decimal place
Purpose	Provides an overview of the level of capital investment. Will be normalised by network length and traffic flow.

9.4 Capital Expenditure Split

Code	**CPX_CONST; CPX_RENEW**
Domain	Finance
Description	Proportion of capital investment in construction of new assets (i.e. network enhancement) compared with renewal of existing assets.
Calculation	To be provided on basis of NRAs in house accounting principles and covering cost categories identified by each NRA as capital expenditure
Segmentation	Construction; Renewal
Unit	Percentage
Permitted values	Percentage to one decimal place
Purpose	Provides an overview of the split in capital investment between enhancement and renewal

9.5 Total Operational Expenditure

Code	**OPEX_TOT**
Domain	Finance
Description	Annual average expenditure directly related to operation and maintenance activities on the road network, in local currency.
Calculation	To be provided on basis of NRAs in house accounting principles and covering cost categories identified by each NRA as operational expenditure
Segmentation	None
Unit	Local currency
Permitted values	Real number to one decimal place
Purpose	Provides an overview of operation and maintenance expenditure. Will be normalised by network length and traffic flow.

9.6 Operational Expenditure Split

Code	**OPX_MAINT; OPX_OPS**
Domain	Finance
Description	Proportion of operational expenditure between operations and maintenance activities
Calculation	To be provided on basis of NRAs in house accounting principles and covering cost categories identified by each NRA as operational expenditure
Segmentation	Operations; Maintenance
Unit	Percentage
Permitted values	Percentage to one decimal place
Purpose	Provides an overview of the split in operational expenditure between operations and maintenance

10 Customer

10.1 Change in Customer Care Satisfaction Index

Code	**CUS_SAT**
Domain	Customer satisfaction
Description	Change in Customer Satisfaction Score compared to the 2023 base year (with base year being 100). It is based on NRAs in house statistics.
Calculation	The indicator is provided on the basis of NRAs in house statistics and it covers different criteria. It is calculated as an index value on the basis of a fixed Base Year chosen by each NRA as follows: **(NewCCSI/BaseYearCCSI)*100** Where: **NewCSSI** is the most updated value of the Customer Care Satisfaction index. **BaseYearCCSI** is the Base Year value of the Customer Care Satisfaction index.
Segmentation	None
Unit	Index number compared to base year
Permitted values	Integer
Purpose	Provides a relative measure in improvements in customers' satisfaction.

11 Glossary

AADT	Annual Average Daily Traffic.
Alternative Fuels Infrastructure Regulation	Draft EU regulation reformulating provisions concerning Member States' national policy frameworks for the deployment of alternative fuels infrastructure.
Average Speed	See Appendix B
Construction	Activities relating to the construction of new or enhancement of existing assets.
Divided Carriageway	Roads with two carriageways (roads in each direction) that are physically divided by a non-road barrier, median, or other obstacle.
Fatal Collision	A collision in which one or more persons dies within 30 days from injuries received[1].
High-speed roads	Long-distance, inter-urban roads which have speed limits greater than 80km/h.
Motorway	A road specially designed and built for motor traffic, which does not serve properties bordering on it and which: ▪ is provided, except at special points or temporarily, with separate carriageways for the two directions of traffic, separated from each other by a dividing strip not intended for traffic or, exceptionally, by other means; ▪ does not cross at grade with any road, railway or tramway track, bicycle path or footpath; and ▪ is specially sign-posted as a motorway.
Network Availability	See Appendix C
NRA	National Road Administration
Other roads	Other roads that are the responsibility of the National Road Authority that are not included in the categories listed.
Primary roads	Roads outside urban areas that connect major cities or regions, or both, belonging to the highest category of road below the category "motorway" in the national road classification.
Renewal	Replacement of an asset that has reached the end of its life by a new asset of the same type.
Road Worker	Staff employed directly and indirectly by the NRA to carry out maintenance and other operational activities on the road network.
Scope 1 GHG Emissions	As defined in the Greenhouse Gas Protocol[2], Scope 1 emissions are direct emissions from owned or controlled sources.

[1] Internationally agreed definition, recommended by IRTAD, UNECE, WHO.
[2] https://ghgprotocol.org/

Scope 2 GHG Emissions	As defined in the Greenhouse Gas Protocol[2], Scope 2 emissions are indirect emissions from the generation of purchased energy.
Secondary roads	Roads of lower importance than primary roads. They often connect smaller towns and villages, providing access to regional areas and connecting to the primary road network. Secondary roads typically have lower traffic volumes, lower speed limits, and may be narrower than main roads or highways.

Appendix A – Calculation of Pavement Condition

1. Variables and classification

Pavement condition is defined using three commonly used condition variables:

1. rut depth, in mm
2. roughness, in IRI (International Roughness Index), in mm/m
3. macrotexture, in mm.

Rut depth affects road safety, as well as macrotexture. Roughness is an indicator of travel comfort and is also a main road condition contributor to vehicle operating costs.

Pavement condition is calculated as **100-meter section** averages separately for each condition variable. After averages have been calculated, they are classified into five condition classes, preferably using traffic and speed limit-based class limits. The general description of condition classes is as follows:

1. **Very good:** Like new. No needs for repairing.
2. **Good:** The condition is good despite normal wear and tear. No needs for repairing.
3. **Satisfactory:** The condition is satisfactory. The measurements and inventories of the condition should be enhanced, and individual repairing works may be justified.
4. **Poor:** Needs repairing and, from the viewpoint of sustainable asset management, this is the right time to do it.
5. **Very poor:** The condition is clearly worse than can be accepted. There will be additional costs for the road user and road management.

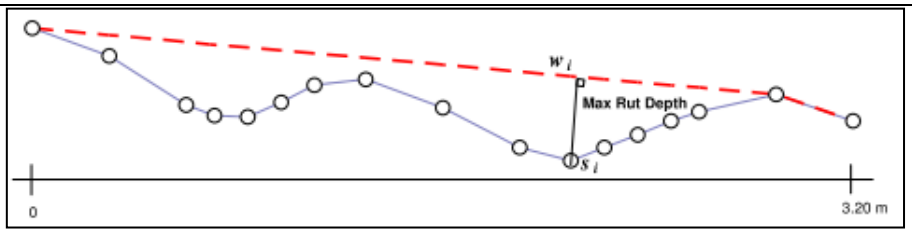
The three condition variables are separately classified into these five classes and the final class for each 100 m road section is defined according to the worst ranking. For example, if rut depth is Good, roughness is Satisfactory and macrotexture is Good, the condition class for this particular section is Satisfactory.

For future utilisation of the data, it would be very beneficial to be able to merge traffic volume data (light, heavy) to each 100-meter section. It would enable calculation of traffic occurring on roads in bad or very bad condition.

2. Rut depth

Rut depth is typically measured using point or line lasers, which produce an estimate of the transversal profile of the road, over a certain width (3,2 meters in several countries).

For the calculation of the **maximum rut depth**, a wire is pinged along the two outer sections of the cross profile. The maximum rut depth for a measurement point is calculated as the maximum between the wire and the cross-profile perpendicular distance, as shown in the Figure below. Value for a longer section is calculated as an average of measurement point values.



Examples of class limits for rut depth are given in Table below (example data from Finland). Similar type of classifications are most probably in use in other organisations as well.

Rut depth (mm)

ADT	Speed Limit	Condition class limits				
		Very good	Good	Satisfactory	Poor	Very Poor
350 - 1500	<= 60 km/h	<= 7	7,1 - 13	13,1 - 18	18,1 - 22	> 22
	70-80 km/h	<= 7	7,1 - 12	12,1 - 16	16,1 - 21	> 21
	>= 100 km/h	<= 7	7,1 - 11	11,1 - 15	15,1 - 20	> 20
1501 - 6000	<= 60 km/h	<= 6	6,1 - 12	12,1 - 17	17,1 - 21	> 21
	70-80 km/h	<= 6	6,1 - 11	11,1 - 15	15,1 - 20	> 20
	100 km/h	<= 6	6,1 - 10	10,1 - 14	14,1 - 19	> 19
	120 km/h	<= 6	6,1 - 9	9,1 - 14	14,1 - 18	> 18
> 6000	<= 60 km/h	<= 5	5,1 - 11	11,1 - 17	17,1 - 20	> 20
	70-80 km/h	<= 5	5,1 - 10	10,1 - 15	15,1 - 19	> 19
	100 km/h	<= 5	5,1 - 9	9,1 - 14	14,1 - 18	> 18
	120 km/h	<= 5	5,1 - 8	8,1 - 13	13,1 - 17	> 17

3. **Roughness**

The longitudinal roughness (unevenness) of the road is described by the International Roughness Index – IRI. It is calculated from the longitudinal profile of the road (usually from the right wheel path) by putting the "Golden Car" equipped with certain suspension parameters to travel along the measured profile at a constant speed of 80 km/h.

IRI is calculated as shown e.g. in SFS EN 13036-5.

An example of condition classes for IRI is shown below (Finland):

Roughness (IRI, mm/m)

ADT	Speed Limit	Condition class limits				
		Very good	Good	Satisfactory	Poor	Very Poor
< 350	<= 60 km/h	<= 1,8	1,8 - 3,4	3,4 - 5,4	5,4 - 6,6	> 6,6
	70-80 km/h	<= 1,6	1,6 - 2,8	2,8 - 4,6	4,6 - 5,8	> 5,8
	100 km/h	<= 1,4	1,4 - 2,6	2,6 - 4,0	4,0 - 4,8	> 4,8
350 - 1500	<= 60 km/h	<= 1,6	1,6 - 3,0	3,0 - 4,6	4,6 - 5,8	> 5,8
	70-80 km/h	<= 1,4	1,4 - 2,4	2,4 - 3,8	3,8 - 5,0	> 5,0
	>=100 km/h	<= 1,2	1,2 - 2,2	2,2 - 3,2	3,2 - 4,4	> 4,4
1501 - 6000	<= 60 km/h	<= 1,4	1,4 - 2,6	2,6 - 4,0	4,0 - 5,0	> 5,0
	70-80 km/h	<= 1,2	1,2 - 2,2	2,2 - 3,2	3,2 - 4,2	> 4,2
	>= 100 km/h	<= 1,0	1,0 - 1,8	1,8 - 2,6	2,6 - 3,6	> 3,6
> 6000	<= 60 km/h	<= 1,2	1,2 - 2,4	2,4 - 3,6	3,6 - 4,6	> 4,6
	70-80 km/h	<= 1,2	1,2 - 2,0	2,0 - 2,8	2,8 - 3,8	> 3,8
	80-90 km/h	<= 1,0	1,0 - 1,6	1,6 - 2,2	2,2 - 3,2	> 3,2
	>= 100 km/h	<= 1,0	1,0 - 1,4	1,4 - 1,8	1,8 - 2,8	> 2,8

4. Macrotexture

Macrotexture is the deviation of the surface from a flat road surface, measured over 0.5 to 50 mm. The macrotexture is expressed as MPD (Mean Profile Depth) with a unit of mm. The macrotexture is measured and determined in accordance with ISO 13473-1.

MPD is usually determined by three longitudinal lines representing the right and left lane side as well as middle. One of those lines, or a function of them, can be used as a variable for classification.

MPD can be classified using e.g., the following class limits.

Table 1. Limit values for MPD macrotexture technical parameter from COST 354 Action (2008).

MPD technical parameter grade	Limit values
very bad	0.30-0.49
unsatisfactory	0.49-0.68
satisfactory	0.68-0.87
good	0.87-1.06
very good	1.06-1.25

Table 1 Macrotexture performance indicators in MPD values [3]

Performance indicator	0–1 (very good)	1–2 (good)	2–3 (satisfactory)	3–4 (un-satisfactory)	4–5 (very bad)
MPD [mm] – motorways and primary roads	1,25–1,06	1,06–0,87	0,87–0,68	0,68–0,49	0,49–0,30
ETD [mm] – motorways and primary roads	1,2–1,048	1,048–0,896	0,896–0,744	0,744–0,592	0,592–0,44
MPD [mm] – secondary and local roads	1,01–0,87	0,87–0,72	0,72–0,58	0,58–0,43	0,43–0,29
ETD [mm] – secondary and local roads	1,008–0,896	0,896–0,776	0,776–0,664	0,664–0,544	0,544–0,432

Appendix B - Calculation of Average Speed

To account for the speeds and distances travelled of all vehicles which travel on the network, **harmonic mean** speed should be used rather than standard arithmetic mean.

Harmonic mean speed is the sum of total distance travelled by each vehicle divided by the sum of total time taken by each vehicle, where:

Total distance: the number of vehicles (flow) multiplied by the length of road

Total time: the sum of time taken by each vehicle to travel the link

The example below is for two vehicles:

$$\frac{1\ mile + 1\ mile}{1\ min + 2\ min} = \frac{2\ miles}{3\ min} = \frac{2\ miles}{0.05\ hrs} = 40mph$$

Calculation of harmonic mean speed

For a single link, for each time period, the general equation is:

$$harmonic\ mean\ speed = \frac{number\ of\ vehicles\ \times distance\ travelled\ by\ each\ vehicle}{number\ of\ vehicles\ \times time\ taken\ by\ each\ vehicle}$$

To obtain **journey time**, divide distance by average speed per time period

Weight distance and time by the average number of vehicles per time period (flow) to account for differences in number vehicles observed travelling on different links.

Sum and **divide** the values

For **more than one link** per time period the equation is:

$$harmonic\ mean\ speed\ over\ n\ link\ time\ periods = \frac{\sum_{i=1}^{n} f_i d_i}{\sum_{i=1}^{n} \frac{f_i d_i}{u_i}}$$

Where:

d_i = length of link

f_i = flow

t_i = journey time

u_i = average speed

Appendix C - Calculation of Network Availability

Carriageway Length:	Total road length in both directions
Lane Km Days Available:	Number of lanes x carriageway length x 365
Closure Lane Length:	Number of lanes x total length of lanes closed x number of days of closures
Occupancy:	Closure length km / lane length km
Availability:	100 – (Closure Length km / Lane Length km)

Example

Total Carriageway Length = 200,000 km

Number of Lanes = 3

Total Closures = 1 lane x 10,000 km x 100 days

Lane Km Days Available = 200,000 x 3 x 365 = 219,000,000 lane Km days available

Total Closure Length = 3 x 10,000 x 100 = 3,000,000 lane km days impacted

Occupancy = 3,000,000 / 219,000,000 = 1.4%

Availability = 100 – (3,000,000 / 219,000,000) = 98.6%