

TIRE REQUIREMENTS FOR PAVEMENT SURFACE CHARACTERISTICS

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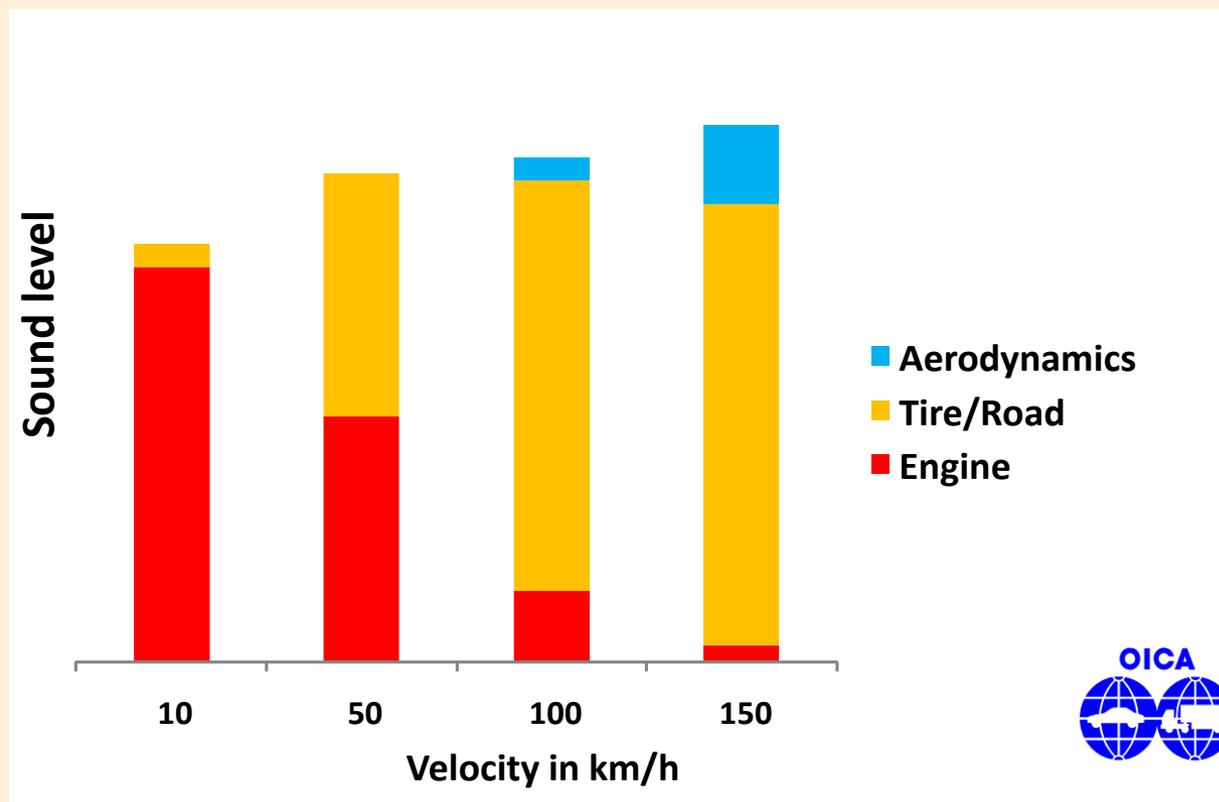
Goodyear SA



Content

- ▶ **Introduction**
- ▶ **Basic functions of the tire**
- ▶ **Pavement and tire interaction**
- ▶ **Road noise mitigation requires holistic approach**
- ▶ **Contributions to noise reduction and tire role**
- ▶ **Road pavement influence**
- ▶ **Framework for managing road noise**
- ▶ **Views/recommendations further work**

Contribution of the three main sources of road noise according to speed in real traffic conditions



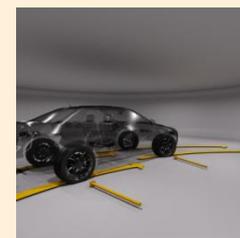
One solution is to consider the noise reduction by acting on the sources:

- Engine and power train
- Sound emissions generated by the tire/road.

Tire Basics – Four Basic Functions

A tire is an important part of vehicle safety. The basic tire functions are:

- ▶ A carcass to contain a volume of pressurized air to support the vehicle load
- ▶ To transmit traction and braking forces to the road surface
- ▶ To provide directional stability needed for safety while changing or maintaining the rolling direction on the pavement
- ▶ To supplement the vehicle suspension (absorbing shocks from the road surface - NVH)



While keeping tire/road noise generation minimum

Tyre Basics – Contribution to vehicle properties

Safety

- Braking (dry & wet)
- Aquaplaning



Handling

- Tyre characteristics
- High Speed

Comfort

- Mechanical comfort
- Acoustical comfort

Economy

- Mileage Performance
- Fuel Consumption



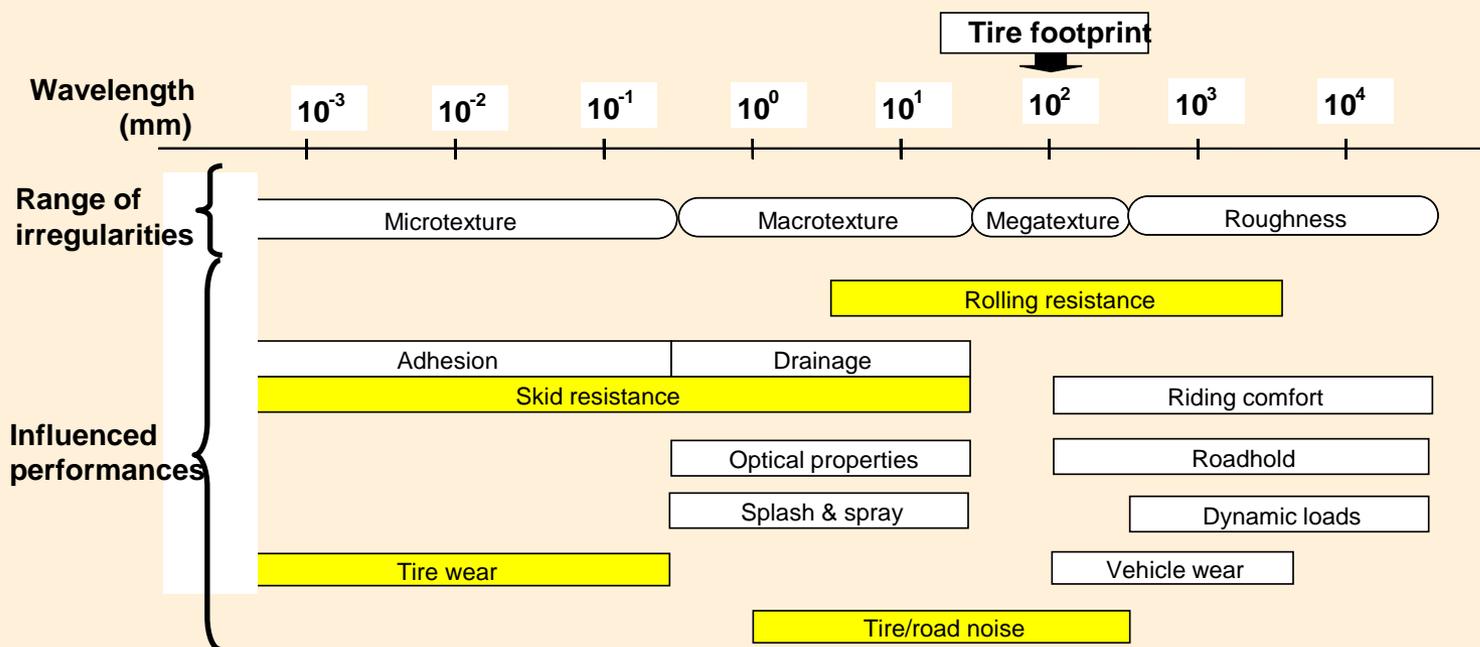
Environment

- CO2 emissions
- Rolling Noise nuisance

A deep interaction takes place between the road and the tire to produce the road / tire / vehicle performances

► geometry

PIARC: Technical Committee Report N°1



► and many other parameters

Chipping size, void ratio, absorption coefficient, slope of drainage path, rut depth,....

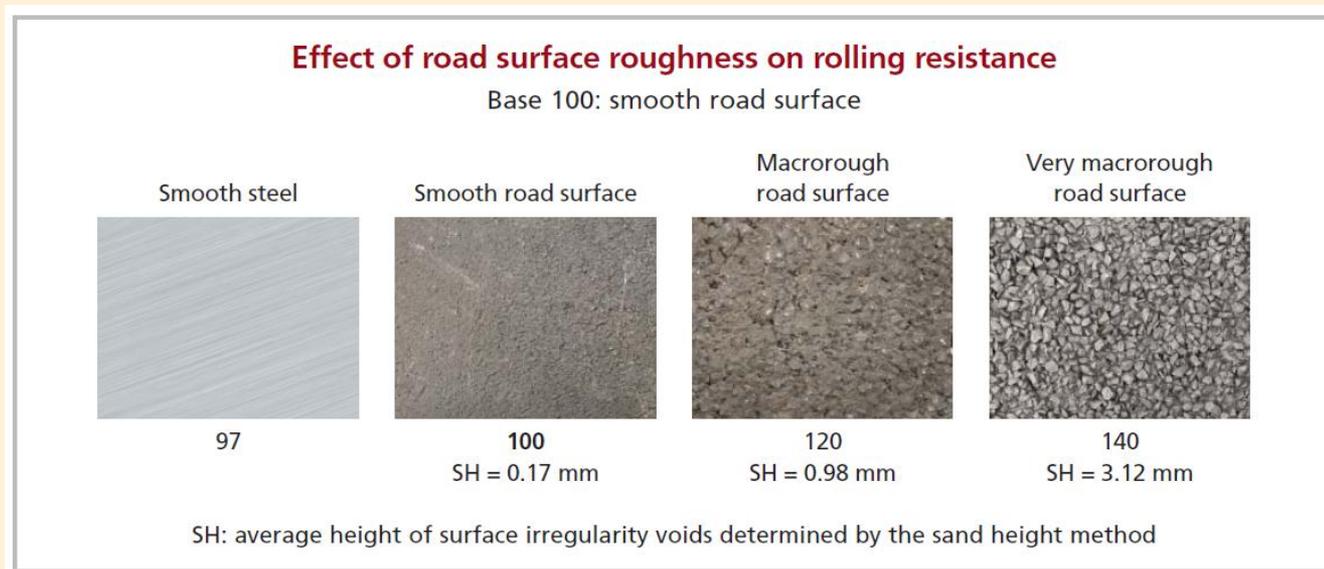
What are the interactions between tire and road to produce the road / tire / vehicle performances?

To what extent can tire manufacturers, road manufacturers, and road owners act independently, or should they join their efforts to make progress on:

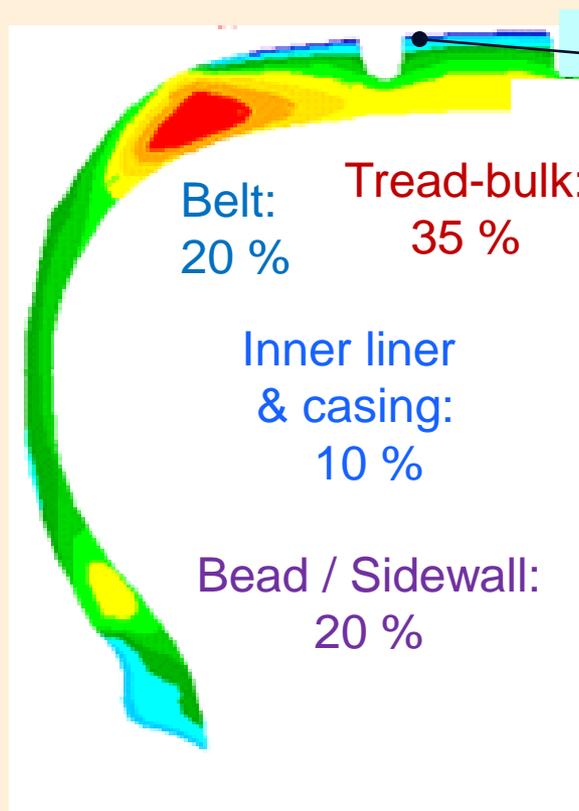
- ▶ Emissions: ROLLING RESISTANCE**
- ▶ Safety: WET GRIP**
- ▶ Natural resources: WEAR**
- ▶ Pollution: NOISE as part of the pavement quality**

Rolling resistance

- ▶ Tire rolling resistance is an important contributor to vehicle fuel consumption and CO₂ emission. It accounts for about 20% of total consumption for passenger cars and up to 30% for lorries.
- ▶ Measurements show that rolling resistance increases in proportion to the macroroughness of the road surface. This is because the macrorough asperities deform the tread block surface (indentation), causing local energy dissipation.
- ▶ However, considering actual road surface roughness distribution in Europe, the potential gains on CO₂ emissions and fuel consumption seem relatively weak.



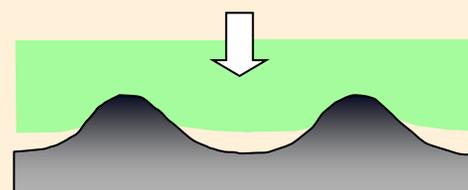
Mechanisms of rolling resistance



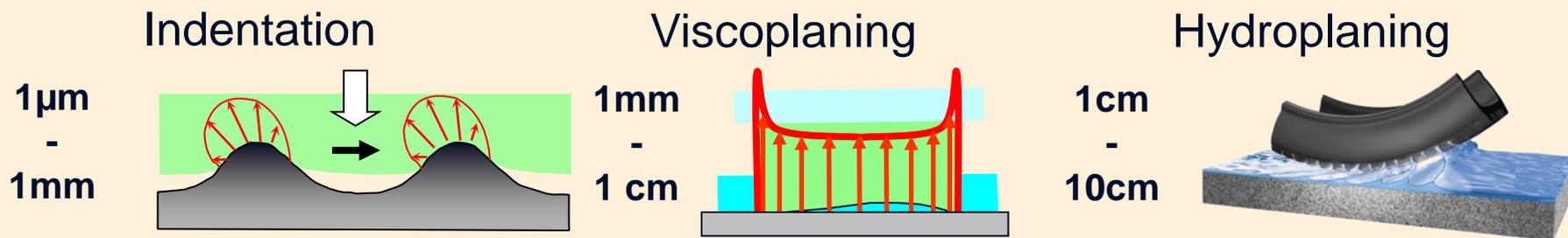
Tread-road contact
15%

Indentation

1mm
-
1cm



Mechanisms of wet grip



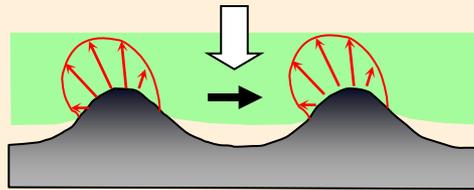
Road	Road texture	Road texture & pollution	Trasversal profile & drainability
Tire	Compound visco-elasticity	Water storage by tread pattern	Water flow by tread pattern

- ▶ The friction coefficient is highly dependent on road texture, road pollution, speed, water depth, temperature, and tire wear level

Mechanisms of wear

Indentation

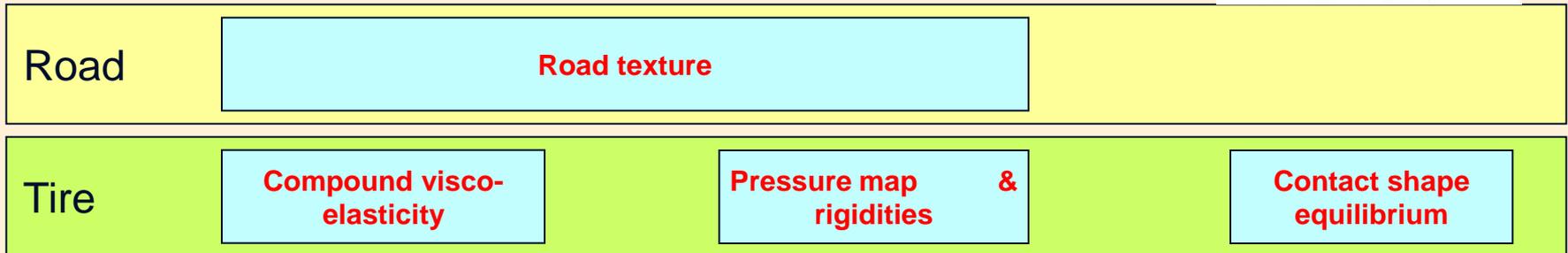
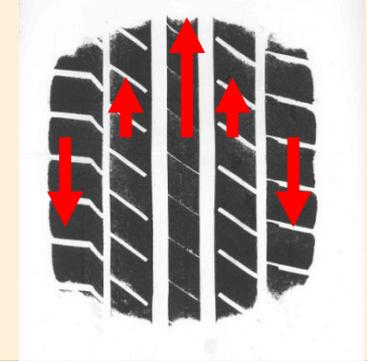
1 μ m
-
1mm



Friction energy

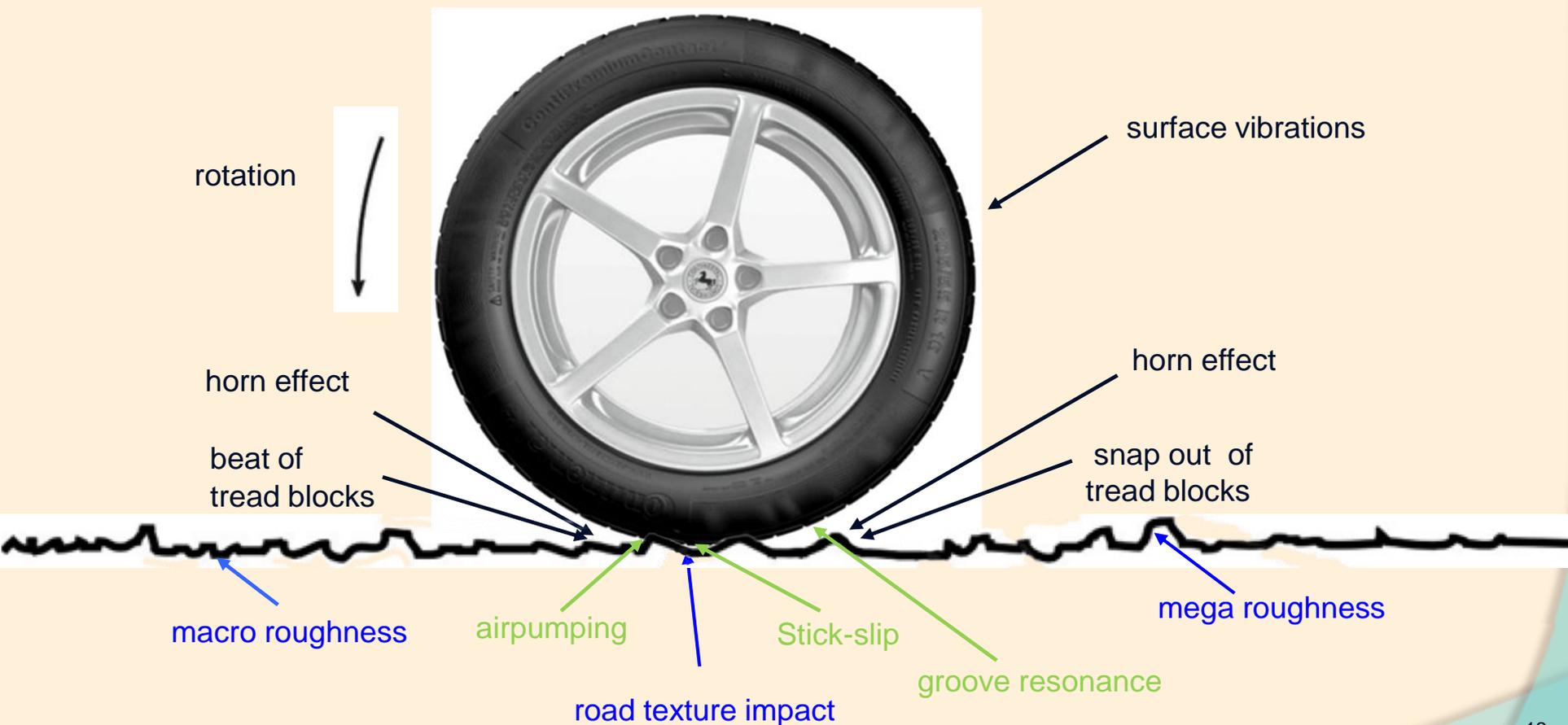


Stresses per rib



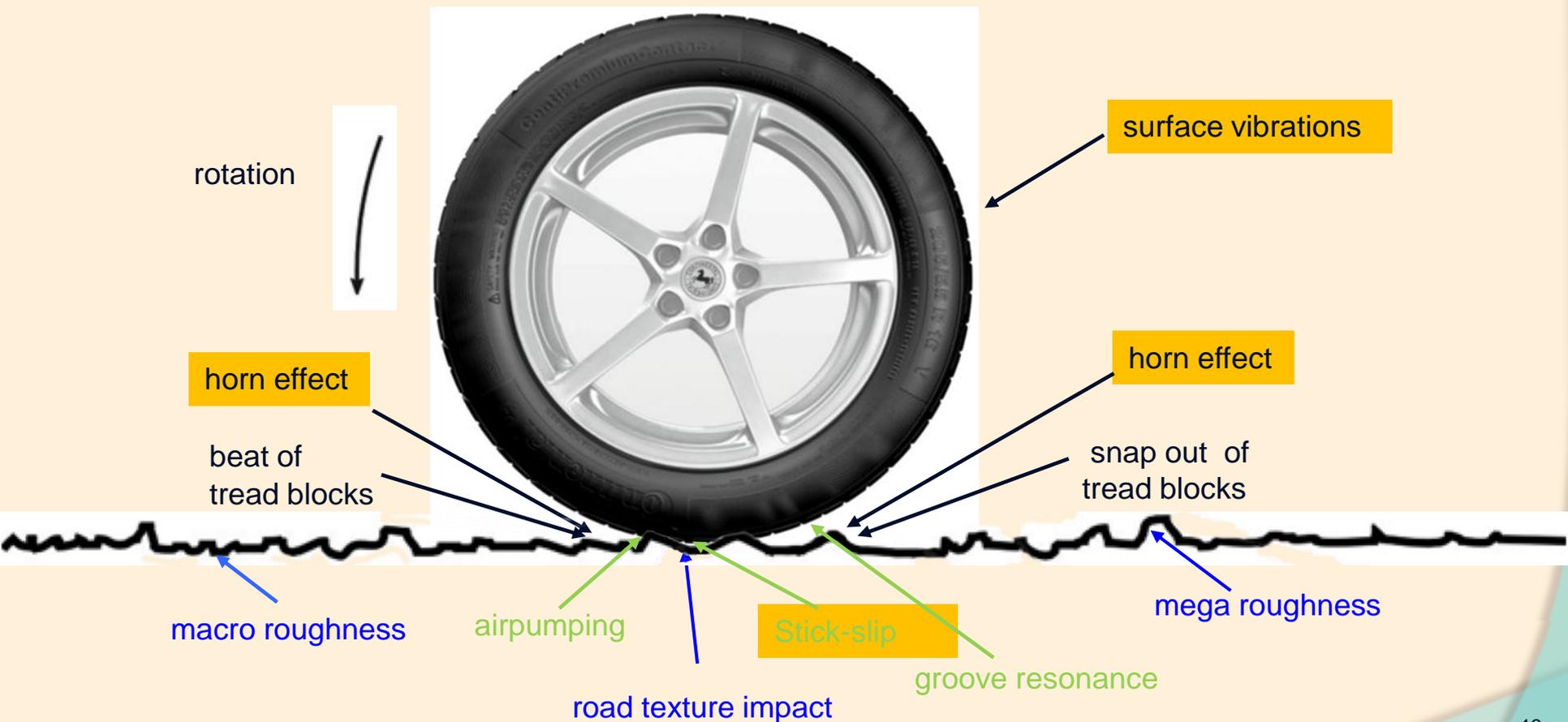
- ▶ The mileage has a very strong averaging effects which frees the tire design choices from road surface characteristics considerations

Noise mechanisms for tire/road noise



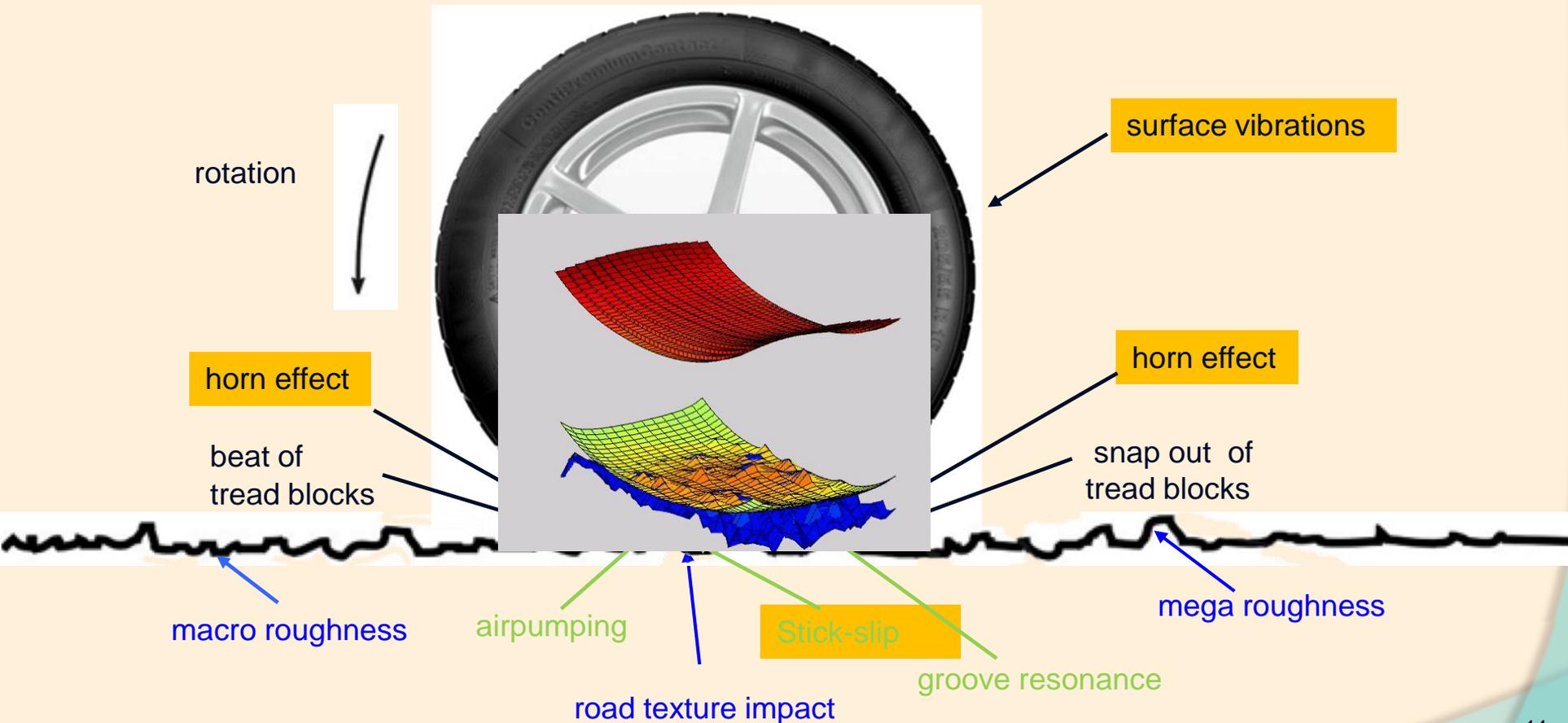
Noise mechanisms for tire/road noise

road pavement influenced



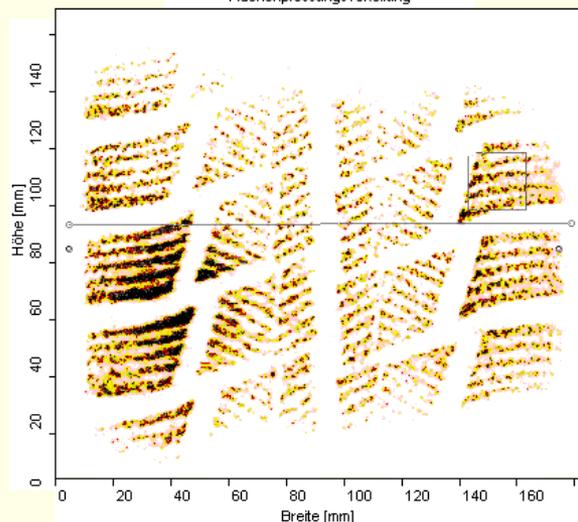
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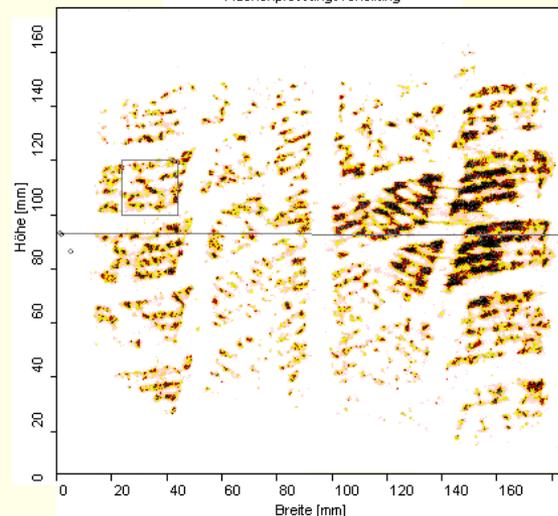
Tire excitation

Flächenpressungsverteilung



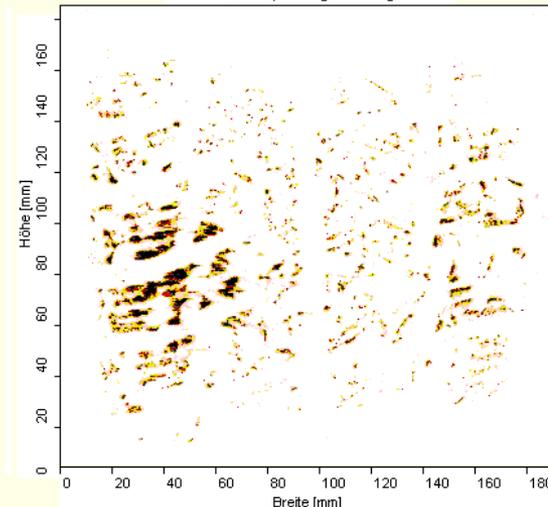
Asphalt accord. ISO 10844

Flächenpressungsverteilung



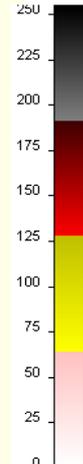
SMA 0/8

Flächenpressungsverteilung



SMA 0/11

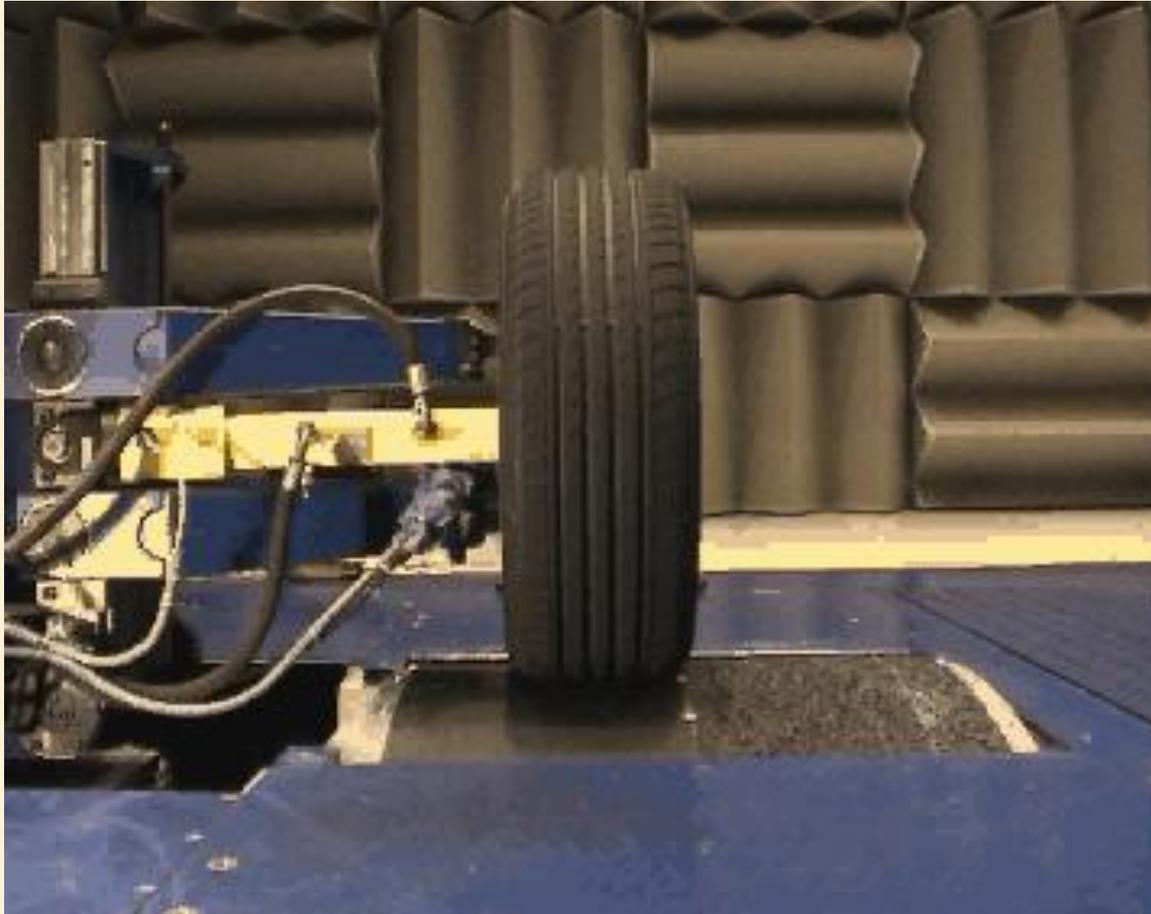
Druckschwelle



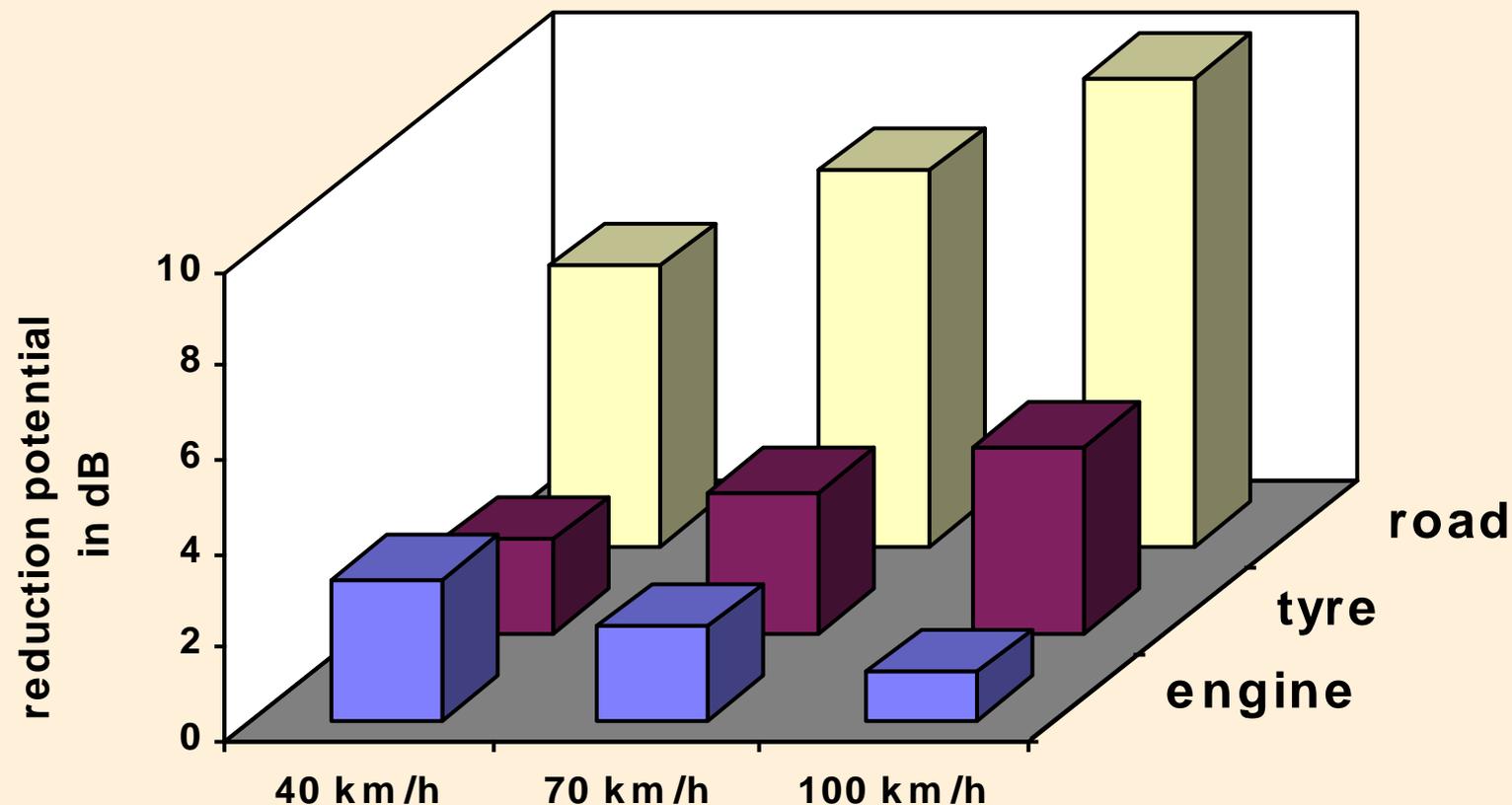
Pressure in the foot print on different road surfaces

- Depending on the roughness and the waviness of the road surface the tread pattern of the tire or the road surface texture is predominating. An effective decrease of rolling noise without measures on road making is not possible.

Rolling sound emissions on different surfaces on a rotating drum



Potential of traffic noise reduction - *engine, tire and road pavement*



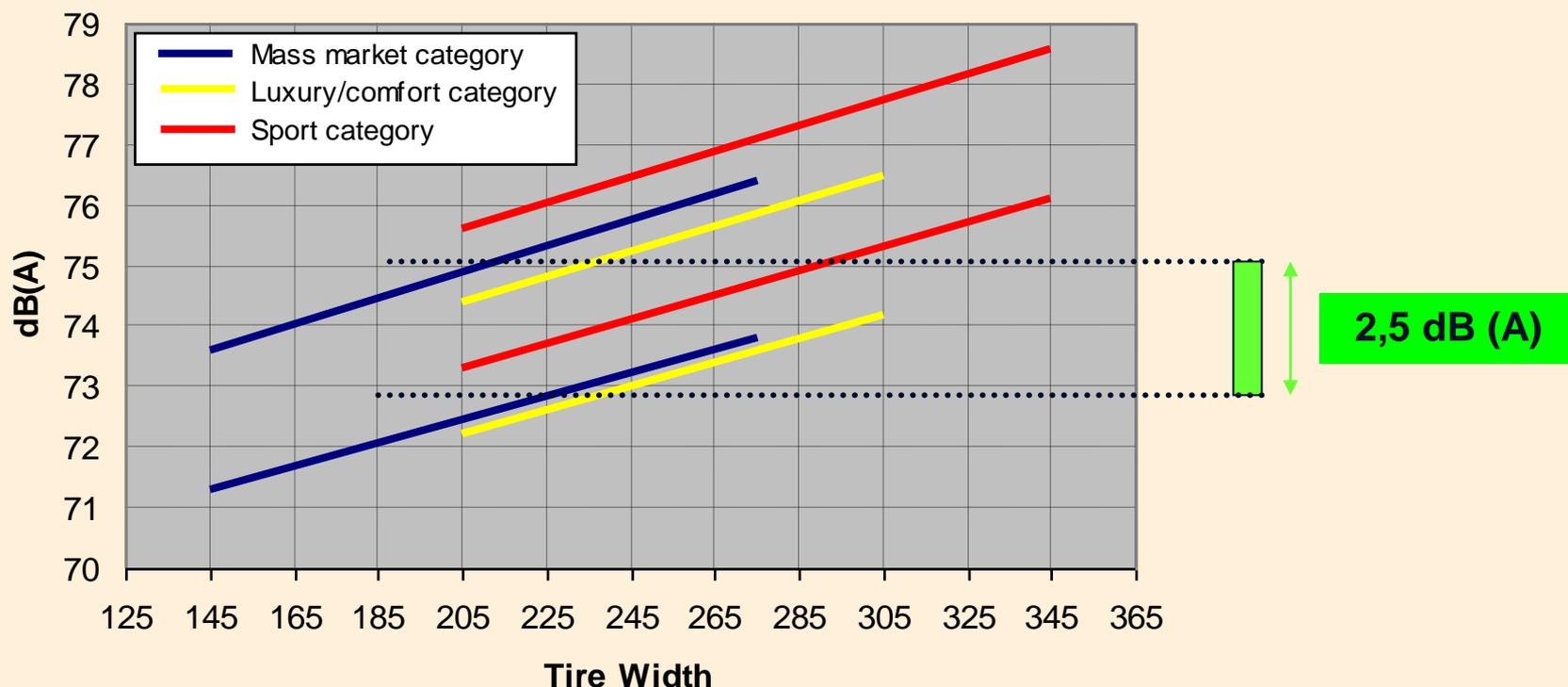
Target conflicts in tire development

To lower the rolling sound level of a tire **by -3 dB** gives the following drawbacks with other performance criteria:

- ▶ **Tread pattern design change** from a tire with 34 % void volume to a slick tire:
 - Increase in wet braking by 40 %
 - Increase in aquaplaning in curve by 60 %
- ▶ **Tread material** from summer tread compound to ice tread compound
 - Increase in wear by 50 %
- ▶ **Tread material** change from normal tread to thicker under tread
 - Increase in rolling resistance by 15 %
- ▶ Stiffness of modern tires is optimized for low noise. **Increase of stiffness** so that the sound level is increased **by + 3 dB** leads to
 - Decrease in wear by 20 %
 - Increase in cornering power by 10 %



Contributors to noise level variability on the road network



- ▶ Tire width and category (winter, entry, high performance, sport) are the choice of the car manufacturer
- ▶ Less than 3 dB(A) spread for a given width/category

Close proximity measurements: CPX Vehicle method and trailer method

The use of Standard Reference Test tires allows to classify road pavement for rolling noise emissions on a normative basis.



Trailer Types CPX

ASTM – F2493 in non-aromatic oil P225/60R16 Available

- Tyre braking traction
- Snow traction
- Wear performance
- Pavement roughness
- Noise
- DOT marked



P225/60R16

**All seasons radial
Uniroyal Goodrich
(Michelin)**

External diameter: 676 mm

Kloosterzande test tracks

Surface S1: ISO 10844



Surface S2: Thin layer 2/4,12 %



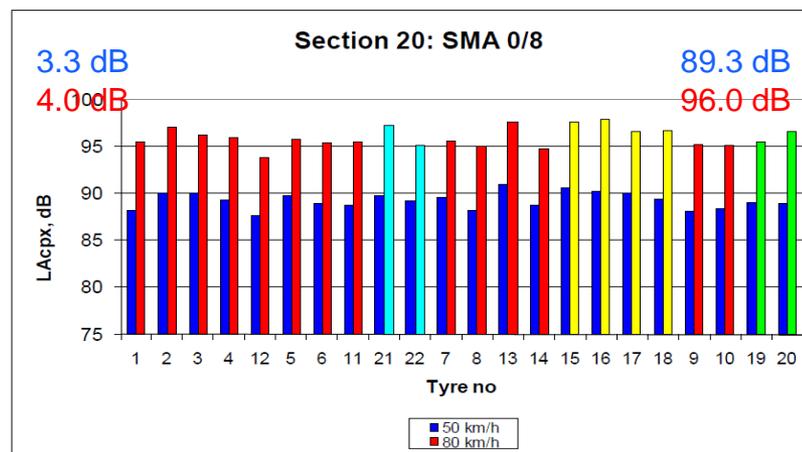
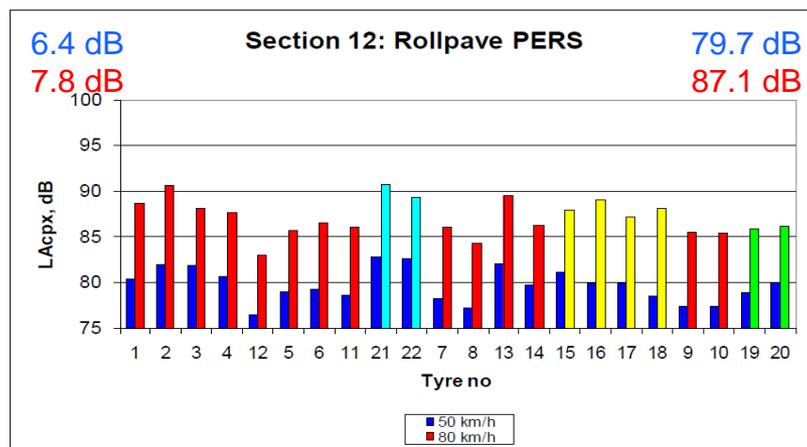
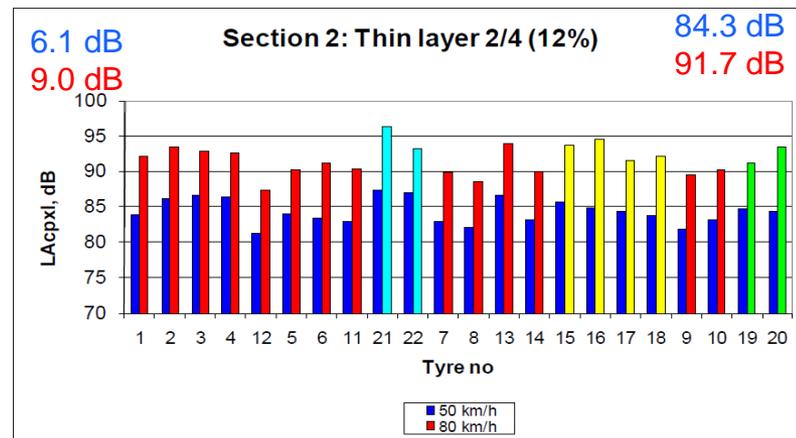
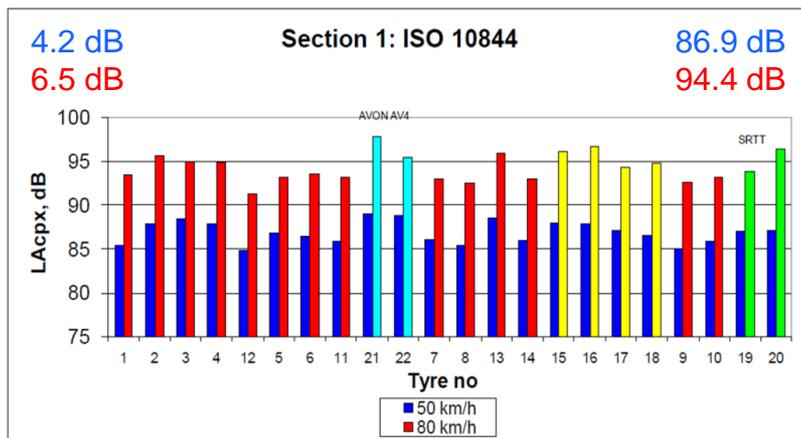
Surface S12: Rollpave PERS



Surface S20: SMA 0/8

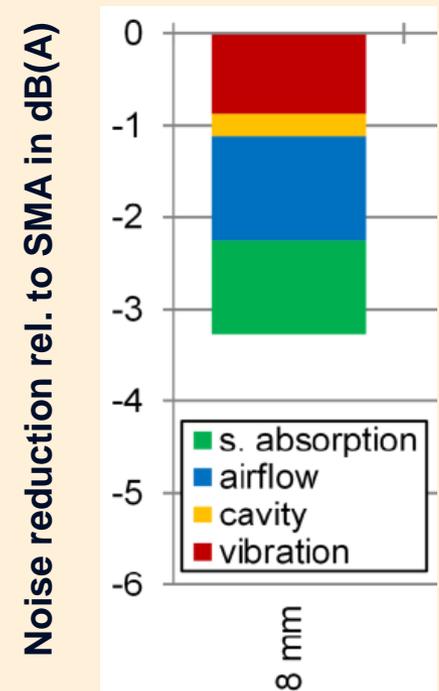
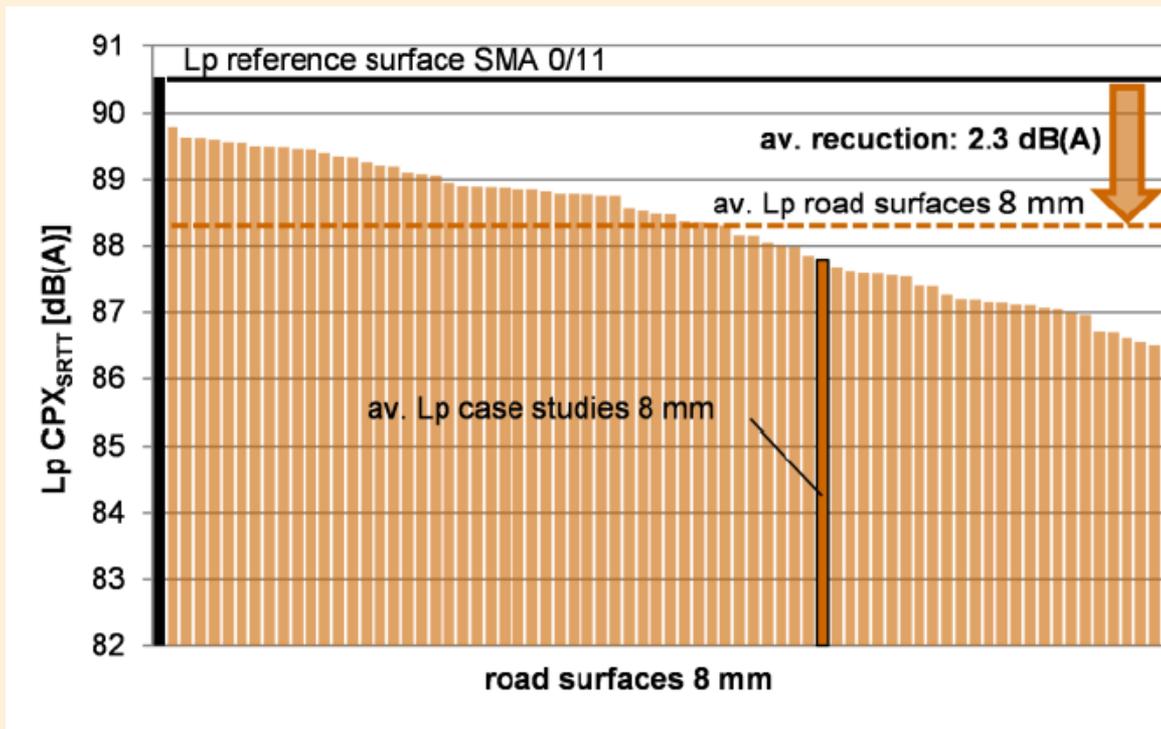


Variation of the tire/road noise on the same pavement



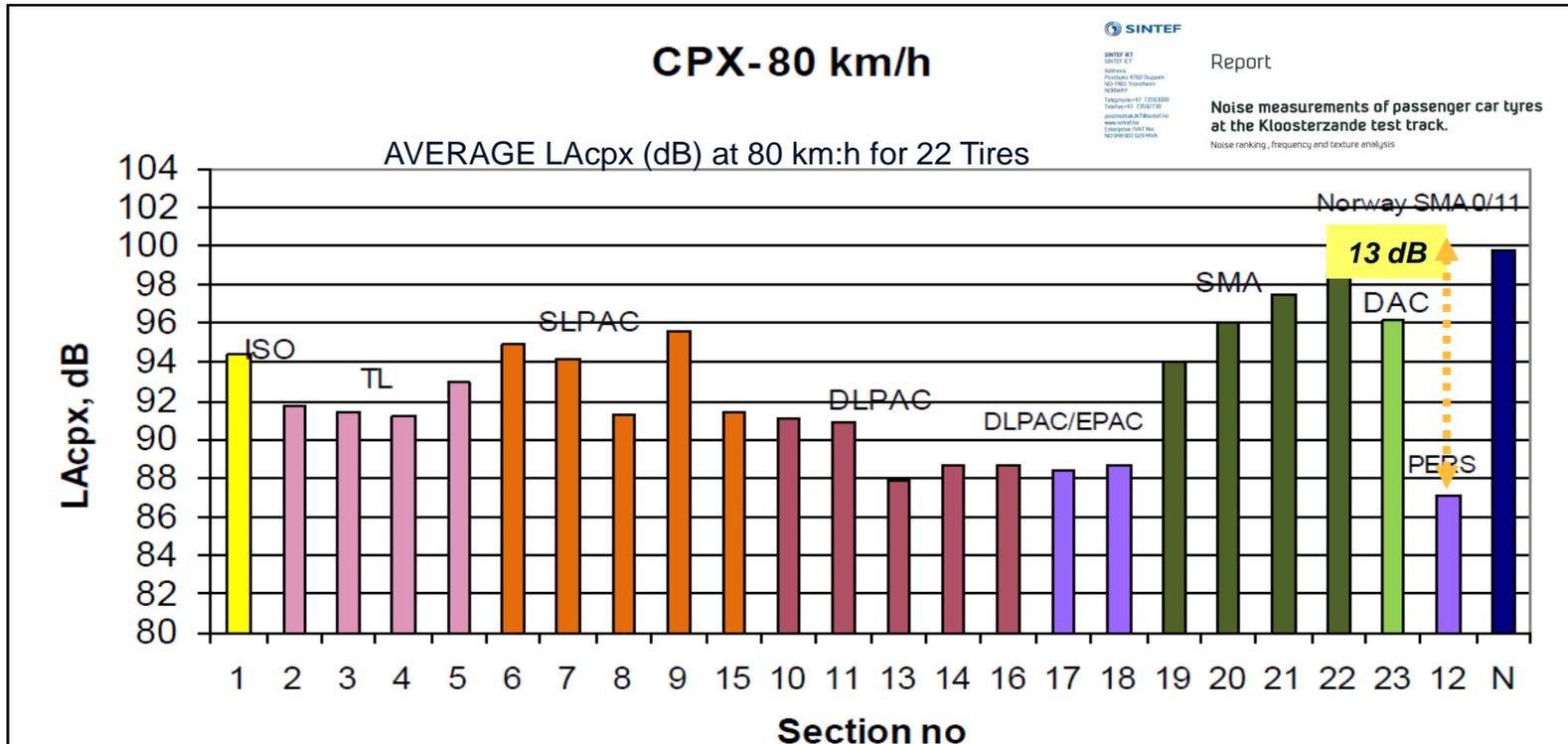
Variation of SMA-like pavements reproduced in different locations

Results from CPX with SRTT mounted in a closed two-wheeled trailer manufactured by M+P



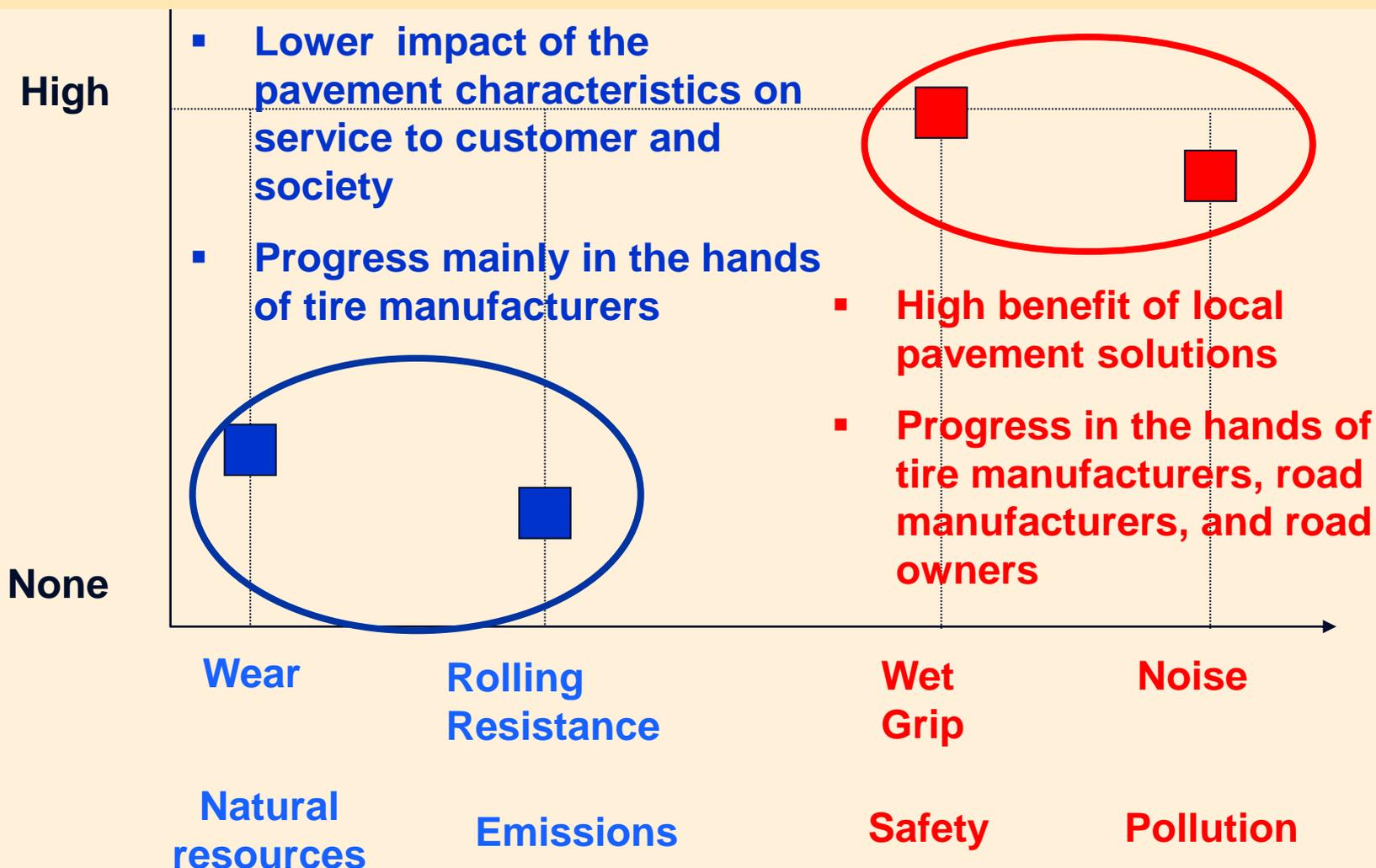
The sample of 36 quiet road surfaces with 8mm chipping size gives a noise reduction ranged from 1dB(A) to 4.5dB(A), average at 2.5dB(A), compared to SMA 0/11. The study concludes that quiet 8 mm road surfaces can only be achieved by a further noise reduction through sound absorption by the road surface.

Variation of the tire/road noise on different surfaces



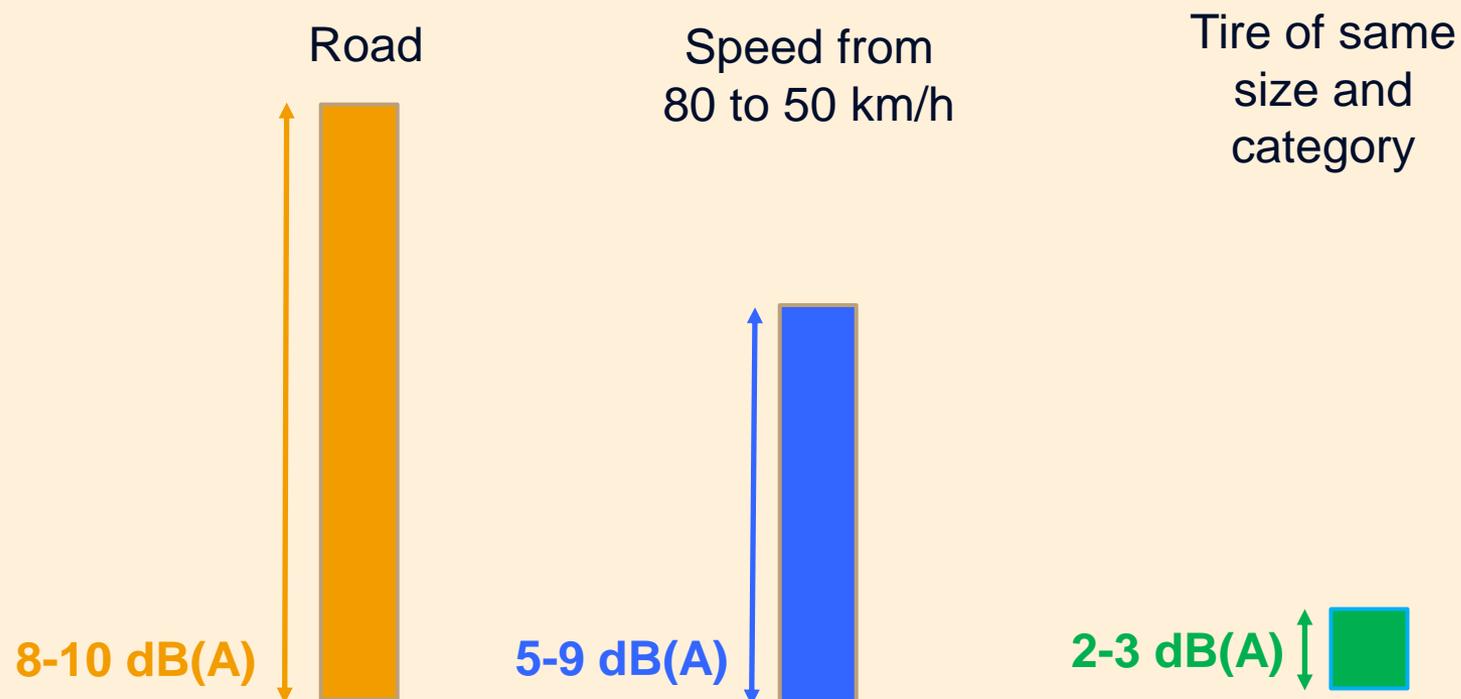
Between the noisiest tire on the noisiest road surface (Tire 16 on SMA 0/16) and the quietest tire on the quietest road surface (Tire 12 on Rollpave PERS), there is a noise difference of approximately 17 dB at both 50 and 80 km/h. Even between tire 16 on the SMA 0/16 and tire 12 on a more commonly used surface as the double layer PAC (section 16), there is a difference of 14-15 dB.

Tire-road interaction



Road pavement potential

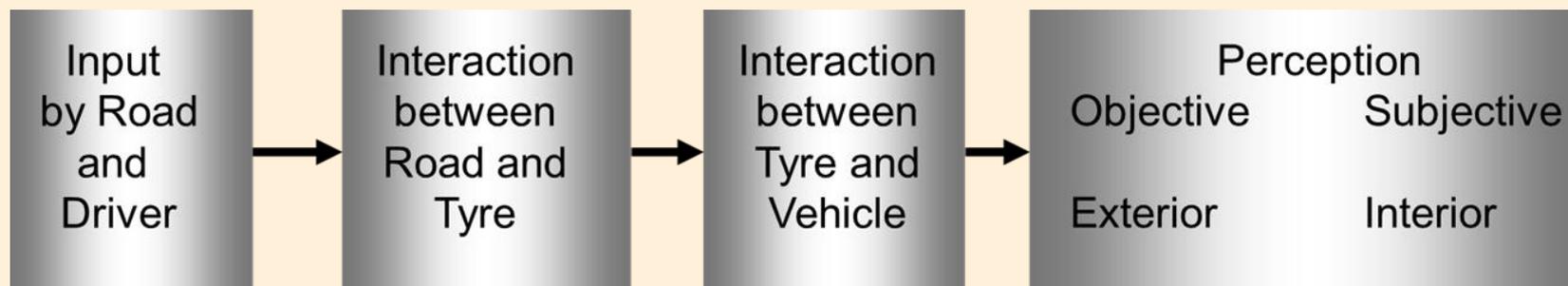
Tire influence compared to road and speed



Road and speed can be controlled locally where annoyance exist

Road noise mitigation requires - Holistic approach

- ▶ The approach for efficient societal benefit for rolling sound emissions has to be considered on a **Global Basis** where the main actors are the pavement, the vehicle & the tire.
- ▶ Traffic flow management & driver behaviour need to be included in this global approach.

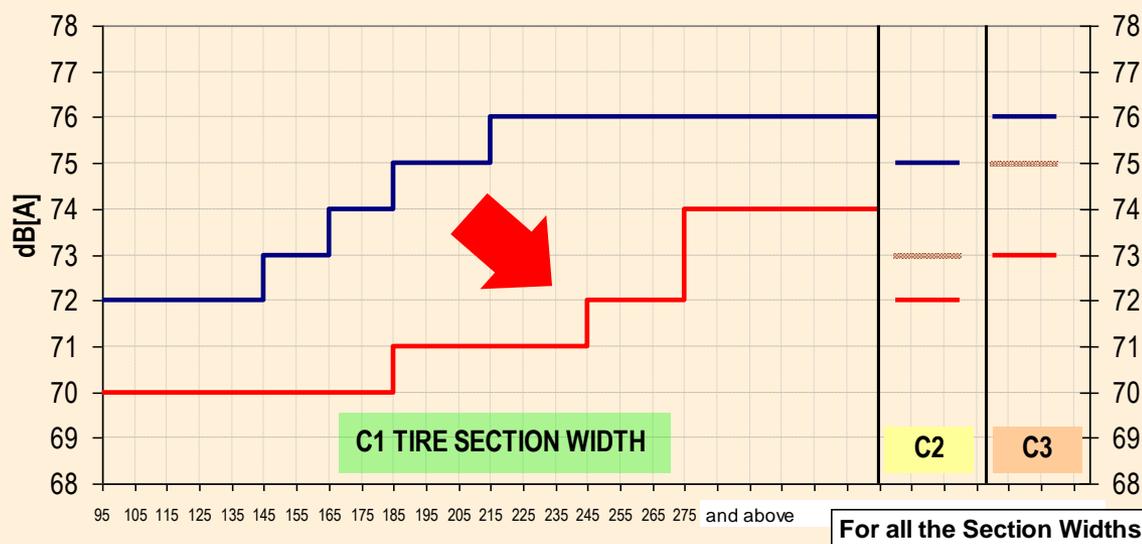


Tire/road noise in real life is generated on a wide range of different road surfaces.

What has been achieved?

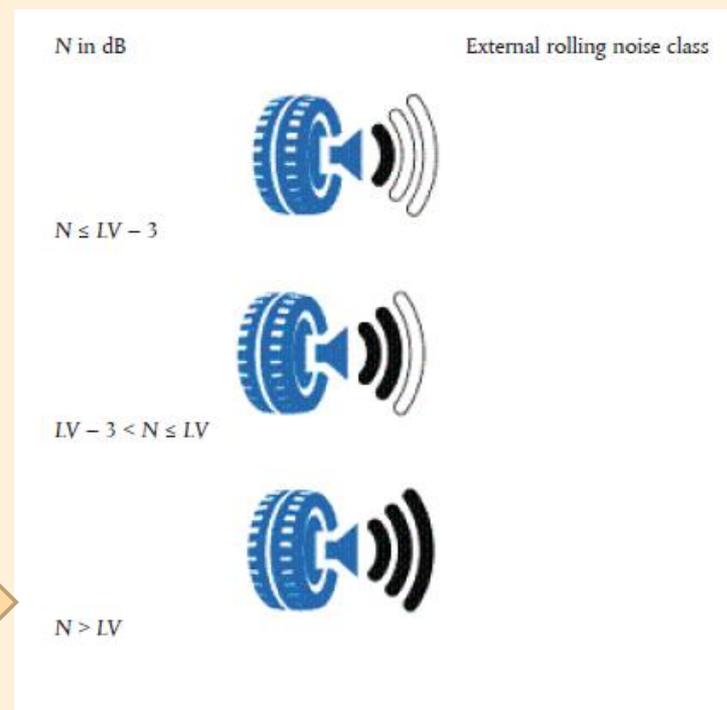
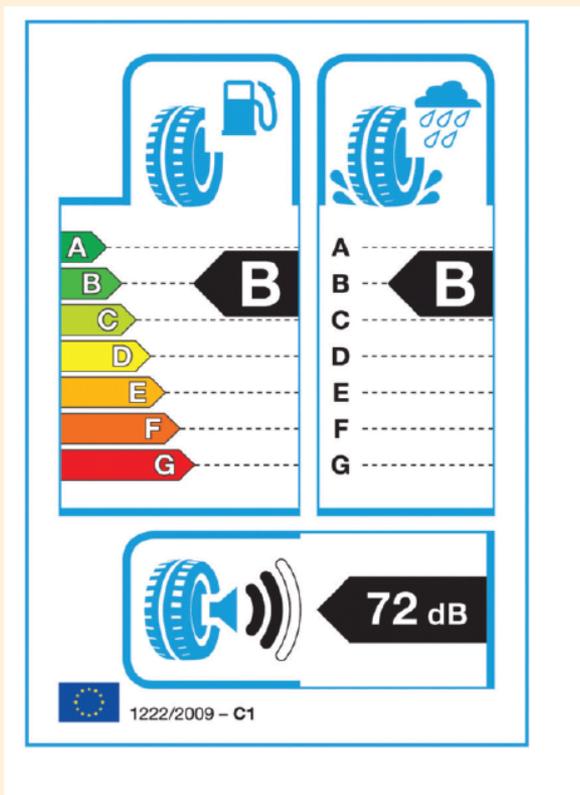
- ▶ EU Directive 2002/49/EC (END and Noise mapping)
- ▶ EU Regulation for tires 661/2009/EC (ECE R117.02) (As of November 2012)

Noise limit change from 2001/43 to REG 661



What has been achieved?

- ▶ **EU 1222/2009 (AND ITS AMENDMENTS) for tire labelling.**



View on further works to be performed

- ▶ **Need for regulations, harmonized procedures or policies for low noise pavements and other noise reducing measures; in particular, harmonised procedures for classification, check of conformity of production of road surfaces**
- ▶ **Many solutions for noise reduction have been developed. Further noise reducing materials are needed by:**
 - ▶ improving the mix design of the pavement
 - ▶ promoting the next generation low noise surfaces
 - ▶ promoting low noise dense surfaces for urban areas
 - ▶ optimization of low noise concrete pavements, both technical and subjective (acceptability by the population)
 - ▶ sharing knowledge and experience

Key questions for the holistic approach

How the road surface characteristics community could:

- ▶ Define harmonized procedures for classification and check the conformity of production of road surfaces? → (Which method ? (CPX, SPB, OBSI ...) and what SRTT tires are necessary)?
- ▶ Share knowledge and experience for silent pavement introduction?
- ▶ Promote the use of low noise surfaces as the most efficient way for noise reduction when repaving the roads ?
- ▶ Cooperate with the tire industry for the future tire road noise reduction?



Norfolk, Virginia / September 19-22, 2012
7th symposium on pavement surface characteristics

SURF 2012

Thank you for your attendance!