WP3 – Road surface properties – skid resistance / rolling resistance / noise emissions

Topics of WP3:

- describing different parameters of road surfaces and tyres with regard to skid resistance, rolling resistance, noise emission

- identifying interdependencies between these parameters with regard to the road surface properties

- making recommendations for optimisation the interaction of road surfaces and tyres

- identifying lack of knowledge and making proposals for further research

WP3 – Road surface properties – skid resistance / rolling resistance / noise emissions

- Started in December 2008; runs for 18 month

- Gather information from:

▪ Literature studies

▪ Workshops – contribution from relevant experts

▪ TYROSAFE partner experience

Work Package 3 – Deliverables / Workshops

Deliverables:

- **D10:** Report on different parameters influencing skid resistance, rolling resistance and noise emission *(August 2009)*

- **D14:** Interdependencies of parameters influencing skid resistance, rolling resistance and noise emissions *(March 2010)*

- **D15:** Report on knowledge gaps and proposals for future research concerning the optimisation of road surfaces and tyres for skid resistance, rolling resistance and noise emission *(May 2010)*

Workshops:

- 1st Workshop: 13thMay 2010, Brussels – *contribution to D10*

- 2nd Workshop: 10th February 2010, Cologne (TireTech 2010) – *contribution to D14, D15*

SKID RESISTANCE   ➡   safety

ROLLING RESISTANCE   ➡   energy saving (fuel consumption / CO_2-emission)

NOISE EMISSION   ➡   health

➡ **interaction between <u>road surface</u> and <u>tyre</u>**

- various aims for optimising
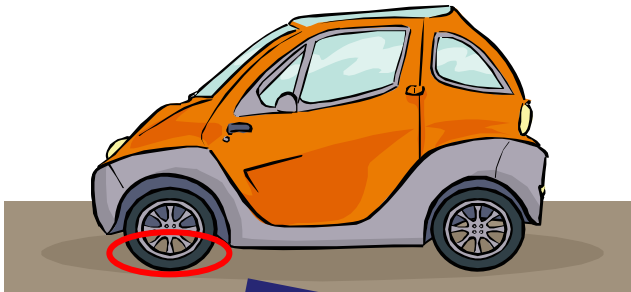- different parameters for optimising

EU-directive for tyre labelling with focus on the three main aspects:

- fuel efficiency, CO_2-emissions
- safety and
- noise emission

These aspects lead to the following tyre properties:

- rolling resistance
- wet grip and
- tyre-noise emission

Different recommendations on surfaces and tyres

Surface	Tyre
• low noise emission	• rolling noise
• high skid resistance	• wet friction
• evenness	• driving comfort
• low rolling resistance	• rolling resistance
• high resistance to permanent deformation	• mileage
• high resistance to fatigue cracking	• wear
• high resistance to low temperature cracking	• aquaplaning
• bright surface	• steering properties (dry /wet)
• low costs (construction/maintenance)	• weight
• ...	• ...

different interests: discussions in various groups (tyre engineers, vehicle engineers and road construction engineers as well as road users and road agency) from different perspectives, because of different interests

Road Manufacturer

Tyre Manufacturer

Road User

Road Agency
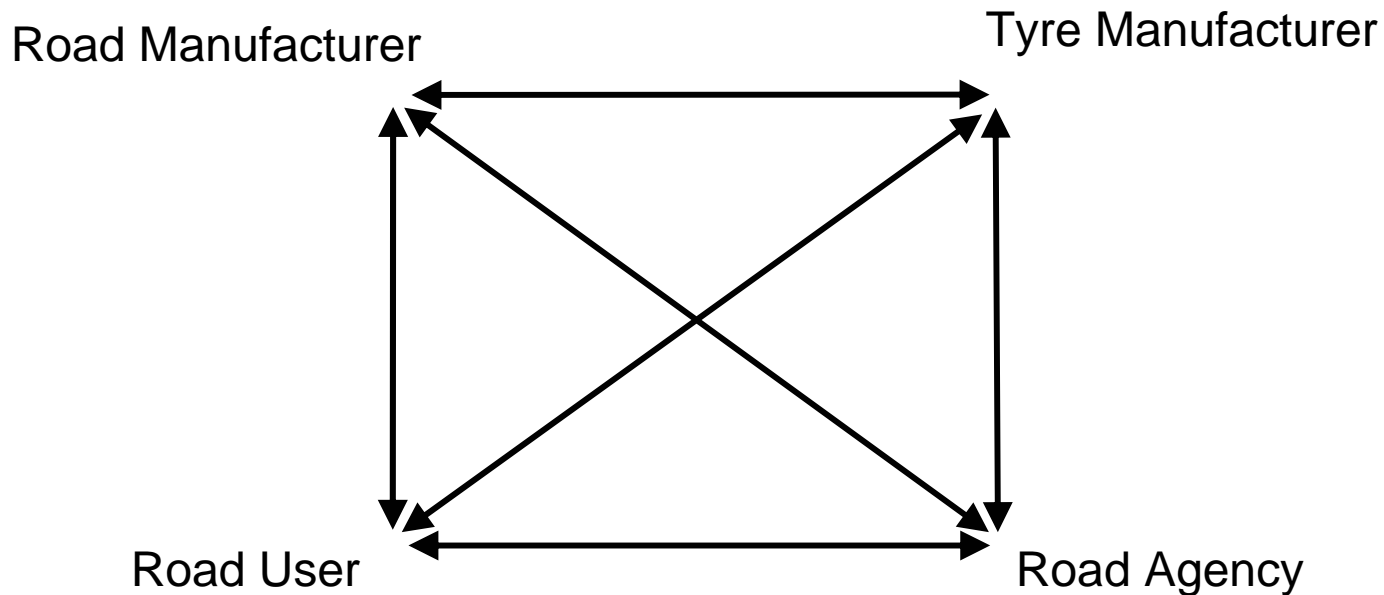
Relevant boundary conditions for road surface properties

surface property	relevant boundary conditions
• skid resistance / tyre-road friction	• wet and clean surface
• rolling resistance	• dry and clean surface
• noise emission	• dry and clean surface

Ignoring all <u>OUTER FACTORS</u>:

- traffic interaction
- tyres properties
- environment
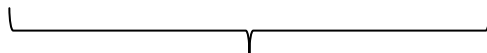
surfaces

- surface parameters (mix design, construction, surface texture)
- traffic interaction
- environment

tyres

Surface parameters vs. road surface properties

SKID RESISTANCE

ROLLING RESISTANCE

ROLLING NOISE

DIFFERENT IMPACTS

surface parameters:
microtexture
macrotexture
megatexture
porosity
absorption
...

can be partly influenced

can't be influenced
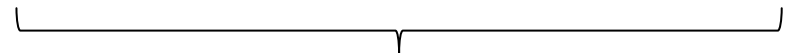
INNER FACTORS

mix design:

surface type
surface layer
composition
aggregate type
(max) aggregate size
aggregate shape
grading
binder type
texture
void content
...

construction:

laying
technique
compaction
temperature
...

OUTER FACTORS

traffic interaction:

traffic load
traffic composition
vehicle properties
tyre properties
speed
road geometry
...

environment:

environmental
effects
water film
thickness
...

can be influenced

Interdependency matrix – surface parameters

asphalt surfaces
(dense / porous)

concrete surfaces
(dense / porous)

aggregate properties
•kind of aggregate
•shape
•angularity
•polishing resistance

texture parameters
•max aggregate size
•water/cement-ratio
•workability of the concrete
•consistence

paving
•chipping
•chipping
polishing
•degree of

finished surface
•layer thickness
•absorption
•surface texturing
•texture parameters (micro-/macro-/mega-texture)

all different parameters can be grouped in a matrix to show the various impacts

Tyre parameters vs. road surface properties

TYROSAFE
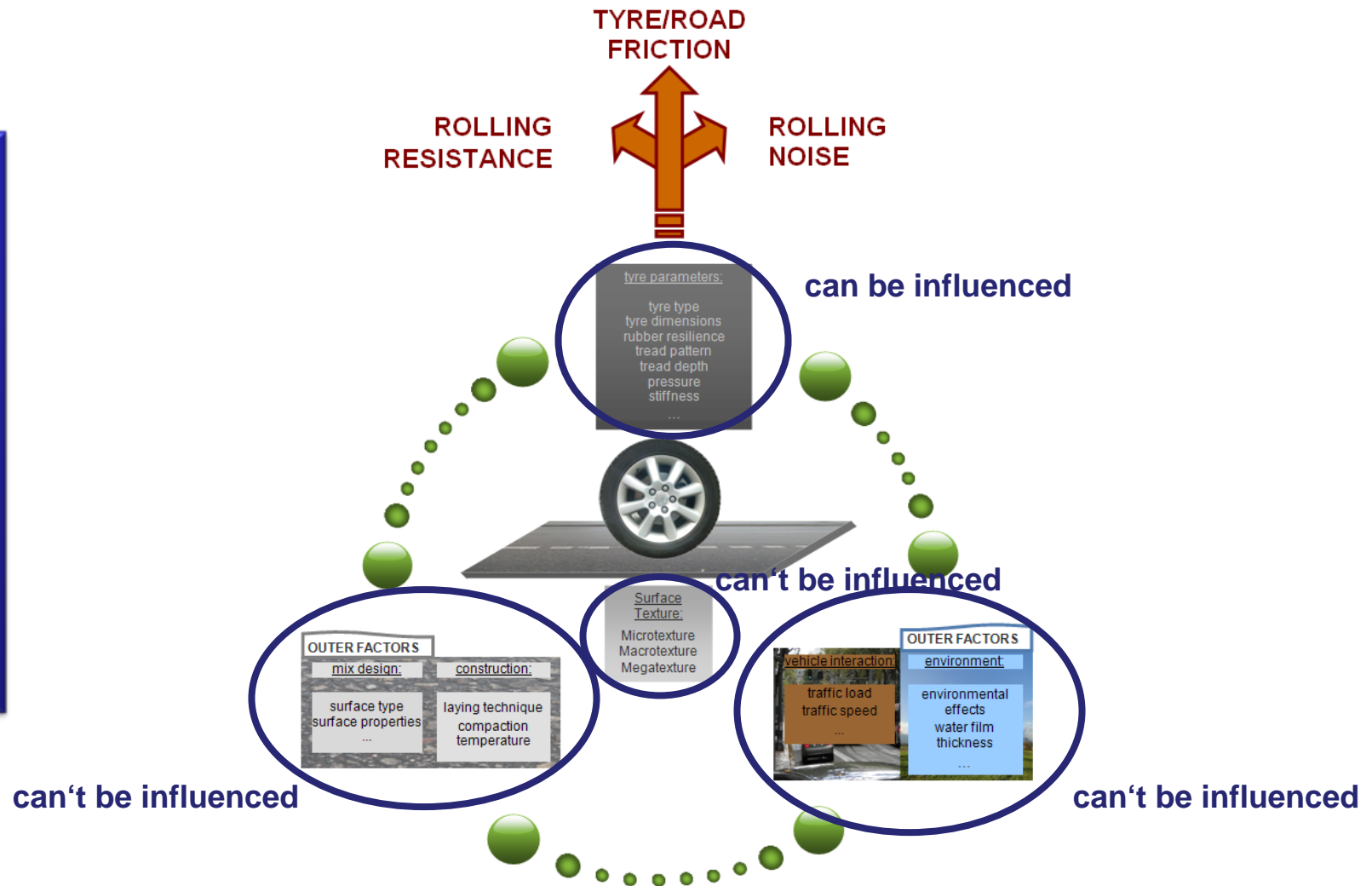
pc- (passenger car) tyres   **HGV- (heavy goods vehicle) tyres**

tyre construction
•tyre dimension
•tread pattern
•tread depth
•inflation pressure
•kind of tyre

bber properties
ber hardness
ber resilience

all different parameters can be grouped in a matrix to show the various impacts

miscella
•age and
•retreated tyres
•load
•studded tyres

•retread tyres
•load
•studded tyres

bast

FEHRL

Interdependency matrix – surface parameters

parameters (asphalt surfaces) - example			SR	RR	NE
aggregate properties	•	⇩	+	?	+

Description:

SR   skid resistance

RR   rolling resistance

NE   noise emission

⇧   increasing/raising value or category *(normally increasing values of this parameter are positive with regard to the parameter)*

⇩   decreasing value or category *(normally decreasing values of this parameter are positive with regard to the parameter)*

+   positive impact *(e.g. higher skid resistance, lower rolling resistance, lower noise emission)*

-      negative impact *(e.g. higher skid resistance, lower rolling resistance, lower noise emission)*

o   no impact *(e.g. no changes on surface property due to due to changing the parameter)*

?   impact unknown – still a knowledge gap

	•	⇧	?	?	+

Interdependency matrix – surface parameters

parameters (asphalt surfaces) *- example*			SR	RR	NE
aggregate properties	•	⇩	+	?	+
	•	⇧	+	-	o
	•	⇧		?	o
mixture parameters	•		+		+
	•				-
	•			+	-
laying & compacting	•		+	+	+
	•	⇧	+	?	o
	•	⇧	?	?	-
finished surface	•	⇧	?	?	+
	•	⇧	o	o	+
	•	⇧	?	?	+

**same matrix also for tyre parameters**

Interdependency matrix

•still knowledge gaps on various surface and tyre parameters with regard to the surface properties

•knowledge gaps can divided in four general areas:

- Road surfaces.
- Tyres.
- Measuring systems.
- Environmental parameters.

⇨**Research needs**

Strategic approach

•research must have a purpose other than simply to answer interesting scientific questions – *Why doing research?*

•research provides the inputs to a complete system
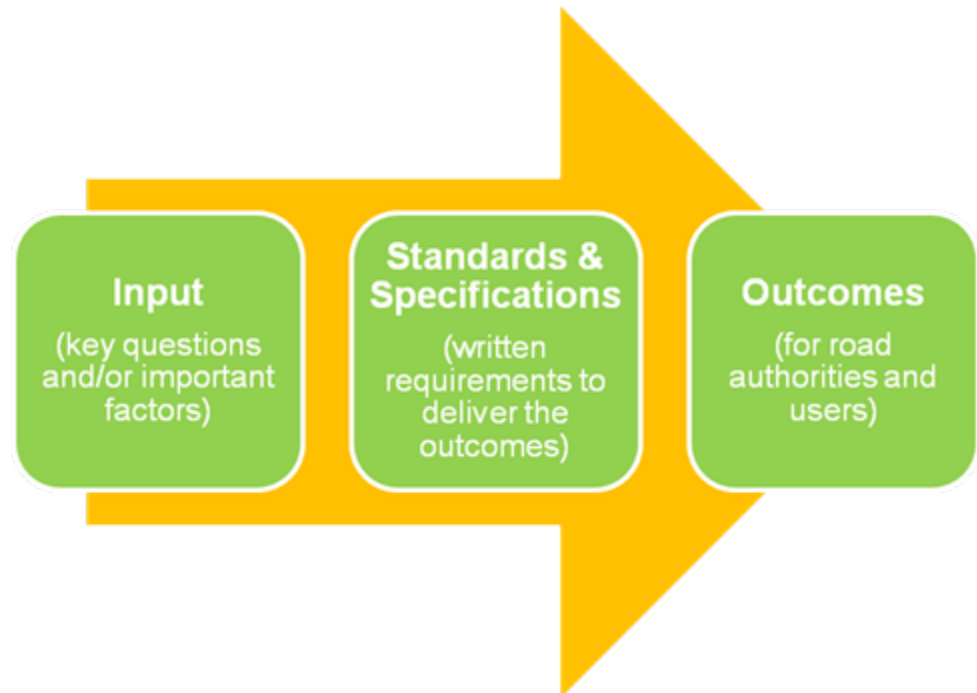
Future research - steps

Research steps

• some tasks/steps must be completed before others can begin since later work depends on the outcomes

• some work will need to be carried out in clear phases, with defined components in each, that move progressively from laboratory studies through to the stage where the results can be applied practically

laboratory stage

trial stage
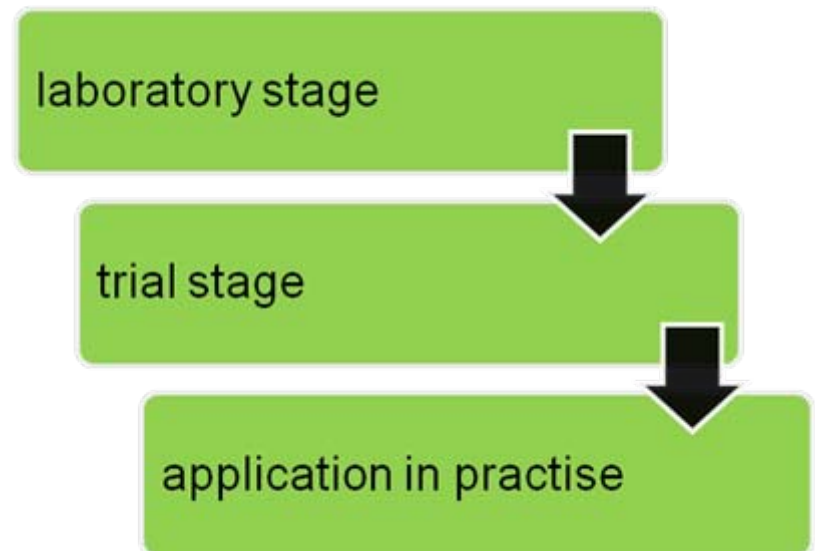
application in practise

- Identified thirteen main research areas

  - Most important is how to measuring and interpreting texture as well as the contact patch of a tyre on the surface with regard to the three surface properties

  - Can be divided in surface parameters (including measuring systems), tyre parameters (including measuring systems) and surface/tyre interaction - simulation models

- Cover a period of 20 years

Optimising surface properties - problems

Problems:

• currently surfaces and tyres – optimised separately

  ➢ surfaces tested with specified methods with regard to skid resistance, rolling resistance and noise emission – surfaces are optimised according to the test methods

  ➢ tyres tested on specified surfaces – especially according to ISO 10844

• Surfaces and tyres – optimised mostly with regard to **one** of these three properties

Thirteen main research areas have been identified as follows:

(1)Developing new texture parameters (with both two-dimensional and three-dimensional representations of the road or tyre) to provide a better description of the interaction of tyres and surfaces in the contact area in relation to the three road surface properties. This will also involve developing laboratory scale measuring techniques.

(2)Assess the impact that various construction parameters (e.g. layer stiffness, interconnected voids) have on the road surface properties.

(3)Establish ways to optimise road surfaces in relation to the parameters identified in (1) and (2) to achieve this in practice (through, for example, the composition of surfacing mixtures, paving techniques and compaction).

(4) Assess the impacts that wear and aging have on the properties of surfaces optimised on the basis of the research from areas (1), (2) and (3).

(5) Develop equipment capable of measuring the parameters identified in (1) and (2) for with adequate resolution and speed for use at traffic speeds.

(6) Develop measurement systems that allow a straightforward assessment of new work while under construction or shortly after construction is finished

(7) Optimise tyres – their tread design, rubber compound, etc. – to performance in relation to the surface properties on real road surfacings used on the network.

(8)Understand the consequences of using measurements with tyres that have been optimised on real road surfaces rather than on artificial surfaces alone

(9)Assessment of the tyre/road surface properties over the lifetime of the tyre with a view to establishing consistent behavior throughout its life.

(10)Assessment of new or futuristic tyre designs/constructions with regards to the surface properties

(11)Development of 'comparable' measuring systems for passenger car and truck tyres

(12) Improvement of existing simulation tools (e.g. SPERoN) – developing textures for low noise surfaces, for example with the help of the developed texture parameters

(13) Improving simulation models for optimising tyres to predict the impact that changes in the tyre will have in relation to the three road surface properties. This could involve developing a numeric model which simulates the dynamics of rotating tyres at medium and high frequencies and extend the current focus on noise emission to include the texture of road surfaces.

Summary

- currently still a lot of knowledge gaps

  - some only interesting from a scientific aspect

  - others a important for harmonisation (e.g. measuring systems, policies)

- to access wear and aging the research will need about 20 years

- a lot of funding needed to solve the open questions

- co-operation between road industry and tyre industry as well as experts from both needed

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Thank you for your attention
and interest
on behalf of the TYROSAFE team