Cutting FUEL CONSUMPTION by regulating Pavement Materials

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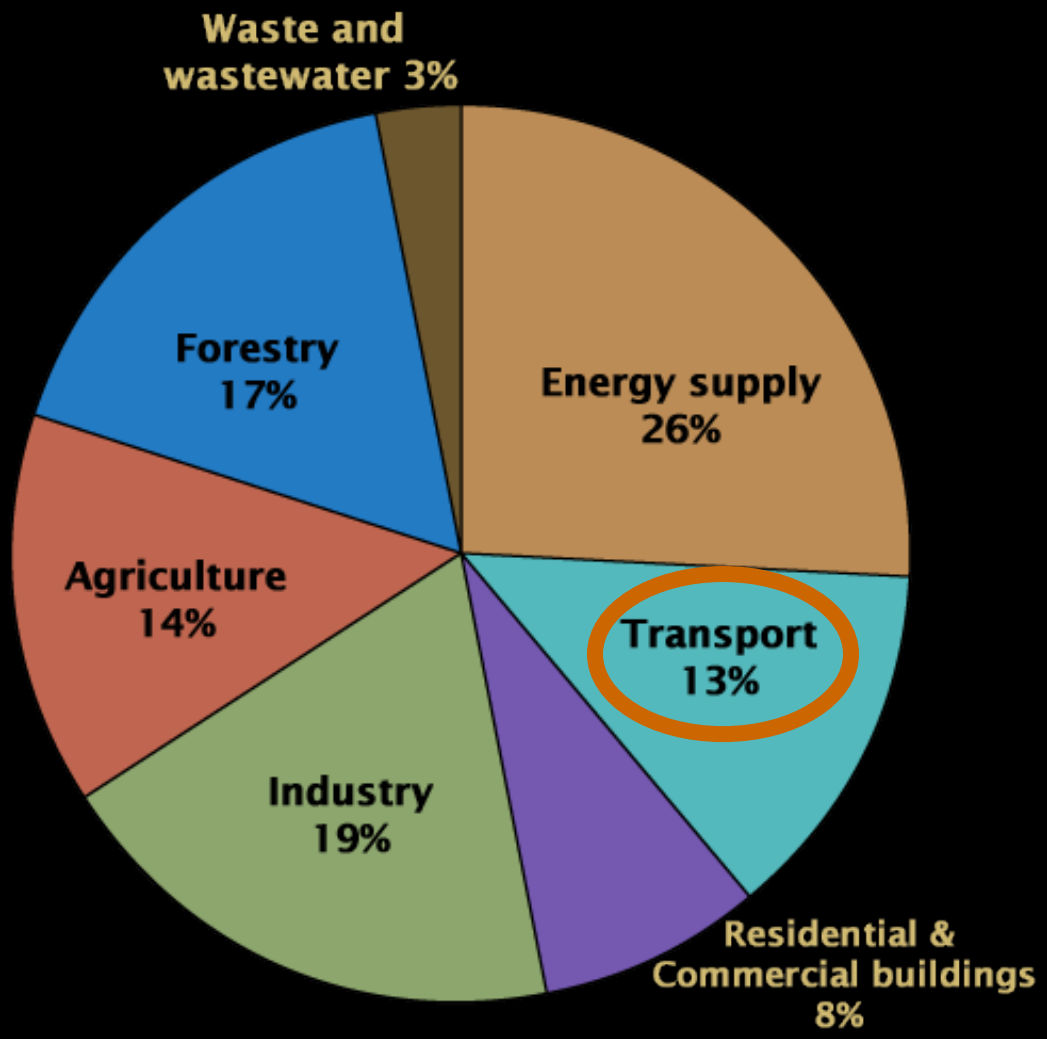
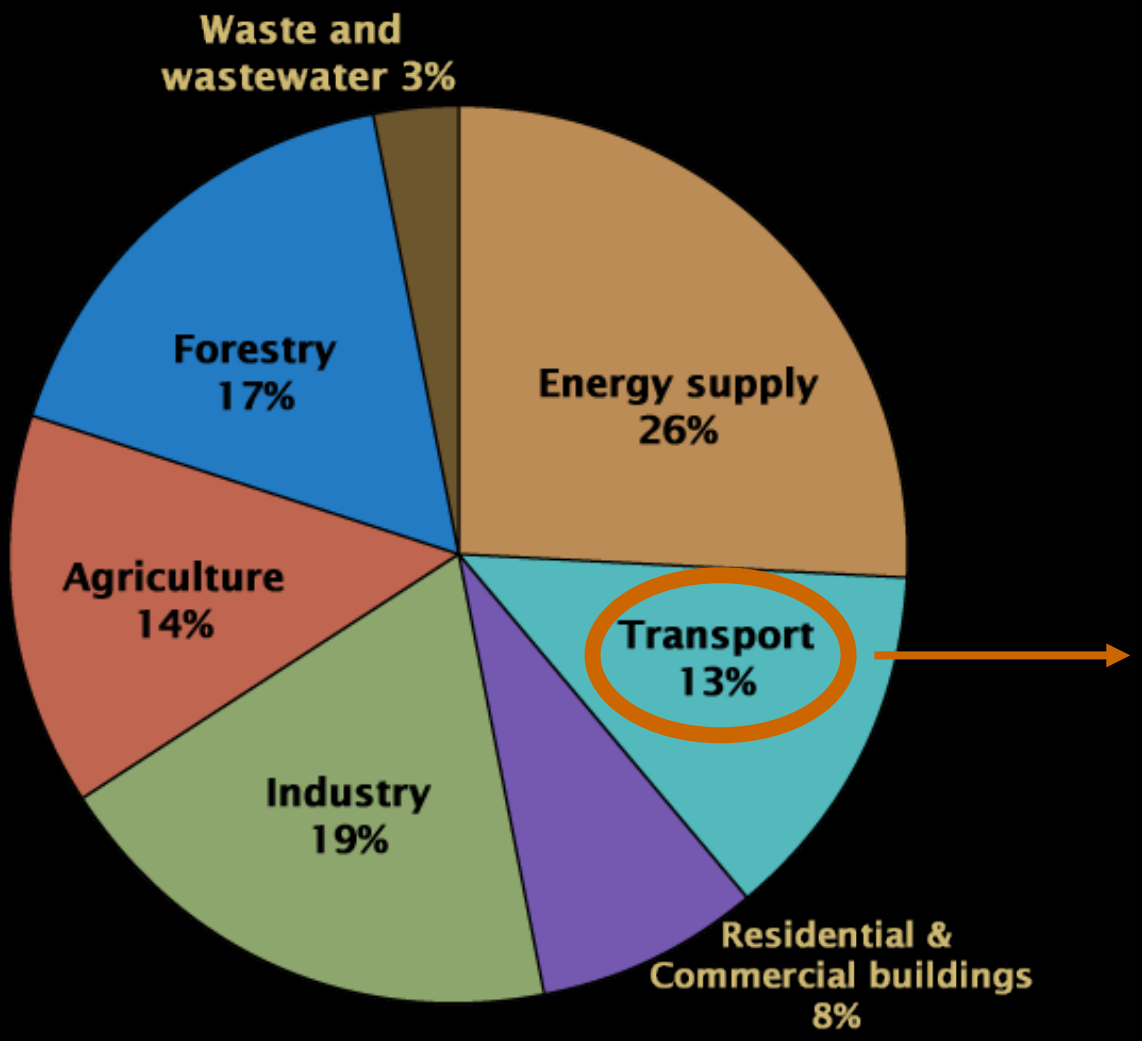
CN Forum
1 October 2015

Global Greenhouse Gas Emission



Global Greenhouse Gas Emission



Key players:

1. Traffic behavior
2. Engine performance
3. Rolling resistance

Rolling resistance

Rolling resistance ≈
Energy loss through
tire-pavement contact

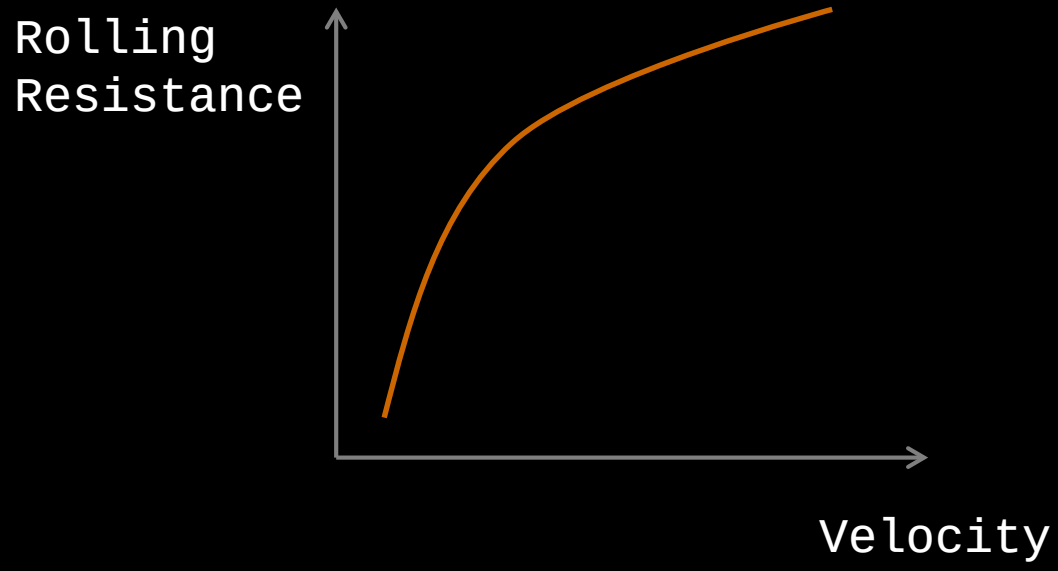
Contribution to energy

20% passenger cars

40% trucks

Key players:

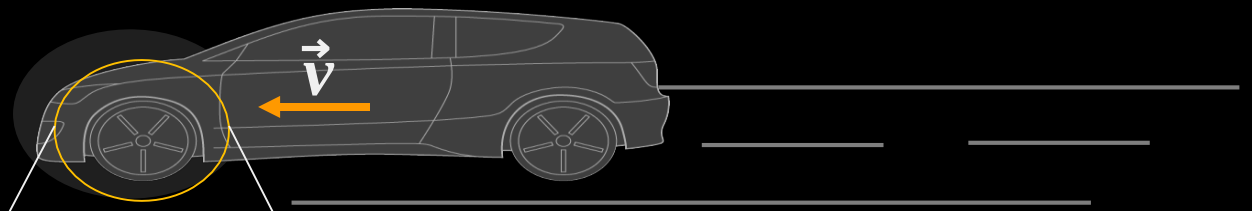
- Tire -> LRR Tires
- Pavement -> ?



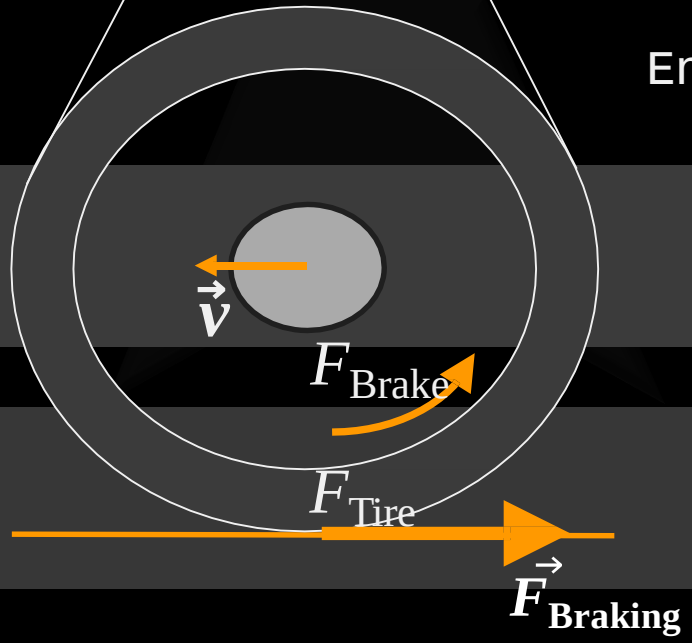
Main Challenge

Breaking Vs Rolling resistance

Kinetic energy of the vehicle



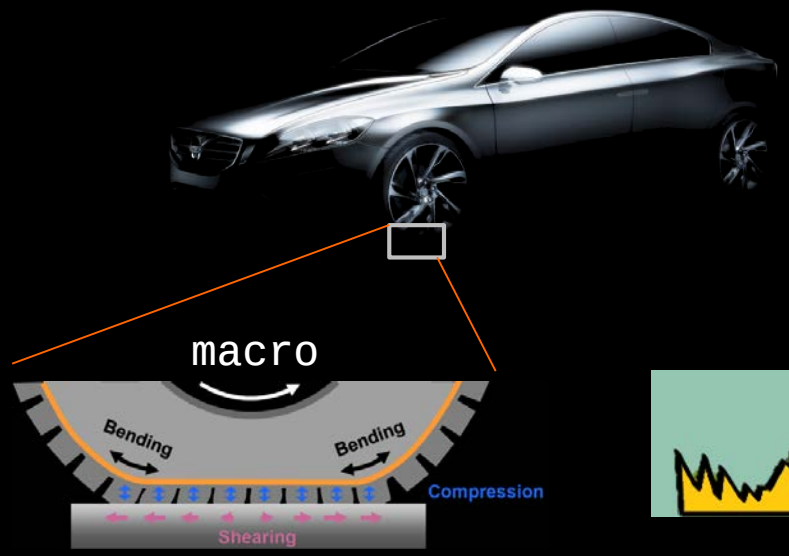
Energy Dissipation in braking		Energy Dissipation in moving
Brake	96%	70 - 85%
Tire	4%	20- 40%



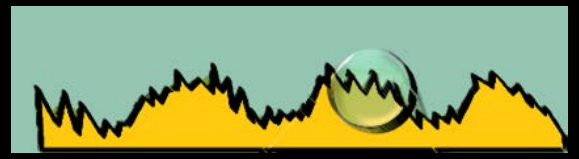
Rolling resistance

Hysteresis

= Tire deflection



Pavement



1-10 mm

= Asphalt dispersion quality

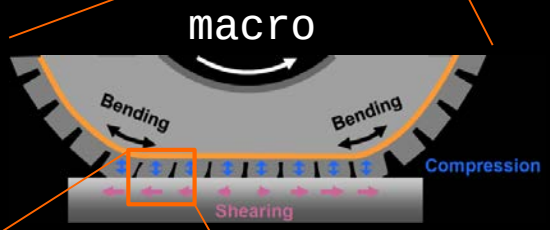
[1] Continental ©

Rolling resistance

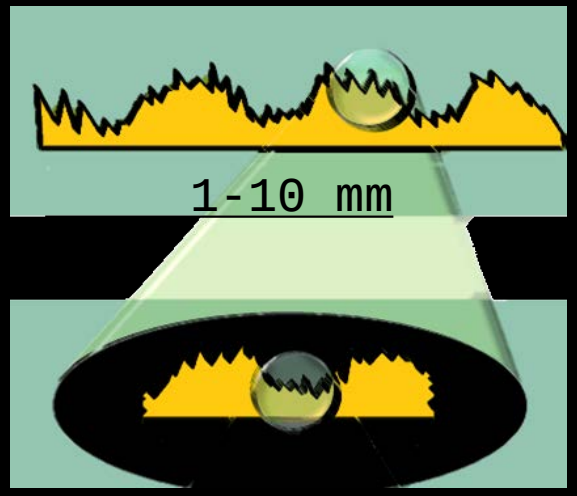
Hysteresis

= Tire deflection

+ Tread slip



Pavement



= Asphalt dispersion quality

+ stone size

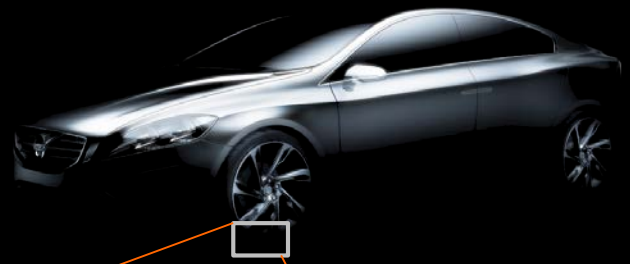
Rolling resistance

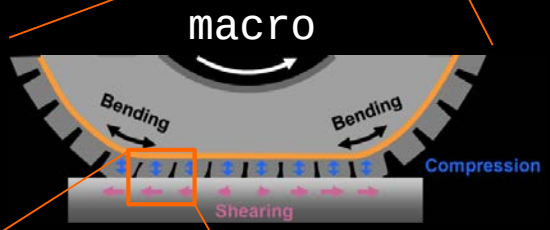
RR in Tire

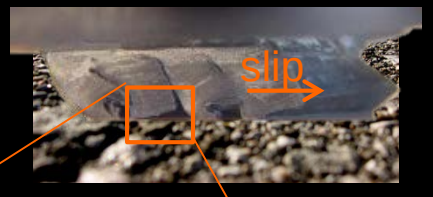
= Tire deflection

+ Tread slip

+ Tread deformation

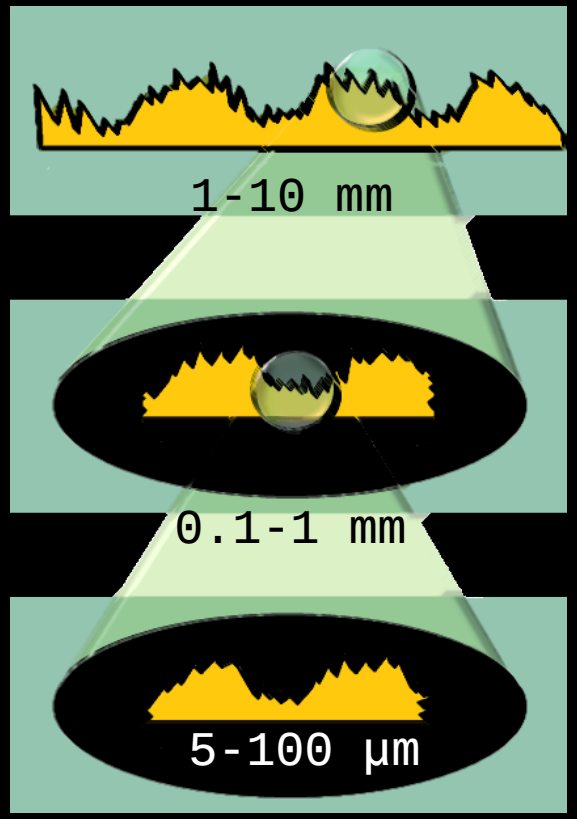






Pavement

= Asphalt dispersion quality



+ stone size

+ stone type

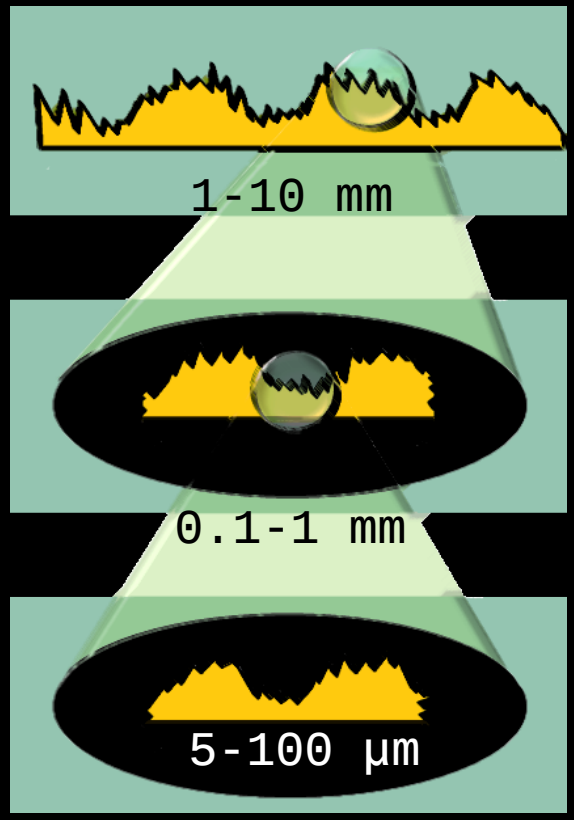
Pavement Design regulations

Pavement

From 1980: US states (all)
Canada
EU countries (all)

From 2010: 6/50 US states
Canada (under research)
EU (under research)

Our topic of research



= Asphalt dispersion quality

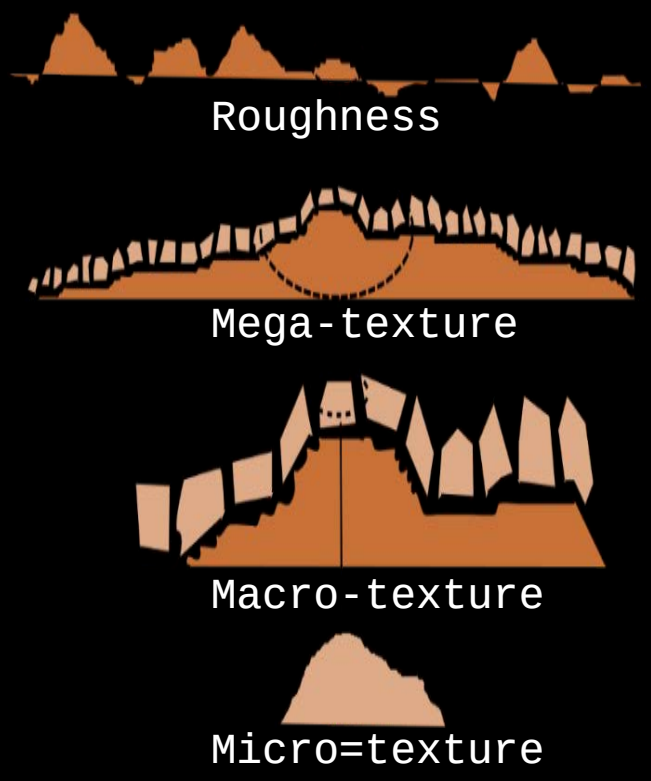
+ stone size

+ stone type

Caltrans Division of Maintenance

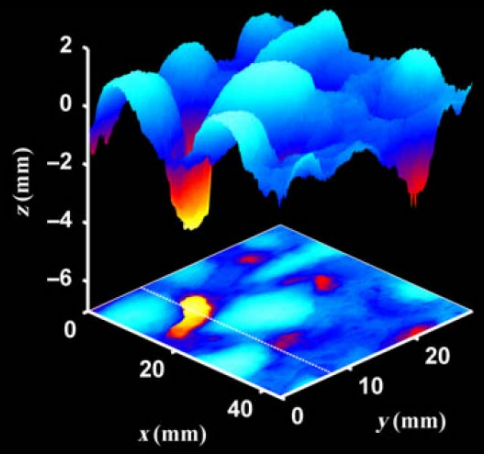
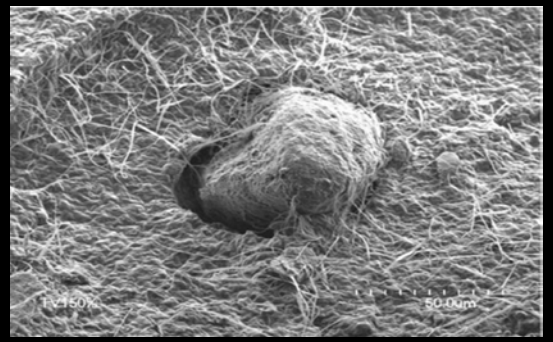
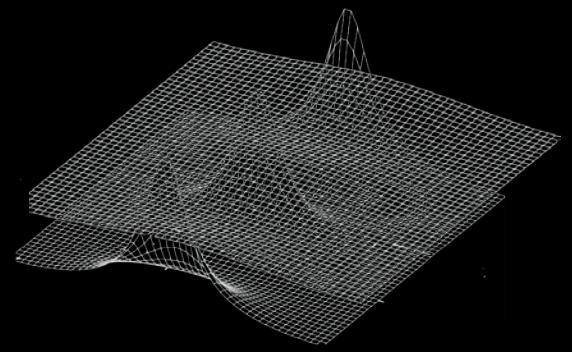
- “While the importance of the role of pavement macro-texture in providing adequate surface friction has been increasing in the United States, few states actually measure it and even fewer appear to have minimum macro-texture requirements.

- Still no policy for Micro-texture



Our approach

Rubber penetration to surface asperities

Pavement Surface analysis	Multi-scale modeling of Rubber	A coupled framework
		
Roughness profile *Fractal description*	*Viscoelasticity* *Damage & inhomogeneity*	*Multiscale framework*
[1] Mahboobkanafi et al. 2013	*[2] Dargazany et al. 2013*	*[3] Dargazany et al. (to be submitted)*

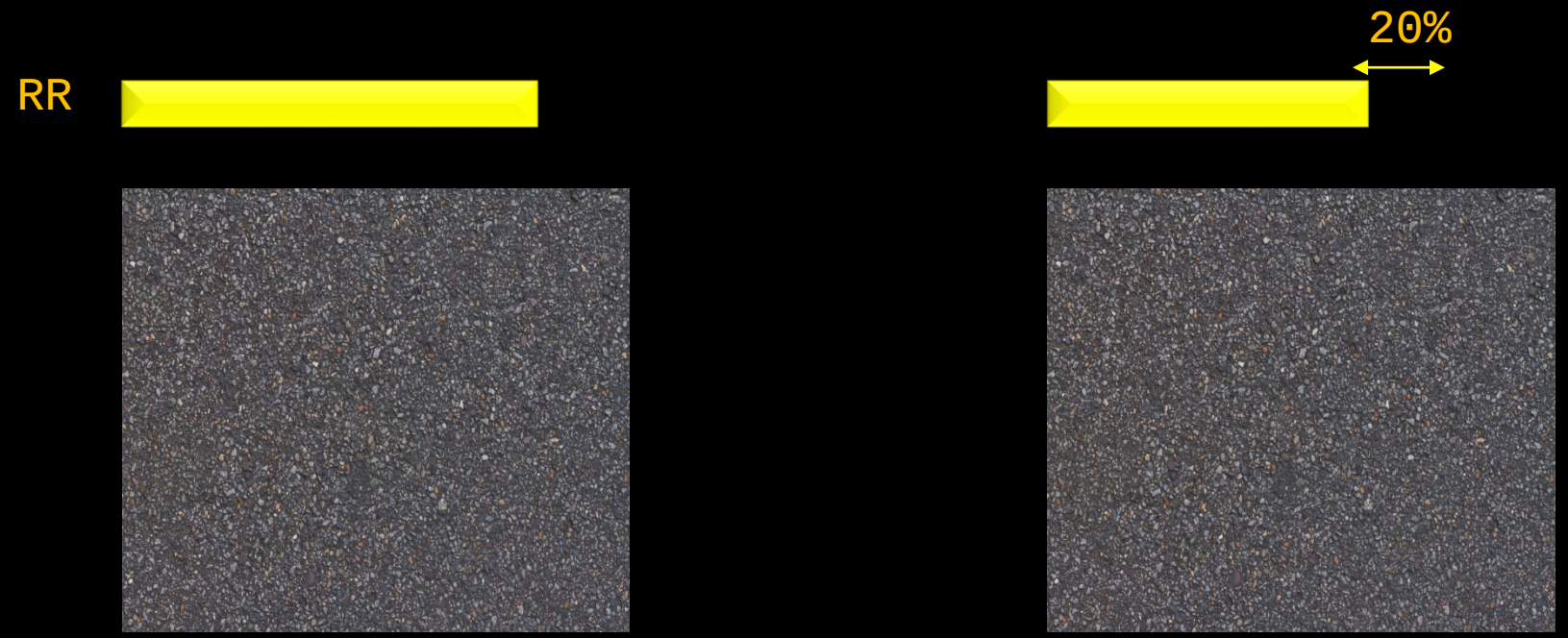
Each method contributes to the understanding of friction & hysteresis in rubber- pavement interface.

Development of a multi-scale framework to explore micro & meso pavement surface roughness spectrum to minimize Rolling resistance

Why it matters?

ROSANNE study in Denmark found 20% difference between the rolling resistance (RR) of similar roads in Poland:

- Same roughness
- Same testing procedure
- Same company
- Different mix



Test sample 1

Test sample 2

Thank You