IFSTTAR

Effect of particulate contaminants on skid resistance

MT. Do, V. Cerezo, C. Ropert, Y. Hichri

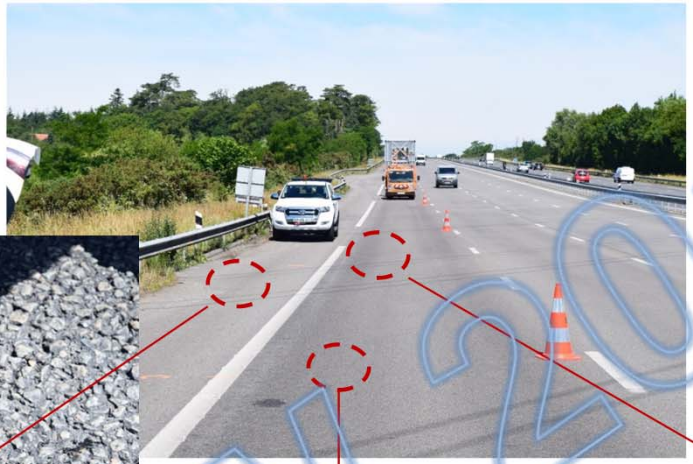
Session

Skid resistance: Measurements and requirements

Thursday, May 23rd 2019

Surface contamination

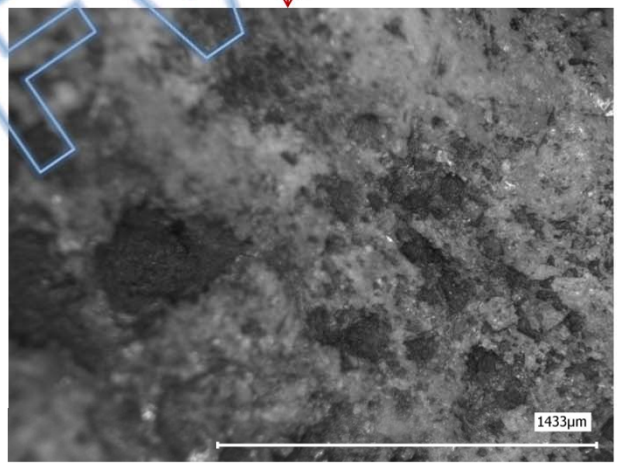
Some evidences

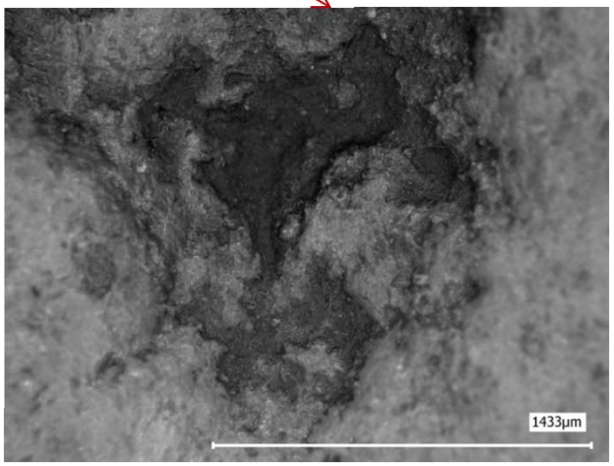


5-40 g/m²
depending on the exposition
(weather, traffic, land use)

1 day since the last rain

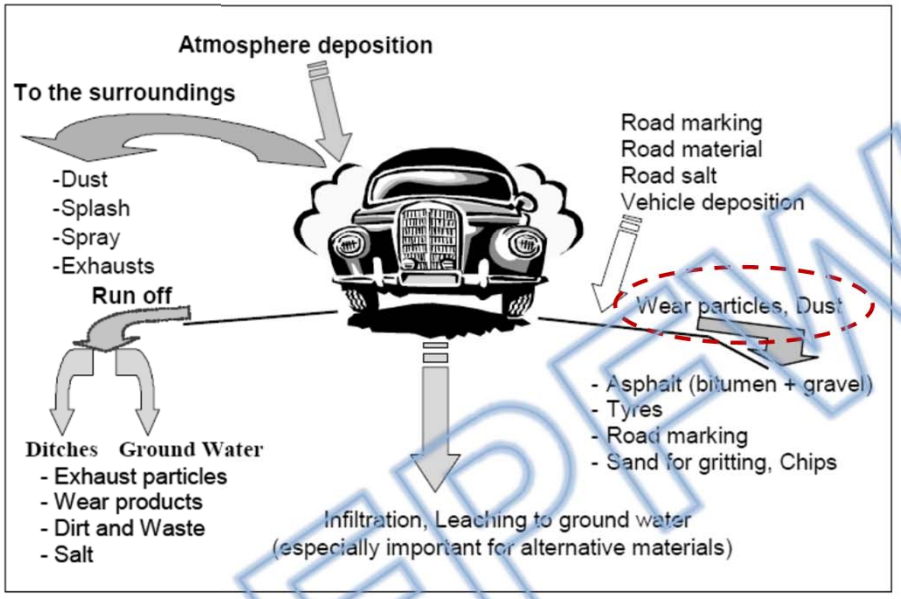
9 days since the last rain





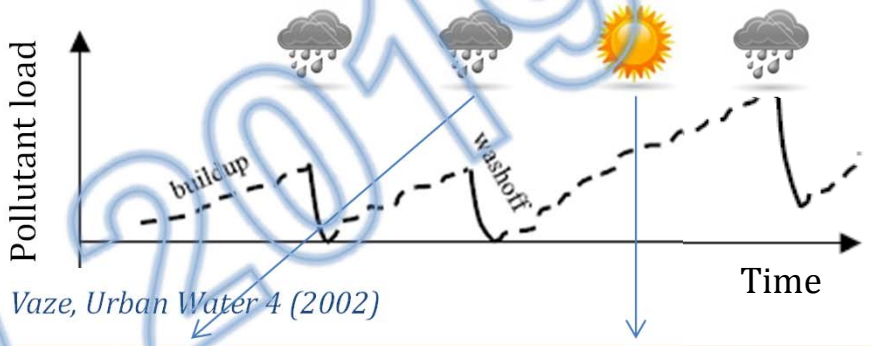
Surface contamination

Origins

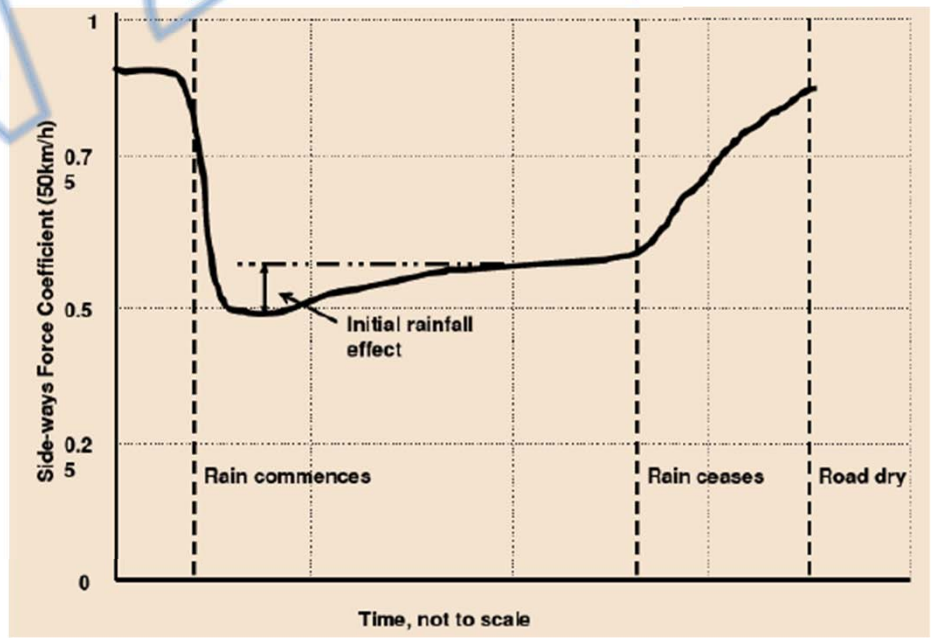


Dawson, Report COST351 (2007)

Consequences on skid resistance



Vaze, Urban Water 4 (2002)

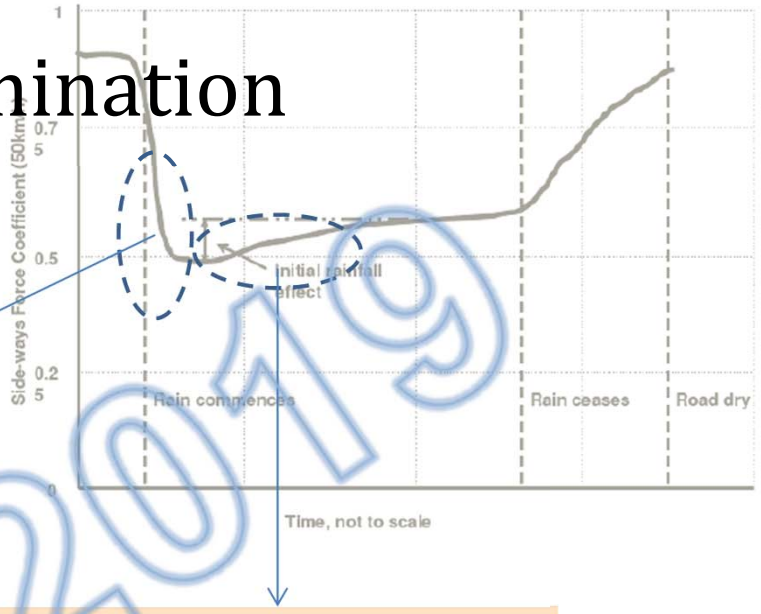


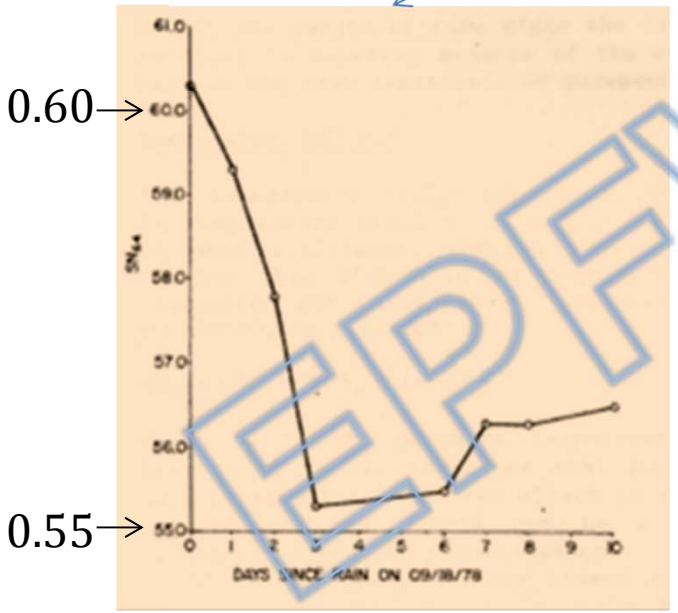
Bird, Road research bulletin n° 1 (1936)
cited in Wilson, PhD (2006)

Surface contamination

Previous studies

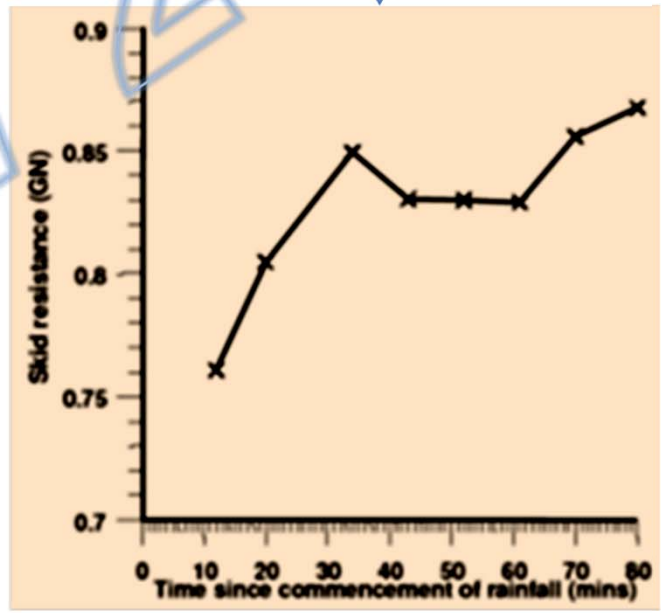
Need to reproduce and characterize the whole process





Hill, Transp. Res. Rec. 836 (1981)

Buildup effect



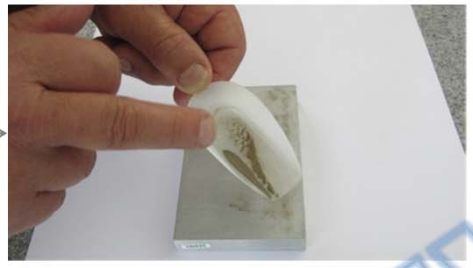
Cenek, Transfund New Zealand Research report 139 (1999)

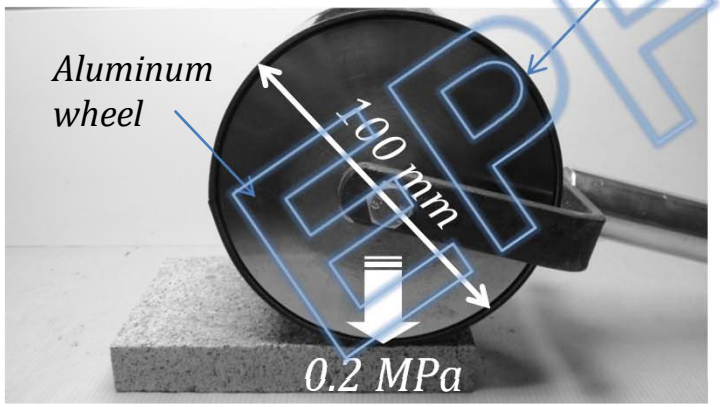
Washoff effect

Surface contamination

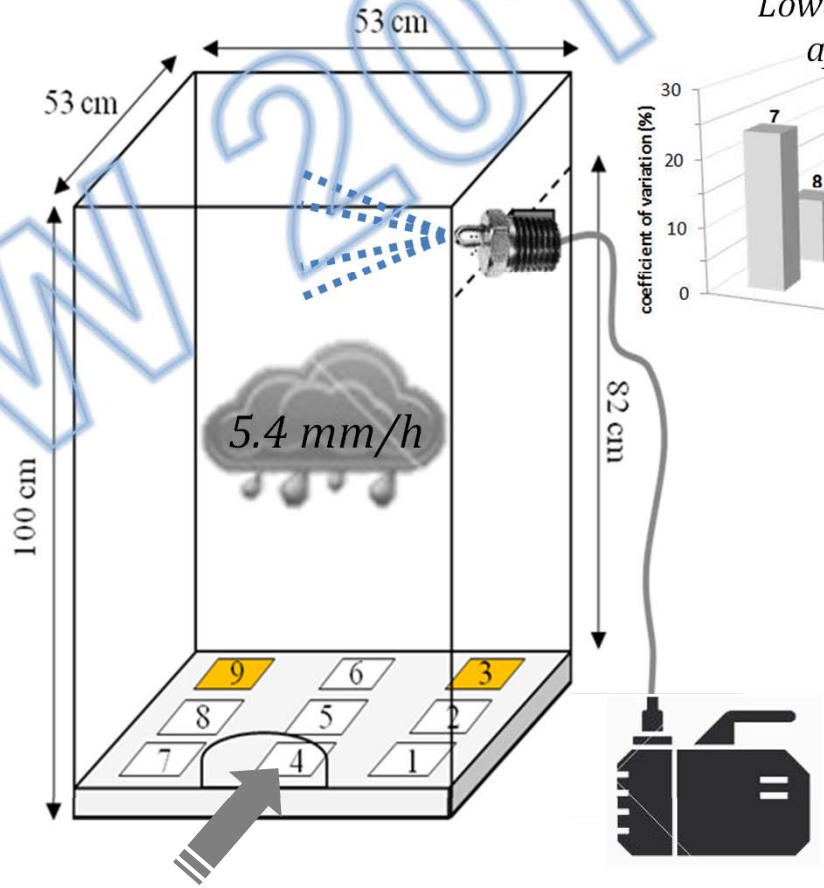
Laboratory investigation

Reproducing the process



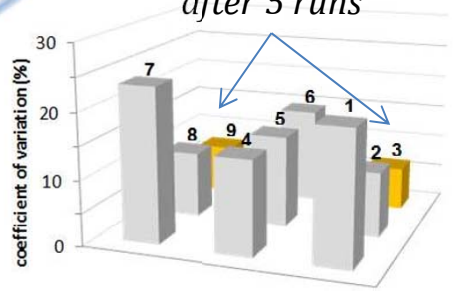


Buildup



Washoff

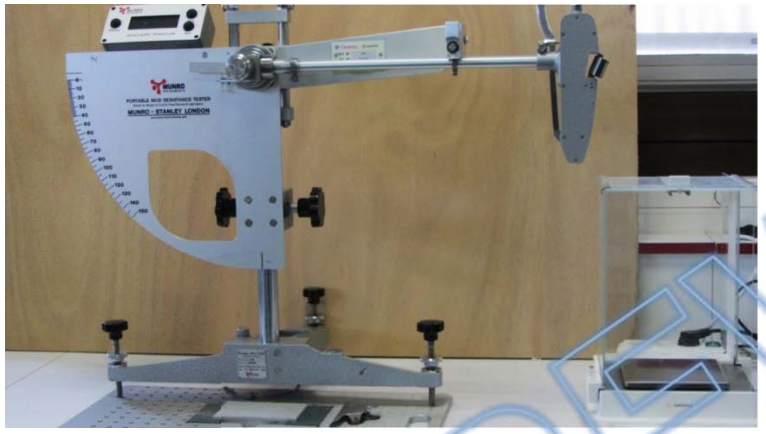
Lowest variability after 5 runs



Surface contamination

Laboratory investigation

Charactering the process



Buildup

Particles spreading/compaction

↓

Sample weighing

Washoff *step*

10s

Friction measurement

↓

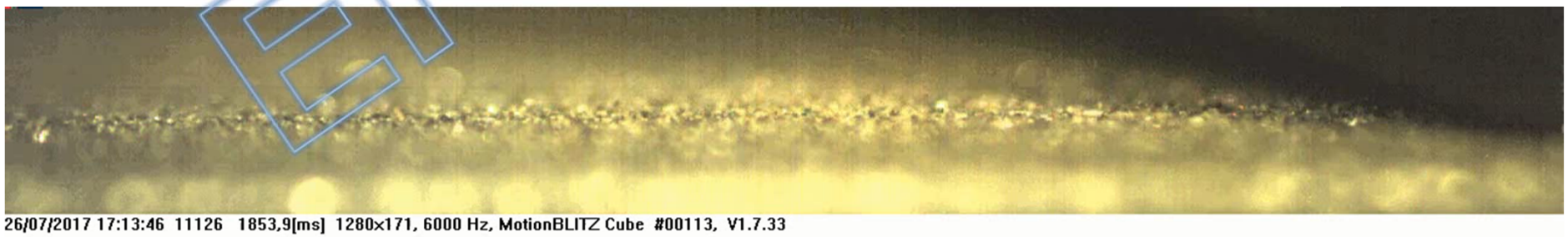
Sample weighing

Drying

60s

Friction measurement

Dry friction test



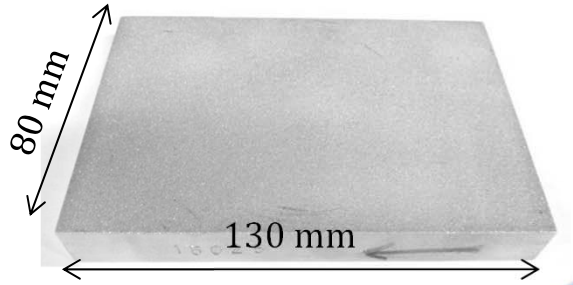
Changarnier, Tribology Int. 128 (2018)

Surface contamination

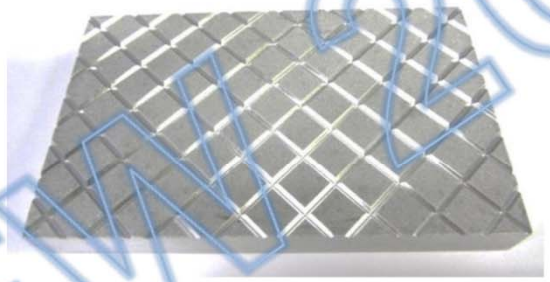
Laboratory investigation

Test surfaces

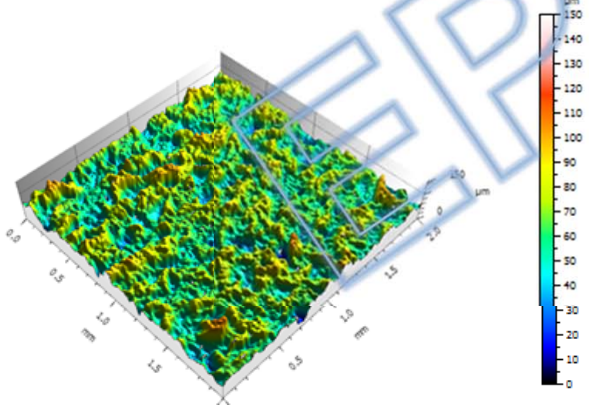
Microtexture

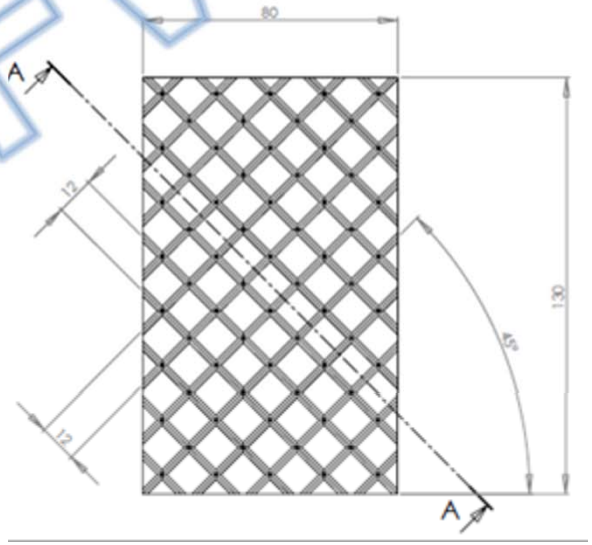


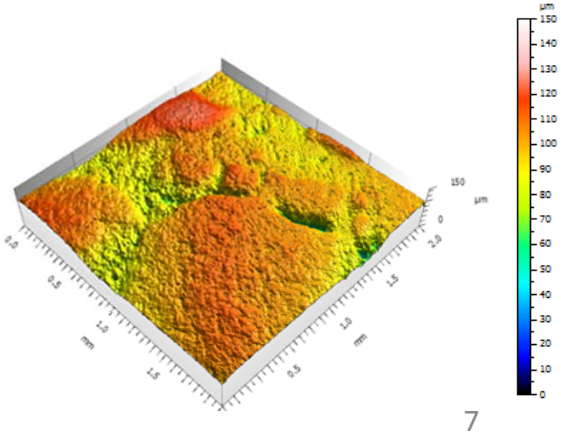
Micro-macrotexture



Aggregate



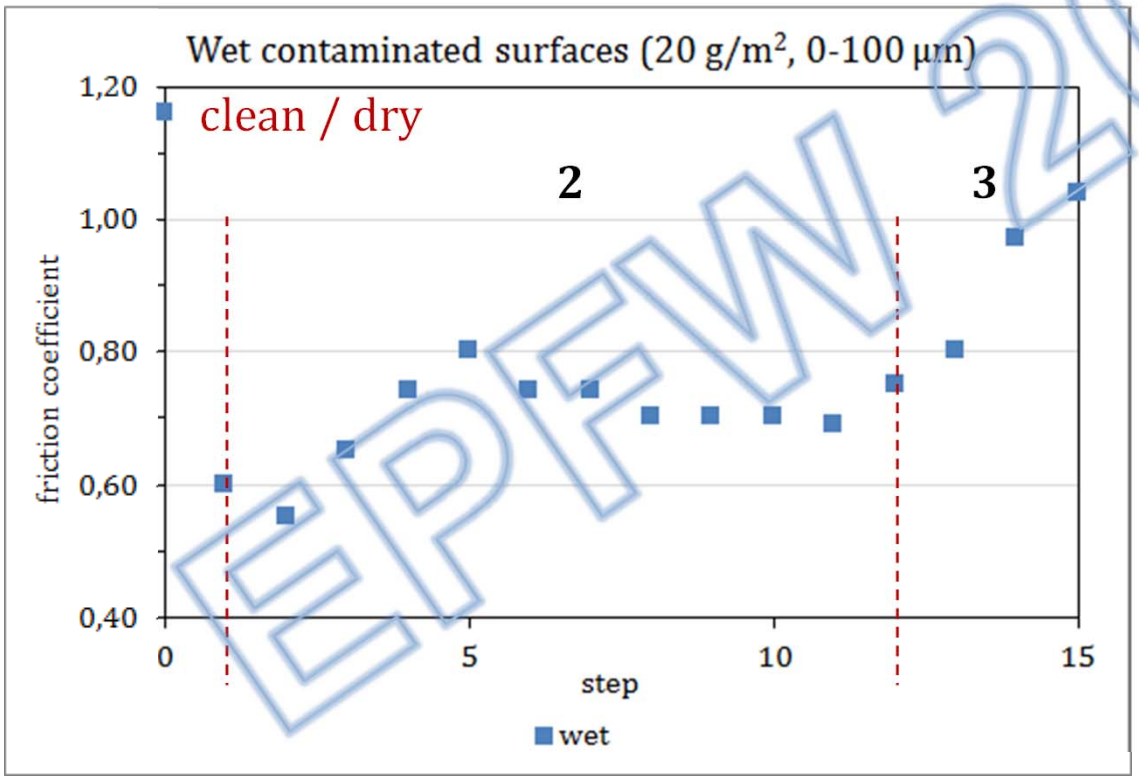


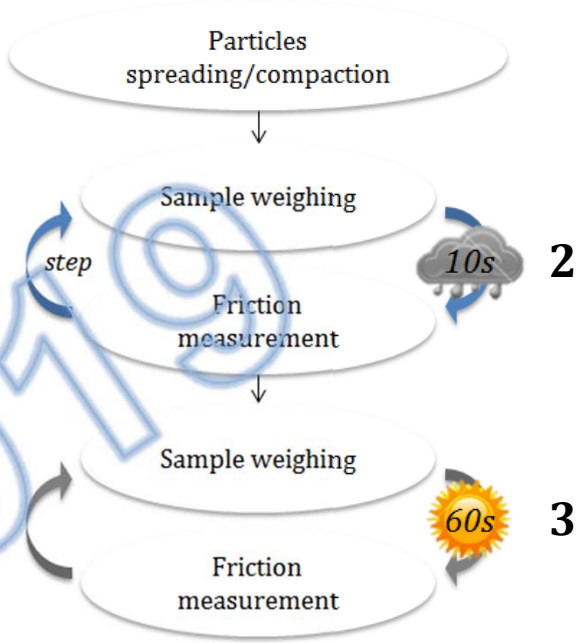


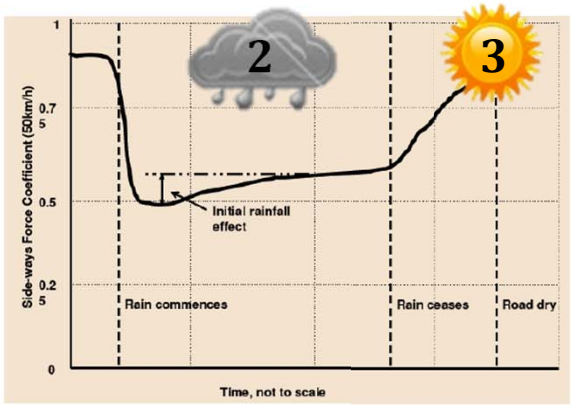
Results

Skid resistance of contaminated surfaces

Transition clean → wet contamination





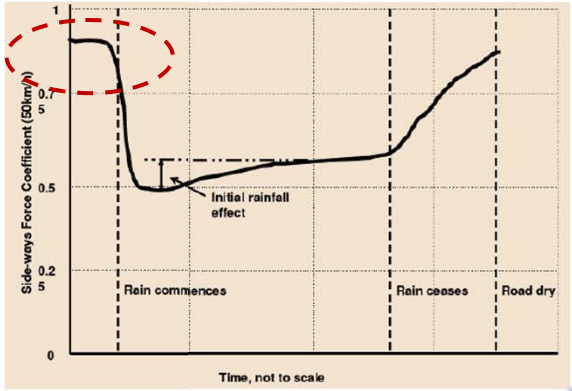


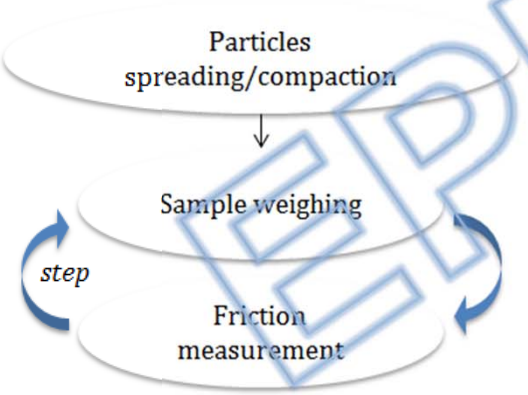
Hichri, Eng. Tribology 231(9) (2017)

Results

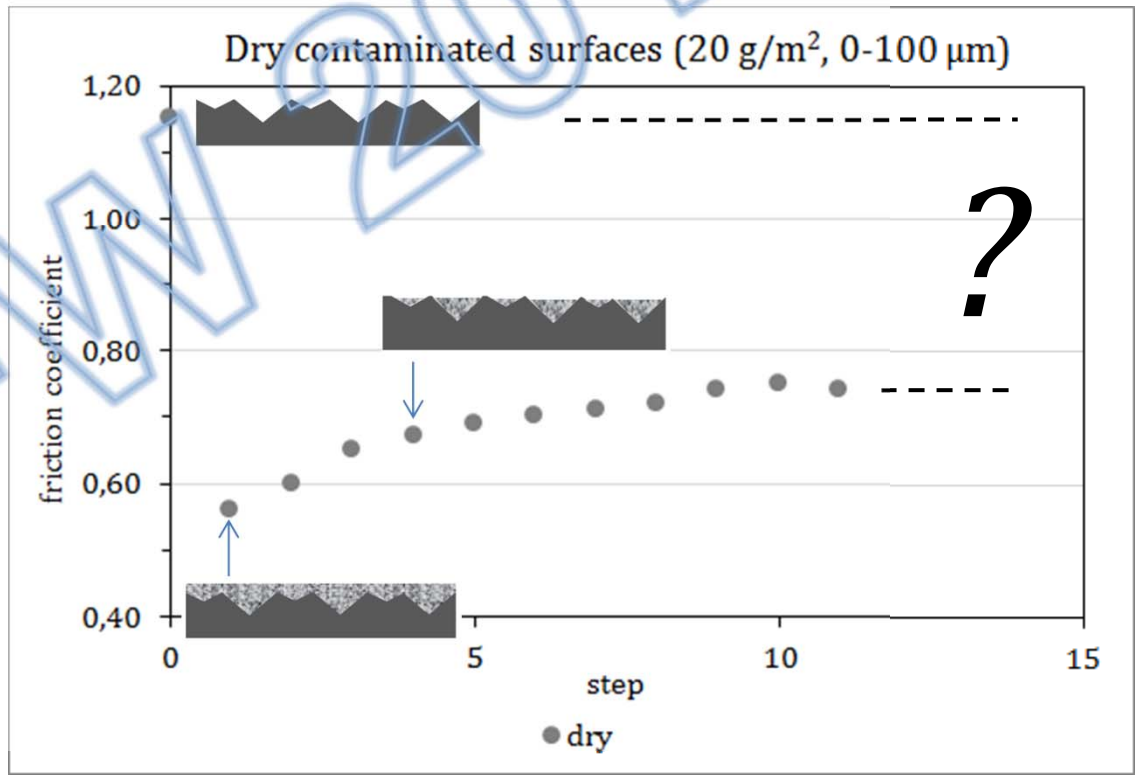
Skid resistance of contaminated surfaces

Transition clean → dry contamination





Modified protocol for dry condition



Hichri, Wear 376-377 (2017)

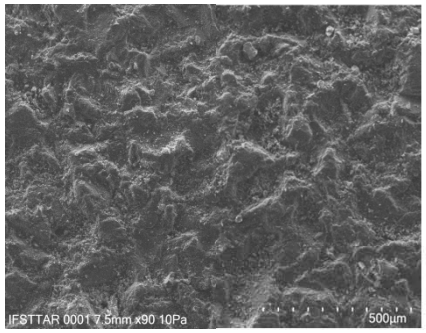
Results

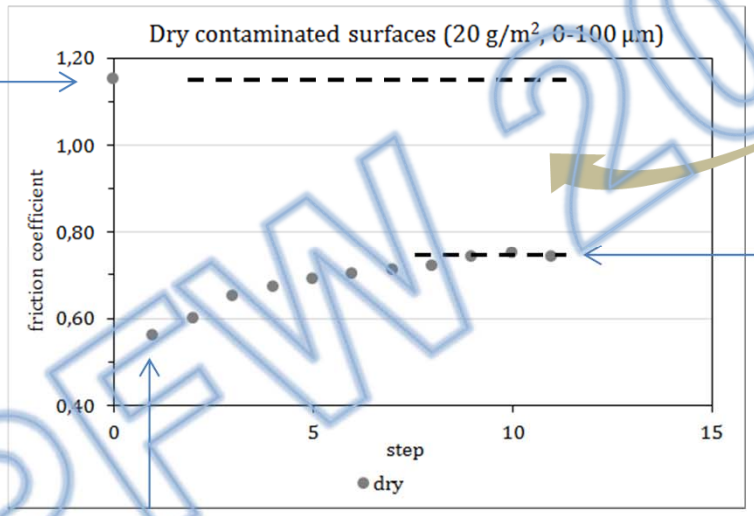
How particles affect the microtexture?

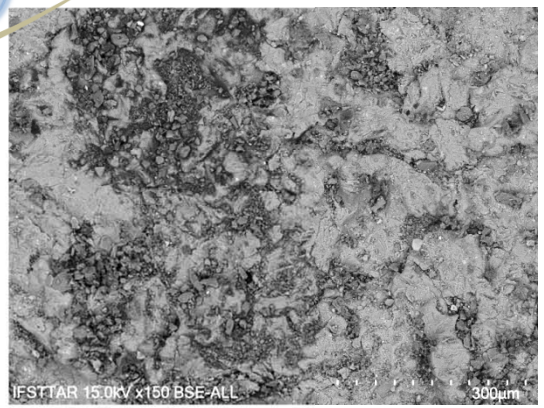
Mechanisms

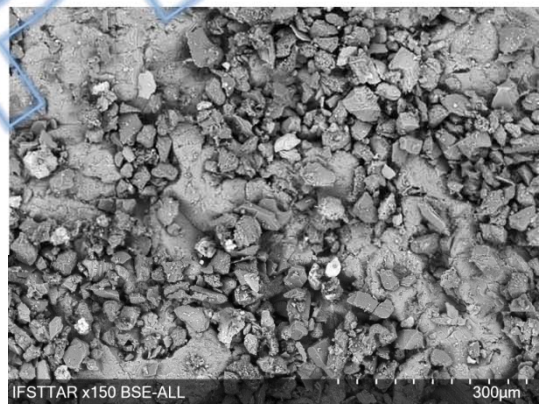
The dust and debris that have settled on the pavement change the microtexture by filling the small asperities and thus affect the tire-pavement interaction

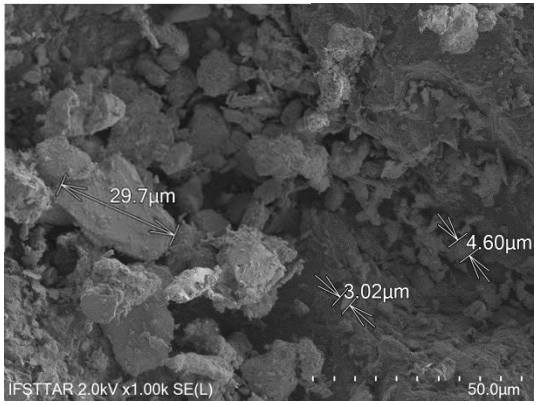
Shakely, Transp. Res. Rec. 783 (1980)









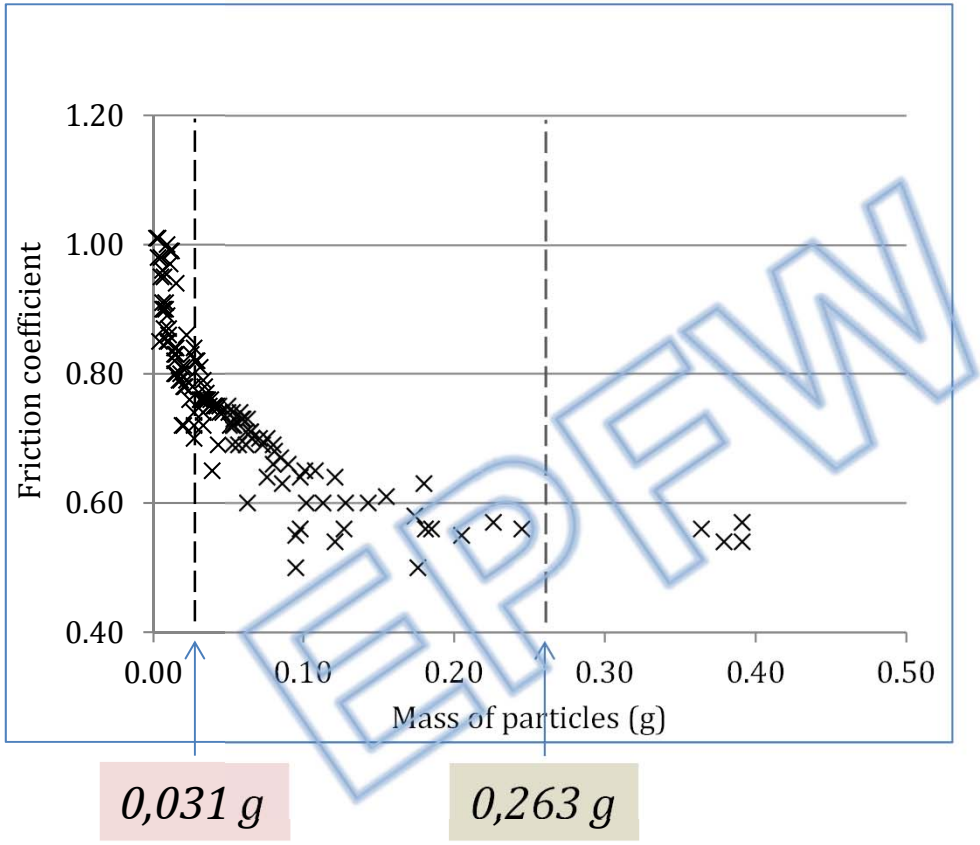


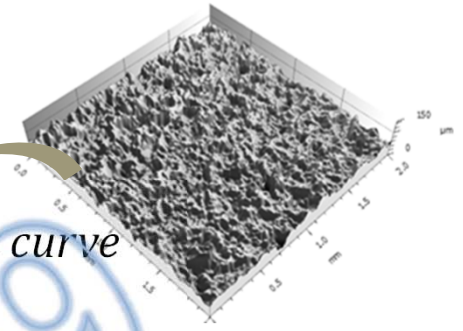
Hichri, PhD (2017)

Results

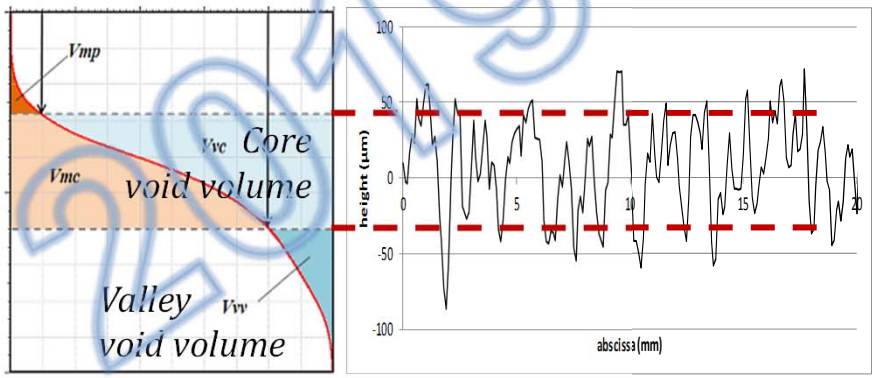
How particles affect the microtexture?

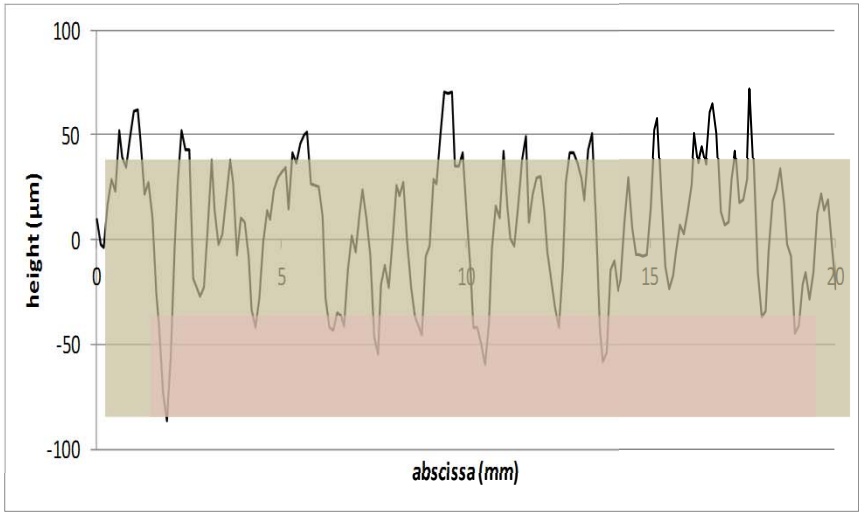
Link with the surface topography





Abbott curve





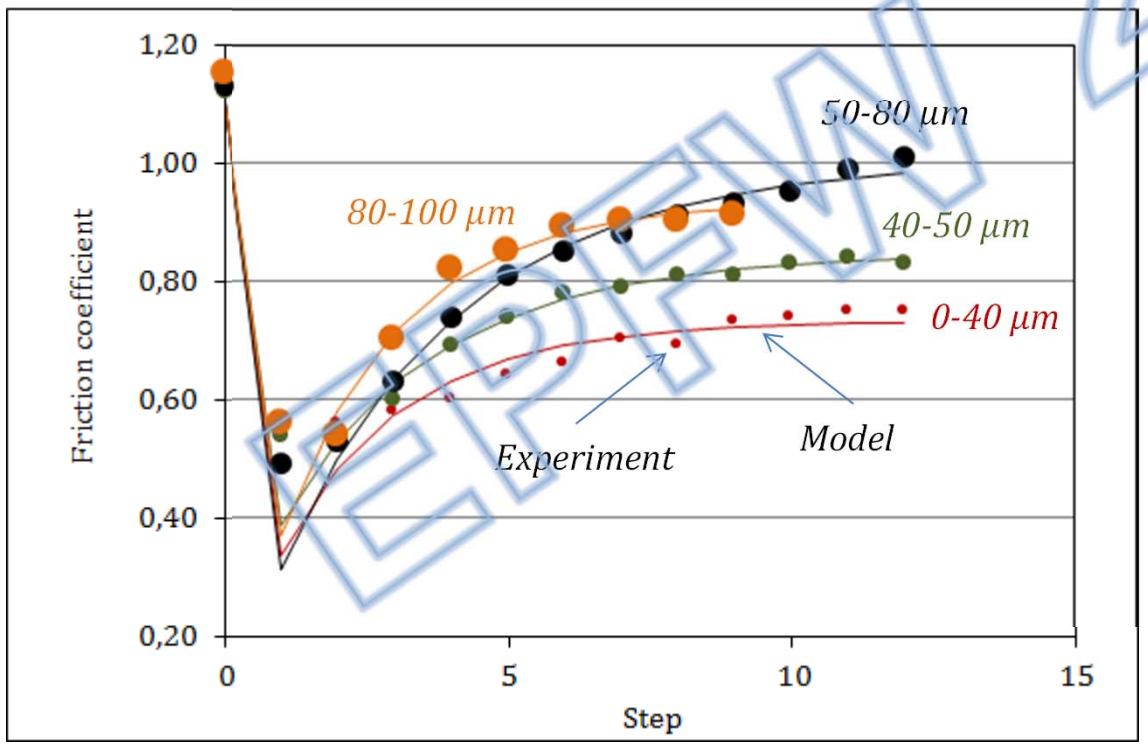
Hichri, Wear 376-377 (2017)

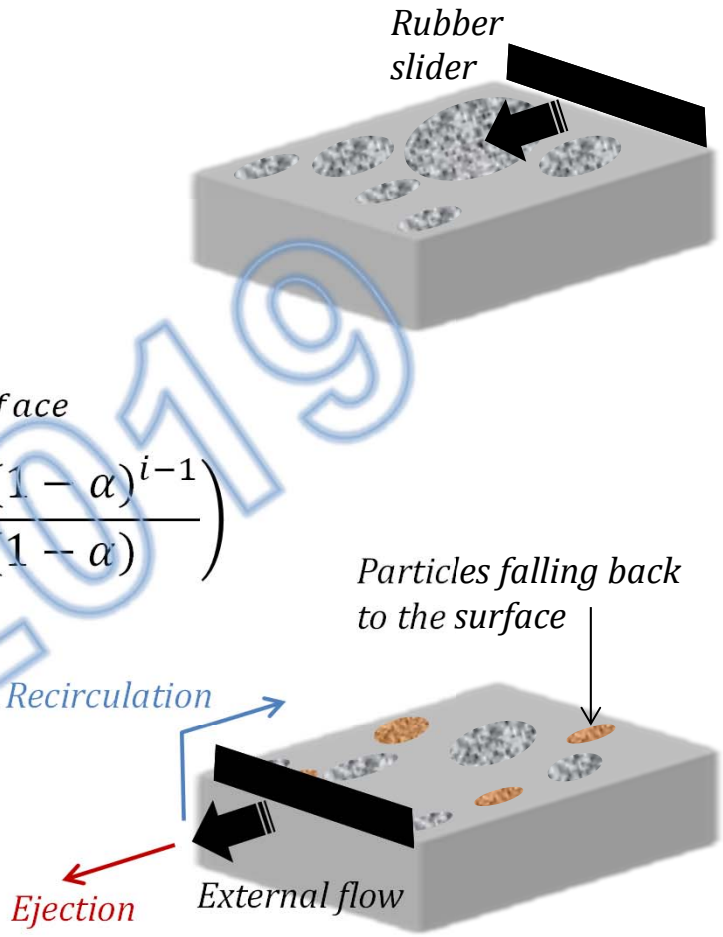
Results

Friction modeling

$$\mu_i = X_i \cdot \mu_{particles} + (1 - X_i) \cdot \mu_{surface}$$

$$X_i = X_{initial}\,(\gamma(1-\alpha))^{i-1} + \alpha\left(\frac{1-\gamma^{i-1}(1-\alpha)^{i-1}}{1-\gamma(1-\alpha)}\right)$$





Hichri, Wear 426-427 (2019)

Conclusions

Effect of particulate contaminants on skid resistance

- Test method:
  - Simulate the buildup of particles on the road surface and their washing by runoff water.
  - Reproduce the variation of skid resistance (friction measured by the British pendulum) during a cycle dry period/precipitation/drying period.
- Interaction with the road surface microtexture
  - Highlight the filling of the surface asperities by particles (SEM images).
  - Estimate the quantity of trapped particles using the surface topography (void volumes).
- Friction modeling
  - Model the surface coverage by particles and the resulting friction coefficient.

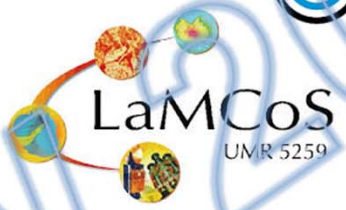
For more information

Articles

- Hichri Y., Descartes, S., Cerezo V., Do M.-T. (2019) Understanding the behavior of fine particles at the tire/road interface. ***Tribology International*** (https://doi.org/10.1016/j.triboint.2019.02.043)
- Hichri Y., Cerezo V., Do M.-T. (2019) Modeling of the surface coverage and application to the calculation of friction on road surfaces contaminated by particles. ***Wear***, vol. 426-427.
- Changarnier S., Hichri Y., Cerezo V., Do M.-T., Salvatore F., Zahouani H. (2018) Observations of dry particles behaviour at the tyre/road interface. ***Tribology International*** , vol. 128.
- Hichri Y., Cerezo V., Do M.-T., Zahouani H. (2018) Effect of particles' characteristics and road surface's texture on tire/road friction. ***Surface Topography: Metrology and Properties***, vol. 6, n°3.
- Hichri Y., Cerezo V., Do M.-T. (2017) Effect of dry deposited particles on the tire/road friction. ***Wear***, vol. 376-377.
- Hichri Y., Cerezo V., Do M.-T. (2017) Friction on road surfaces contaminated by fine particles: some new experimental evidences. ***Engineering Tribology***, vol. 231, n° 9.
- Do M.-T., Cerezo V., Zahouani H. (2014) Laboratory test to evaluate the effect of contaminants on road skid resistance. ***Engineering Tribology***, vol. 228, n° 11.

minh-tan.do@ifsttar.fr

Acknowledgement



(alphabetical order)

Stéphane Bouron

Dominique Demare

Dimitri Deneele

Jean-François Le Fur

Patrick Maisonneuve

Erwann Rayssac

(alphabetical order)

Sylvie Descartes

(alphabetical order)

Simon Changarnier

Hassan Zahouani