New and renewed measures related to pavement surface texture and the potential applications

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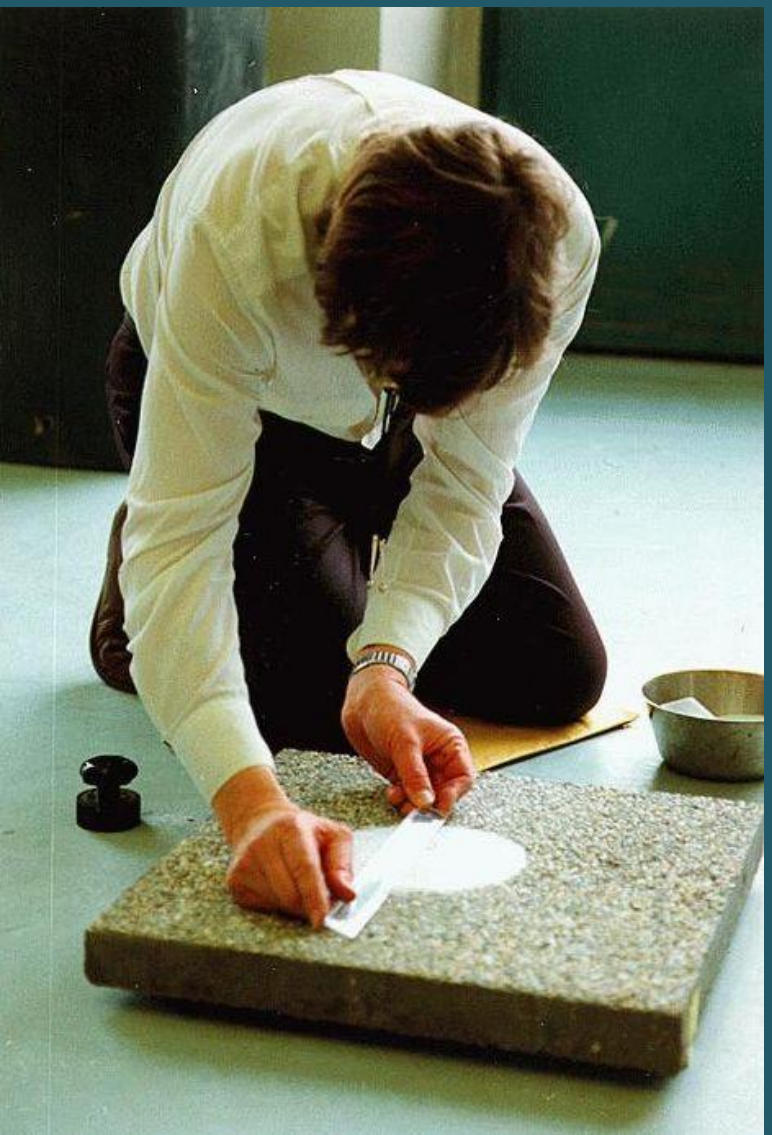
In the beginning ….

Sand patch (TRL Road Note) → Volumetric patch (ASTM)

Also outflow meter



Association mondiale de la Route

AIPCR

PIARC

World Road Association

The International PIARC Experiment 1992-95

Expérience internationale AIPCR de Comparaison et d'Harmonisation des Mesures d'Adhérence et de Texture

International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements

Sandpatch: Mean Texture Depth (MTD)

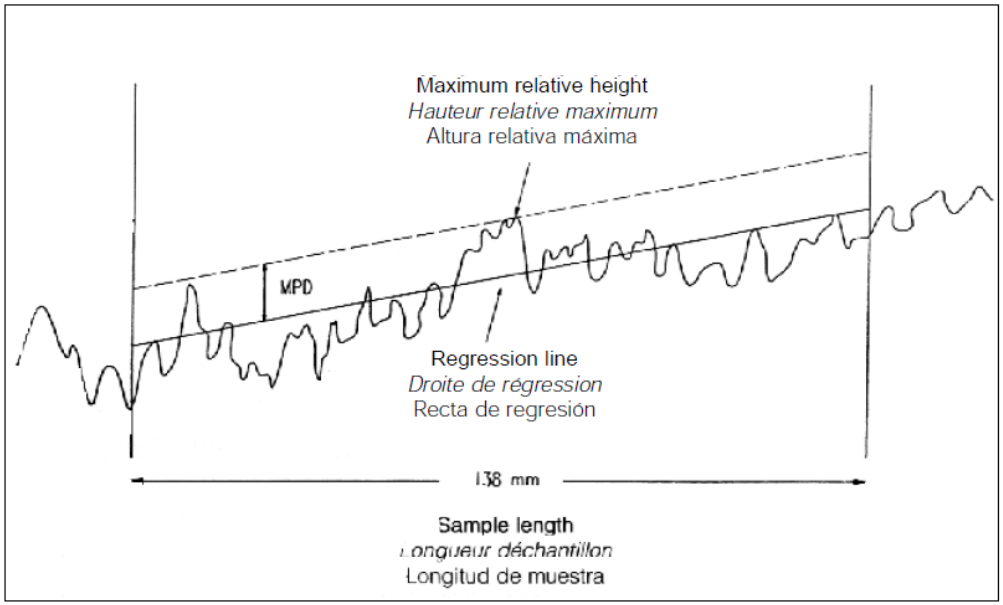


Figure 7. Definition of Mean Profile Depth (MPD) as reported by devices A4 and A5. Note that ISO/CD 13473 now requieres a baseline (sample length) of 100 m.

Profile: Mean Profile Depth (MPD)

ISO/TC 43/SC 1/WG 39

"Measurement of pavement surface macrotexture depth using a profiling method"

1993 --- present

Convenor: Ulf Sandberg

Overview – ISO standards

ISO 13473-1:1997 - Mean Profile Depth -- also EN std
New: ISO/FDIS 13473-1, now submitted for final vote

ISO 13473-2* - Terminology & Basic requirements

ISO 13473-3* - Specification of profilometers

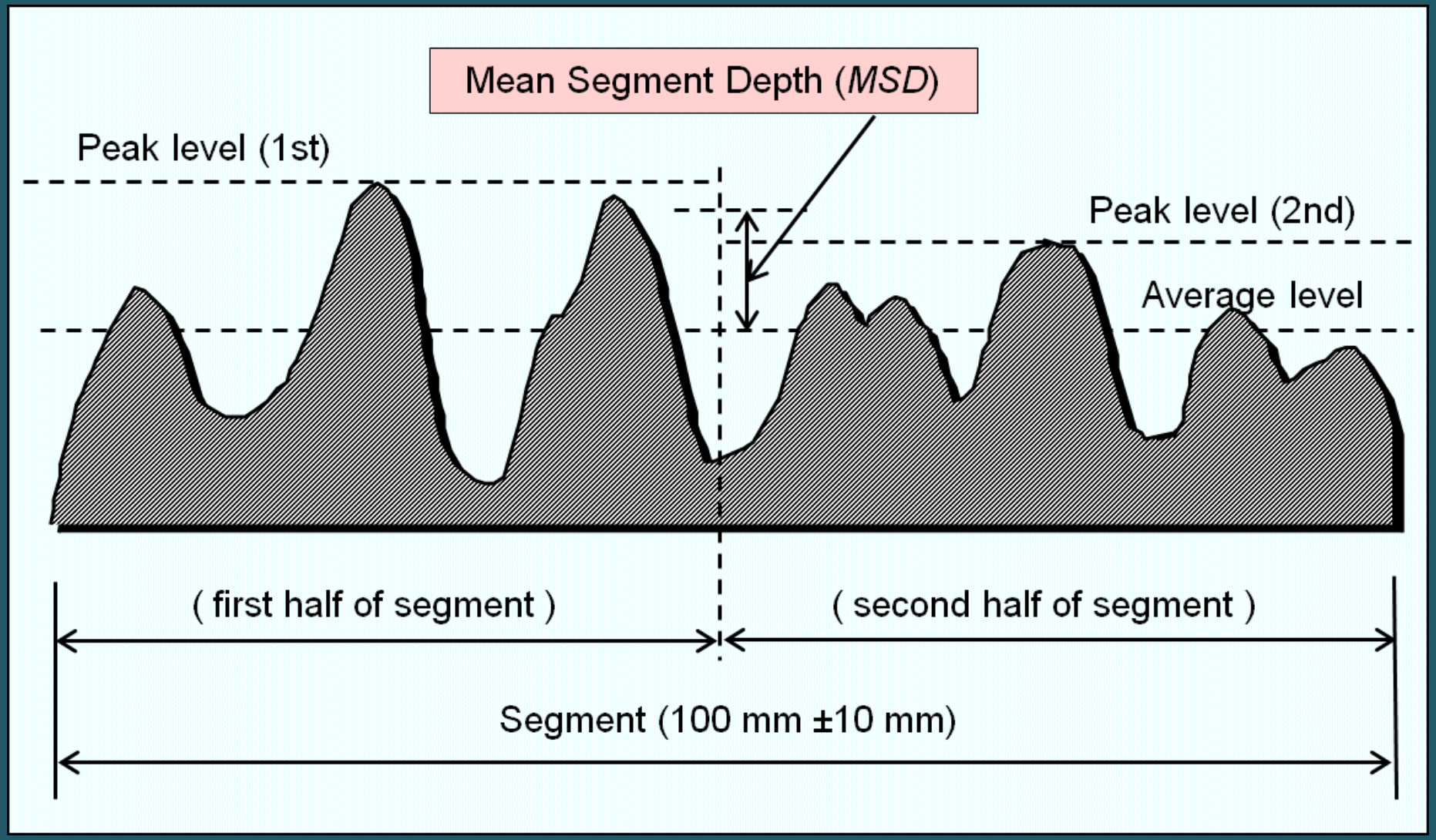
ISO/TS 13473-4* - Texture spectrum determination

ISO 13473-5 - Megatexture measurement -- also EN std

ISO/PAS 13473-6 - Development of a verification procedure for contactless profilometers (under development)

* Will be revised in the next few years, to reflect the developments

(New) Mean Profile Depth (MPD)



MPD is the average of all *MSD*:s for a test section

Estimated Texture Depth: $\boldsymbol{ETD = 1,1 \cdot MPD}$

What we have done with the MPD standard:

Introduce a number of data quality enhancements and eliminating data-influencing options

~~**Slope suppression**~~ **- Highpass filtering, cutoff at 140 mm (minimize phase distortion)**

Limit sampling options

Normalize profile sharpness

Specify the use of lowpass filtering better
(cutoff at 3,0 mm, minimize phase distortion and overshoot)

Requiring the use of low- and highpass filtering, using 2nd order Butterworth – applied in both directions (similar effect as 4th order filters)

Limiting performance

The standardized filtering means that we deliberately are limiting the high-frequency performance and sharpness of peaks that we can detect

Better to do so than getting non-comparable results from different equipment, and running at different speeds and conditions

In future revisions of the standard, the performance may be increased by changing the filter cutoff frequencies

Result

The new version should be free of the problems we have noticed with the old one

There is no significant change in MPD values from old to new method

The new MPD standard is submitted for final ballot in October 2018


The future

Microtexture profile measurements

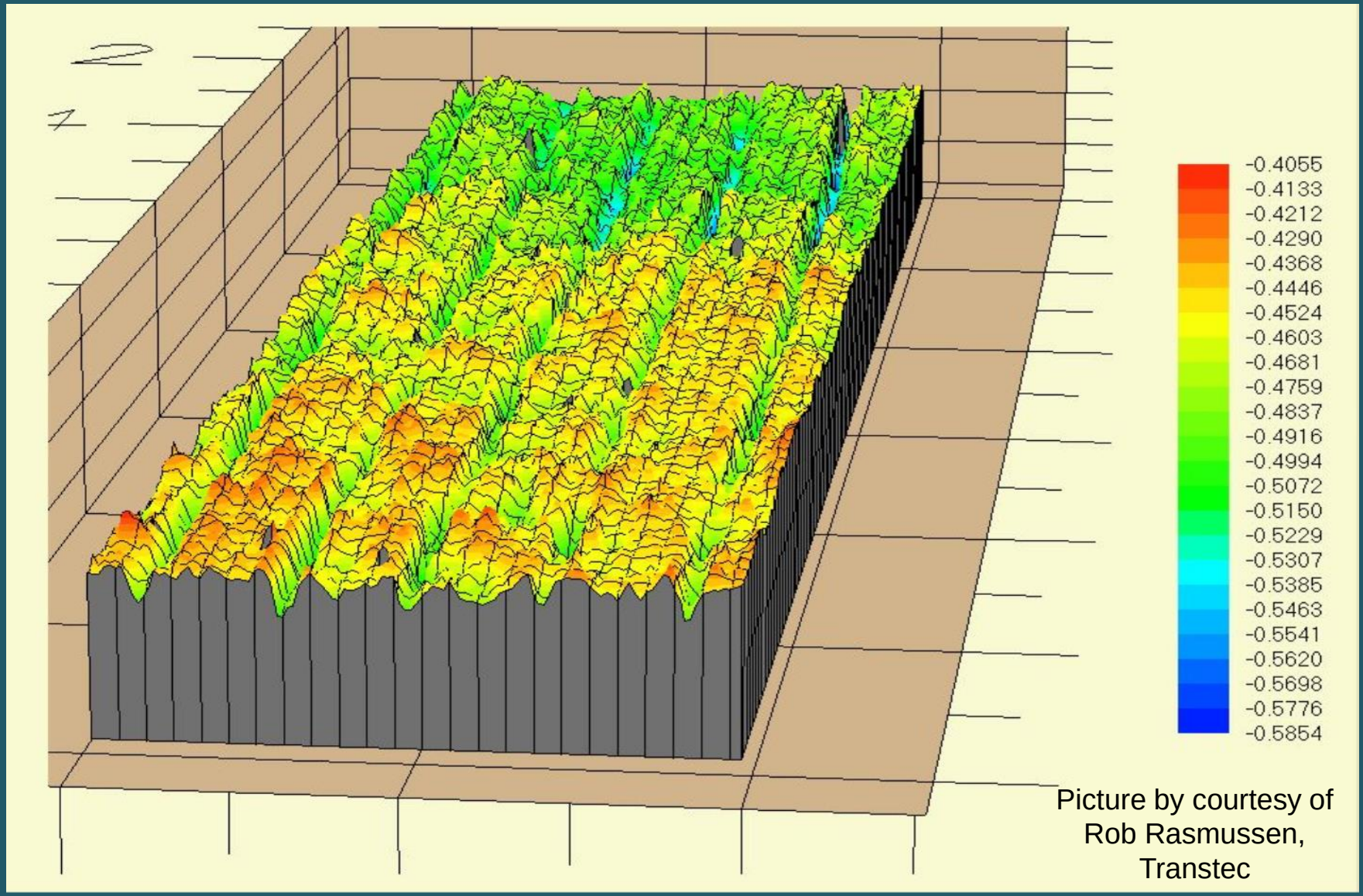
Stationary devices available, but mobile highly desirable

Possibilities worth trying:

High-resolution, ultra-high-speed stereo cameras
Depolarization of light (although not profile)?

While waiting for better technology, use the wavelength range 0.2 – 1.0 mm as a microtexture proxy

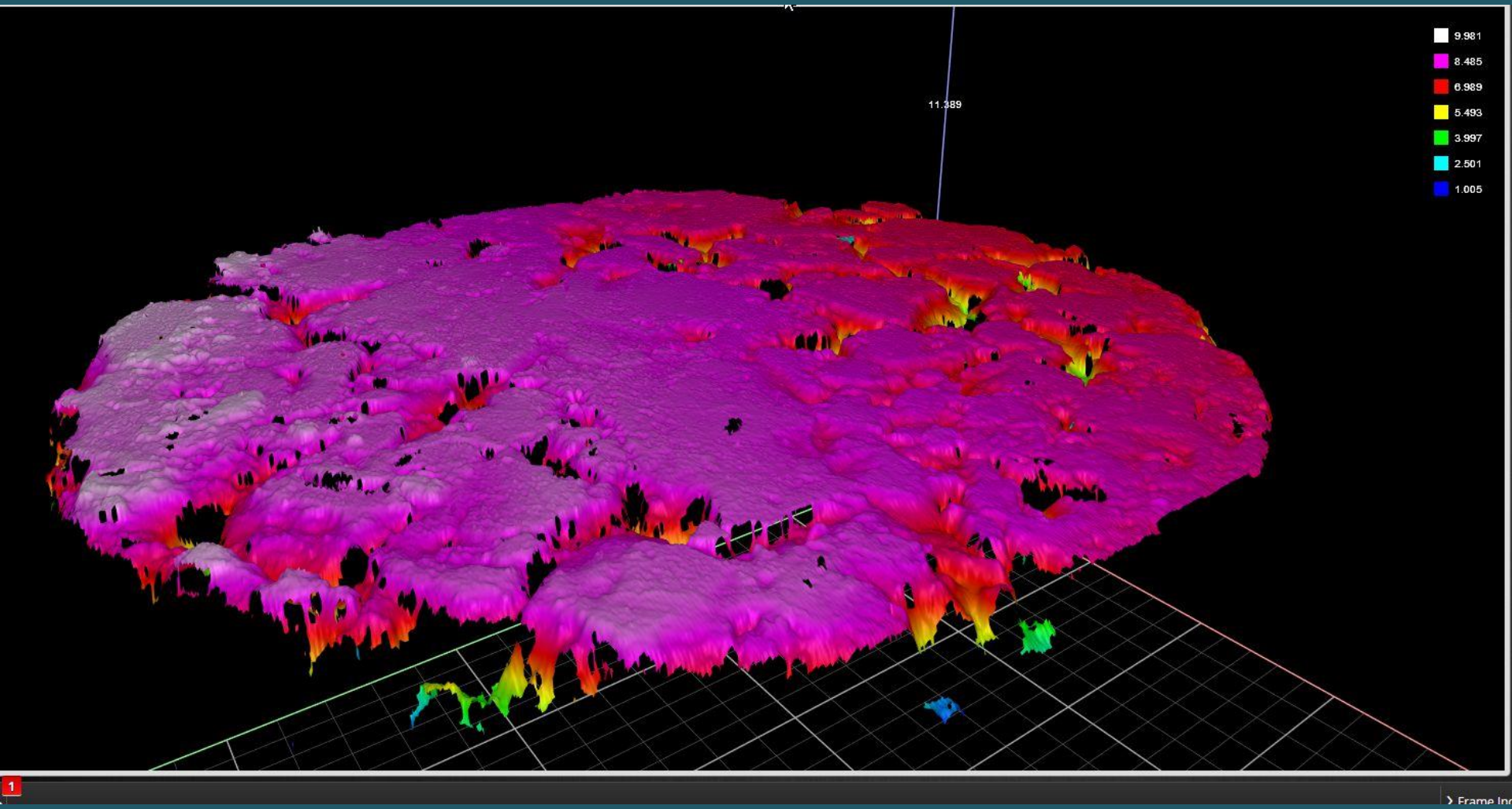
Digital 3D surface profile



Picture by courtesy of Rob Rasmussen, Transtec

Spectacular; but it comes at a price; more useful to develop resolutions into microtexture

Digital 3D texture depth method
(Current questionnaire in CEN/TC 227/WG 5)

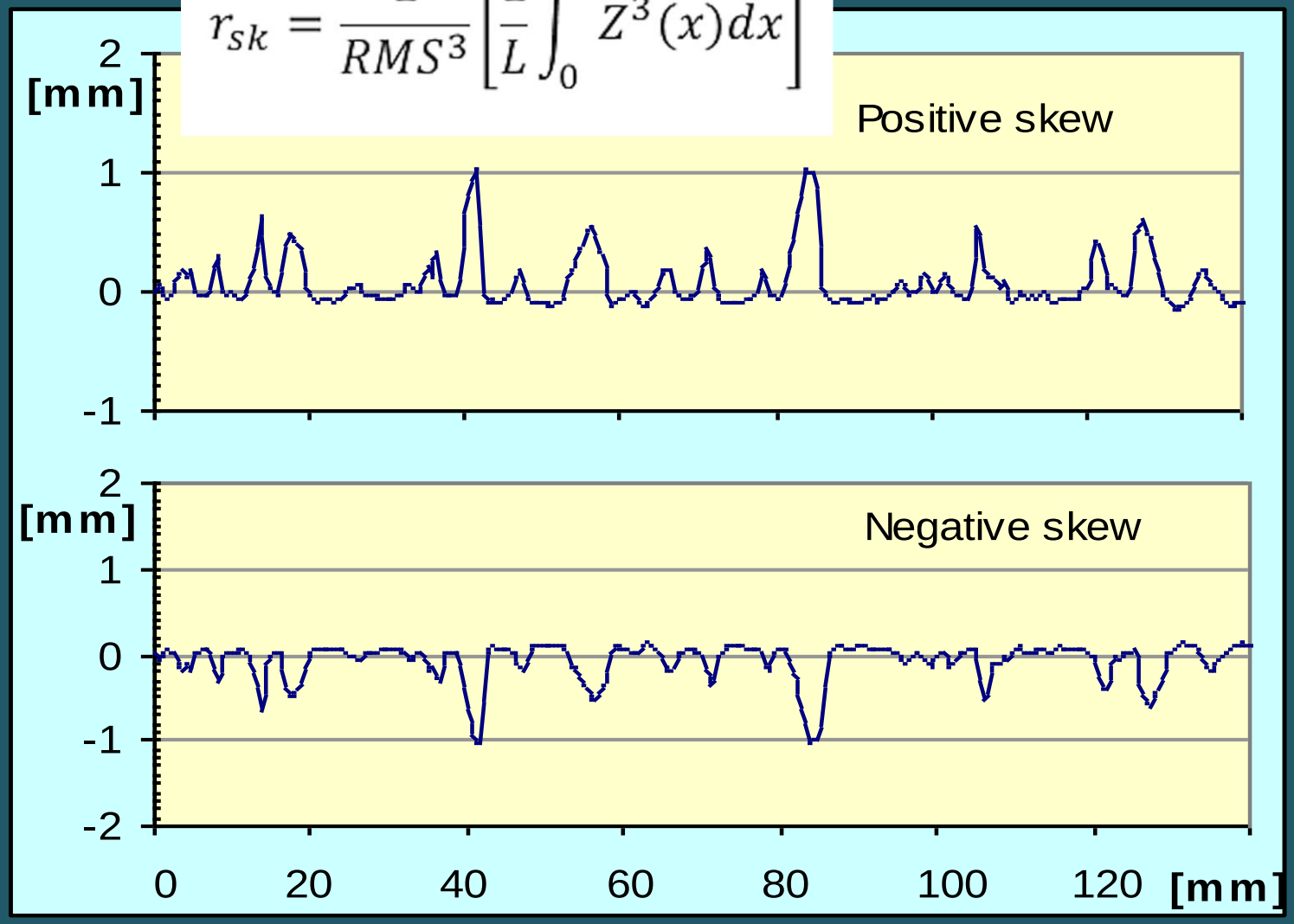


Picture courtesy by Leif Sjögren

Negative and positive texture: skew

Skewness parameter defined in ISO 13473-2

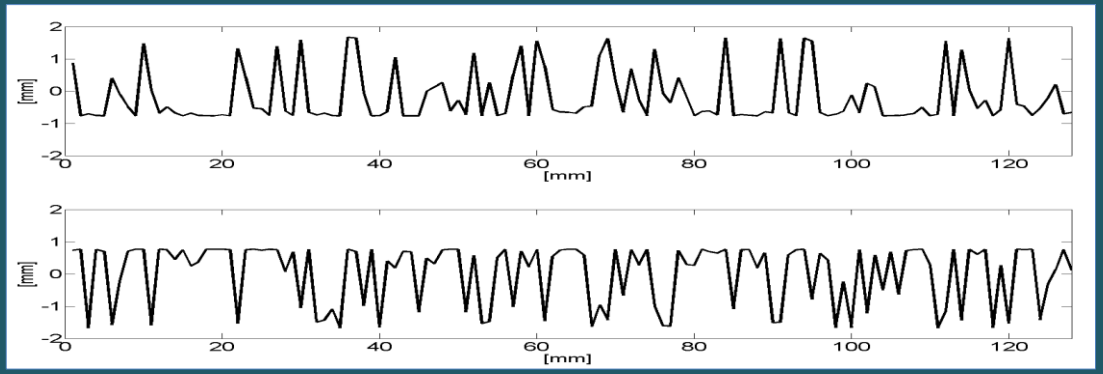
$$r_{sk} = \frac{1}{RMS^3}\left[\frac{1}{L}\int_0^L Z^3(x)dx\right]$$

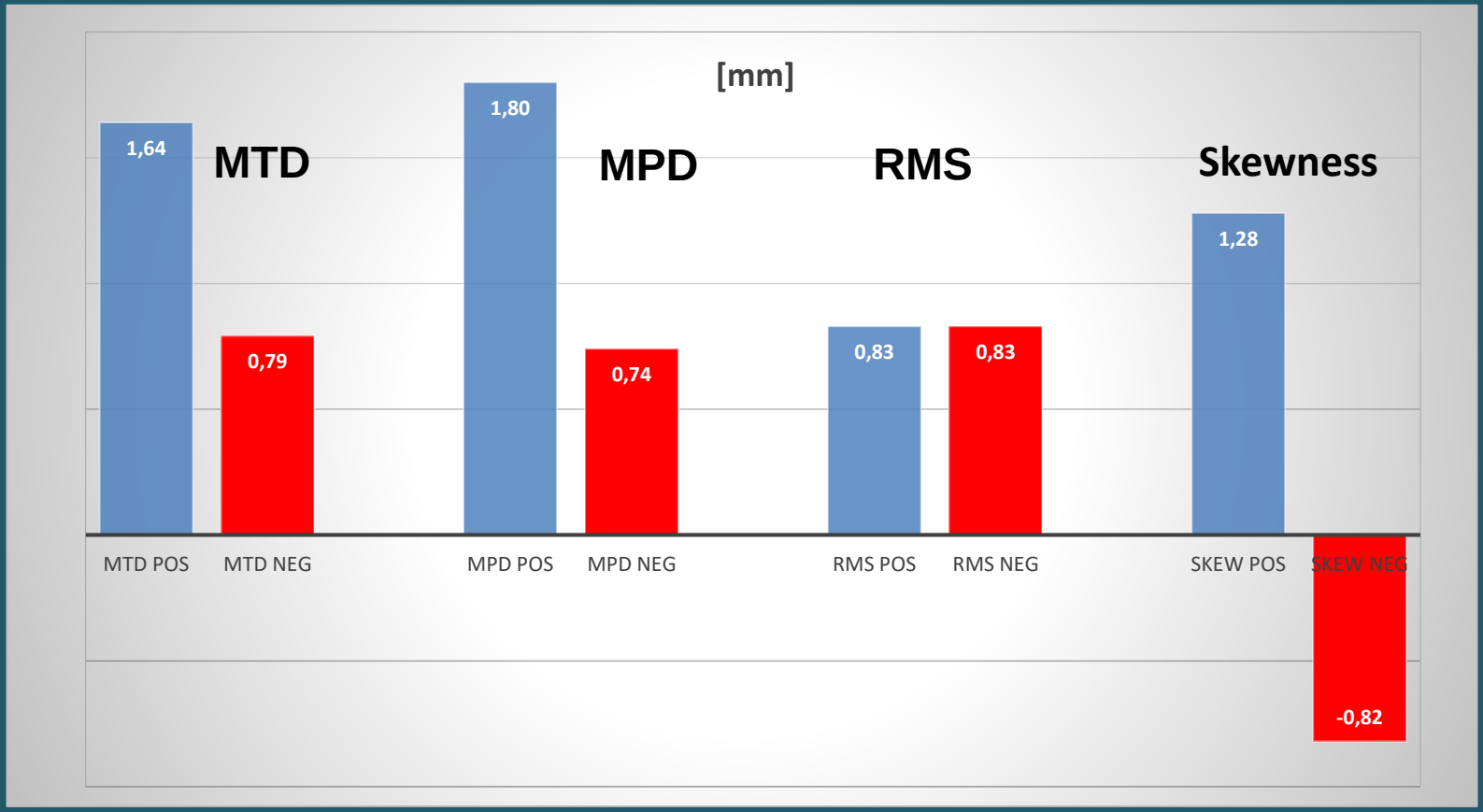


Various measures applied on asymmetrical profiles

Blue:

Red:

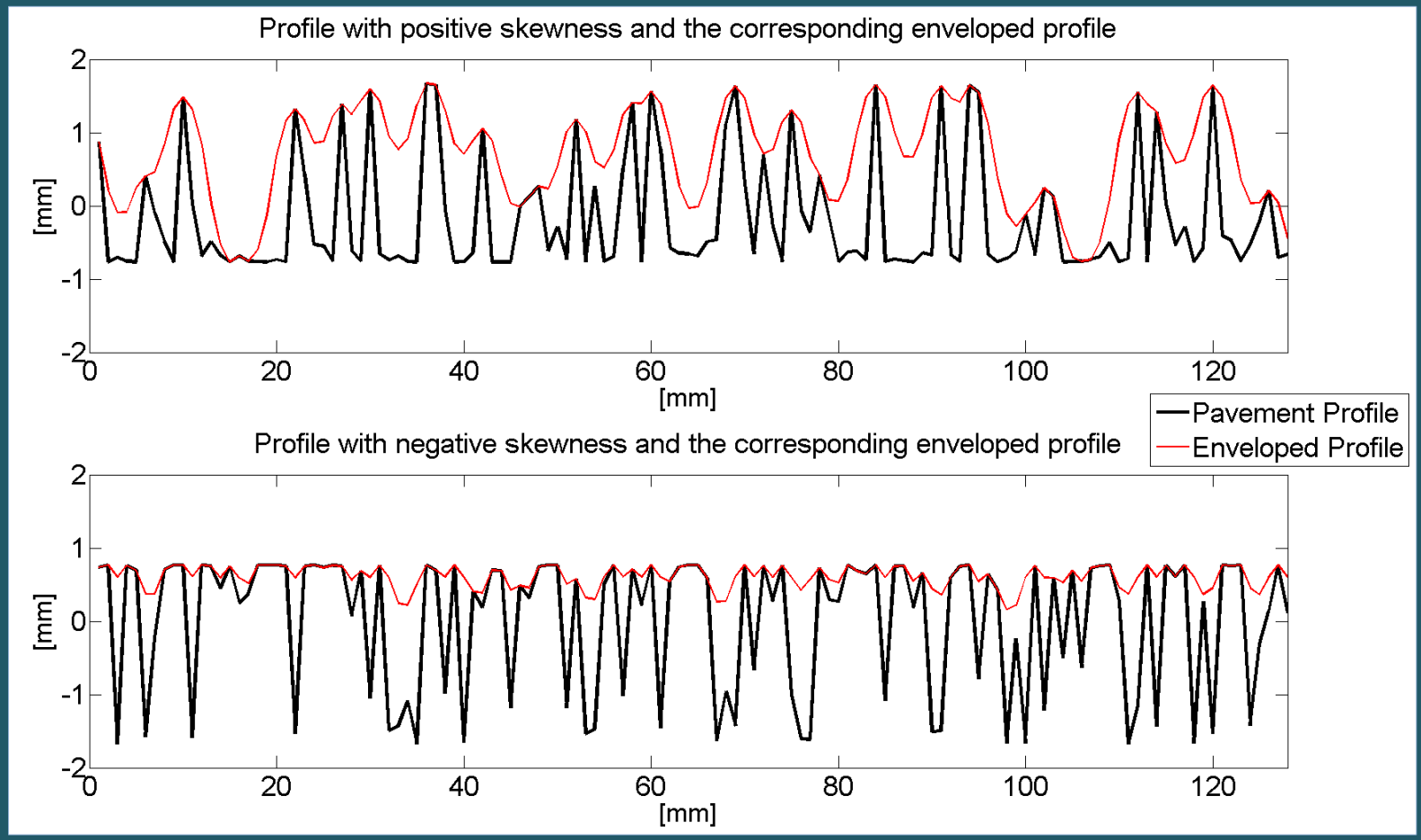




Enveloping profile measurements

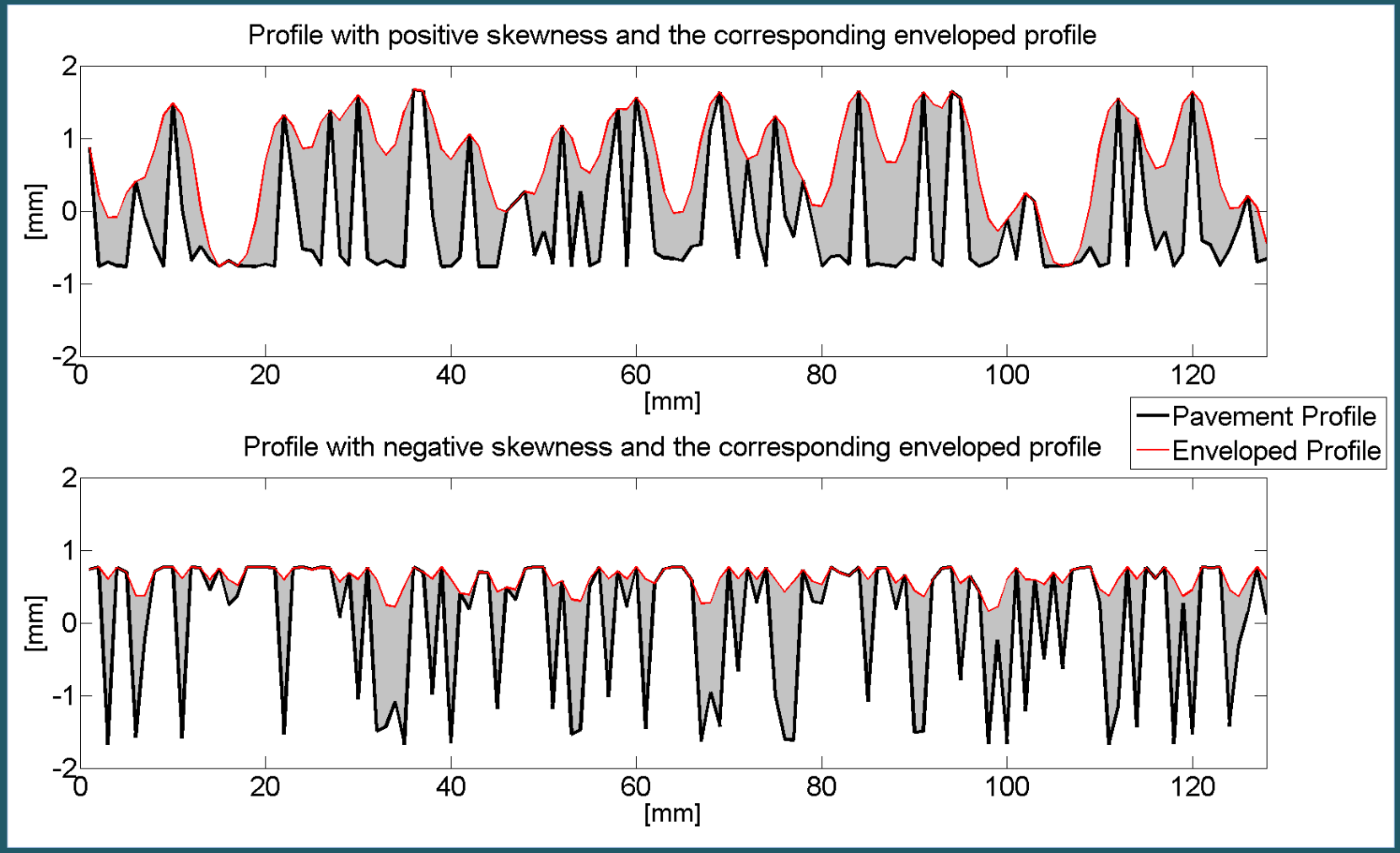
To simulate the enveloping of the surface by tyre treads

Tyre enveloping of the profile – Enveloped Profile Depth (’EPD’)



Enveloped curves generated based on properties of reference tyres P1 and H1 in ISO/TS 11819-3, using the procedure described at the SURF 2018 conference, in [Goubert & Sandberg, 2018]

Texture drainage area: ’TDA’



115 mm^2

75 mm^2

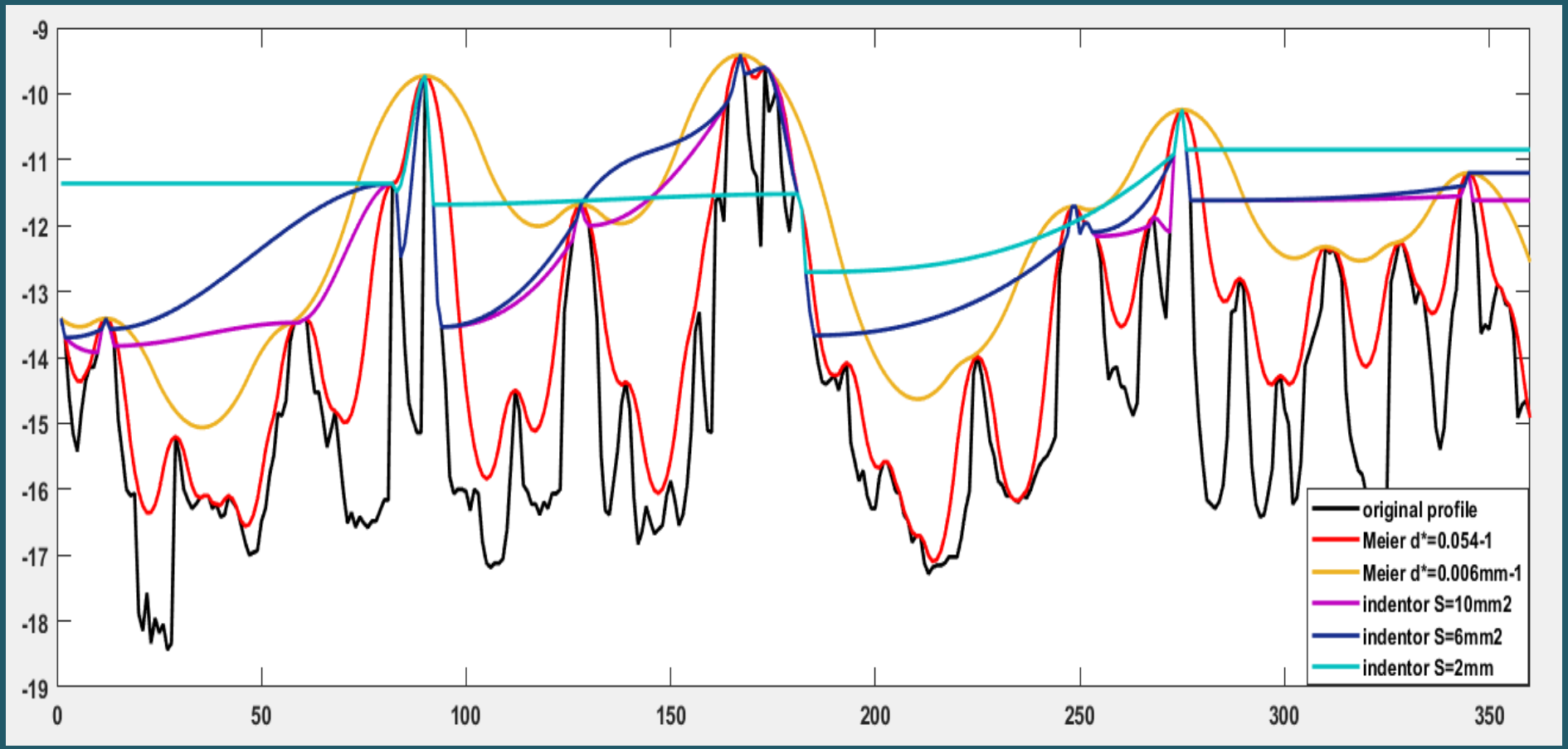
Texture drainage area: ’TDA’

Another measure, similar to TDA: ‘**Effective Area for Water Evacuation (EAWE)**’

proposed by Mogrovejo et al, 2016, at Virginia Tech

We prefer TDA because the area is important not only for water evacuation
also for air and dust

Various enveloping methods proposed



Problem with enveloping

Ideally, each tyre's enveloping property should be tested

And it depends on the tyre load and inflation!

Obviously, one must make several simplifying assumptions.

New area of R & D

Effect of enveloping the profile, as seen currently

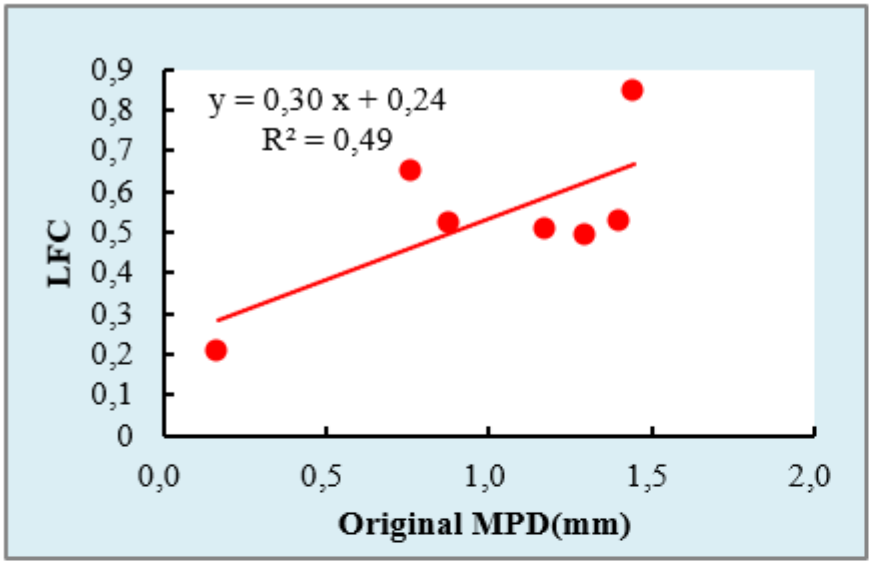
Rolling resistance: Correlation RRC – MPD improves somewhat, according to projects MIRIAM and ROSANNE

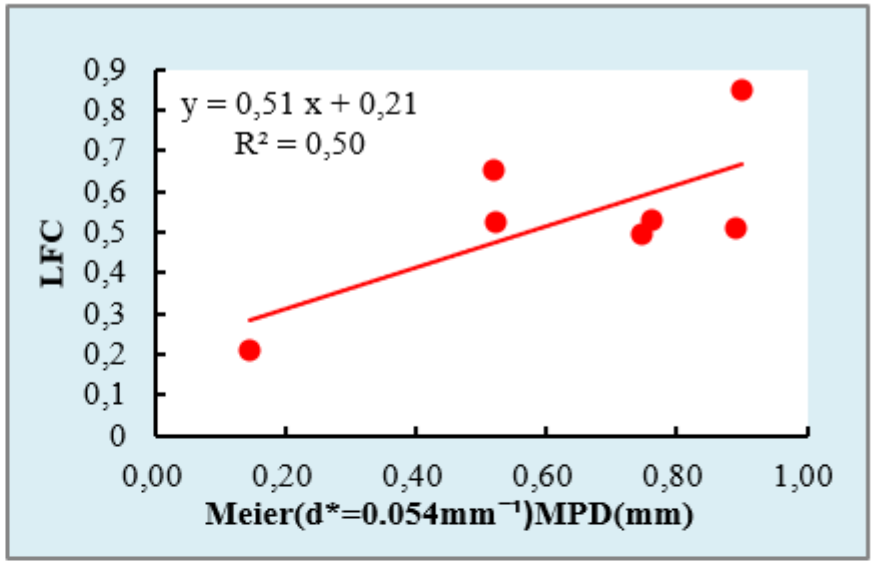
Noise: Correlation Noise level – MPD does not improve ….
…. but there is a potential for substantial improvement if separating noise in frequency bands (not yet demonstrated)

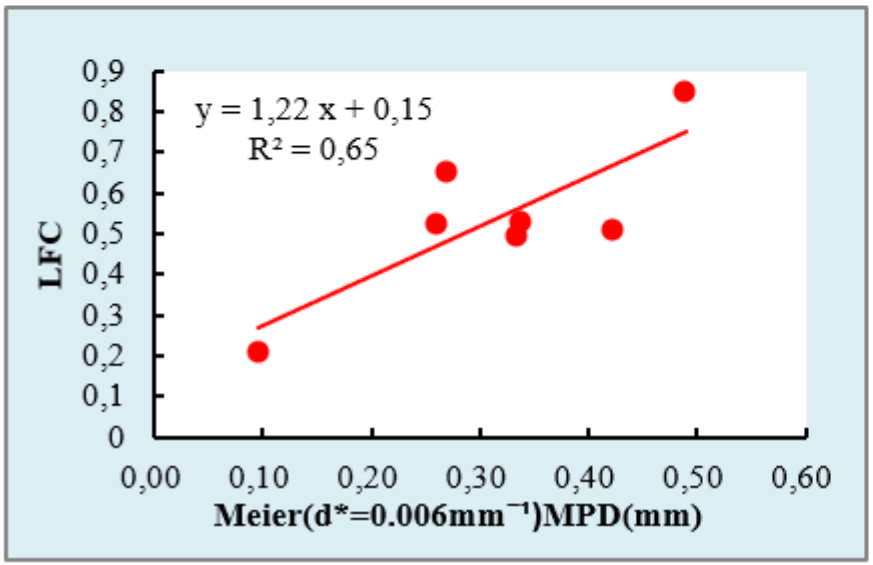
Friction/Skid resistance: See next page!

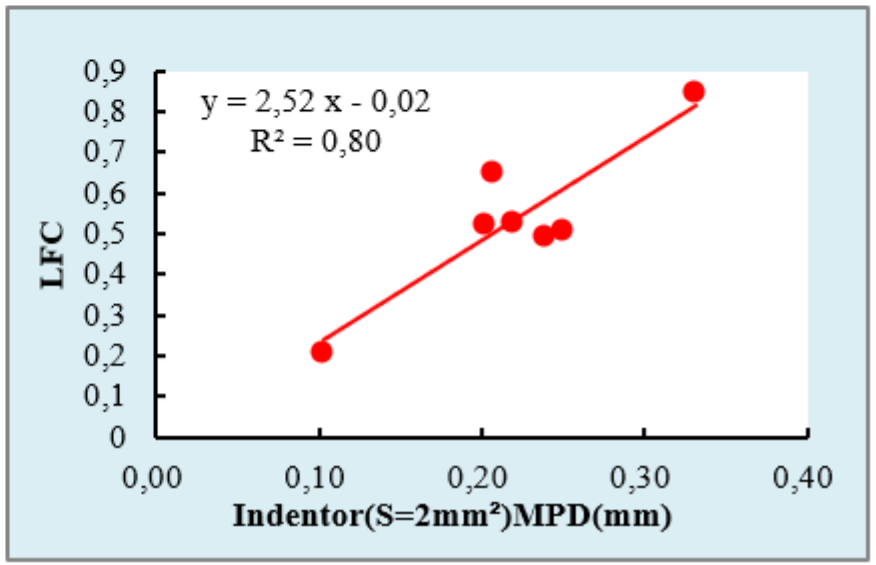
Effect on friction coeff. (LFC) of enveloping the profile

Data from ROSANNE project 2014, processed by Maoping Ran, VTI









Effect on friction coeff. (LFC) of enveloping the profile

Data from ROSANNE project 2014, processed by Maoping Ran, VTI

Similar but somewhat lower effects seen for SFC values!

And yet, we don’t have enveloping property of exactly the friction test tyres

The effect is expected to be even greater for the speed coefficent of friction but not yet tested

Promising for the future, as mobile profiling can supply much better prediction of friction than currrently

Estimation of road surface properties from texture measurements – my vision

Rolling resistance: Enveloped MPD or RMS, combined with megatexture

Noise: Enveloped MPD or RMS for low-frequency noise, TDA for high-frequency noise; potentially supplemented by filters

Speed influence on friction: Enveloped MPD or RMS, or TDA

Friction: Enveloped MPD or RMS, in far future combined with microtexture

Splash and spray: TDA; ideally combined with voids content for porous surfaces

Emission of fine particles and dust: TDA may be a descriptor of dust load (PhD student at VTI working on this)

Tyre wear and microplastics emission: TDA ; in future combined with microtexture

Note: Maybe a measure for profile at wavelengths of 0.2-1 mm can be used as a temporary proxy for microtexture

Conclusions

ERPUG has a great future!
Researchers will have a lot to do


ERPUG
The end