Megatexture measurement with a non-contact profilometer: accuracy of the method and parameters of influence

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MEGATEXTURE MEASUREMENT WITH A NON-CONTACT PROFILOMETER: ACCURACY OF THE METHOD AND PARAMETERS OF INFLUENCE

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Word Count: 3015 words + 8 figures + 4 tables

ABSTRACT

Megatexture corresponds to surface irregularities with wavelengths of a pavement profile lying between 50 mm and 500 mm and vertical amplitude ranging from 0,1 to 50 mm. Wavelengths of megatexture are the same order of size as tire/road interface. Megatexture is measured by a profilometer called RUGO (mlpc device) composed of a non-contact sensor, which measure the distance between its datum-line and the pavement surface examined. Then, the profile curve is analyzed by digital filtering technique in order to determine the magnitude of its spectral components at different wavelength. Thus, the texture spectrum of the profile is calculated with a texture level, given in dB, for each one-third-octave band and each path of measurement. This study investigates elements that may affect megatexture measurements like the type of captor, the speed or the operator. Experiments were realized in order to evaluate the reproducibility and the repeatability of the megatexture measurements following the international standard ISO 5725.

In the first part, the device used and the information relative to the megatexture measurements and indicators are described. In the second part, the statistical analysis results are exposed and the value of repeatability r and reproducibility R are given for each one-third-octave band.

INTRODUCTION

Pavement texture corresponds to the deviation of a pavement surface from a true planar surface with a texture wavelength λ less than 0,5 m. Thus, road profile is characterized by two values: the vertical amplitude "a" and the horizontal dimension of the surface irregularities "λ".

The values of "a" and "λ" allow defining three levels of pavement texture: microtexture, macrotexture and megatexture.

Microtexture corresponds to surface irregularities with wavelengths of pavement profile inferior to 0,5 mm and vertical amplitude inferior to 1 mm. Macrotexture corresponds to surface irregularities with wavelengths of a pavement profile lying between 0,5 mm and 50 mm and vertical amplitude inferior to 10 mm. Megatexture corresponds to surface irregularities with wavelengths of a pavement profile lying between 50 mm and 500 mm and vertical amplitude ranging from 0,1 to 50 mm. Wavelengths of megatexture are the same order of size as tire/road interface. Thus, megatexture has a great role both in low frequency noise generated inside and outside the vehicle and in vibrations of the vehicle (wheels, steering column, steering wheel…). It is an unwanted feature of the road.

Megatexture is continuously measured by a profilometer set up on a passenger car vehicle with pneumatic suspensions, which provide a good stability during the tests even if evenness is not good.

This study investigates elements that may affect megatexture measurements like the type of captor, the speed or the operator. Experiments were realized in order to evaluate the reproducibility and the repeatability of the megatexture measurements following the international standard ISO 5725.

In the first part, the device used and the information relative to the megatexture measurements and indicators are described. In the second part, the statistical analysis results are exposed.

MATERIALS AND EXPERIMENT PLAN

Data processing measurement

Megatexture is measured by a profilometer called RUGO (device developed by the French laboratory of roads and bridges) composed of a non-contact captor, which measure the distance between its datum-line and the pavement surface examined. The device consists essentially of a laser transmitter and of an optical potentiometer: the emitted ray strikes the surface of the ground and reflects itself on the optical potentiometer, fit to deduce the height which separates it from the point of reflection on the pavement surface, under an average angle of observation of 30° (see figure 1).

Then, the profile curve is analyzed by digital filtering technique in order to determine the magnitude of its spectral components at different wavelength. This is done by considering profile as a stationary random function of the distance along the surface (not true from a strictly mathematical point of view).

This spectral analysis (or texture wavelength analysis) of two-dimensional profile is realized with a constant narrow bandwidth frequency analysis by means of Discrete Fourier transform, followed by a transformation of the narrow-band spectrum to a one-third-octave-band spectrum (ISO/CD 13473-4). A Hanning window, which has a shape of squared cosine, is used for the spectral analysis of the surface profile.

Thus, the texture spectrum of the profile is calculated with a texture level, given in dB, for each one-third-octave band and each path of measurement (see figure 2).

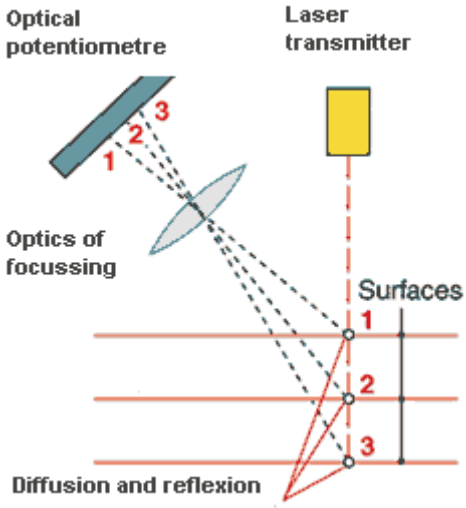

FIGURE 1: RUGO device and RUGO device principle

Characteristics of the sensor

In this study, two laser captors were used. The differences between them lie in the sampling frequencies and the through band. Their main characteristics are given in the following table.

TABLE 1: Laser captors' characteristics

	Captor 1	Captor 2
Sampling frequency (kHz)	62,5	32
Through band(kHz)	20	10
Resolution (1 LSB = 32 µm)	1 LSB	1 LSB
Accuracy (1 LSB = 32 µm)	± 2 LSB (± 0,025% of the measurement band)	± 2 LSB (± 0,025% of the measurement band)

Megatexture indicators

In the megatexture field, three indicators can be calculated in order to characterize the megatexture profile of a pavement surface: L_{Me}, L_{63} and L_{500}. They are obtained by using this formula:

$$L_{TX,\lambda} = 20\log\left(\frac{a_\lambda}{a_{ref}}\right)$$

with a_λ: root mean square value of the vertical displacement of the surface profile,
a_{ref}: 10^{-6} m,
λ: subscript indicating a value obtained with a one-third-octave band filter having center wavelength λ.

The significance of the indicators is the following:

- L_{Me} [dB] referred to the whole of the deformations in the megatexture domain (bands at an interval 63 – 500 mm). This indicator is used to have an overall

assessment of the profile irregularities. It is similar to a “mean value of megatexture”.

- L_{63} [dB] related to the shortest deformations (50, 63 and 80 mm). This indicator allows the characterization of the deformations corresponding to the length of tread prints on car tires, which are responsible of the tire/pavement surface contact noise.
- L_{500} [dB] related to the longest deformations (400, 500 and 630 mm). This indicator allows the characterization of the deformations having an influence on the vibrations of the wheels, which generate a decrease of comfort and safety. This indicator completes the information provided by evenness measurements.

Path of measurement

The evaluation length L should respect the following requirements for a spectral analysis:

$$L >= n * \lambda_{max}$$

where:

n is the number of sub-bands of the spectrum,
λ_{max} is the longest one-octave band center wavelength or one-third-octave-band center wavelength used in the spectral analyses.

This is due to the “sampling theory”, which says that the spectral analysis can be done only if you have at least three spectrum lines in each one octave or one-third-octave band considered for calculations. In this work, the authors focused only on a one-third-octave bands analysis.

Wavelengths of megatexture range from 0,0449 to 0,707 m. The mega-band is covered by 13 sub-bands whose central frequency lies between 0,630 m and 0,039 m. Thus, we have:

$$L >= 13 * 0{,}630$$
$$L >= 8{,}19 \text{ m}$$

A path of 10 m was chosen for providing the values of megatexture.

Experiment plan

The comparative tests are realized with three laboratories called “Lab.1”, “Lab.2” and “Lab.3” in the rest of the paper. The laboratories are composed of an operator and an equipment (i.e. a captor). Their characteristics are the following:

- “Lab.1”: captor 1 (62,5 kHz) + operator 1,
- “Lab.2”: captor 2 (32 kHz) + operator 1,
- “Lab.3”: captor 2 (32 kHz) + operator 2.

Two homogeneous sections of 400 m long, were characterized: a surface dressing 2/3 and an asphalt concrete 0/10.
The test speeds were 40 km/h, 60 km/h and 80 km/h.
Each “Lab” made five repetitions on each section for each speed.

For each repetition, an average value of megatexture by one-third-octave band is considered (i.e. the mean of the 40 values of megatexture measured on each section). Thus, the statistical analysis is done by one-third-octave band following the international standard ISO 5725.

	INDICATORS			ONE-THIRD-BAND OCTAVE VALUES									
	Lme	L63	L500	630	500	397	315	250	198	157	125	99	79
10+310	47,4	44,5	38,7	28,5	34,2	36,2	35,6	31,7	37,7	35,9	37,0	39,6	39,9
10+320	47,0	44,3	34,2	30,7	29,1	28,2	34,9	34,4	37,7	34,7	38,7	36,6	40,3
10+330	48,0	45,2	40,4	37,7	33,5	34,5	36,8	36,1	37,4	34,9	38,4	40,1	40,6
10+340	47,2	44,7	40,0	37,2	34,7	32,7	34,3	36,5	33,1	34,8	38,3	38,8	40,8
10+350	47,8	44,6	39,1	30,7	32,3	37,2	32,9	34,2	38,9	35,1	39,4	39,8	39,9
10+360	47,9	44,9	38,8	30,9	36,1	33,6	35,1	39,3	35,4	35,7	36,7	38,8	38,6
10+370	47,3	44,2	38,5	30,5	27,4	37,4	33,8	38,3	36,2	34,9	36,8	38,4	39,7
10+380	48,5	45,0	42,2	35,9	38,8	37,2	35,0	37,4	34,0	37,9	39,4	37,4	41,6
10+390	45,4	42,6	39,0	35,0	32,6	34,5	33,9	24,6	31,7	34,5	37,1	37,0	35,2
10+400	45,8	43,2	36,0	30,4	33,0	29,7	35,4	34,0	32,8	35,0	35,2	36,6	39,6
10+410	47,0	44,7	37,9	32,0	33,9	33,1	29,5	36,1	36,0	34,5	36,6	39,5	39,7
10+420	46,0	42,5	36,9	30,9	31,4	33,5	34,1	33,5	34,2	34,2	39,3	37,4	35,0
10+430	47,6	44,3	40,9	36,9	34,4	36,6	35,0	32,9	34,8	38,9	39,1	38,7	40,1
10+440	46,7	43,3	39,0	34,7	32,9	34,9	33,4	37,5	31,2	37,7	37,5	38,4	39,2
10+450	48,3	45,1	40,7	36,4	36,9	33,7	36,8	36,7	38,3	37,5	37,6	38,8	40,6
10+460	49,5	46,4	39,9	33,5	35,5	35,9	33,1	41,6	38,8	38,8	38,6	39,9	41,9
10+470	49,9	46,6	37,1	25,1	33,2	34,3	35,5	38,7	39,1	42,3	40,2	40,1	40,6
10+480	45,7	42,5	38,3	29,4	35,7	33,4	32,3	31,4	34,9	36,9	33,9	36,8	39,3
10+490	46,9	43,1	39,0	36,4	28,3	34,8	35,6	35,4	38,9	35,6	37,8	37,8	37,7
10+500	46,5	43,6	38,8	33,5	34,9	33,3	31,1	34,6	32,9	36,2	38,0	37,8	38,3
10+510	47,8	45,1	40,0	37,1	34,5	33,1	32,6	34,1	37,5	39,1	37,2	37,9	39,9
10+520	46,7	44,2	37,1	26,8	34,9	32,0	33,1	33,0	34,9	34,3	37,7	37,3	39,8
10+530	48,1	45,6	40,4	34,6	35,1	36,8	34,1	35,2	33,7	36,1	39,1	41,4	40,0
10+540	47,6	44,5	38,7	34,6	32,8	34,7	34,5	33,0	35,3	36,3	40,8	38,0	41,5
10+550	48,9	46,5	39,4	34,7	34,8	34,3	36,1	36,7	35,4	38,0	39,4	40,6	40,3
10+560	48,2	45,2	40,4	31,7	36,6	36,9	35,8	37,1	32,7	30,2	40,8	41,7	38,6
10+570	47,7	45,3	37,1	29,6	32,4	33,9	34,1	37,0	35,8	36,1	37,6	40,3	40,7
10+580	46,9	44,0	40,3	36,0	33,8	36,3	32,4	35,0	35,1	36,2	37,2	38,2	39,7
10+590	48,6	45,9	39,3	34,3	37,2	27,0	35,1	38,5	37,3	35,5	39,1	41,2	41,5
10+600	46,6	43,7	40,7	34,3	38,7	32,2	31,0	34,0	35,4	33,9	35,1	38,5	38,3
10+610	47,8	45,6	36,5	34,9	28,9	27,8	34,2	33,3	36,7	38,4	38,0	40,0	39,7
10+620	47,3	44,3	38,3	25,1	36,3	33,2	33,7	39,1	31,9	34,6	37,1	39,5	37,7
10+630	47,6	45,3	36,0	30,2	33,4	28,8	37,0	37,1	33,1	36,0	36,4	39,9	39,1
10+640	48,7	45,9	36,8	31,9	32,5	31,8	35,8	38,6	38,4	38,4	39,1	40,1	41,9
10+650	46,5	43,7	39,2	35,2	33,7	34,3	29,9	36,2	34,7	35,7	36,0	37,2	38,1
10+660	46,3	43,4	37,6	29,0	30,6	35,8	34,2	35,1	33,7	33,2	37,7	36,2	39,1
10+670	47,5	45,3	38,9	33,9	33,3	35,0	35,1	34,2	33,9	34,7	37,2	37,1	41,4
10+680	47,8	44,2	39,4	33,5	36,5	33,3	36,2	37,3	38,1	37,4	37,7	40,0	39,2
10+690	48,4	45,7	38,6	31,0	33,9	35,4	37,4	36,4	35,2	36,2	39,8	41,6	41,8
10+700	47,6	44,1	40,0	34,5	34,3	36,4	34,3	36,2	38,3	38,2	36,1	37,1	40,1
average value	47,5	44,6	38,8	32,7	33,8	33,8	34,3	35,6	35,5	36,1	37,9	38,8	39,7
Standard deviation	1,0	1,1	1,6	3,3	2,6	2,6	1,8	2,8	2,2	2,1	1,5	1,5	1,5

FIGURE 2: Example of megatexture values measured on a section of 400 m of asphalt concrete 0/10

RESULTS AND DISCUSSION

The repeatability and reproducibility of megatexture measurement are determined through comparative tests led on several homogeneous sections with different surfacing. The tests aimed at assessing the aptitude of RUGO devices to reproduce same megatexture measurement values in the execution of several repetitions on the same longitudinal alignment with different test speeds. The statistical analysis of the experimental results and the calculus are based on the international standard ISO 5725. In a first part, the influence of speed, type of captor and the operator is analyzed. In a second part, the results of the statistical analysis are given.

Parameters of influence

Influence of the sampling frequency of the captors

The first step of the study consisted in verifying the impact of the sampling frequency of the laser captors on megatexture measurements. The value of megatexture in each one-third-band octave is calculated with the captor 1 (62,5 kHz) and the captor 2 (32 kHz) measurements on the two homogeneous sections, covered by surface dressing and asphalt concrete.

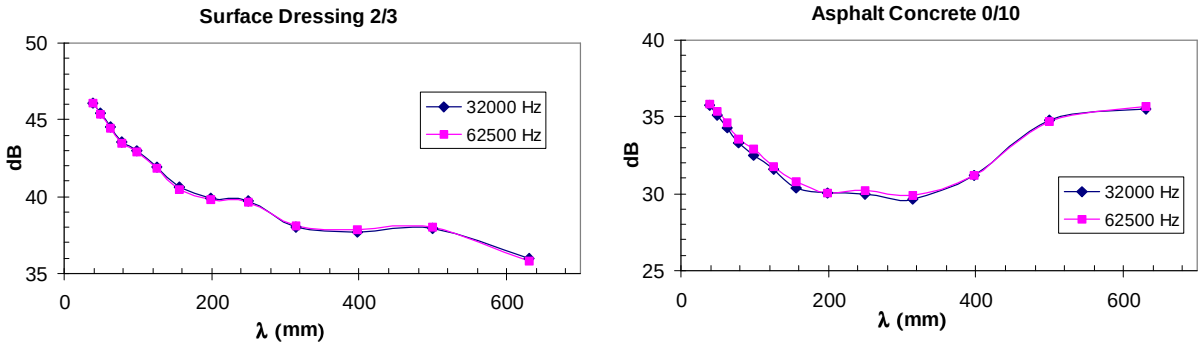

FIGURE 3: Influence of the sampling frequency of the laser captors

Figure 3 shows a good agreement of the results obtained with the two devices. The difference between the megatexture values ranges from 0 to 0,2 dB. Thus, the influence of the sampling frequency of the captors can be neglected.

Influence of the speed of the vehicle

The two operators used the same captor, the same vehicle and the same homogeneous sections. They drove successively at 40 km/h, 60 km/h and 80 km/h. The speed of the vehicle was constant during each test.

Figure 4 shows a good agreement of the results. The megatexture values measured by the device are independent from the speed of the vehicle.

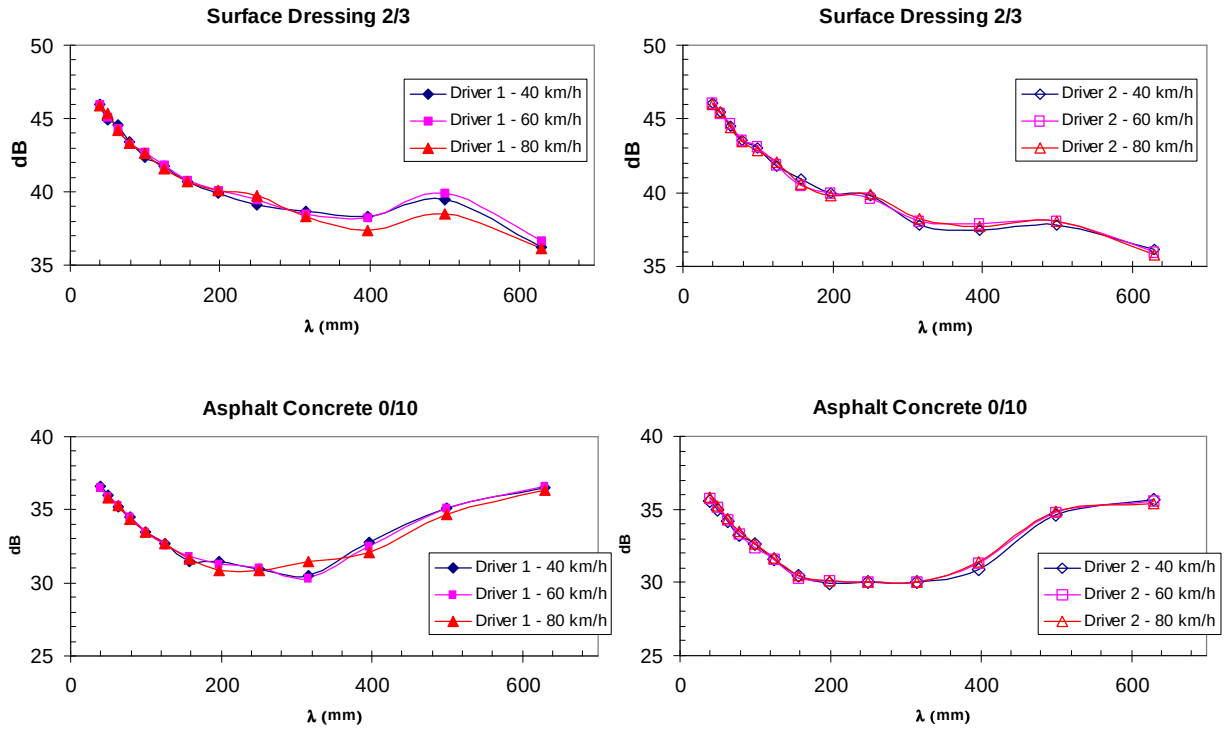

FIGURE 4: Megatexture values by one-third-octave band as a function of speed for the two drivers

Influence of the operator

Two operators took part in the tests. They had instructions in order to measure the sections in the same way. Before making the statistical analyses, their measurements were compared at 40, 60 and 80 km/h (see figure 5).

We can notice that the results obtained by the two operators are equivalent on surface dressing except for the megatexture value corresponding to the one-third-octave band with the central wavelength of 0,500 m. The difference can be explained by the fact that in this one-third-octave band, the spectral analysis is based on a small number of spectrum lines. Thus, the calculus of megatexture values cannot offset a weak difference on test tracks.

On asphalt concrete, the difference of megatexture values is inferior to 1 dB whatever the wavelength. It can be explained by the tests tracks, which are not exactly the same. Indeed, the transversal profile of this section is less regular than the one of the surface dressing section. That's why we obtained few differences on asphalt concrete and not on surface dressing.

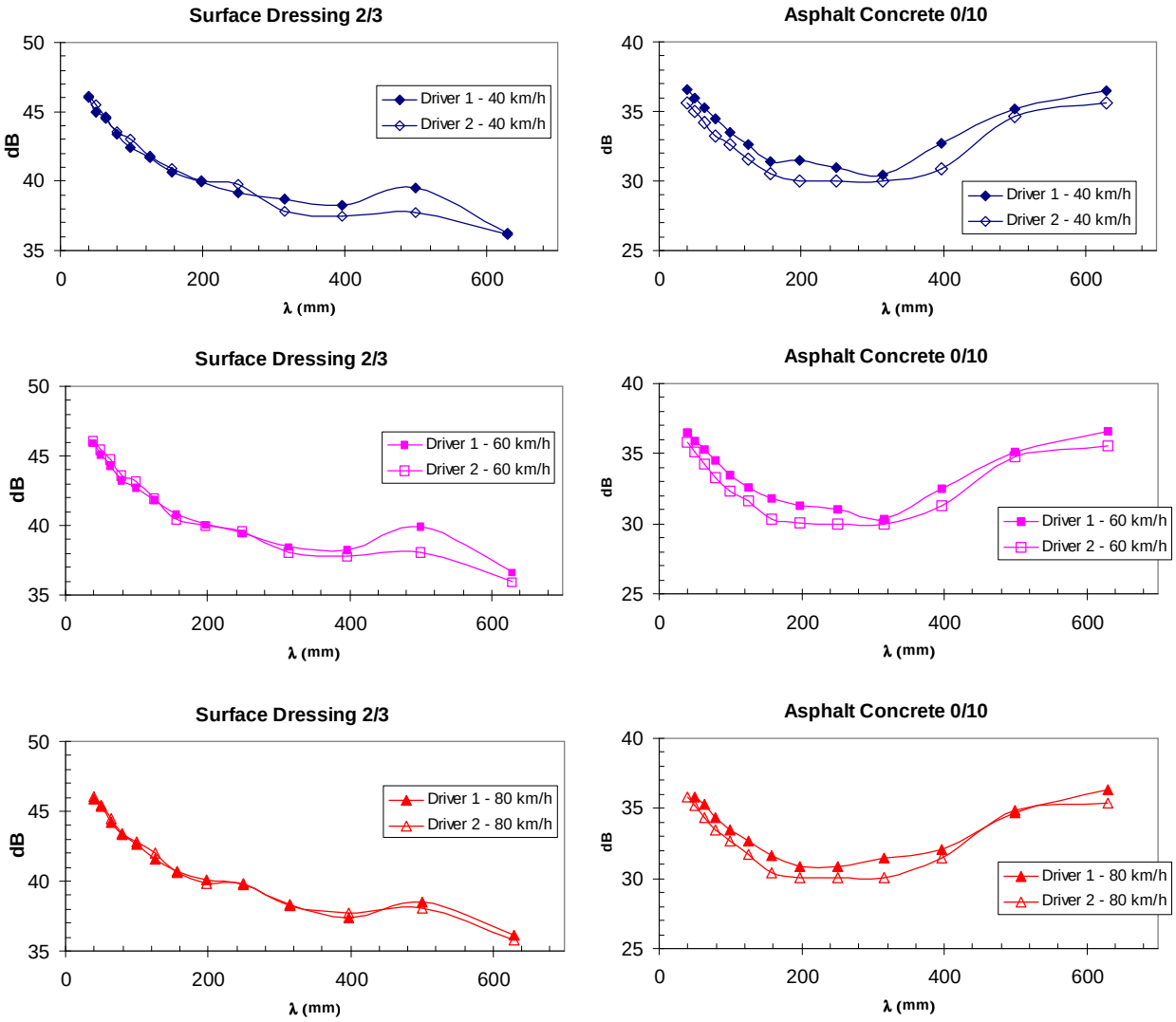

FIGURE 5: Comparison of the megatexture measurements made with two operators

Conclusion

These comparisons showed that:

- The sampling frequency of the captor has no influence on the results,
- The speed of the vehicle where the captor is got on, has no influence on the results,
- The influent parameter on megatexture measurement is the operator, considering the fact that the operator chooses the line of the surface profile measurement. A small variation of the transversal profile entails differences in the megatexture values.

STATISTICAL ANALYSIS

Statistical analysis principle

The principle of the statistical analysis is summed up in the following scheme (see figure 6). Two statistical tests are used: Grubbs' test and Cochran's test. The Grubbs' test is applied to a set of data in order to detect if one value or more are too far from the mean value of the set. The Cochran's test is based on an analysis of the standard deviation of sets of data. It allows comparing sets of data and detecting if the variations in the measurements are similar.
The limits of the Grubbs' test and Cochran's test are given for an interval of confidence of 95%, which mean that 95% of the values are in the field.

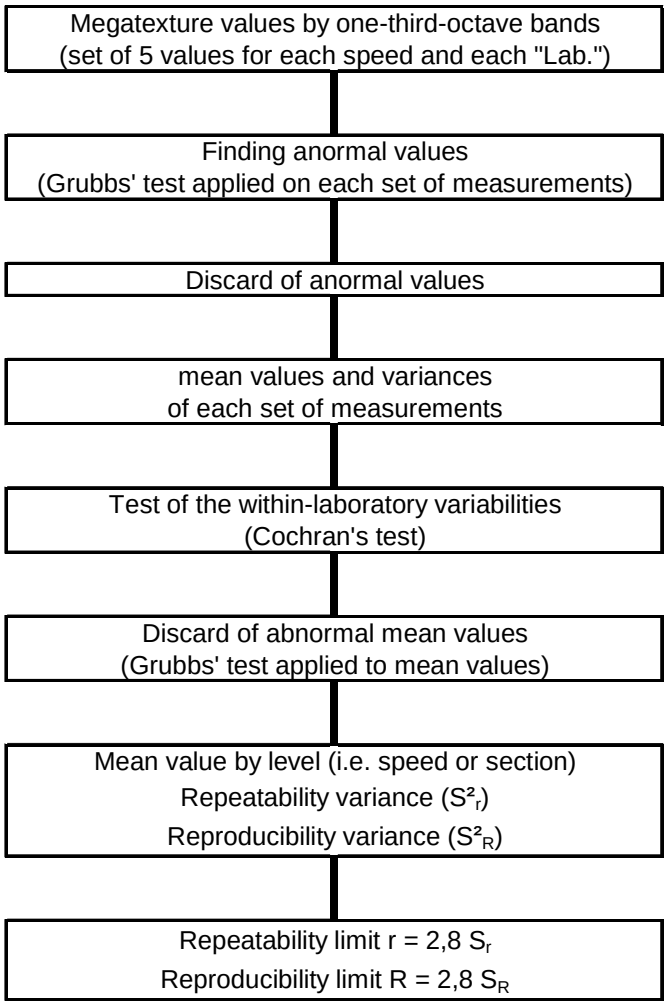

FIGURE 6: Statistical analysis principle following ISO 5725

Accuracy of the measurement

ISO 5725-1 defined the accuracy of a measurement as the closeness of agreement between a test result and the accepted reference value. This accuracy is evaluated through a trueness criterion and a precision criterion. Trueness is the closeness of agreement between the average value

obtained from a series of test results and an accepted reference value. Precision is the closeness of agreement between independent test results obtained under stipulated conditions.

Precision of the measurement method

The precision of the method is based on the study of the standard deviation of the sets of data. This standard deviation is inferior to 1 dB for mean values of megatexture ranging from 30 dB to 52 dB (see figure 7).

Therefore, a variation of 1 dB corresponds to a variation of the deformation of 12%. Knowing that a megatexture value of 40 dB corresponds to a deformation of 0,1 mm and a megatexture value of 60 dB corresponds to a deformation of 1 mm, we can consider that the precision of the measurement is around 0,1 mm for vertical amplitude of the surface profile.

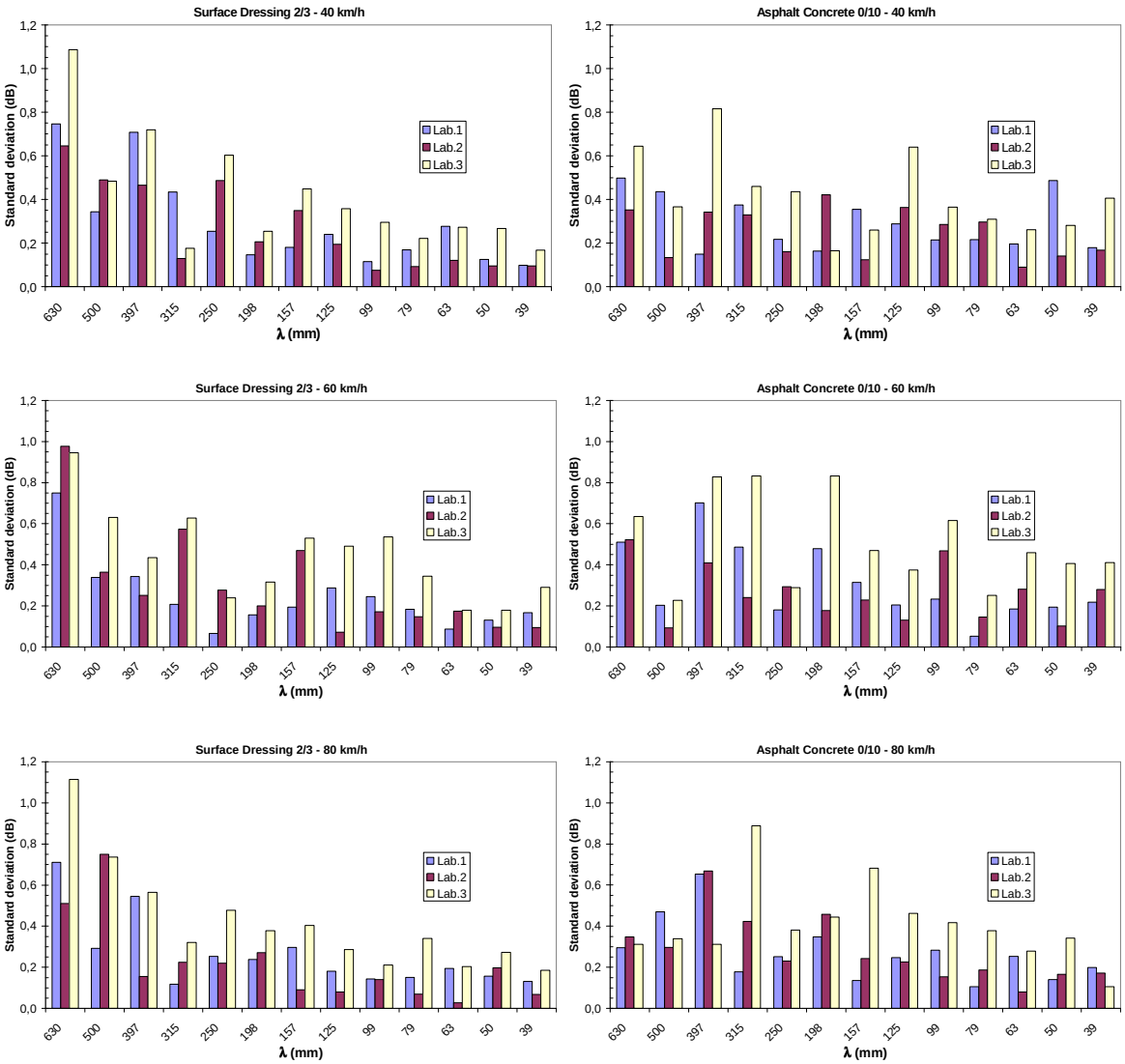

FIGURE 7:Standard deviation of the set of measurements by one-third-octave band

Moreover, we can notice that the precision of the measurement is better for small wavelengths field than for high wavelength field taking into account the fact that the number of spectrum lines used in the spectral analysis is weak in the high wavelength field.
Lastly, the precision increases when the megatexture values increases. The following average standard deviation "σ" were found as a function of the megatexture value:

- 30 to 35 dB σ = 0,8 dB
- 35 to 45 dB σ = 0,5 dB
- 45 to 50 dB σ = 0,3 dB.

Trueness of the measurement method

The trueness of the measurement method is evaluated by considering that the mean value of the sets of data measured by the three laboratories in each one-third-octave band is the reference value.
Then, the difference between the mean value of the set of data obtained by each laboratory and the reference value is calculated. The table 2 sums up the results obtained by giving the maximum value of the difference between the reference value and the mean value of each set of data. The difference ranges from 0,27 dB to 1,11 dB, which corresponds to a gap of 15% with the reference value (i.e. 0,1 mm for the vertical amplitude).

	Central wavelength of the one-third-octave band (mm)	**630**	**500**	**397**	**315**	**250**	**198**
Asphalt concrete 0/10	Mean value	35,9	34,9	31,6	30,1	30,4	30,4
	Maximum difference	0,64	0,47	0,83	0,89	0,44	0,83
Surface Dressing 2/3	Mean value	36,0	38,5	37,9	38,2	39,6	40,0
	Maximum difference	1,11	0,75	0,72	0,63	0,60	0,38

	Central wavelength of the one-third-octave band (mm)	**157**	**125**	**99**	**79**	**63**	**50**	**39**
Asphalt concrete 0/10	Mean value	30,8	32,0	33,0	33,8	34,7	35,4	36,0
	Maximum difference	0,68	0,64	0,62	0,38	0,46	0,49	0,41
Surface Dressing 2/3	Mean value	40,6	41,9	42,9	43,5	44,5	45,3	46,0
	Maximum difference	0,53	0,49	0,54	0,35	0,28	0,27	0,29

TABLE 2: trueness of the measurements

Repeatability and reproducibility of the measurement method

The precision and the trueness of megatexture measurement method are good considering experimental results. Thus, it is possible to evaluate the repeatability and reproducibility of the measurements (see tables 3 and 4).
In the thirteen one-third-octave bands, the standard deviation of repeatability (sr), the standard deviation of reproducibility (sR) and the limits of repeatability (r = 2,8*sr) and reproducibility (R = 2,8*sR) are provided for each level of speed.
Then, considering the fact that megatexture measurements are independent of the speed, an average value of the standard deviations of reproducibility and repeatability can be considered by one-third-octave band (see figure 8).

		40 km/h	60 km/h	80 km/h
630 mm	**sr**	0,700	0,747	0,621
	sR	0,898	0,979	0,835
	r	1,959	2,093	1,739
	R	2,515	2,740	2,337
500 mm	**sr**	0,394	0,352	0,519
	sR	0,860	0,945	0,598
	r	1,102	0,986	1,454
	R	2,409	2,646	1,673
397 mm	**sr**	0,583	0,535	0,525
	sR	0,975	0,820	0,810
	r	1,633	1,498	1,470
	R	2,729	2,296	2,269
315 mm	**sr**	0,343	0,541	0,425
	sR	0,638	0,643	0,885
	r	0,959	1,515	1,191
	R	1,787	1,799	2,478
250 mm	**sr**	0,410	0,237	0,314
	sR	0,670	0,543	0,504
	r	1,147	0,665	0,880
	R	1,876	1,522	1,411
198 mm	**sr**	0,242	0,432	0,365
	sR	0,724	0,713	0,502
	r	0,678	1,210	1,021
	R	2,026	1,995	1,405
157 mm	**sr**	0,307	0,390	0,340
	sR	0,545	0,779	0,501
	r	0,858	1,092	0,953
	R	1,527	2,183	1,403
125 mm	**sr**	0,374	0,297	0,262
	sR	0,570	0,526	0,503
	r	1,047	0,831	0,734
	R	1,596	1,473	1,409
99 mm	**sr**	0,244	0,414	0,241
	sR	0,421	0,552	0,450
	r	0,685	1,161	0,674
	R	1,180	1,544	1,261
79 mm	**sr**	0,229	0,197	0,226
	sR	0,539	0,610	0,428
	r	0,642	0,550	0,632
	R	1,508	1,708	1,198
63 mm	**sr**	0,214	0,251	0,193
	sR	0,420	0,535	0,435
	r	0,600	0,702	0,539
	R	1,177	1,499	1,219
50 mm	**sr**	0,269	0,207	0,220
	sR	0,489	0,457	0,321
	r	0,752	0,579	0,617
	R	1,370	1,279	0,900
39 mm	**sr**	0,213	0,264	0,152
	sR	0,503	0,394	0,330
	r	0,595	0,738	0,427
	R	1,408	1,104	0,924

TABLE 3: repeatability and reproducibility of the megatexture measurements by one-third-octave band at different levels of speed

		40 km/h	60 km/h	80 km/h
LMe	sr	0,161	0,193	0,154
	sR	0,401	0,473	0,323
	r	0,450	0,540	0,432
	R	1,124	1,323	0,906
L500	sr	0,362	0,268	0,394
	sR	0,669	0,643	0,474
	r	1,015	0,751	1,104
	R	1,874	1,799	1,327
L63	sr	0,211	0,237	0,166
	sR	0,443	0,500	0,363
	r	0,591	0,663	0,465
	R	1,241	1,400	1,016

TABLE 4: repeatability and reproducibility of the megatexture indicators measurements

Figure 8 represents the limits of repeatability "r" and reproducibility "R" of megatexture measurements as a function of the wavelength. The limits of repeatability and reproducibility increase when the wavelength increases due to the decreasing number of spectrum lines usable for texture spectrum analysis. The values of "r" ranges from 0,5 dB to 1,8 dB and the values of "R" ranges from 1,3 dB to 2,6 dB.

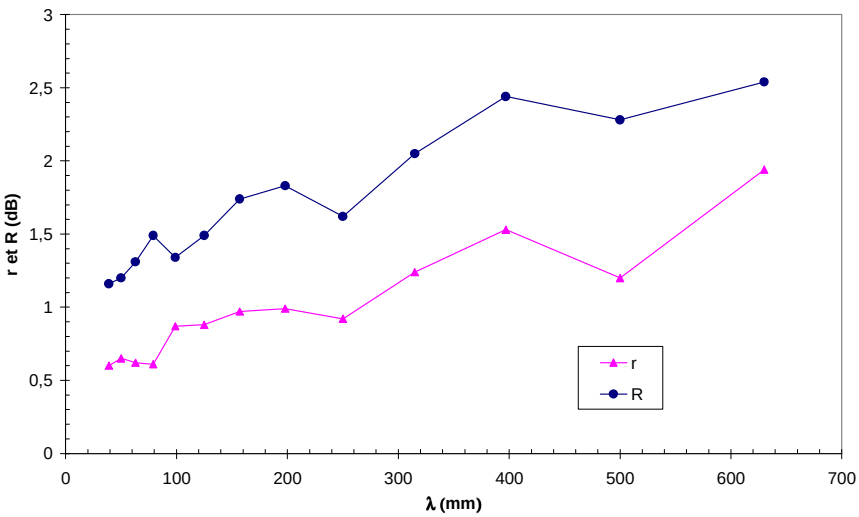

FIGURE 8: limits of repeatability and reproducibility of megatexture measurements depending on the wavelength

CONCLUSIONS

This paper presented the megatexture measurement method and its accuracy. In a first part, some comparisons were realized in order to detect the parameters that have an influence on the megatexture measurements. The experimental tests showed that:

- The sampling frequency of the captor has no influence on the results,
- The speed of the vehicle has no influence on the results,
- The operator has a strong influence on the results because he chooses the line of the surface profile, which is analyzed.

In a second part, the statistical analysis of the results following ISO 5725-2 showed that:

- the precision of the measurement method is better for small wavelengths field than for high wavelength field,
- the precision of the measurement method increases when the megatexture values increases,
- the precision of the measurements is around 0,1 mm for vertical amplitude of the surface profile,
- the limits of repeatability and reproducibility increase with the wavelength,
- the limit of repeatability "r" ranges from 0,5 dB to 1,8 dB,
- the limit of reproducibility "R" ranges from 1,3 dB to 2,6 dB.

To conclude, the megatexture measurement method with a non-contact profilometer has a good accuracy. The next step of the study will be the correlation between megatexture measurements and noise measurements.

REFERENCES

1. ISO 5725-1, *Application of statistics - Accuracy (trueness and precision) of measurement methods and results – Part 1: general principle and definitions*, 1994.
2. ISO 5725-2, *Application of statistics - Accuracy (trueness and precision) of measurement methods and results – Part 2: basic method for the determination of repeatability and reproducibility of a standard measurement method*, 2002.
3. ISO 13473-1, *Characterization of pavement texture by use of a surface profile – Part 1: determination of mean profile depth*, 2002.
4. Méthode d'essai des LPC n°50, version 2, avril 2006.
5. Gothié M. *Determination of megatexture indicators by non-contact profilometer and analysis of a road surface profile*, Proceedings of the 4th International Symposium on Pavement Surface Characteristics of Roads and Airfields (SURF 2000), Nantes, France, 2000.
6. Cerezo, V Gorand J.L. and Gothié M. Fiabilité des mesures de megatexture et corrélation entre le spectre de texture et le spectre de bruit, rapport de recherche LCPC, France, 2006.