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SURF 2012

3D PAVEMENT SURFACE MACROTEXTURE: MEASUREMENTS AND FRICTION RELATIONSHIPS

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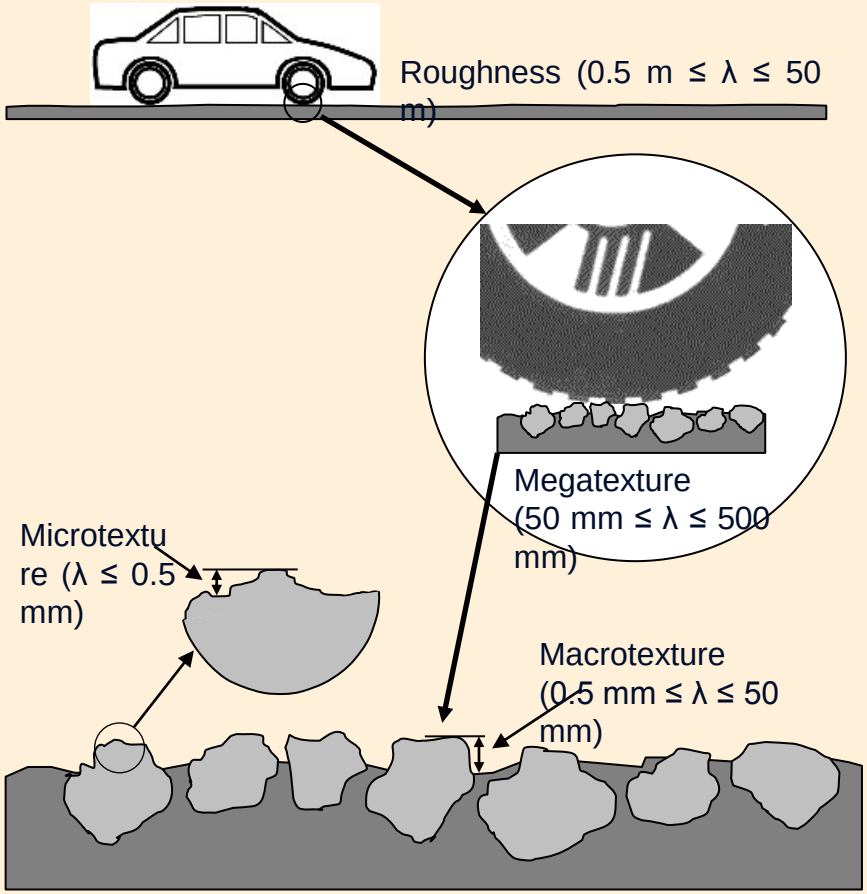
3D Pavement Surface Macrotexture: Measurements and Friction Relationships

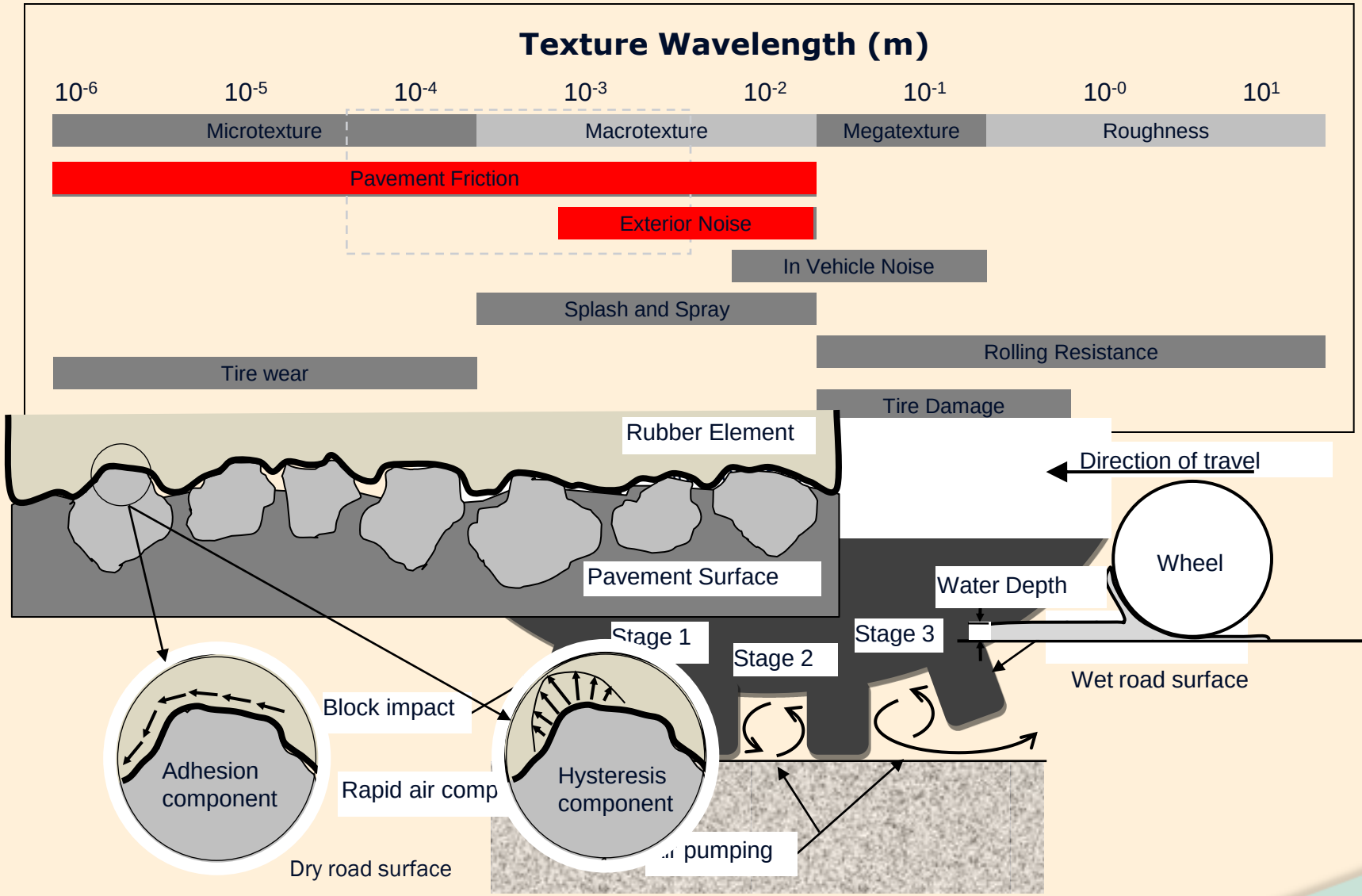
- Pavement Texture
- Influence of Surface Texture
- How to Measure Texture
- Image-Based Macrotexture
- Macrotexture Indicators and Tire/Pavement Friction
- Field Application
- Results and conclusions

Pavement Texture Classification

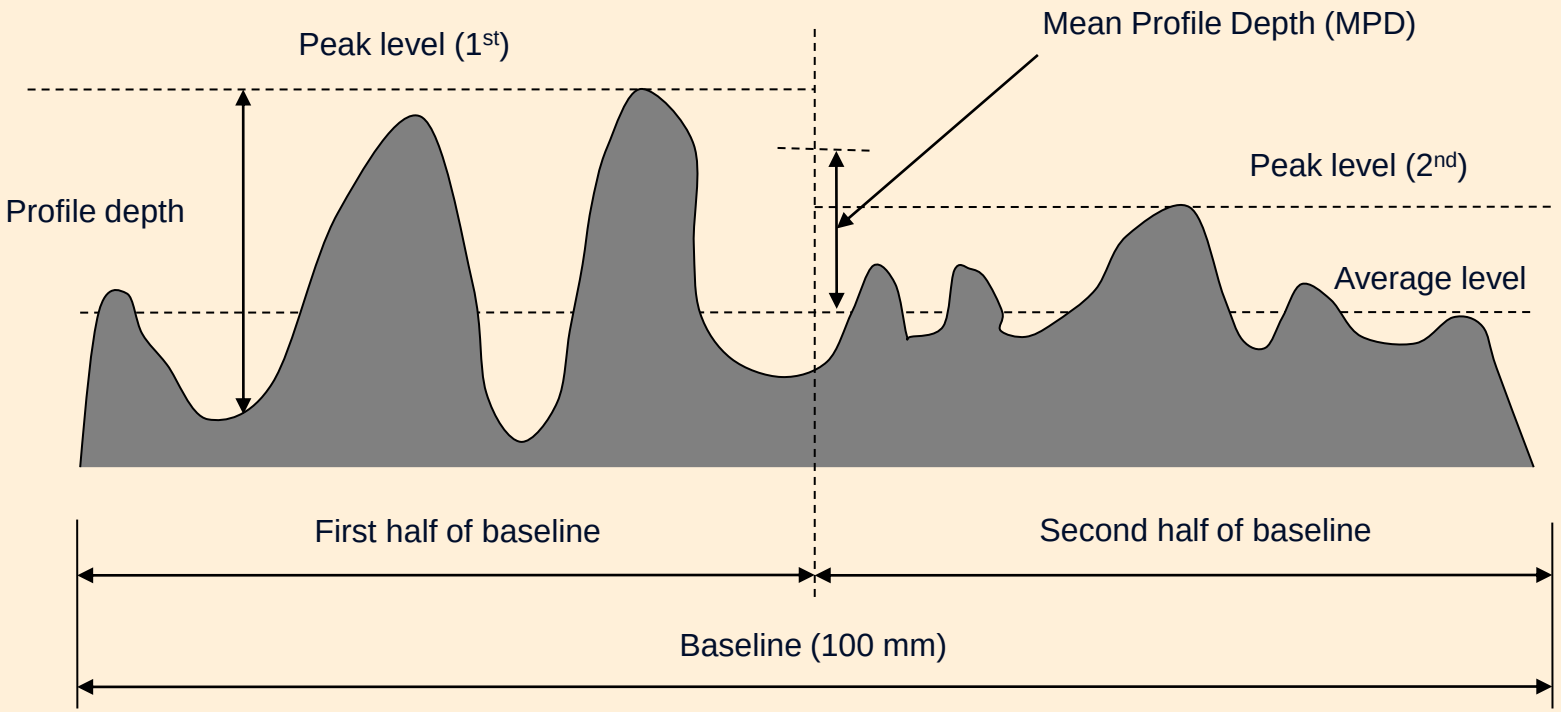


Is measuring road surface texture important ?

Influence of Road Surface Texture



Mean Profile Depth (MPD) and Root Mean Square Roughness



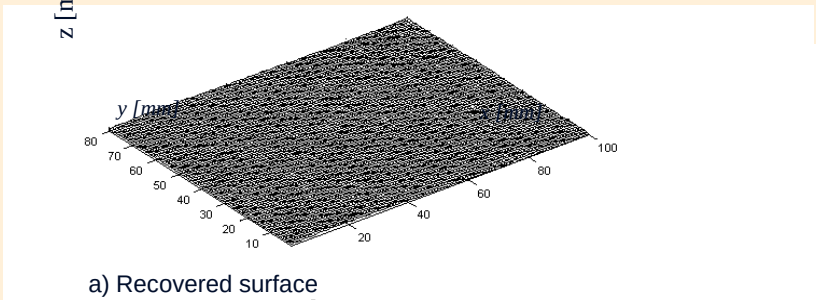
Root mean square roughness $\delta = \sqrt{\frac{1}{n}\sum_{i=1}^{n} z_i^{\,2}}$

z_i = height of surface profile from the mean profile level at position i,
n= number of discrete measured points along the profile length.

Power Spectrum Indicator

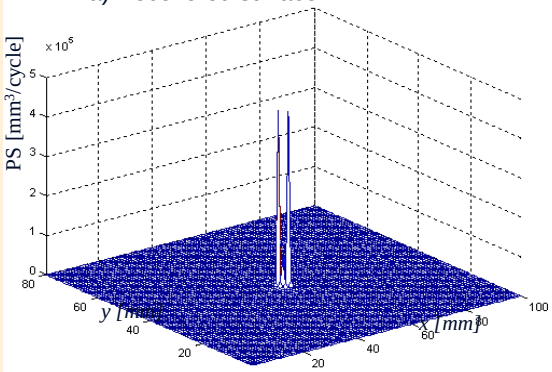
- **The sum of power spectrum (energy) provides information about the frequency content and a better indication of the quality of the texture**
- **The image-based surface is recovered in the frequency domain**
- **If image specifications are standardized (dimensions of images and condition of lighting) the energy can be used as texture indicator**

Smooth versus Rough Surfaces



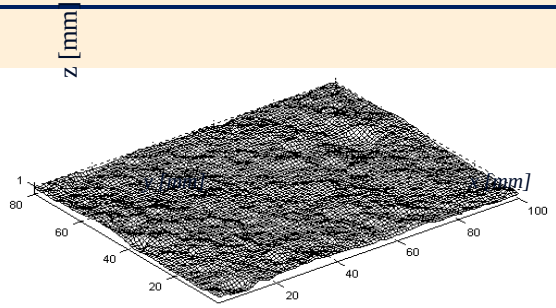
a) Recovered surface

PSE=1.3 ×10^6 (mm^3/cycle)



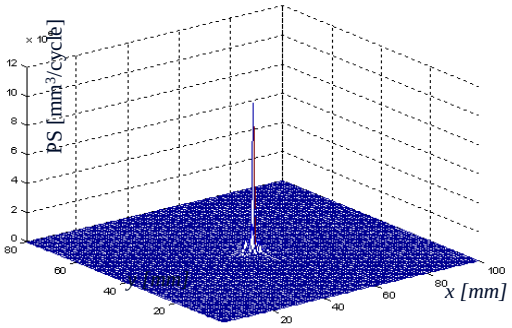
b) Power Spectrum of the recovered surface

c) Sample A1

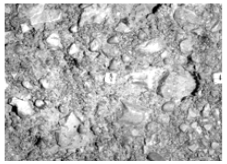


a) Recovered surface

PSE=19.5×10^6 (mm^3/cycle)



b) Power Spectrum of the recovered surface

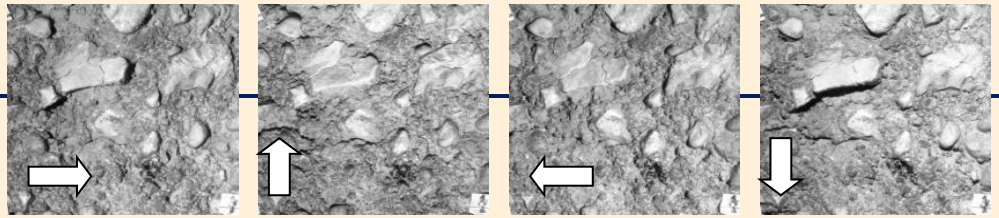


c) Sample E1

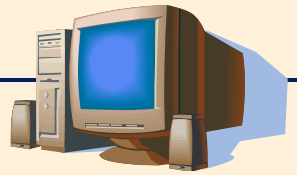
Recovered surface in time and frequency domains for sample A1

Recovered surface in time and frequency domains for sample E1

Measuring surface three-dimensional heights using PhotoTexture



Four images of pavement surface illuminated from tilt angles of 90 increment τ =0 , 90 , 180 and 270

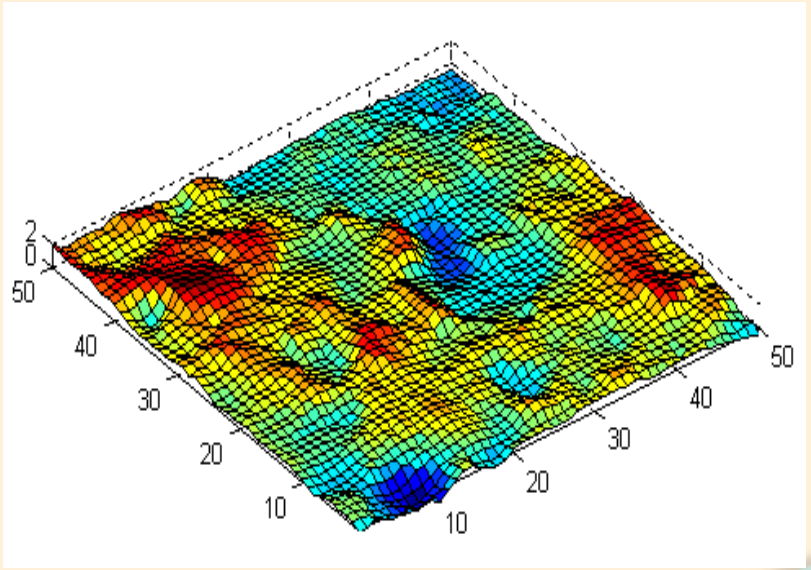


photometric stereo software used for recovering the texture information

Digital camera: 5.1 mega pixels

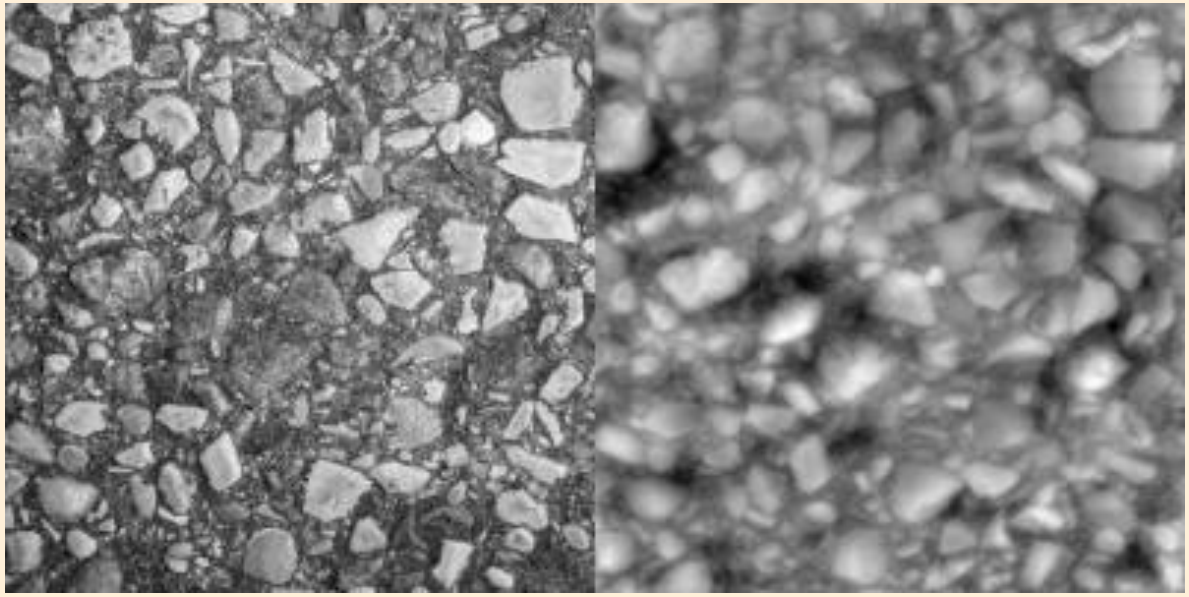
12X optical zoom

System with fixed four light sources



3D recovery of the texture

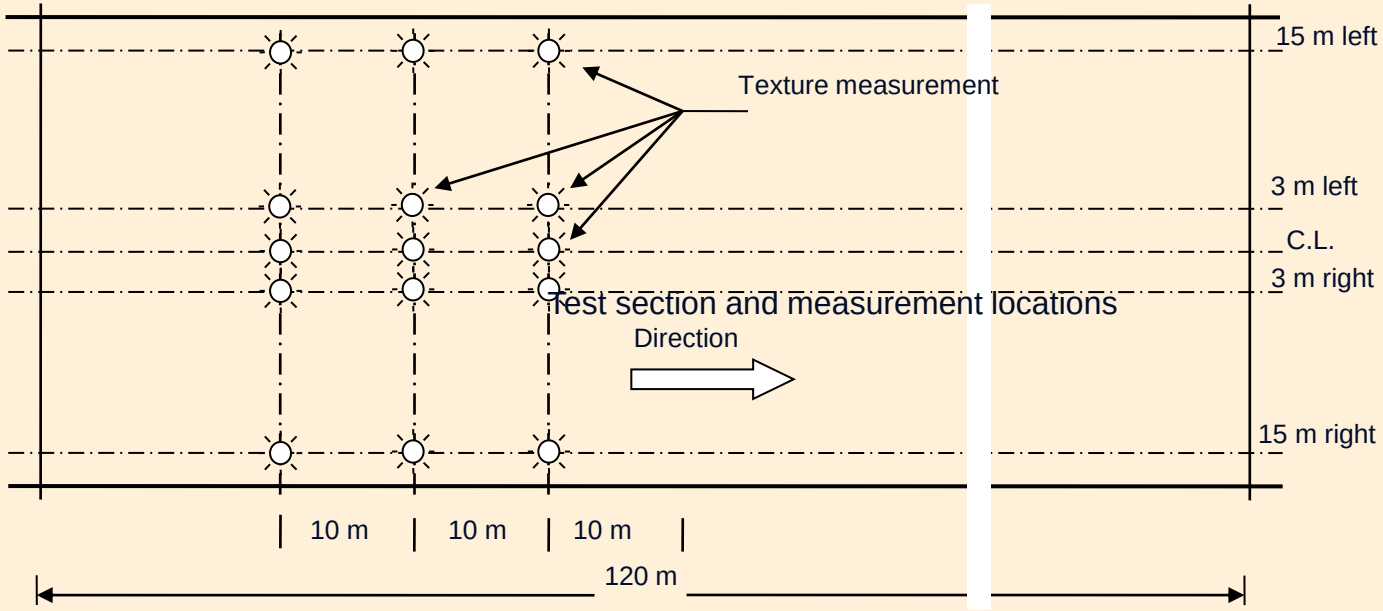
Three-dimensional surface recovery of pavement surface



a) Pavement surface

b) Map of heights

Relating Image-Based Macrotexture Indicators to Tire/Pavement Friction



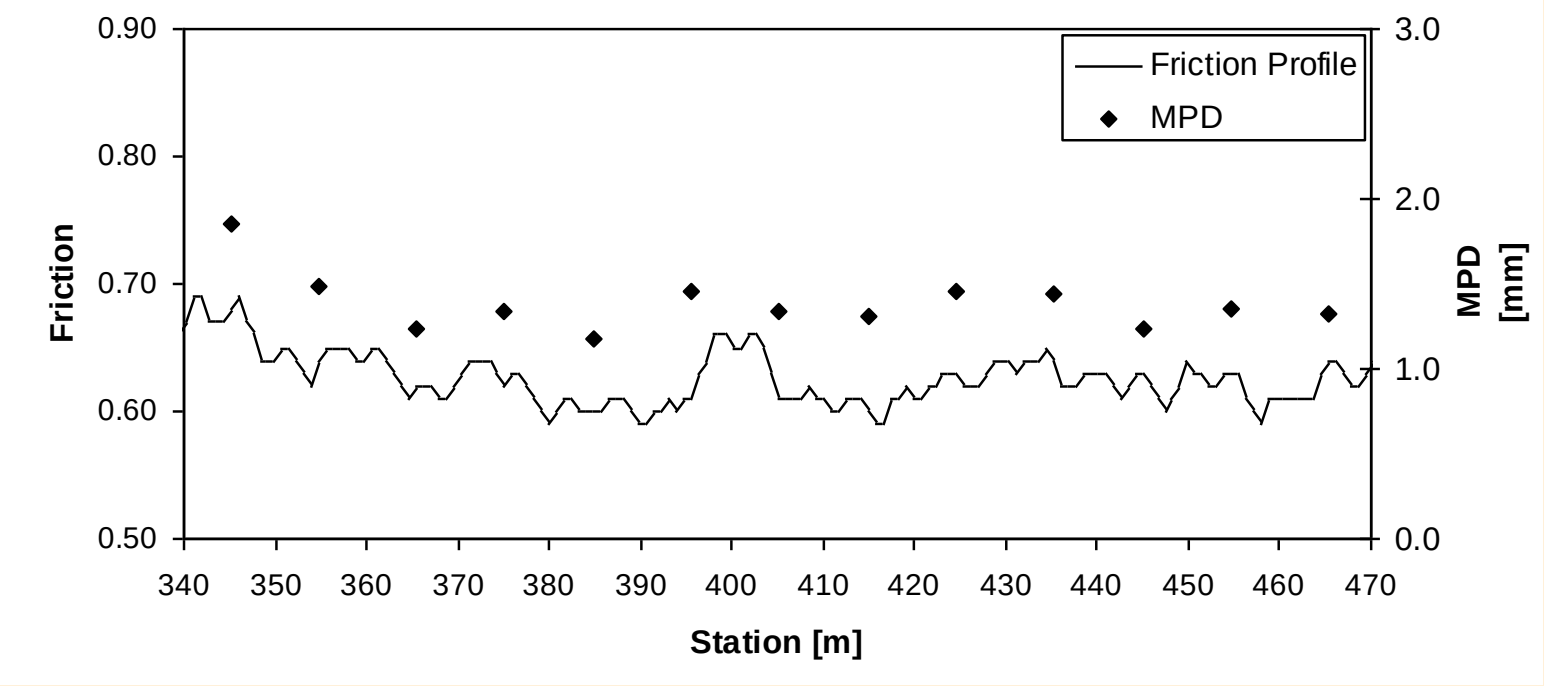
With the support of Department of National Defence (DND), an airport runway was tested to examine the relationship between image-based macrotexture indicators and friction measurement.

Statistical Properties

	GripTester Friction	Image-Based Macrotexture		
		MPD (mm)	RMSR (mm)	PSE (mm^3/Cycle)
Mean	0.65	0.38	1.40	**9.09E+09**
Standard Deviation	0.02	0.05	0.19	**2.82E+09**
Minimum	0.61	0.29	1.12	**5.26E+09**
Maximum	0.69	0.58	2.19	**2.09E+10**

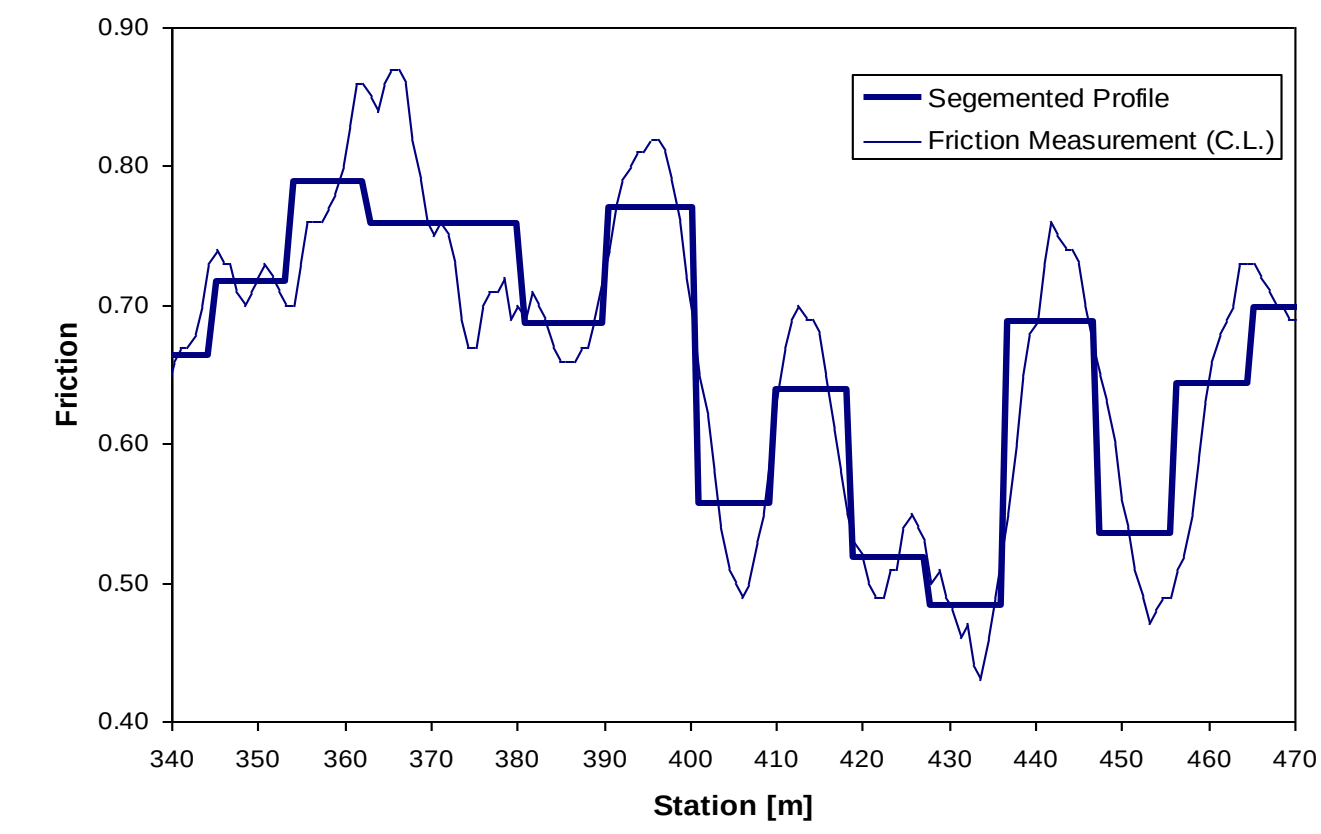
(Sample size n= 52)

Friction and texture measurements



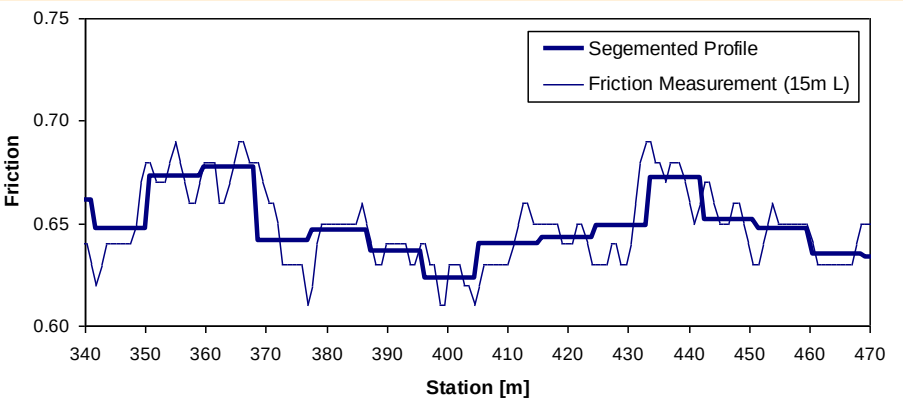
Friction and texture measurements at 3m left from the centerline of the runway

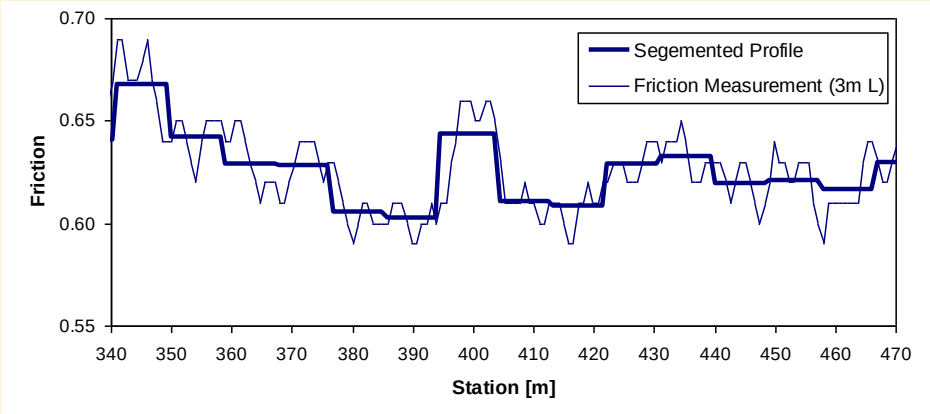
Segmenting friction profile

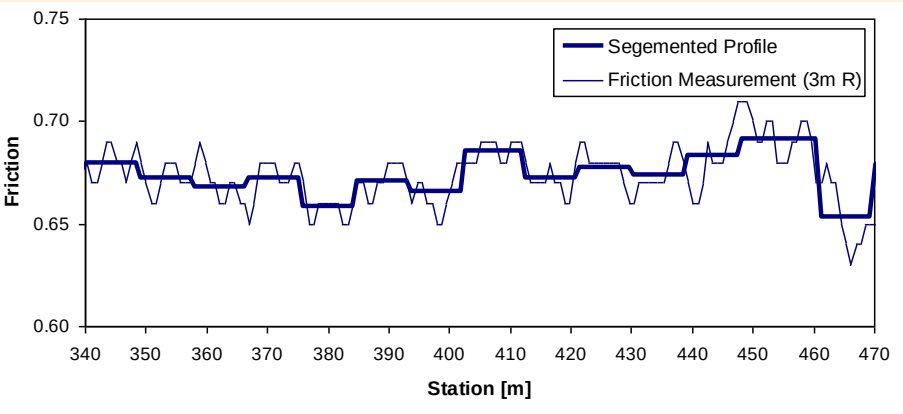


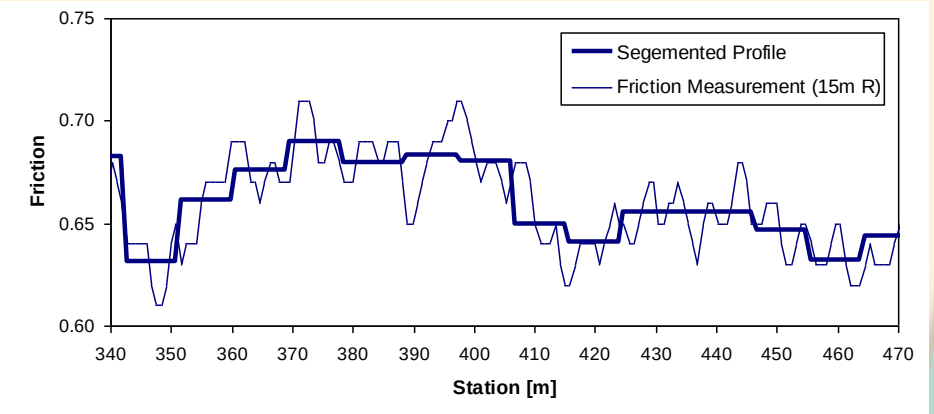
Using CDA approach for segmenting C.L. friction profile

Segmenting friction profile









Using CDA approach for segmenting friction profiles (3m and 15m left and right)

Relationship between Surface Texture Indicator and Skid Resistance

Calculating international friction index from macrotexture according to the ASTM Standard (E1960-98)

1- Use the macrotexture measurement (TX in mm) to calculate the speed constant (S_p) which is used to adjust friction measurement to a common speed of 60 km/h.

$$S_p = a + b \times TX$$

a, *b* are constants depending upon the method of computing the macrotexture.

2- Adjust the friction measurement (FRS) at given speed S to the speed of 60 km/h

$$FR60 = FRS \times e^{[(S-60)/S_p]}$$

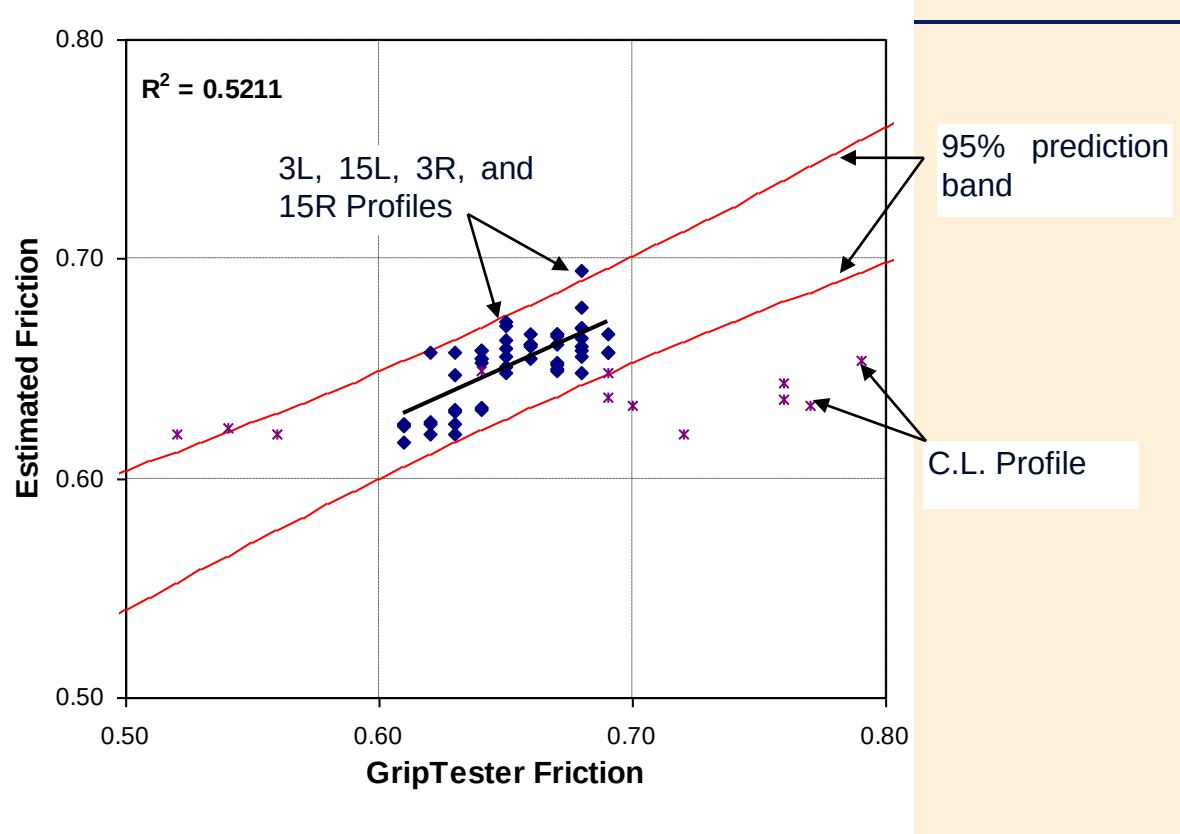
3 - Determine the calibration constants (A, B and C)

$$F60 = A + B \times FR60 + C \times TX$$

For calibrating new equipments that has never been calibrated and when Griptester is used, the estimated target F60 and S_p could be determined by the Griptester and the texture measurements.

TX is replaced by MPD, RMSR, and MPD= $a1.PSE^{b1}$

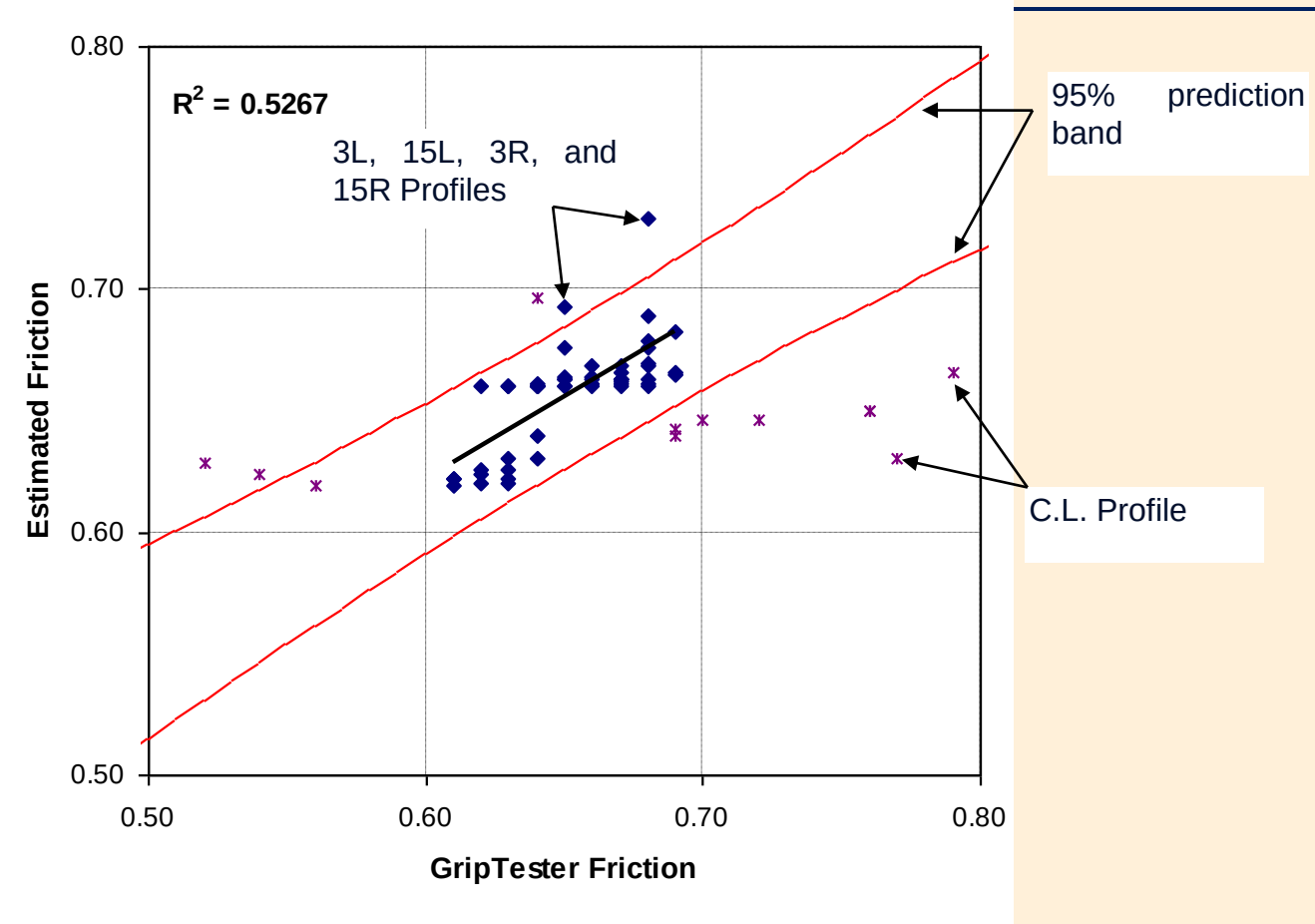
Relationship between MPD and Skid Resistance



Correlation between GripTester friction and friction estimated from MPD

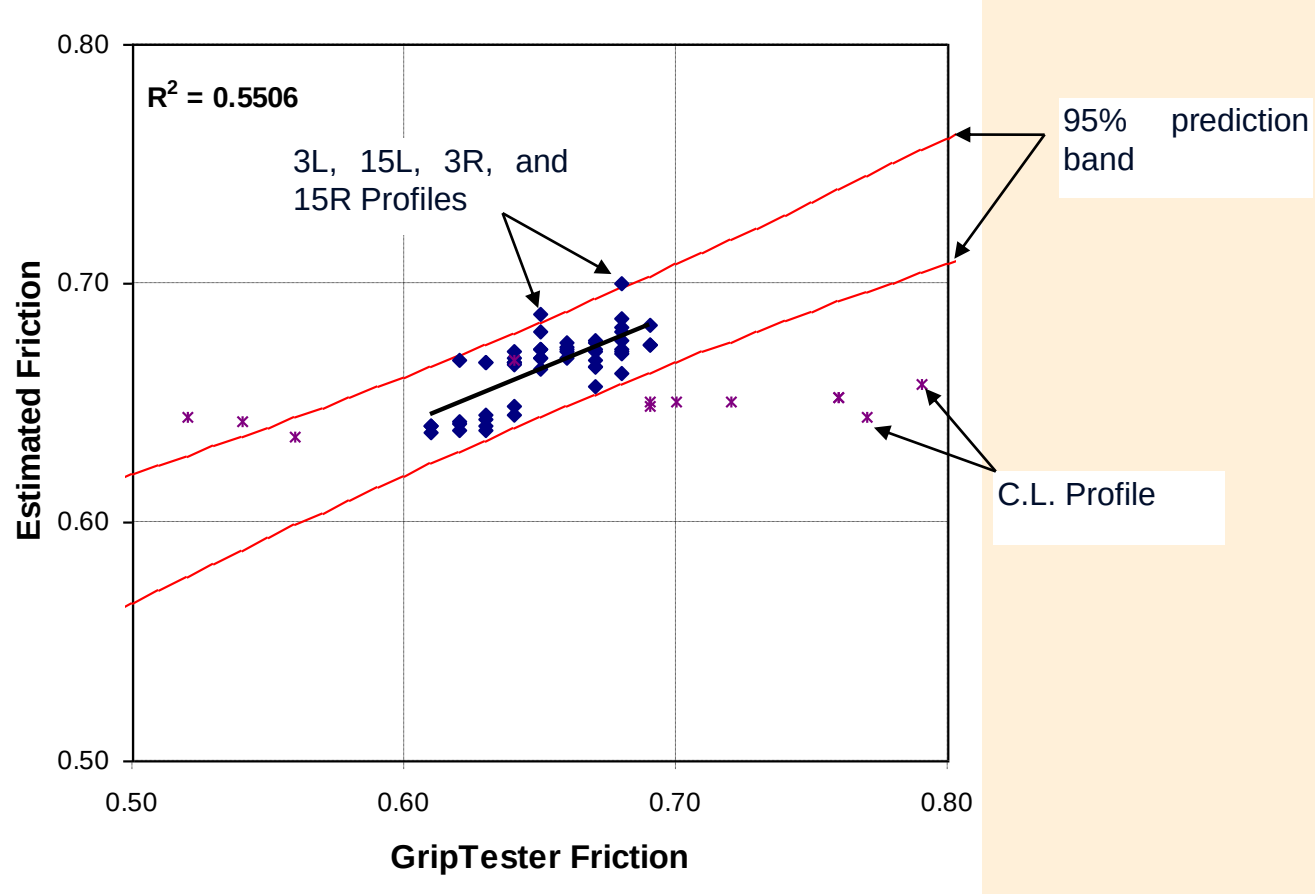
- **The centreline profile data were not included in the analysis**
- **The probabilistic models are examined for 95% confidence interval.**

Relationship between RMSR and Skid Resistance



Correlation between GripTester friction and friction estimated from RMSR

Relationship between PSE and Skid Resistance



Correlation between GripTester friction and friction estimated from PSE

Relationship between Surface Texture Indicator and Skid Resistance

- Test of hypothesis of the constant parameters support that there is a correlation between Grip Tester friction and image-based macrotexture
- Texture-skid resistance relationship required a wider range of textures and surface types

Thank You