NANOVEA®
A Better Measure.

Surface Roughness of Concrete with 3D Metrology

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INTRO:

Concrete, rock and core samples all have an important characteristic in common, their surface roughness and or topography can play a vital role in applied use and or an explanation to fracture and interaction. For example, concrete surface roughness can play a crucial role in the bonding to applied substrates, during geologic studies a rock surface can provide answers to important fault shifts and the study of core sample surfaces can provide clues to fluid mechanics. Many of these measurements require portable instrumentation.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR R&D AND QUALITY CONTROL

Because surface roughness and or topography of concrete is vital to applied use and or research, it is crucial to understand and control this parameter. Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unmatched capability to measure concrete and or rock surfaces. Where other techniques fail to provide reliable data, due to surface variation, angle and reflectivity, Nanovea Profilometers succeed and now with portable capability.

MEASUREMENT OBJECTIVE

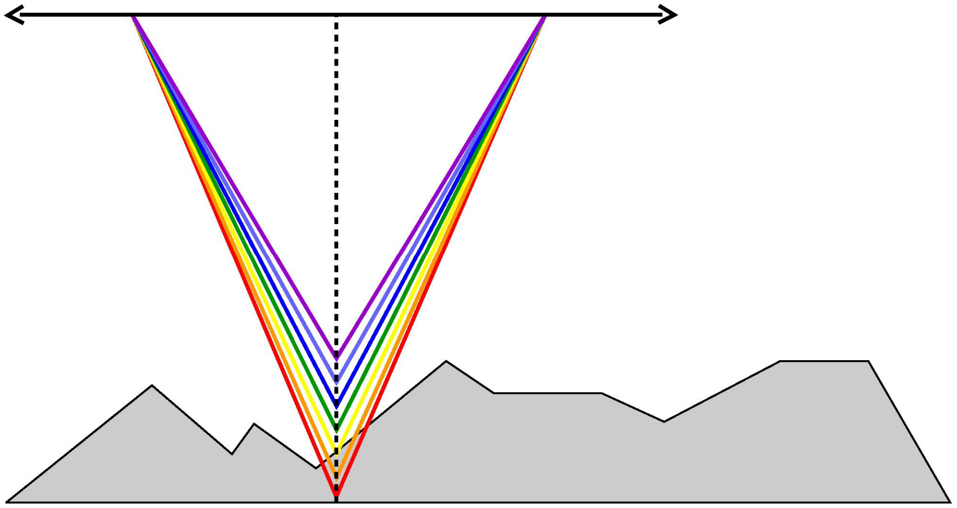
In this application, the Nanovea JR25 (new portable Profilometer) is used to measure the surface of a concrete sample. Several surface parameters will automatically be calculated including the most common, Sa (average surface roughness).

MEASUREMENT SET-UP & TIPS:

Measurement area randomly selected on the concrete surface, the drastic changes in surface topography is not an issue for the JR25. Small height variation down to nanometers up to 27mm of height variation can easily be measured.

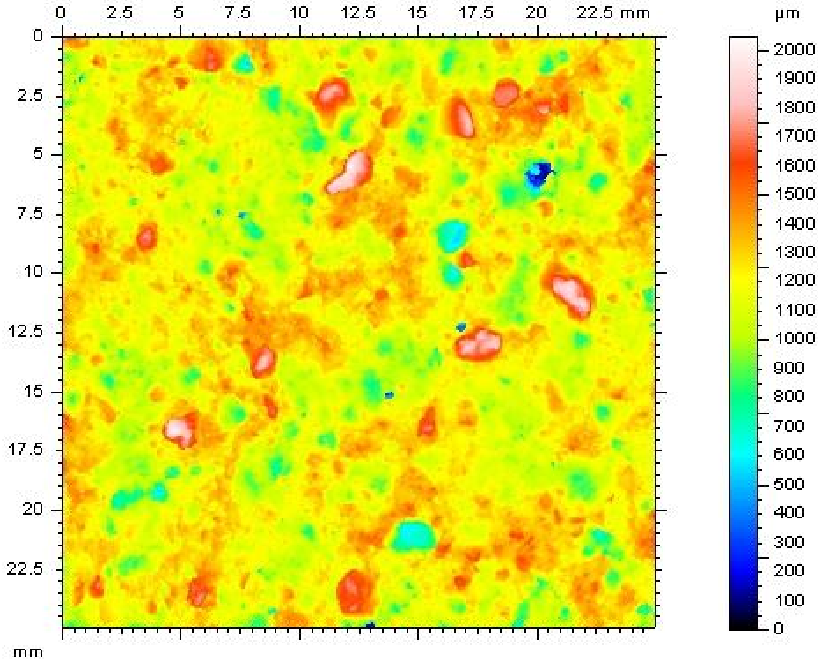
MEASUREMENT PRINCIPLE:

The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.

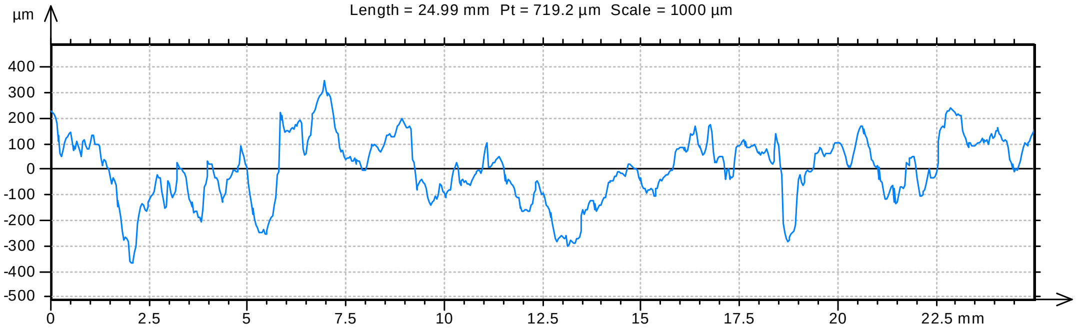


Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough.

RESULTS:

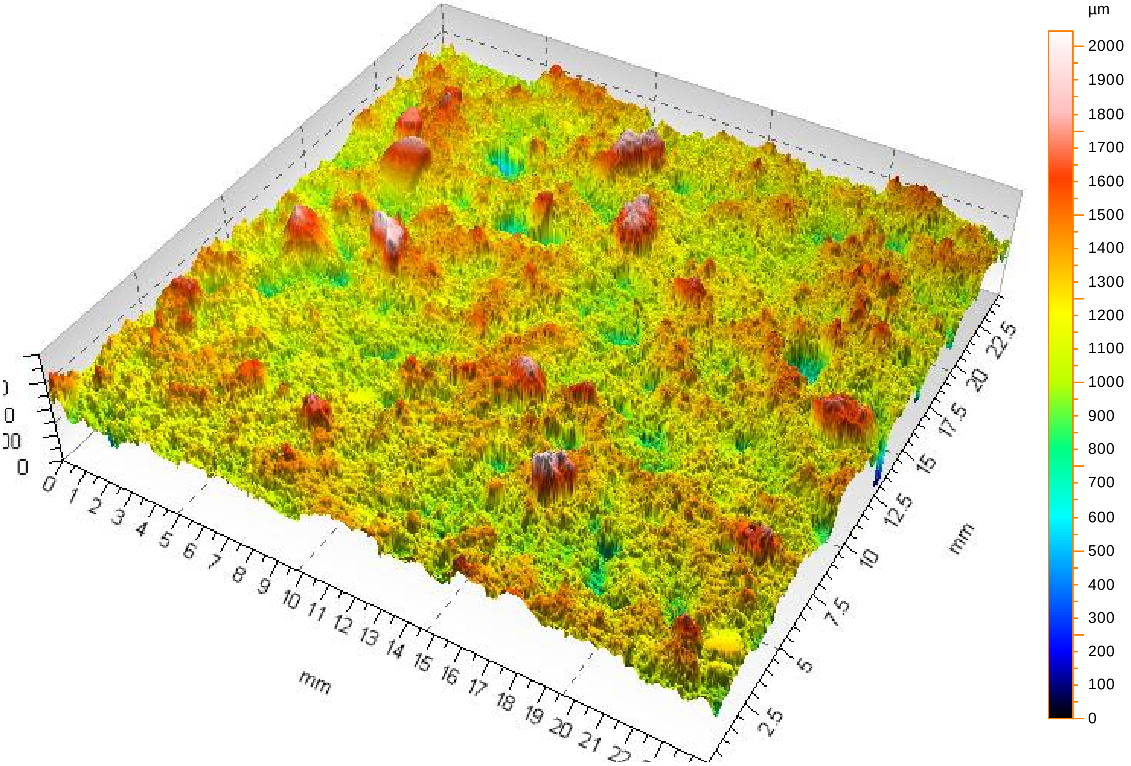


False color representations of flattened Area 1 (above) and Profile Extraction (below)



Sa	125.9 µm	Arithmetical Mean Height
Sq	170.8 µm	Root Mean Square Height
Sp	839.0 µm	Maximum Peak Height
Sv	1208 µm	Maximum Pit Height
Sz	2047 µm	Maximum Height
Ssk	0.01933 Skew	ness
Sku	5.831	Kurtosis

	Height Parameter	Definition
Sa	Arithmetical Mean Height	Mean surface roughness. $Sa = \frac{1}{A}\int_A \lvert z(x,y)\rvert dxdy$
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness. $Sq = \sqrt{\frac{1}{A}\iint_A z^2(x,y)dxdy}$ Computes the standard deviation for the amplitudes of the surface (RMS).
Sp	Maximum Peak Height	Height between the highest peak and the mean plane.
Sv	Maximum Pit Height	Depth between the mean plane and the deepest valley.
Sz	Maximum Height	Height between the highest peak and the deepest valley.
Ssk	Skewness	Skewness of the height distribution. $Ssk = \frac{1}{Sq^3}\left[\frac{1}{A}\iint_A z^3(x,y)dxdy\right]$ Skewness qualifies the symmetry of the height distribution. A negative Ssk indicates that the surface is composed of mainly one plateau and deep and fine valleys. In this case, the distribution is sloping to the top. A positive Ssk indicates a surface with a lot of peaks on a plane. Therefore, the distribution is sloping to the bottom. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Sku	Kurtosis	Kurtosis of the height distribution. $Sku = \frac{1}{Sq^4}\left[\frac{1}{A}\iint_A z^4(x,y)dxdy\right]$ Kurtosis qualifies the flatness of the height distribution. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.



3D Profile

CONCLUSION:

The area measured shows an average roughness of 125.9µm and a total height variation of 2,047µm over a 25mm^2 area. This suggests that over the area scanned there were some large peaks and valleys relative to the average roughness, but not enough to skew the average roughness values. With no weight restrictions and a maximum measurement area of 25mm^2, the JR25 makes an ideal choice for portable surface measurements of large immovable surfaces. Vital field study surface measurement will now have the option of Nanovea 3D non-contact technology with a compact potable profilometer.