Topography evaluation methods for concrete surface

Luc COURARD, Université de Liège, Belgium
Andrzej GARBACZ, Warsaw University of Technlogy, Poland
Benoît BISSONNETTE, Université LAVAL, Canada

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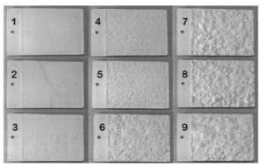
Surface preparation
What? Why? How?

Surfology:
techniques and principles

1. Preparation of concrete surface
   Needs for knowledge
2. Topography evaluation
   Parameters and techniques
3. Methodology comparison
   What is the best technique?
4. Conclusions and propectives
   Extension of CSP's

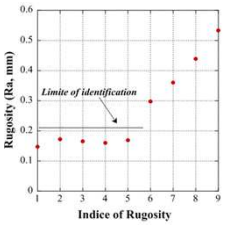
Topography:
Concrete Surface Profiles

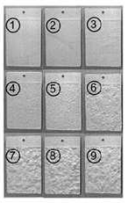
Reference ICRI plates and comparison with roughness on site



Surface preparation methods	CSP
Detergent scrubbing	1
Low-pressure water cleaning	1
Acid etching	1-3
Grinding	1-3
Abrasive (Sand) blasting	2-5
Steel shotblasting	3-8
Scarifying	4-9
Needle scaling	5-8
Hydrodemolition	6-9
Scabbling	7-9
Flame blasting	8-9
Milling/rotmilling	9

Topography evaluation: Concrete Surface Profiles





Opto-morphometric method

- the limit of identification depends on the camera characteristic.
- for Ra > 0.250 mm, differentiation is satisfactory

Perez, F., Courard, L., Bissonnette, B., Garbacz, A. and Gorka (2005) ICCRRR 2005: 1015-1020

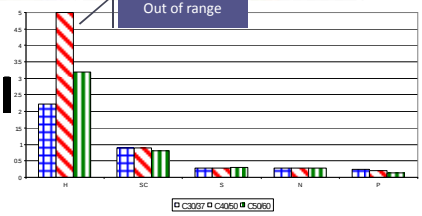
Topography evaluation : Sand Patch Test

ASTM E965
EN 13036-1: 2002
EN 1766: 2000

Surface Rough Index
$SRI = 4V/\pi D^2$

Out of range

H = water-jetting
SC = scabbling
S = sandblasting
P = polishing



Topography evaluation : mechanical profilometry

Technical characteristics

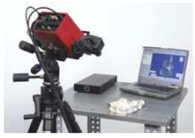
- **system capacity: 1000 by 1000mm**
- **surface of measurement : 30 by 30mm**
- **shape of the stylus: spherical**
- **diameter of the stylus: 6µm and 1.5mm**
- **step of measurement: 300µm**

Courard L., Garbacz A., Gorka M. (2004) ICPIC Berlin: 125-132

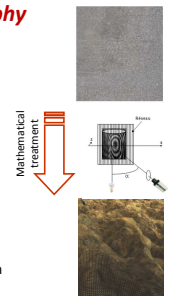
Topography evaluation : optical profilometry

Equipments to measure surface topography

Mechanical profiling
Measuring area : 200x200 mm
Shape of the stylus: truncated cone
Diameter of the stylus: 1 mm
Path of measurement: 1 mm

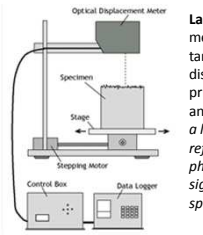


Atos I 3D Digitizer
Fringe patterns
Measuring area:
120×100 - 1000×800 mm²
Spatial resolution: 0,04-1 mm

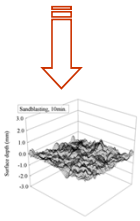


Topography evaluation : optical profilometry

Equipments to measure surface texture



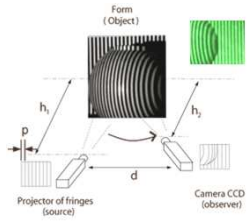
Laser profiling
method based on a laser distance measurement by optical displacement meter,
principle based on optical triangulation,
a lens focuses the spot of reflected laser light onto a photodetector, which generates a signal that is proportional to the spot's position on the detector

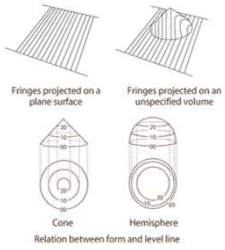


Fukuzawa, K., Mitsui, M. and Numao, T. (2001) ICPIC 01 Honolulu

Topography evaluation : optical profilometry

Deformation of parallel and periodic fringes (level line)

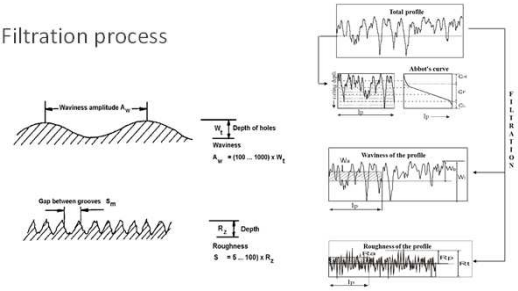




Perez, F., Courard, L., Bissonnette, B., Garbacz, A. and Gorka (2005) ICCRRR 2005: 1015-1020

Topography evaluation : descriptive parameters

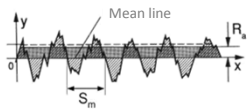
Filtration process



Courard L., Nélis M. (2003) Mag. Concr. Res., 55(4): 355-366

Topography evaluation : descriptive parameters

Parameters	*Definition*
X_t	*total height of the profile*
X_v	*maximum depth of the profile (holes)*
X_p	*maximum height of the profile (peaks)*
X_a	*arithmetic mean of the deviation of the profile from the mean line*
X_q	*quadratic mean of the deviation of the profile from the mean line*
S_k	*skewness of surface height distribution*
S_m	*mean spacing between profile peaks at the mean line, measured over the assessment length*
C_r, C_c, C_t	*Bearing ratio parameters*



Courard L., Nélis M. (2003) Mag. Concr. Res., 55(4): 355-366

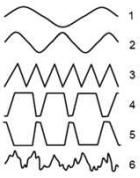
Topography evaluation : descriptive parameters

Xa parameter seems to be accurate …

More than 2 parameters are needed to obtain a correct description of waviness/roughness

Profiles 4 and 5 have same S_m

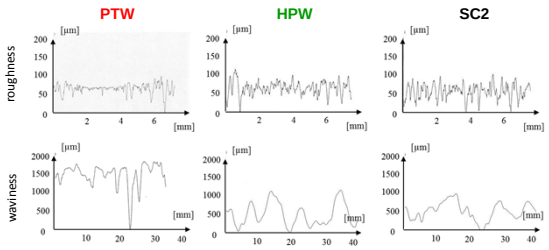
Profiles 1 to 6 have same R_a



Consequences on adhesion are probably different …

Topography evaluation : descriptive parameters

Mechanical evaluation



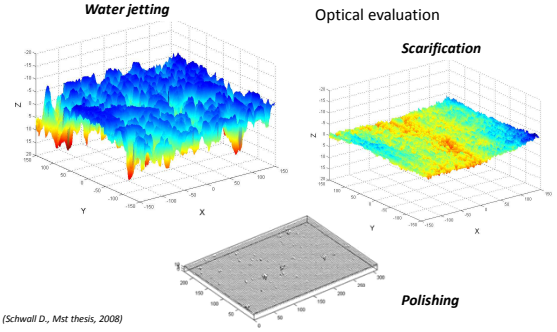
Garbacz A., Courard L., Kostana K. (2006) Materials Characterization, 56: 281-289

Topography evaluation : descriptive parameters

Water jetting

Optical evaluation

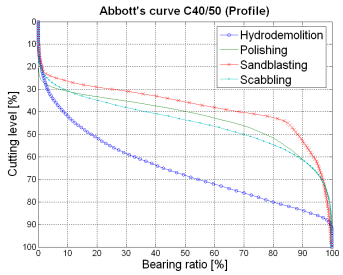
Scarification



Polishing

(Schwall D., Mst thesis, 2008)

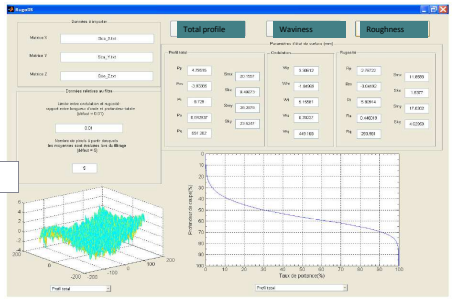
Topography evaluation : descriptive parameters



Courard L., Garbacz A., Piotrowski T. (2008) Challenges for civil construction,CCC08, Porto

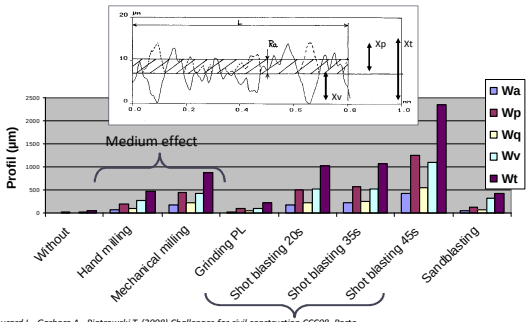
Topography evaluation : calculation software

RugoDS



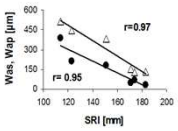
(Schwall D., Mst thesis, 2008)

Surfology: surface preparation techniques

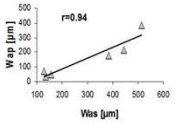


Courard L., Garbacz A., Piotrowski T. (2008) Challenges for civil construction,CCC08, Porto

Topography: comparison



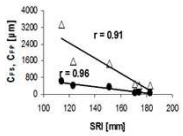
Surface Rough Index vs arithmetic mean of waviness for mechanical (p,Δ) and laser (s,•) profilometers



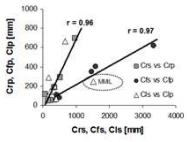
Comparison of mean waviness for mechanical (p) and laser (s) profilometers

Garbacz A., Courard L., Kostana K. (2006) Materials Characterization, 56: 281-289

Topography: comparison



Surface Rough Index vs Abbott's parameters for mechanical (p,Δ) and laser (s,•) profilometers



Abbott's parameters for mechanical (p,Δ) and laser (s,•) profilometers

Garbacz A., Courard L., Kostana K. (2006) Materials Characterization, 56: 281-289

Topography evaluation : conclusions

CSP is not really accurate for concrete surface preparation techniques (water-jetting, jack hammering, …)

the geometrical parameters determined for both macroscopic level (SRI value) and microscopic level (RS, RL ratios and waviness parameters) generally indicate that a higher roughness was obtained after shot blasting for 45s and a lower roughness by grinding,

there is a quite good correlation between SRI and statistical parameters measured by mechanical (optical) and laser profilometry,

mean waviness or Abbott's parameters are the most appropriated parameters for roughness (waviness) evaluation.

… we are working on extending applicability of CSP (higher roughness)

Acknowledgements

Thanks for your attention…

… and to my co-authors who allowed me to come to Cape Town!