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Review

Multi-scale metrology of concrete surface morphology: Fundamentals and specificity

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HIGHLIGHTS

- Fundamentals of metrology of concrete surface morphology were presented.
- Fundamental scales of metrology of concrete morphology were elucidated.
- Epistemology, etymological and the semantic context were discussed.
- Fundamental approaches to concrete 3D morphology measurement were proposed.
- The selection of the most relevant 3D roughness parameters is an key open problem.

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ABSTRACT

Nowadays the interest in esthetical and functional aspects of concrete surfaces has considerably increased. To reach a desired functionality and level of durability of constructed and existing concrete structures, proper and improved descriptors of physical-chemical and morphological states are needed. The proper generation, treatment and characteristics of concrete surface are an important stages in building and renovation of architectural structures. Moreover, due to the complexity of heterogeneous concrete materials, the multi-scale and multi-physics approaches are discussed. The needs of specific algorithms and methods useful for the measurement and characterization of a heterogeneous concrete surface, and therefore its complexity, is demonstrated.

Contents

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Nomenclature

A	Binary image
B	Structuring element
B_o	Board
B_z	Translation of B by the vector z
D	Portion [%]
D_{max}	Maximum grain size of the aggregate [m]
E	Origin
E_o	Substrate space
F	Aggregate

Abbreviations

DMD	Discrete Modal Decomposition
GF	Gaussian Filtering
NSL	Near-to-surface layer
PSD	Power Spectral Density
WT	Wavelet Transform

1. Introduction and motivations

In the last 50 years the interest in esthetical as well as functional aspects of concrete surfaces has considerably increased [1]. This is essentially due to the diversification of the process which offers an increased aid value. The deterioration of concrete structures and the performance of interfaces with various types of concrete are major problems facing the civil engineering industry. To reach a desired functionality and durability of planned and existing concrete structures, proper and improved descriptors of physical-chemical and morphological states are needed. The proper treatment of the surface of concrete, and therefore its characteristics, is an important stage in the construction and renovation of architectural structures.

Recent technological progress in civil engineering and diversified worldwide requirements have contributed to the development of the new science surfometry concerning morphological quantitative metrology of concrete surfaces. It is not only due to an increasing interest of sensor analysis and a good looking impression of concrete, but also thanks to a growing quality of coatings and of its adhesion quantification which also depends on roughness. Concrete surface morphology plays an important role in most classical phenomena and physical phenomena such as electrical and thermal conductivities, adhesion, wetting etc. Committed funds in the progress of knowledge and mastery of these phenomena are colossal. How to reduce abrasion and friction? How to increase adhesion and reduce wear for road tyre contact? How to improve the adhesion of coatings and paintings? How to improve adhesion between gravels and the cement matrix? These are questions that are in the general theme of the topic considered here. Moreover, due to the complexity of heterogeneous concrete, materials and their multi-scale approaches have to be discussed. It is evident that concrete morphology measurements are an open problem and specific methods to rapidly measure a wide area of the surface of

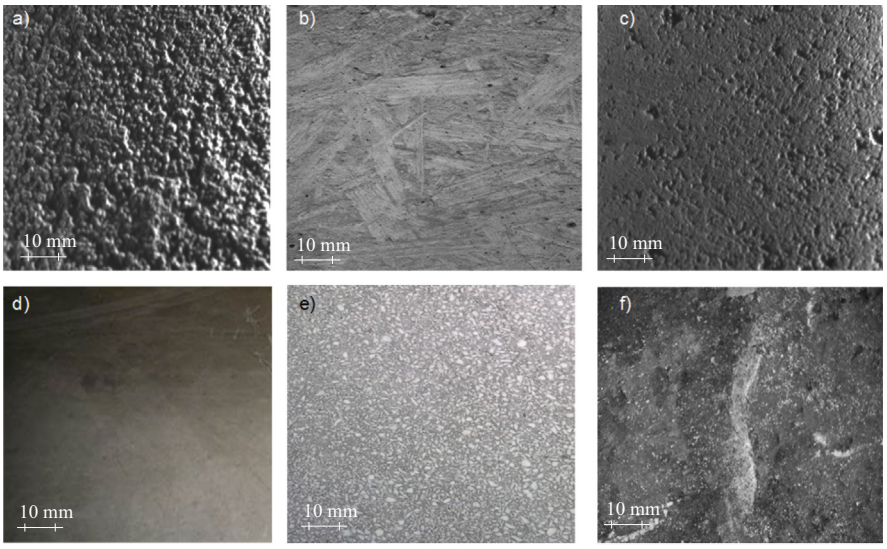

Fig. 1. Black and white optical view of concrete surfaces: a) as cast, b) raw concrete formwork, c) ground, d) architectural, e) polished, f) aged concrete.