

Towards air-purifying and self-cleaning concretes

Anibal Maury Ramirez

Supervisor(s): Nele De Belie, Kristof Demeestere

I. INTRODUCTION

Environmental pollution on a global scale has drawn attention to the vital need for new environmentally friendly technologies and processes. In this context, the implementation of heterogeneous photocatalysis in the building industry offers promising potential. Indeed, by adding titanium dioxide (TiO_2) to cementitious materials air-purifying and self-cleaning properties (including antimicrobial properties) have been obtained. TiO_2 contained in cementitious materials is a photocatalyst material that when exposed to UV light can produce different oxidizing/reducing compounds (e.g. $\cdot\text{OH}$ and $\text{O}_2^{\cdot-}$) which have been able to degrade almost all kind of organic compounds (e.g. VOC's) and also some other inorganic ones (e.g. NO_x).

Even when the application of TiO_2 properties on cementitious materials has been studied since some years ago, not many practical applications have been developed. In order to make this technology feasible, more efforts have to be made to reduce the amount of TiO_2 used to load the cementitious materials. Thus, TiO_2 coatings on cementitious materials which allow efficient and autonomic air-purifying and cleaning processes on the surface of concrete are studied in this doctoral research. Air-purifying and self-cleaning properties obtained at laboratory scale using two TiO_2 coating methodologies applied on autoclaved aerated concrete samples are under evaluation.

II. AIR-PURIFYING PROPERTIES

For evaluating the air purifying properties of TiO_2 coated cementitious materials, a set of four concretes (AAC, CB, CW and CS) was enriched with TiO_2 photocatalyst by a dip-coating method [1].

The air purification potential of coated TiO_2 enriched concrete samples was investigated on lab-scale using a rectangular plexiglass flat-plate photoreactor which was operated in a flow-through mode with toluene as pollutant model. See Figure 1.



Fig. 1 Flat-plate photoreactor

By measuring and comparing toluene concentrations at the inlet and outlet of the reactor during UV-irradiation, high removal efficiencies were found on dip-coated samples. Removal efficiencies up to 86% were found on autoclaved aerated concrete samples (AAC). See complete results in reference [2].

III. SELF-CLEANING PROPERTIES

Under certain environmental conditions, autoclaved aerated concrete has evidenced serious problems due to the easy growth of micro-organisms such as algae. In order to prevent this situation, traditional preventive practices such as water repellents and biocide

A. Maury works at the Structural Engineering Department, Ghent University, Ghent, Belgium. E-mail: anibal.mauryramirez@ugent.be

agents have been studied. Nevertheless, these efforts have not led to a complete elimination of the problem [3].

Based on the evidence that TiO_2 decomposes organic compounds belonging to the cell wall of living micro-organisms such as algae (*Cladophora*) and the promising results obtained with porous lavas (pumice stones) as supports for TiO_2 in water treatments, experiments to evaluate the algicidal activity of titanium dioxide on autoclaved aerated concrete samples have been executed using a recently developed equipment for accelerated algae growth tests on cementitious materials [3].

Considering the weathering conditions for the samples during this test, an alternative coating method based on vacuum saturation was used. As the problems of aesthetics on autoclaved aerated concrete are related to the proportion of the area covered with algae and to the intensity of coloring, the degree of fouling was evaluated by means of visual inspection, colorimetric and image analyses. After five weeks and in relation to reference samples (without TiO_2), TiO_2 coated samples evidenced partial photodegradation of algae species (*Chlorella vulgaris*). See Figure 2 to visualize the algacide activity. More details at reference [4]

IV. CONCLUSIONS

The air purifying properties described here might be of particular interest for air purification in confined spaces such as canyon streets in densely populated cities where relatively high pollution levels occur because of vehicles exhaust and/or industrial sources. Also, algicidal properties of the TiO_2 coating presented here provide the potential to decrease the number of cleaning activities on building facades during service life, particularly in Europe where algae has been identified as one of the most common micro-organism types formed on the exterior of buildings.

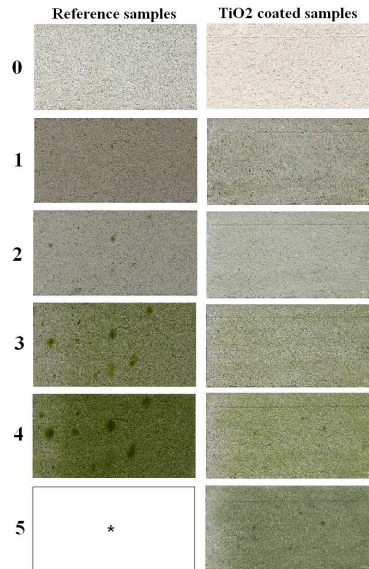


Figure 2. Results from accelerated algae growth test on autoclaved aerated concrete.

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