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TiO_2 Photocatalysis in Cementitious Systems

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ABSTRACT

Concretes with self cleaning and depolluting abilities provides a better insight into preserving the building's exterior from the environmental exposure which can cause darkening of the surfaces. The high photocatalytic activity of TiO_2 photocatalyst serves the purpose into cementitious materials. TiO_2 modified buildings would be a suitable proposal for maintaining aesthetic durability. The present work aims, to enhance the aesthetic durability in the cementitious systems by loading TiO_2 into the cement. Cement samples were tested according to the Rhodamine B(RhB) standard discoloration test under UV light. Experimental results confirmed the degradation of the dye upto 60% for 3% TiO_2 in the cement sample tested for 8 hrs under UV light exposure.

KEYWORDS

TiO_2, Photocatalyst, Cement, Rhodamine B(RhB).

INTRODUCTION

The outdoor air quality is constantly getting degraded by the harmful compounds and gases that are being released by the automobiles causing damage to the aesthetical durability of the cementitious materials i.e. buildings. TiO_2, a photocatalyst, has served the purpose into the concrete thereby forming a photocatalytic surface. Applications of TiO_2 into cemented materials has started itself from 1980s. Photocatalytic surface can be prepared in either of the two ways: (i) by directly mixing TiO_2 powder into the raw cement, (ii) by coating a layer of TiO_2 over the cementitious materials. Thus, an incorporation of TiO_2 into the concretes leads to the development of self cleaning cement.

EXPERIMENTAL

Two samples were prepared by adding TiO_2 nanoparticles (Aeroxide P25) with the white cement and water (water/cement=0.4) to produce a cement paste. TiO_2 nanoparticles were incorporated into the samples as 0% and 3% (by mass) of the cement. After curing of one day at room temperature, samples were cut into the slabs of area 1 inch^2 and were coated with Rhodamine B (RhB), a red dye. Samples were irradiated with TL40W/10 R (Phillips) UVA lamp (λ_{max}=365nm). Discoloration of RhB (λ_{max} at 554 nm) on the surface of the cement slabs was measured using UV-visible spectrophotometer UV 2600 (Shimadzu) at fixed interval of 4h for total 8h.

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RESULTS

The prepared cement slabs were used to degrade RhB using UV light for evaluating its degradation efficiency and self-cleaning characterstics. Table 1 shows the absorbance values recorded by the UV-visible spectrophotometer at the intervals of 4h.

Table 1: percentage decrease in absorbance values of the cement samples

Sample	Absorbance (at different time intervals)			Percentage (%) degradation
	t=0h	t=4h	t=8h	
Cement	0.305	0.300	0.287	5.90
Cement +3% TiO_2	0.336	0.254	0.141	58.04

Fig. 1 shows the degradation curve for the prepared cement slabs. The graph is plotted between the absorbance and time intervals for both the samples (i) Cement (ii) Cement+3% TiO_2 showing the reduction in the colour of the coated Rhodamine B dye over the samples. This is indicated by the reduction in the absorbance values with the increasing time. It can be seen clearly from the graph that after 8h exposure of samples under UV light, cement slab containing 3% TiO_2 showed a significant decrease in the absorbance values from 0.336 (at time t=0h) to 0.141(at time t=8h), i.e. it showed of approximately 60% degradation while the cement sample containing no TiO_2 just showed a degradation of approximately 6% under UV light exposure.

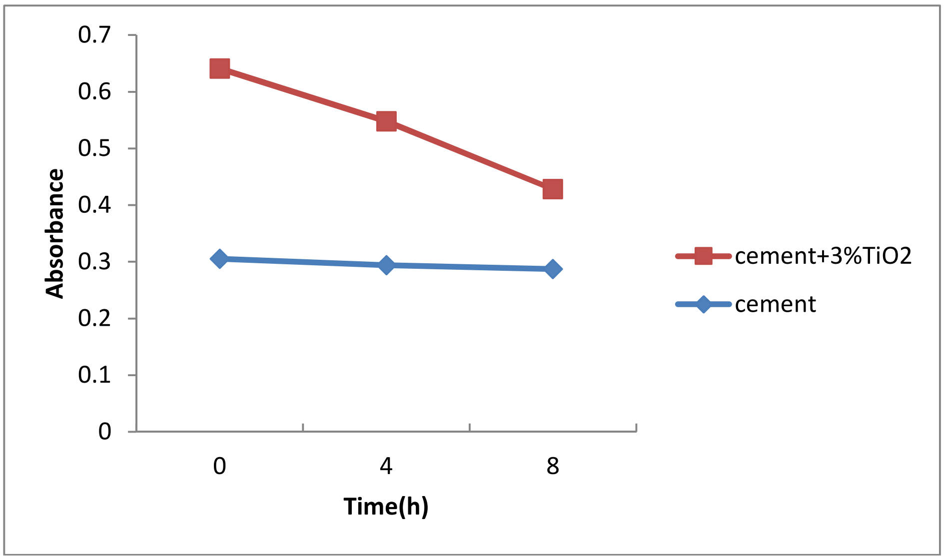

Fig. 1 : Degradation curve showing reduction in the absorbance values of both the samples with respect to time.

CONCLUSION

This paper confirmed the self cleaning ability of the TiO_2 containing cement slab as it showed the reduction in the colour of the coated Rhodamine B on the cement slab got reduced upto 60% under the exposure of UV light for 8h. It is expected when cement sample containing TiO_2 is exposed to the UV light then there is the formation of electron and hole pairs. Positive hole breaks down the water molecule into H_2 and hydroxyl radical; and electron forms superoxide anion by reacting with oxygen. These OH and superoxide anion breaks the dirt (which causes darkening of the surfaces, i.e., VOCs, inorganic compounds etc) apart on the walls into harmless compounds which can be washed away with rainfall keeping the exterior of the building clean thereby imparting self cleaning property to the surface. The much higher degradation (approximately 80%) is expected for the long intervals of exposure of samples under UV irradiation.

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