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Technical Report: 20RE00005

10.02.2020

Object: Evaluation of photocatalytic abatement index on concrete samples from:
WIGMET S.C.

Job: **2200682**

The concerned sample was characterized by measuring the photocatalytic activity in continuous gas flow, according to UNI 11247, at the Italcementi i.lab in Bergamo, Italy. The principle consists in measuring the photocatalytic abatement of nitrogen oxide NO_x, defined as the molar sum of NO + NO₂, on inorganic materials dispersed in cement-based matrices using an analytical method based on chemiluminescence.

Continuous Gas Flow Test according to UNI 11247

Photoactivity tests are performed on air to which NO_x (NO+NO₂) is added to simulate a plausible degree of air pollution.

The NO_x content is set to (0.55 ± 0.10) ppm, of which (0.40 ± 0.05) ppm is NO and (0.15 ± 0.05) ppm is NO₂.

The specimens are placed in a photochemical reactor consisting of:

1. Borosilicate glass reactor, with a total volume of $3 \text{ l} \pm 20\%$. The gas flow (NO_x+Air) during the test is set to $1.5 \text{ l/min} \pm 5\%$; temperature and humidity inside the reactor are continuously registered.
2. UV lamp, that has a UV ($\lambda < 400 \text{ nm}$) in-band irradiance spectrum. The irradiation system shall provide for an average irradiance (in UV-A band) of $20 \pm 1 \text{ W/m}^2$ on the specimen during the test.
3. NO/NO₂ Analyser calibrated in compliance with UNI EN ISO 9169.

The specimen to be analysed shall have a geometrical surface area of $(64 \pm 6) \text{ cm}^2$ ($\pm 10\%$) and be representative of the cast-in-place product. The geometrical surface area exposed to the gas flow can be square, rectangular or circular.

The procedure involves the following measurement stages:

1. Measurement of the initial concentration of nitrogen oxides before entering the photochemical reactor (C_A). The gas flow is conveyed to the analyser across the path which excludes the reactor. The concentration value must be measured after the flow has remained constant for at least 10 min.
2. Measurement of the concentration at the exit of the photochemical reactor in the dark (C_B). This is determined by conveying the gas flow across the reaction chamber kept in the dark. The C_B value will correspond to the constant concentration value for at least 10 min.
3. Measurement of the concentration at the exit of the photochemical reactor under light (C_L). This is determined by conveying the gas flow across the reaction chamber under UV irradiation. The test shall be considered complete when the NO_x values have stabilized and, in any case, at least 30 min after the lamp has been switched on. The value of C_L will correspond to the value measured at the end of the test.

The determination of the photocatalytic abatement index A_C , as formulated in (1), incorporates corrections for average irradiance I and the specimen's surface area S .

$$A_c = 100 \times \frac{(C_B - C_L)}{C_B} \times \frac{I_N}{I} \times \frac{S_N}{S} \quad (1)$$

Where:

- A_c Adimensional abatement index under test conditions (in percentage)
 C_B NO_x concentration at the reactor's exit in the dark (in parts per billion)
 C_L NO_x concentration at the reactor's exit under radiation (in parts per billion)
 I Average irradiance as measured and possibly corrected (in Watts per square metre)
 I_N Nominal irradiance (20 W m^{-2})
 S Surface area of the specimen as measured (in square centimetres)
 S_N Nominal surface area of the specimen (64 cm^2)

NOTE: The adimensional index of photocatalytic abatement refers only to the test conditions reported in this standard for making comparisons among the activities of the various products and does not constitute a physical measurement of the photocatalytic activity that can be used to forecast or estimate the absolute NO_x abatement effect of a cast-in-place product.

Materials preparation

We received three concrete samples of the same batch ($200 \times 100 \times 20 \text{ mm}$) made with photocatalytic cement (TioCem CEM II/A-S 42,5 R) and labelled: "TX/19/15". The samples were cut to obtain smaller segments with dimensions suitable for testing; two specimens $80 \times 80 \times 20 \text{ mm}$ were obtained from two different pieces of concrete (Fig.1). After cutting, the specimens were dried at $(55 \pm 5)^\circ\text{C}$ for 2 days. Before the measurement of photocatalytic abatement index, all the specimens were maintained for at least 3 days at laboratory condition at a temperature of $(23 \pm 5)^\circ\text{C}$ and $(60 \pm 10)\%$ of Relative Humidity and then cleaned for at least (17 ± 1) hours under UV irradiation $(10 \pm 1) \text{ W m}^{-2}$.



Fig.1 Specimens

Results and comments

The result, expressed as an average of the NO_x abatement index (A_c), is shown in the table below.

Sample	Producer	Description	Production date	NO _x Abatement index (A_c)	
				Average	Δx
TX/19/15	WIMET S.C.	Concrete with top layer based of TioCem CEM III/A-S 42,5 R (tx) from Leimen	11.10.2019	27.9	± 0.6

According to the abatement index values, the sample can be considered "active" photocatalytic cementitious material.

Certificate attached n° 20RP00105 (07/02/2020)

Piero Negro



Rapporto di prova n°: **20RP00105** del **07/02/2020**

Dati relativi al campione

Codice campione: **19RS00377**
Natura e origine del campione: **Manufatto (RS)**
Gorzdze Cement S.A.
Facade panels based of TioCem
No : TX/19/15
Producer: WIMET S.C.
Production Plant: os. Kazimierza Wielkiego 9,56-200 Gora
Production date 11.10.2019
Cement TiOCem CEMII/A-S 42,4R (tx) from Leimen

Materiale: **MANUFATTO**
Data accettazione: **05/12/2019**
Data inizio prove: **05/12/2019**
Richiedente: **i.lab - Innovation Laboratories**
Via Stezzano 87 24126 Bergamo (BG)

Dati relativi al campionamento

Modalità: **a cura e responsabilità del cliente**

Note:

Firmato digitalmente da:
Il Responsabile dei Laboratori di Innovazione
Ing. Massimo Borsa

Il Direttore della Direzione Innovazione di Prodotto Globale
Dr. Enrico Borgarello

Il presente rapporto riguarda il campione sottoposto a prova ed inoltre non può essere riprodotto in forma parziale senza l'approvazione scritta del laboratorio.

Le incertezze estese di misura (U) dichiarate in questo documento sono espresse utilizzando un fattore di copertura k (corrispondente ad un livello di fiducia di circa il 95%) calcolato secondo il numero di gradi di libertà effettivi (nel caso di distribuzione normale, $k = 2$).

I valori delle determinazioni inferiori all'incertezza associata U , sono puramente indicativi.

Le procedure di prova eventualmente citate possono essere richieste.

segue Rapporto di prova n°: **20RP00105** del **07/02/2020**

Campione: **19RS00377**

Risultati analitici

Parametro	U.M.	Risultato
<i>Metodo</i>		
Fotocatalisi metodo continuo		
Tipo e numero di serie analizzatore <i>UNI 11247:2010</i>		AC32M 755
Volume del reattore <i>UNI 11247:2010</i>	l	3
Flusso del gas <i>UNI 11247:2010</i>	l/min	1,50
Tipo di lampada <i>UNI 11247:2010</i>		Osram ULTRA VITALUX UV
Temperatura del gas di miscela <i>UNI 11247:2010</i>		27
Umidità relativa del gas di miscela <i>UNI 11247:2010</i>		4
Superficie del campione <i>UNI 11247:2010</i>	cm ²	64
Concentrazione iniziale NO <i>UNI 11247:2010</i>	ppbv	403
Concentrazione iniziale NO ₂ <i>UNI 11247:2010</i>	ppbv	147
Abbattimento fotocatalitico in flusso continuo		
Provino 1: indice di abbattimento adimensionale (Ac) <i>UNI 11247:2010</i>	%	29
Provino 2: indice di abbattimento adimensionale (Ac) <i>UNI 11247:2010</i>	%	27
Indice medio di abbattimento adimensionale (Ac) <i>UNI 11247:2010</i>	%	28
Durata di illuminazione <i>UNI 11247:2010</i>	min	30

File firmato digitalmente.