
TX®
Active
by Italcementi

The active photocatalytic principle

Photocatalysis: the power of light

Photocatalysis is a natural phenomenon whereby a substance known as a photocatalyst uses light to alter the rate of a chemical reaction.

Using the light energy, photocatalysts can induce the formation of strong oxidizing reagents which decompose some organic and inorganic substances in the atmosphere.

Photocatalysis is therefore an accelerator of oxidation processes that already exist in nature. It promotes faster decomposition of pollutants and prevents them from accumulating.

Photocatalysis has been applied for over a decade to various materials - among which cementitious binders - to obtain a "self cleaning" and now an "anti-polluting" effect.

Ever increasing air pollution affecting urban areas has recently urged researchers to take advantage of photocatalytic properties to abate the noxious substances that are contaminating the atmosphere. Therefore, photocatalysis effectively contributes to better quality of life. Italcementi was the first industrial group to patent photocatalytic cementitious materials.

Photocatalysis in urban areas

(1) CO, VOC (Benzene, Toluene, etc.), Methyl Mercaptan(gas), Organic chlorinated compounds, Polycondensed aromatic compounds, Acetaldehyde, Formaldehyde.
(2) NO_x, SO_x, NH_3 (gas)

Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

The active photocatalytic principle

Scientific results: laboratory test

Effectiveness of TX Active® in abating polluting substances
Laboratory tests

Italcementi carried out a number of laboratory experiments aimed at assessing the pollution-preventing properties of TX Active® elements. Innovative equipment and testing methods were adopted to this end.

Nitrogen oxides

Effectiveness against nitrogen oxides (NOx) is assessed in a chamber of known volume into which NOx is first blown and then diluted with air to achieve a preset concentration of pollutant. The chamber contains a UV lamp - the light source - and a test specimen - smoothly finished and of known surface area - made with TX Active® cement. Externally to the test chamber, there are an NO_2 analyzer and a chemiluminescence analyzer. These instruments have been used to carry out a number of tests at a specified light intensity: the pollutant concentration is measured both before and after the photocatalytic reaction. Tests recorded NO_x abatement rates of up to 91%. Italcementi's test results have been confirmed also through the experimental procedures set up by the University of Ferrara, the ISPRA's research center and CNR's ITC, the Institute of Construction Technologies, in Italy.

PM10 (Particulate matter < 10 microns in diameter)

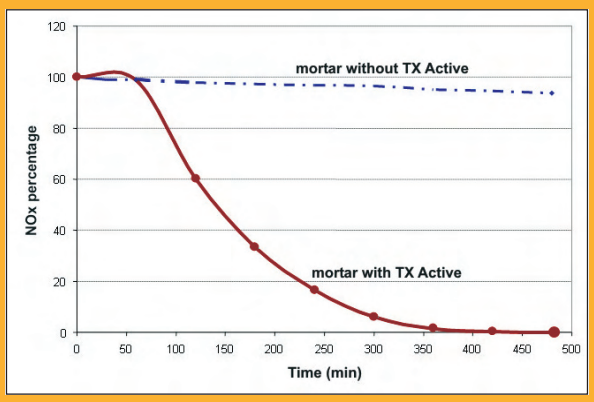
Other tests carried out at the University of Rome confirmed the effectiveness of TX Active® in abating PM10. When PM10 particles come into contact with the built element's surface, the portion of organic pollutant is decomposed.

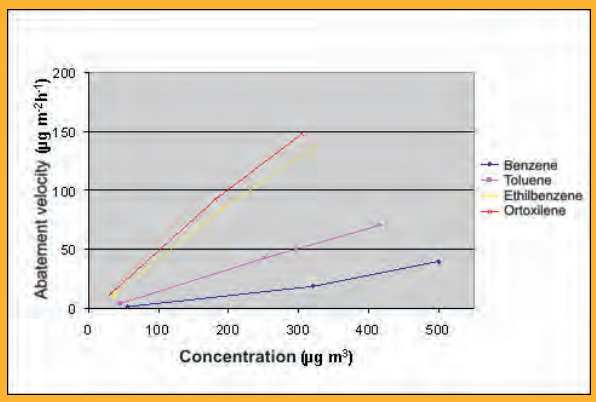
VOCs (Volatile Organic Carbons)

Laboratory tests conducted by CRN ITC have demonstrated that TX Active® cements are also effective against VOCs – Volatile Organic Carbons.

The chart illustrates the NO_x photo-degradation activity carried out by TX Active®. The red curve indicates a H" 99.5% abatement of NO_x after a 400-minutes' treatment in a special 35-m^3 chamber (Indoortron facility).

Source: PICADA Project





Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

The active photocatalytic principle

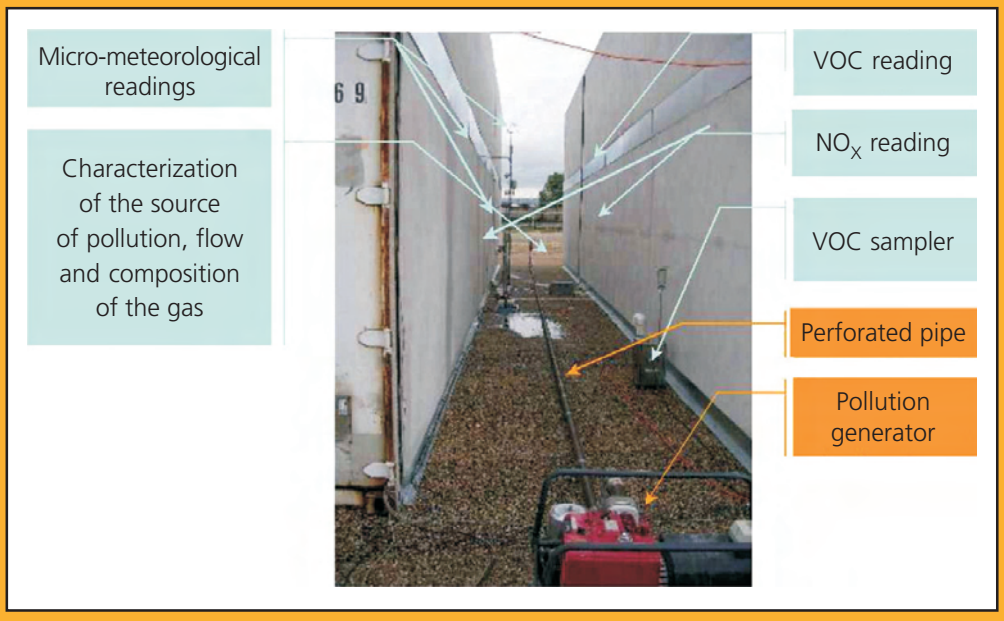
Scientific results: the Guerville tests

Pilot site in Guerville, France

In 2004, a "Street Canyon" pilot site was constructed at the Group Technical Center's labs in Guerville, France.

The site was built within the framework of the *PICADA Project (Photo-catalytic Innovative Coverings Applications for De-pollution Assessment)*, an EU project involving European research institutions and private undertakings, among which Italcementi.
Tests were aimed at assessing the effectiveness of photocatalytic properties on a model reproducing the environmental conditions of a street located between two condos in a generic urban context.

Two alleys were reproduced, each being 18 m long, 2.44 m wide and 5.18 m high. Both walls in the alleys were plastered - one with TX Active® cement-based plaster and the other with a traditional cementitious binder-based product.
To simulate the polluting conditions generated by urban traffic, a perforated pipe from which exhaust gases would be emitted was laid along the entire length of the walls. The exhaust gases were produced by an internal combustion engine connected to the pipe.



Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

Monitoring

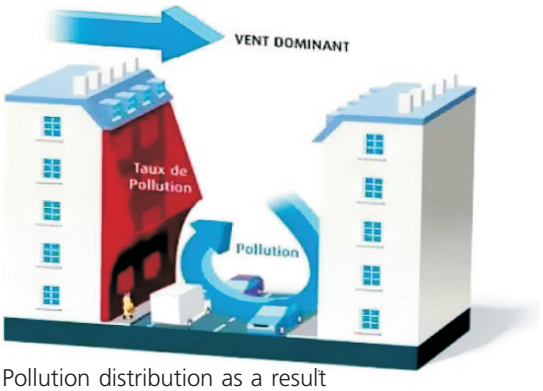
Sensors were placed at different heights and regular intervals to measure humidity, temperature, and solar irradiation. Anemometers were also installed to measure wind velocity and direction. In addition, NOx and VOC analyzers were installed at the both upper and side ends. The speed, temperature and composition of the exhaust gases were also monitored and measured.

The mathematical model

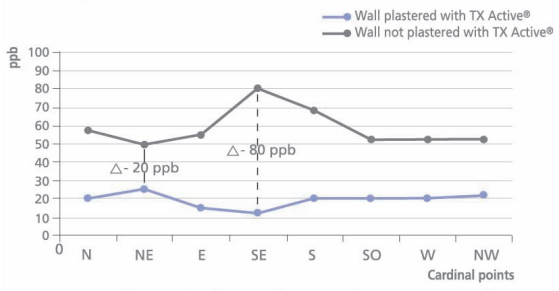
A three-dimensional calculation model was used to reproduce air and particulate matter flows under different atmospheric conditions. Particulate dispersion was reproduced analytically using numeric simulation, which took into consideration both the inclination of the surfaces compared to the air flows and the effect of solar irradiation.

The results

Results proved highly interesting. Compared to an untreated wall surface, the street canyon onto which TX Active® plaster had been applied recorded a particulate abatement rate ranging between 20 and 80% depending on wind conditions. Desoiling of TX Active® walls is linked to important variables that depend on particulate matter concentration, weather conditions and solar irradiation.



Pollution distribution as a result of the joint wind/traffic action



Experimental results from the Picada Project's pilot site

Italcementi
Italcementi Group

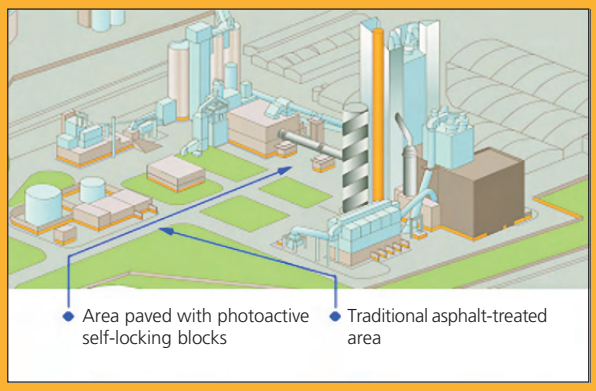
Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

The active photocatalytic principle

Scientific results: the Calusco d'Adda test

Self-locking block pavement at an industrial site
Calusco d'Adda - Bergamo

Another test aimed at assessing the efficiency and effectiveness of horizontal surfaces made of photoactive binders in terms of atmospheric NO_X abatement was carried out in March 2003. The tests involved 8,000 m^2 of self-locking cement-based blocks laid down on a portion of the yard of one of Italcementi's cement manufacturing plants.

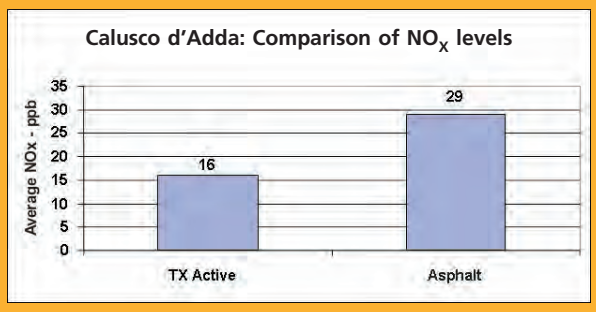


The experiment

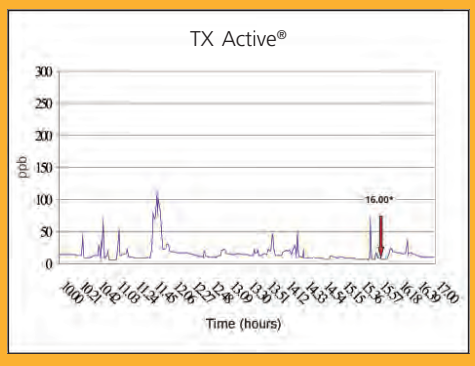
The NO_X analyzers were placed in the central section of the photocatalytic pavement and, for comparative purposes, also 80 m apart in an area treated with traditional asphalt (reference area).

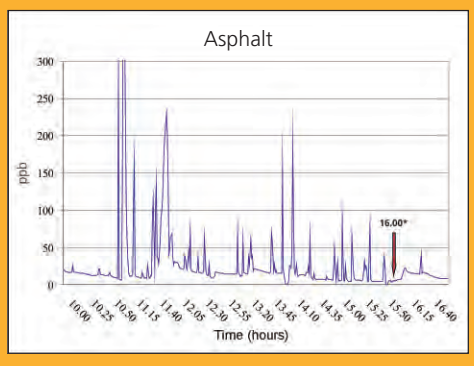
The results

NOx was measured simultaneously using the two analyzers, as is shown in the graph on the right.
As is apparent, the concentration of NOx in the area paved with photocatalytic blocks is remarkably lower than in the reference area. The NO_X abatement rate, calculated on the basis of average results recorded, was found to be 45%.



Experimental test





**For the purpose of appraising the reproducibility and reliability of the testing instrumentation, at 4.00 p.m. both analyzers were placed in the area paved with photoactive blocks with data being acquired for about an hour.*

Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

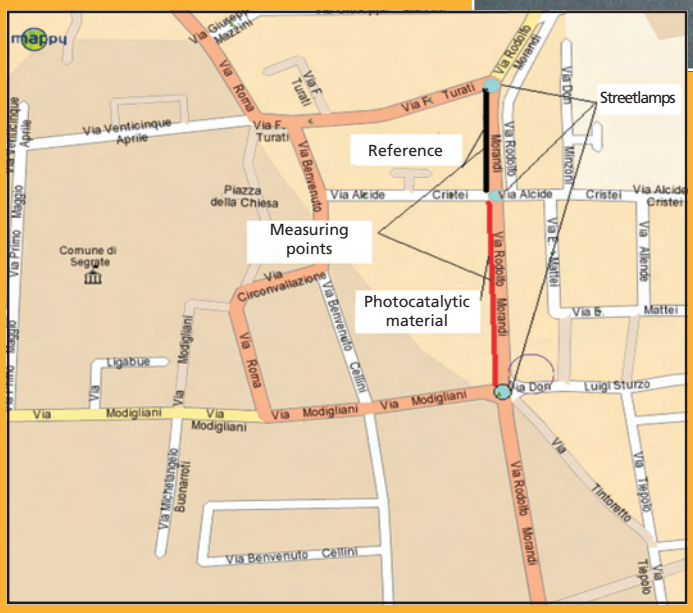
The active photocatalytic principle

Scientific results: the Segrate test

Road surfacing experiment
Segrate, Milan

The experiment started in November 2002 in Segrate, Milan, was aimed at investigating the effectiveness of photocatalytic binders in abating environmental NO_X on horizontal structures.
Segrate's municipal authorities had identified Morandi Street as a suitable site for the testing campaign.

Morandi Street is a heavily trafficked two-way road (over 1,000 vehicles/ hour) connecting the main road SS11 Cassanese with the provincial road SP Nuova Rivoltana.



The characteristics of Morandi Street are constant along the entire section involved in the test: the road is approximately 10 m wide with room for parking at the sides; residential blocks are situated to the east and west at a distance of 7 to 10 meters from the edge of the road, providing as much as 30 meters' continuity between one block and another. The various buildings are separated by railings which do not prevent air from circulating freely and the sidewalks are lined with trees.

Italcementi
Italcementi Group

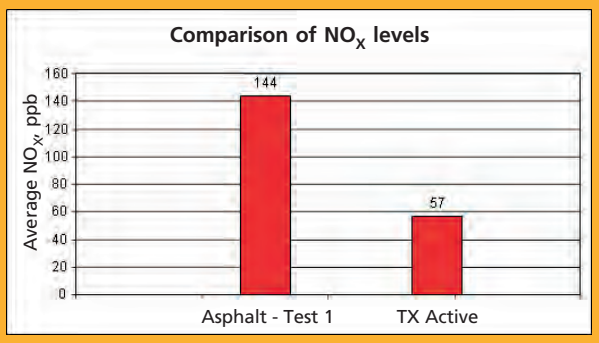
Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

The experiment
A thin layer of photoactive TX Active® binder-based mortar was applied to a 230 m-long section of bituminous road surface totaling about 7,000 m^2.

The continuation of Via Morandi to the north, featuring a traditional asphalt-treated pavement, was used as a reference for the experiment.

This experiment can be considered the first and most remarkable field experiment ever made in the world for assessing photocatalytic cementitious materials.

To evaluate the influence of the environmental conditions, several test campaigns were performed November 2002 through July 2003.



Based on recorded data, up to 60% NOx abatement was achieved compared to the untreated area, depending on luminous intensity, traffic volume, as well as wind speed and direction. The best results were obtained in summer with an average luminous intensity of about 90,000 Lux, a wind speed of approximately 0.7 m/s, an ambient temperature of 32°C, and 46% humidity.

Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it

The active photocatalytic principle

Scientific results: the Milan test

Tunnel experiment
Porpora Street - Milan

The experimental activity associated with the rehabilitation scheme devised for the tunnel crossing under the railway in Porpora Street, Milan, entailed the application of photocatalytic materials. To this end, Italcementi cast in place a patented high-performance concrete road pavement for the tunnel, while a different manufacturing firm treated the tunnel roof with a non-cementitious photocatalytic paint.
This 104-m- long, 7-m-wide tunnel is situated near the Milano Lambrate rail station and connects Porpora Street to Monte Titano Square. The traffic volume affecting this two-way road tunnel, which runs along the main road connecting downtown Milan to Tangenziale Est (Eastern Ring Road), can be as high as 30,000 vehicles per day.

Traffic-related measurements performed by the *Agenzia Mobilità e Ambiente* with the support of the Milan Police force clearly highlighted the high level of stress to which this road is exposed. Measurements and data processing campaigns conducted by Milan's Provincial Department of Arpa Lombardia – the Regional Agency for Environmental Protection – evidenced a 22.7% reduction compared to the usual NOx concentration recorded inside the tunnel under the worst conditions of light exposure for the product.

(Source: Comune di Milano, Experimental TiO_2 campaign, July 2004, Final report, in co-operation with Police Force and ARPA, Dipartimento di Milano Città)

Italcementi
Italcementi Group

Via Camozzi, 124
24121 Bergamo, Italia
www.italcementi.it