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Smog: A Nice, Light Snack?
Photocatalytic Concrete Field Trials along Ontario's Freeways

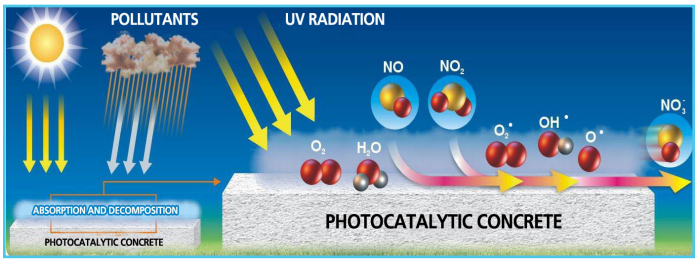
Air pollution is a major global issue affecting our social, economic, and environmental sustainability. The Ontario Ministry of Transportation (MTO) is partnering with the Ministry of Environment, the University of Toronto, Armtec (a noise barrier manufacturer), and Essroc Italcementi Group (the North American division of an international supplier of photocatalytic cement) to conduct photocatalytic concrete field trials. A new "smog-eating" technology, photocatalytic concrete will be applied to a section of noise barriers along Highway 401, near the Highway 404 Interchange in Toronto, starting in the summer of 2011.

Photocatalytic concrete is an emerging green technology which incorporates titanium dioxide particles into Portland cement used to make concrete. Studies have shown that photocatalytic concrete can significantly reduce air pollution and keep concrete surfaces clean. When activated by ultra-violet rays from sunlight, titanium dioxide acts as a catalyst to accelerate the oxidation process that converts nitrogen oxides and other smog components such as fine particulate material, carbon monoxide and sulphur dioxide, to less harmful compounds. Photocatalytic concrete has the potential to significantly reduce smog-forming air pollutants in its vicinity, thus acquiring the moniker "smog-eating concrete".

Italcementi, an international cement producer, has been the industry leader in research and development of photocatalytic cement over the last decade. This technology is being examined by industry and researchers around the world in European, Asian, and North American countries. Positive test results have been generally consistent among industry and researchers. PICADA, a European consortium of manufacturers and research laboratories, has also confirmed industry claims. Prominent technical conferences and workshops have been held, such as the Rilem Symposium on Photocatalysis, Environment, and Construction Materials (Italy, October 2007), and a workshop on Passive Photocatalytic Oxidation of Air Pollution, held at the Lawrence Berkeley National Laboratory (California, June 2007).

Over the last decade, several successful demonstration projects have been completed that involved the application of photocatalytic concrete to the surfaces of buildings, roads, tunnels, and noise barriers. Results show air pollutant improvement ranging from 20 to 70 percent in the vicinity of photocatalytic concrete, depending on sunlight, wind, and other factors. Project costs are minimized since only a thin surface layer of photocatalytic concrete is placed over a conventional concrete base.

Results reported from European trials suggest photocatalytic concrete placed in an area the size of a soccer field can remove emissions equivalent to approximately 190,000 car-km per year. Testing indicates that 1 square metre of photocatalytic concrete removes up to 60 mg of NOx per day. Demonstration projects show that the best pollution reduction occurs when photocatalytic concrete is used in urban areas closest to the source of pollution. The photocatalytic effect is more significant in partially confined spaces such as "canyon" streets. During the photocatalytic concrete demonstrations, the following factors made air pollution abatement more efficient:



Mechanism of decomposition of air pollutants, in presence of photocatalytic cement-based surfaces.
(Image used with permission from Essroc Italcementi Group, 2011).

- Light intensity above 5 W/m2
- Temperatures above 10°C
- Less than 65 percent relative humidity
- Higher pollution concentration
- Concrete surface close to pollution source
- Wind direction blowing perpendicular to concrete's surface
- Porous surface characteristics.

In addition to reducing pollution, the photocatalytic concrete reaction has an established self-cleaning quality found to be most effective on organic stains, in dry conditions and smooth surfaces with minimum porosity. The Ministry plans to evaluate the self cleaning capabilities of the photocatalytic sound barrier Hwy 401 test site.

Through collaboration between government agencies, industry, and academia, using concrete to "clean" outdoor air could become a reality in Ontario. Many potential applications have been identified, although more project demonstrations and research are required. Certainly, the properties of photocatalytic concrete align well with the Ministry's goal of having the greenest roads in North America, but it remains to be seen whether significant benefits are accrued on site. Over the course of a year, the Ministry of Environment plans to conduct air quality monitoring at MTO's test site to confirm the smog reducing capabilities previously obtained in laboratories elsewhere. The final results of MTO's field trial will be used to determine if smog-reduction is significant enough to warrant further, large-scale applications in Ontario. ●

For more information, please contact:
Shawn Smith, P.Eng, Project Engineer, Highway Engineering, Highway Standards Branch, at (416) 235-3598 or at Shawn.Smith@ontario.ca,
OR
David Rhead, P. Eng., Senior Concrete Engineer, Material Engineering & Research Office, at (416) 235-3706 or at David.Rhead@ontario.ca,
OR
Chris Blaney, Senior Environmental Planner – Acoustics, Environmental Services Section, at (416) 235-5561 or at Chris.Blaney@ontario.ca