Press release from Jan de Beer, cell 082 456 3677:

Air-purifying concrete can reduce atmospheric pollution

The use of air-purifying concrete in both pavements and surrounding structures can play a major role in the reduction of atmospheric pollution in urban areas, says Bryan Perrie, MD of The Concrete Institute.

Perrie says air pollution is a steadily increasing problem in densely populated area and towns with the most significant pollution caused by fine particulate matter, volatile organic compounds (VOCs), and nitrous oxides.

"When nitrous oxides are present concurrently with VOCs, they lead to ozone formation and amplify the impact of the fine articulate matter. It is important to limit traffic emissions as much as possible primarily by limiting the traffic and therefore the emissions. This is where concrete pavements and concrete structures in the immediate vicinity of the pavements can assist in reducing the effect of the emissions. It is possible to achieve an air purifying effect by using titanium dioxide on the pavement and or structure's surface."

When exposed to ultra-violet light, titanium dioxide acts as a catalyst converting harmful compounds such as nitrogen monoxide and nitrogen dioxide into nitrates. These nitrates settle on the surface and are washed away by rainfall. The nitrogen dioxide which can lead to ozone formation, acid rain and the formation of the particulate matter is captured from the air. Photocatalytic materials such titanium dioxide can also capture harmful organic compounds from the air by causing it to dissociate. The titanium dioxide is added separately to the concrete mix or alternatively specially formulated cements can be used that contain nano particles of titanium dioxide.

"Various research projects have demonstrated the photocatalytic effect in the laboratory. In these tests, the conversion of nitrogen dioxide as a result of a single contact between the air and the photocatalytic material was determined: reductions of between 30 and 95% were measured. Efficiency in real-life applications will not be entirely dependent on the efficiency of the photocatalytic material itself but also on the contact quantity of air and contact time between the air and the surface, the light intensity, relative humidity, and the amount and type of pollution present in the air," Perrie explains.

He says the use of photocatalytic materials in the surface layer of a twin-layer concrete pavement or in thin concrete overlays were tested at the Porte de Vanves in Paris. Two 300 metres sections of a busy street used by 13 000 vehicles a day were repaved as follows:

- One section with conventional concrete paving;
- Another section with an experimental thin concrete overlay using cement with a photocatalytic action.

"Measurements of the air quality and the surface water run-off were carried out over the course of a year and it was then found that nitrogen dioxide contamination was cut by about 20%. Research also revealed that the photocatalytic reaction took place in ordinary visible light and not only in ultra-violet light, opening the prospect of lining tunnels with air-purifying concrete tiles combined with conventional lighting," Perrie states.

As far as carbon dioxide uptake by concrete is concerned, the process is generally very slow but can be deleterious to concrete in that it can promote the corrosion of steel reinforcement. This is not a problem for concrete pavements because:

- Jointed plain concrete is not reinforced and carbonation is therefore not harmful;
- In continuously reinforced concrete, the reinforcement lies at a depth of 60mm or more depending on the design. “This is sufficient to ensure that the reinforcement zone remains untouched by the carbonation front during the lifetime of a pavement.”

Perrie says pavement concrete is of an exceptionally high quality and dense, with few pores. The carbonation depth - which is proportional to the square root of the duration of the exposure - is only likely to be 5 to 10mm after a period of 40 years. In addition, because of the superior quality of pavement concrete, the uptake of carbon dioxide by the concrete is limited. However, the concrete will still carbonate and the absorption of carbon dioxide from the atmosphere increases significantly when the concrete is demolished or crushed.

“Research from the Nordic Innovation Centre has indicated that as much as 57% of the carbon dioxide emitted due to the calcination process in the manufacture of cement will be reabsorbed by the concrete over 100 years.”

As far as hazardous leaching products are concerned, tests have shown that the leaching behaviour of pavement concrete – including both pavement-quality and lean concrete – is totally harmless to the environment. “In fact, the quantities of heavy metals leached out turned out to be lower than the quantities that occur naturally in the mineral water sold in stores,” Perrie adds.

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