TILE COUNCIL OF NORTH AMERICA, INC.
PRODUCT TESTING SERVICE
100 Clemson Research Blvd. Anderson, SC 29625 Tel (864) 646-TILE Fax (864) 646-2821

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GranitiFiandre S.p.A
Via Radici Nord, 112
42014 Castellarano RE – Italy

StonePeak Ceramics, Inc.
314 W. Superior St.,
Chicago, IL 60654 – USA

Dear Mr. Verdi,

In response to your request, TCNA has undertaken an extensive literature review on NO_x (nitrogen oxides) reduction by common trees and how this information might be plausibly compared to a typical photocatalytic tile installation. We have included for your reference the primary sources of information used to make this comparison, as well as general information on the basics of these two differing processes (abatement by trees and reduction by photocatalysis) in reducing components of NO_x.

The reactive nitrogen species, collectively referred to as NO_x, are composed of both nitric oxide (nitrogen oxide, NO) and nitrogen dioxide (NO_2). The cycling of reactive nitrogen species in the environment entails complicated processes dependent on many factors. Mitigation of NO_x by trees also entails an array of complicated processes that are highly dependent on environmental factors. Generally speaking, trees remove NO_x through dry deposition of the gas in the tree canopy from the ambient environment and also uptake of the gas into the inner leaf. The vast majority of NO_x gas removed by trees is in the form of NO_2. Photocatalysis degrades NO_x by a different mechanism. In the photocatalytic reaction, reduction of NO_x levels involves the degradation of NO by oxidation and the degradation of NO_2 through reaction with available hydroxyl radicals.

Therefore, while we cannot directly compare NO_x degradations rates of trees with photocatalytic tiles, we can make comparisons between the two processes with regard to each process's relative contribution to overall NO_x abatement.

Based on the information provided to TCNA from University of Ferrara, Italy, a surface area of 0.0064 m^2 of "ExtraWhite Active" photocatalytic tile can remove 8 µg of NO from the air per hour under the laboratory conditions tested (1000 m^2 can be calculated to remove 0.00276 pounds per hour).[1] From our review of the scientific literature, a reasonable estimate of 0.3417 pounds of NO_2 is removed by the average mature tree (62-76 cm dbh, diameter breast height) in one year.[2] The average estimate of effective daylight hours (based on 120 watts/$meter^2$) in the central regions of the U.S. is 7.1 hours per day (2591.5 hours per year). Based on these figures and without considering any additional factors, including creation and degradation of NO_2, we can calculate the amount of NO removed from the air by 1000 m^2 of "ExtraWhite Active" photocatalytic tiles is 7.14 pounds on an annual basis.

Accordingly, per the data provided and the assumptions herein, 1000 m^2 of "ExtraWhite Active" photocatalytic tiles have a relative contribution to overall NO_x reduction comparable to 20 mature trees.

Again, it should be noted that this estimate is a measure of equivalency comparing the amount of reduction in NO_x (NO + NO_2) between the two different systems, where trees contribute to ambient NO_x reduction through

the removal of NO_2 and tiles contribute to NO_x reduction through the photocatalytic process as generally represented and simplified in the below reactions.

$$2NO + O_2^- \text{ (super oxide ion)} \overset{+3e^-}{\leftrightarrows} 2NO_2$$

$$NO + {}^{\bullet}OH \text{ (hydroxyl radical)} \leftrightarrows HNO_2 + {}^{\bullet}OH \leftrightarrows NO_2 + H_2O$$

$$NO_2 + {}^{\bullet}OH \rightarrow HNO_3$$

TCNA would be pleased to work in collaboration with GranitiFiandre and StonePeak Ceramics to develop further testing to support predictive environmental modeling, to further elucidate the extent of NO_x reduction from the use of photocatalytic tiles.

References:

[1] Official laboratory test report issued by University of Ferrara, Italy, Institute for the Organic Synthesis and Photoreactivity "Report for the photocatalytic activity on ceramic materials provided by Centro Ceramico Bologna, abatement of NOx" on behalf of GranitiFiandre S.p.A. Date issued July 20, 2009. Centro Ceramico Bologna, Italy test report dated July 23, 2009.

[2] McPherson, Gregory E.; Nowak, David J.; Rowntree, Rowan A. 1994. Chicago's urban forest ecosystem: results of the Chicago Urban Forest Climate Project. United States Department of Agriculture Forest Service. General Technical Report NE-186. *Available online*: http://www.nrs.fs.fed.us/pubs/gtr/gtr_ne186.pdf

Respectfully submitted,

Claudio Bizzaglia
Directory of Laboratory Services

Jennifer J. Ariss, PhD
Research and Standards
Development Scientist