

# Photocatalytic Concrete Pavements: Laboratory Investigation of Nox Elimination By Using TiO<sub>2</sub> And Flyash

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**Abstract-** In recent years there is change in atmospheric condition. One of the major reason behind this change is air pollution which is increasing day by day. Air pollution is mainly due to rapid industrialisation and increase in vehicular transportation system. The major components of air pollution such as SO<sub>x</sub>, NO<sub>x</sub>, CO and many other gases are released due to combustion of vehicle engine. In developing country like India roadways plays a key role in transportation system. Hence to curb the effect of this transportation system on our ecosystem new ways of elimination of this pollutants shall be find out.

Hence an attempt will be made in this research to construct the pollution absorbing pavements i.e. to construct such pavements which will absorb these harmful pavements. The main aim of this research is to investigate the elimination of NO<sub>x</sub> i.e. Nitrogen Oxides by casting pavements of Cement, Flyash, Recycled Glass and Photocatalyst such as TiO<sub>2</sub>, i.e. Titanium Dioxide or Titanium (IV) oxide under varied conditions

**Keywords-** NO<sub>x</sub>, Titanium Dioxide, Photocatalyst.

## I. INTRODUCTION

In developing country such as India vehicular pollution has grown very rapidly which have many adverse effects on human health and environment. Due toxic gases such as Nitrogen oxides, Sulphur oxides and other gases released from trucks cars and other vehicles there is sudden change in atmospheric conditions. Around 40% of total emission of NO<sub>x</sub> comprising NO and NO<sub>2</sub> is only due to vehicles.

NO<sub>x</sub> are not very harmful to humans but when released from combustion engine high concentrations are often toxic. It affects the respiratory system and irritating of eyes. Even ability to resist the bacterial infection were also affected due significant concentration of Nitrogen Oxides (NO<sub>x</sub>) exposure. NO<sub>x</sub> is also responsible for acid rain, smog

formation and ozone depletion though the percentage is very low but still the threat caused due to NO<sub>x</sub> cannot be ignored. Photocatalytic concrete is recently developed technique which has ability to absorb these NO<sub>x</sub> pollutants and reduce their concentration in air. It is the mixture of titanium dioxide which act as catalyst and cement. It is used for construction of pavements in many countries. Photocatalytic concrete is patented in USA and Europe. Various researchers have used these concrete for their research purpose.

In this project an attempt is made to prepare the pavements which will absorb the pollutants specifically NO<sub>x</sub> by using Cement, Flyash, Artificial Sand and mechanically crushed glass sand and also to study the effectiveness of TiO<sub>2</sub> for elimination of NO<sub>x</sub> under varied combination of Flyash, Recycled Glass sand, Cement and Artificial sand along with fixed proportion of TiO<sub>2</sub>.

## II. MATERIALS AND METHODS

Photocatalytic mortar slabs will be casted to analyze the objective of the study. 150mm X 150mm X 25 mm size pavements will be casted. For this commercially available OPC Birla Shakti Cement 53 grade, Pozzolana Flyash C class, mechanically crushed recycled glass of size 0.002 mm size and artificially crushed sand along with Titanium Dioxide (nano-particle) of type B101 Anatase will be used. The proportion of TiO<sub>2</sub> will be kept 2% by mass of Cement and Flyash combined, also artificial crushed sand will be replaced by mechanically crushed glass in varied proportion. The Flyash will be kept in varied proportion. The table mentions the proportion of the material used. The water cement ratio will be taken 0.5. The samples will be cured for 28 days.

Table 1 Details of proportion os samples

Sample	Flyash % of weight of Cement	TiO <sub>2</sub> % of weight of Cement	Recycled Glass % of Weight of sand.
A	0	0	0
B	20	2	25
C	25	2	50

Before testing the slabs for NO absorption they will be oven dried at 60°C for 20 H. This procedure is same as mentioned in ISO 22197-1:2007(E), which governs the evaluation of NO removal by photocatalytic material.

### III. EXPERIMENTAL APPARATUS

PMMA i.e Poly Methyl Methacrylate Photo reactor(Plexi Glass) will be used as basic primary component of apparatus along with NO<sub>x</sub> test gas supply system, Mass flow controller, UV-A light source and multi gas analyser which is generally used for Pollution Under Control analysis. The setup was done as per International Standard ISO 22197-1:2007(E).

The size of reactor will be 400 mm X 400mm X 200mm. At one side provision for Inlet of gas will be done while at other end outlet of gas will be provided.

### IV. OPERATIONAL PROCEDURE

Operation of the experimental apparatus is divided into two phases: parameter setting and testing. While in the parameter setting phase, the test gas flowed through the photoreactor; however, the slab will not be irradiated by UV light. This phase is used to set airflow rate, relative humidity, and pollutant concentration and lasted for approximately 10 min. After adjusting parameters to desired values, gas flow will be maintained through the photoreactor for a period sufficient to reach steady-state conditions.

The testing period comprised two steps during which the UV light will be turned off and on and concentrations of NO and NO<sub>x</sub> will be measured. Time to complete this cycle will limited to 3 hrs and 6 hrs to minimize the possible influence of slab degeneration (e.g., due to the adsorption of reaction products) on collected data.

### V. DISCUSSION

The material such as cement, flyash, recycled glass powder, artificial sand will be tested. The alternate setup will be used for testing the gas adsorbing capacity of the specimen

pavements. Also along with lab testing field testing will be done for any one sample. TiO<sub>2</sub> of anatase type will be used.

By using TiO<sub>2</sub> and Flyash pavement can be casted and tested for its ability to adsorb the NO<sub>x</sub> present in atmosphere.

### VI. CONCLUSION

This research will be beneficial in order to find out new ways and technology to minimize the effect of the harmful toxic gases such as NO<sub>x</sub> and SO<sub>x</sub> present in the atmosphere. Also by using the eco friendly material such as Flyash and naturally available material such as TiO<sub>2</sub> another attempt can be made to minimize the cost of the construction of concrete pavements.

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