

# Use of Smog Eating Concrete in Road Construction

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## Abstract

In today's world one of the major problems is pollution. In order to reduce the pollution we need a sustainable solution. This sustainability includes socio-economical equity and environmental protection. To achieve a sustainable solution, these three issues must be solved. Titanium dioxide blended concrete is the most promising solution for this ever-increasing problem. This concrete has the same structural properties as normal concrete but because of the presence of titanium dioxide in the concrete which removes the pollutants effectively. This solution provides a viable option to high traffic volume roads or areas.

The smog-absorbing or photocatalytic concrete acts as a pollution reducer. It means it converts harmful pollutants into harmless pollutants. In our project we are making concrete blocks by replacing the cement with titanium from 0% to 5% and we tested the blocks for compressive strength and smog-absorbing test to know the number of pollutants absorbed by the concrete blocks by using a Multi Gas Analyser machine and we compare the results with normal concrete.

**Keywords:** Pollution • Smog eating concrete • Titanium dioxide • Photocatalysis

## Introduction

Ever since the beginning of industrial revolution, the entire planet has combated the side effects of expanded usefulness i.e., pollution. Since the mid-1800's, pollution levels are expanding at a fast rate. All the more as of late, pollution has been checked by the United Nations. Air pollution may cause diseases, allergies and even death to humans, it may also cause harm to other living organisms such as animals and food crops and may damage the natural environment such as climate change, ozone depletion, acid rain, etc. In recent years World Health Organization sets the limit for some pollution-causing gases i.e. molecular matter was restricted to somewhere in range of  $10 \mu\text{g}/\text{m}^3$  and  $20 \mu\text{g}/\text{m}^3$ , depending on size, nitrogen oxides to  $40 \mu\text{g}/\text{m}^3$ , sulphur dioxide to  $20 \mu\text{g}/\text{m}^3$  and ozone to  $100 \mu\text{g}/\text{m}^3$ . These pollutants are mainly contributing to the buildup of smog [1].

Presently, the World Health Organization exposes that 92% of the total population lives in the regions where in polluted areas i.e., air quality has not met standards. Due to this pollution and pollution-causing gases in the atmosphere many of human beings are suffering from many health issues such as chest pain, coughing, reduced resistance to infections, and fatigue, to more serious problems such as acute bronchitis, aggravated asthma, and development of chronic respiratory illnesses, irregular heartbeat and premature death [2]. The human health effects of poor air quality are far-reaching, but principally affect the body's respiratory system and cardiovascular system. The outdoor air pollution alone causes 2.1 to 4.21 million deaths annually. Overall, air pollution causes 7 million people worldwide each year, and is the world's largest single environmental health risk.

## Objectives

- All the main objective of our project is to make our environment "GREEN"
- To reduce harmful pollutants (NO<sub>x</sub>, CO<sub>x</sub>, HC, organic matter) are

formed by vehicle combustion.

## Materials and Methodology

The following materials are generally used to produce smog-absorbing concrete:

- Cement
- Aggregates
- Titanium dioxide

### Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together and also; it fills the fine voids in concrete. A cement is seldom used on its own, but rather to bind sand and gravel together. Cement mixed with fine aggregate produces mortar for masonry or with sand and gravel produces concrete.

Specific gravity test-3.15

Fineness modulus test-95.45%

Initial setting time-42 mins

Final setting time-10 hrs.

### Aggregates

The particle size distribution of an aggregate as determined by sieve analysis is termed as grading of aggregate. If all the size of an aggregate are uniform size. Compacted mass will contain more voids; whereas aggregate comprising particulars of various sizes will give an aggregate with lesser voids between larger particles. \

The proper grading of aggregate produces a dense concrete and needs less quantity of aggregate, cement, pastes. Therefore, it is essential that the

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coarse aggregate be well grade to produce quality concrete.

**Fine aggregate:** Specific gravity: 2.65; Water absorption test: 0.9%

**Coarse aggregates:** Water absorption test: 0.5%; Impact test: 13.67%; Specific gravity: 2.64

**Titanium dioxide**

Titanium dioxide is also known as titanium oxide or titania, is the naturally occurring oxide of titanium, chemical formula  $TiO_2$ .

Figure 1 shows cementations material which can replace cement concrete for some extent. As titanium dioxide blended in concrete, it helps concrete to absorb pollution from air and concrete made is self-cleaning concrete so pollution absorbed on surface of concrete in the form of powder can be washed by water. Titanium dioxide accelerates the reaction of conversion of harmful pollutants into harmless pollutants.

Chemical formula:  $TiO_2$

Molar mass: 79.866 g/mol

Density: 4.23 g/cm<sup>3</sup>

Melting point: 1843-degree celcius.

Boiling point: 2972-degree celcius.

Specific gravity: 3.1

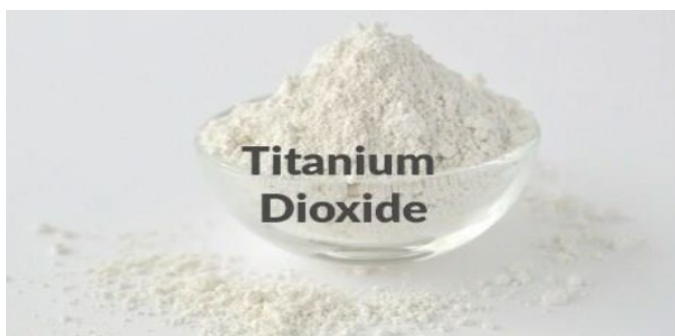


Figure 1. Titanium dioxide

**Results and Discussion**

- Firstly, take all the materials, equipment or necessary things i.e., cement, sand, aggregates, Titanium dioxide, water, and concrete mould (150\*150\*150 mm).
- The cement and aggregates are mixed together with the replacement of cement with titanium dioxide by 2% and make the concrete cubes of mix M30.
- Increase the percentage replacement of titanium dioxide from 2% to 5% and cast the concrete cubes. And also cast the concrete cubes without replacing  $TiO_2$ .
- Place the concrete cubes into water for curing for 7 and 28 days.
- After curing period check the smog absorbing capacity of concrete cubes by the use of Multi gas analyzer machine.
- After smog absorbing test, check the compressive strength of concrete cubes. And compare the results.

**Working principle and its mechanism**

**Photo catalytic process:** Figure 2 shows oxidation of various molecules, including the pollutants in the air and on the surface, as well as the formation of hydroxyl and oxygen radicals from water and oxygen in the air. The products of these reactions then form salts. The salts are then washed off of the surface efficiently due to the super hydrophilicity of titanium dioxide [3-6]. When water normally encounters a surface, it tends

to bead up due to the combination of the surface tension of the water and the difference in polarity between the water and the surface. Since both water and titanium dioxide are polar, they tend to be attracted to each other. This attraction is strong enough to compensate for the water tension, and as a result, water will run as a sheet rather than droplets across the surface, allowing for a more complete wetting of the surface [7].

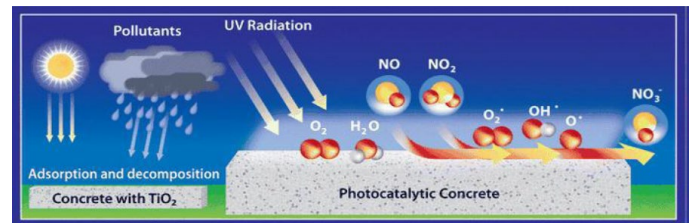


Figure 1. Titanium dioxide

**Mix proportions**

Table 1 shows Mix proportions for M25 grade concrete and Table 2 shows finalized mix proportions for various percentage of  $TiO_2$ .

**Tests conducted**

- Workability tests on concrete-confirming IS:1199-195
- Compressive strength of concrete-confirming IS 516:1959
- Smog absorbing test

**Smog absorbing test**

**Apparatus:** Two wheeler, glass chamber having two holes for inlet and outlet, concrete and mortar cubes, two pipes, multi gas analyzer.

**Setup:** Prepared a glass chamber having size 40 cm x 30 cm x 30 cm with two holes on cover of chamber.

1. From one hole we were supplying polluted air through the silencer of petrol engine vehicle.
2. Second hole was for the checking quality of air passing over the concrete block with the help of multi-gas analyzer machine's probe.
3. multi-gas analyzer has a facility of providing the quantity of different pollutant.
4. The pollutants checked by the multi-gas analyzer are, CO, CO , HC (hydrocarbons).

Table 1. Mix proportions for M25 grade concrete

Sl. No	Particulars	For 1 m <sup>3</sup> concrete	Mix proportions
1	Cement	394 kg	1.0
2	Fine aggregates	790.55 kg	2.0
3	Coarse aggregates	1002.35 kg	2.54
4	Water	197.00 liters	0.50

**Table 2.** Mix proportions for M25, cement replaced by TiO<sub>2</sub>

Mix	Materials		Cement (kg/m <sup>3</sup> )	TiO <sub>2</sub> (kg/m <sup>3</sup> )	Fine Aggregate (kg/m <sub>3</sub> )	Coarse Aggregate (kg/m <sub>3</sub> )	Water (kg/m <sub>3</sub> )	w/c
	Cement %	TiO <sub>2</sub> %						
NC	100	-	394.00	-	790.55	1002.30	197	0.50
SEC1	99	1	390.06	3.94	790.55	1002.30	197	0.50
SEC2	98	2	386.12	7.88	790.55	1002.30	197	0.50
SEC3	97	3	382.18	11.82	790.55	1002.30	197	0.50
SEC4	96	4	378.24	15.76	790.55	1002.30	197	0.50
SEC5	95	5	374.30	19.70	790.55	1002.30	197	0.50

## Conclusions

The blocks prepared by replacing cement with titanium dioxide will reduce the harmful pollutants such as carbon oxides (CO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), particulate matter etc.

- As TiO<sub>2</sub> is cementitious Nano material so there is not any change in compressive strength of concrete
- This photocatalytic concrete is quite expensive, but it reduces more pollution which can save thousands of life
- The percentage replacement of TiO<sub>2</sub> in concrete shall be in between 2% to 3%, at which it is most economical and most helpful to reduce harmful pollutants such as HC and CO<sub>2</sub>.

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