Smog Eating Concrete Roof Tile

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Abstract — Our project is about to study the ill effects of smog and air pollution and control it by using "Smog Eating Concrete Roof Tiles''. The rapid growth in pollution is due to use of vehicles, previous and growing industries such as steel industries, thermal electric power plant etc. These tiles are normal roofing tiles which are installed on the roof. The only thing which differs is titanium dioxide on it. The coating of titanium dioxide is applied on the tiles which can be done in the form of paint. It is applied on the roofing tiles with painting tools. This concrete tile is made up of traditional cement mixed added with Titanium Dioxide in form of the paint. It is found that it is very effective against the nitrogen oxide (NOx), sulphur oxide (SOx) and many other pollutants. Cost of these tiles is just 25% more than the normal roofing tiles. The main focus of this paper is to get detailed reviews of all the previous papers so that we can get maximum benefits from it and also find out other ways in which it can contribute more to civil engineering world. Further we compare it with normal roofing tile by casting both and testing it to find how we can absorb maximum pollutant from it.

Keywords: Smog Eating Concrete Roof Tiles, Titanium Dioxide, Nitrogen Oxide, Sulphur Oxide

I. INTRODUCTION

There is a growing account of air pollution and the outbreak of smog every year in many parts of the world. Immense amount of dangerous gases is emitted by burning of fuels through the consumptive or productive activities. The air pollution has been one of the biggest concerns of the environment protection agencies all through the world owing to the hazards it causes to human health monuments and ecology. The smog is as simple as that smog is a combination of smoke and fog, but what lies within smog here is a deep insight on same. This could be achieved by introducing a compound which help in the absorption of nitrogen oxide. The solution which was developed by the university student involves coating the roof tiles of Residential building by titanium dioxide. They call it as "Smog eating concrete roof tiles''.

II. LITERATURE REVIEWS

Abhijeet Shukla, Rao Faraz Waris, Mohd. Arhab, Syed Sajid Husain (2018) Pollution controlling and smog-eating properties induced in a self-cleaning cementitious material were identified recently. Initially meant as a self-cleaning material, it was discovered that this material had the ability to reduce certain pollutants from surrounding air, and this reduction in the concentration of the pollutants depends upon the surrounding conditions and the amount of exposed area. These properties induced in cementitious material were mainly due to the photocatalytic action of TiO_2, which under the influence of sunlight acts as a catalyst and triggers chemical reaction due to that decomposition of dirt particles take place on the concrete's surface, also it reacts with certain pollutants that contribute to smog, breaking it under the presence of sunlight and accelerating their natural oxidation process. It is found that it is very effective against the Nitrogen oxides (NOx), Sulphur oxides (SOx) and many other harmful pollutants, which are mainly released due to the burning of fossil fuels and is one of the major constituents of smog. It decomposes NOx effectively up to a great extent in the surrounding environment and to a height of about 2-3 meters above the surface. In simple words, this material showing photocatalytic property due to TiO2, when irradiated with sunlight accelerates the decomposition process of pollutants and dirt clearing up the smog and ultimately cleaning the environment and that is the reason why the term self-cleaning and smog-eating is given to it. This material has already found relevant applications, and is being used in a variety of projects such as self-cleaning walls and in the reduction of urban pollutants and serves multiple purposes. Furthermore, the main focus of this paper is to explain the mechanisms involved and to understand the merits and demerits of using this cementitious material in a better way and also it aims at finding out ways in which it can contribute more to this new environmental friendly civil engineering world.

Recent researches on photocatalytic cementitious material in the last two decades have shown that how these materials can reduce the urban pollution up to some extent in parallel of being aesthetically sober and cleaner.

These materials can be used for various purposes like in concrete pavements, rooftops, paving blocks and paving plates, coatings on buildings and sidewalks, for tunnel lining and ultra-thin white topping, etc. India has such a vast network of highways and roadways which can also be used as a potential site for pollution reduction; thus, making the environment cleaner and greener. These materials are known to perform better if the source is in the close vicinity of the material and also under UV rays. Also, the article discussed the formation of ozone as a by-product under a certain set of conditions, which is an alarming issue related to this material. This issue can be resolved by using materials like modified TiO_2, Pt and Ni-doped TiO_2 and by using TiO_2 nanoparticles. The case study of the Cermak road shows that, along with reducing atmospheric pollutants, it also reduces water dissolved hazardous compounds effectively. This material can prove out to be worthy if implemented on a large scale by reducing the contaminants as well as by enhancing the aesthetical quality. Also, both the case study clearly showed that the efficiency of this cementitious material was found to be more in the case when it was used as a coating 20-70% as compared to the use of mortar containing TiO_2, where the efficiency was just around 20%. It is also being used in multiple vertical constructions, like in the case study of Torre de Especialidades, and it is observed the efficiency of the former is much better due to being closer to the source and getting sunlight for more period of time. Also, it is quite clear that this photocatalytically active cementitious material is being used in many parts of America and Europe, for making the environment cleaner, greener and a better place to live.

Banme Aayyaj J., Hawaldar Sayyad Alam A., Khalate Pawankumar S., Kotkar Prasad A. Prof. Sarika Kale, (2019) In our Project we are aiming to make a 'Smog Eating Concrete', which contains Titanium dioxide in addition to the conventional ingredients. Titanium dioxide is already commonly used to coat surfaces that are hard to clean -- it is a component in some paints because it functions as a self-cleaning chemical, meaning the new concrete has the additional advantage that it breaks down algae and dirt so its surface stays clean. The concrete is made up of traditional cement mixed with titanium dioxide. This unique mixture allows air to pass through while simultaneously capturing nitrogen-oxide particles, a main component of smog. Titanium dioxide functions as a catalyst to the chemical reaction which is activated by UV light. Not only does it filter the air, but the collected smog residue washes off with a light rainfall.

TiO_2 improves the surrounding air quality by reducing air pollutants. Reduction in the Air Pollutants are as follows:

- Using 5% Tio2 in concrete by weight of cement reduces air pollutants by 23-25%.
- Using 10% Tio2 in concrete by weight of cement reduces air pollutants by 30-35%.
- Using 15% Tio2 in concrete by weight of cement reduces air pollutants by 40-45%.

Sriman Narayanan K., Anupriya B., (2019) The main aim of our project is to make our environment "Green" and to control the air pollution in a highly polluted area. Pavements which have been blended, coated, sprayed etc., with photo catalytic 2 additives have attracted worldwide interest during the past decade plus period based on their environmentally beneficial abilities to provide reactive (i.e.) smog absorbing pavement. The photo catalytic concrete contains 2 which allow for the oxidation of air pollution occurs on the surface of the pavement. In our project we are making a paver blocks using titanium dioxide and we stored it in a highly polluted area for a one day,one week and two weeks. And we done "SCANNING ELECTRON MICROSCOPIC" test for each pavement which have been absorbed a different quantity of pollutants such as Carbon, Nox., etc. The Tio2 can absorbed the certain amount of air pollutants from the vehicle emission.

Now a days air pollution is one of the major problems in our world. It can causes many harmful things to the atmosphere as well as human beings. Air pollution is one of the source which leads to cause the global warming and cause some health effects. Our main aim is to prevent the environment from air pollution. Being a civil engineer we are doing a part to save our mother nature by paving sustainable "green pavement" called smog absorbing pavement. In this study, we have conducted experimental investigation on the paver blocks by coating titanium dioxide which can absorbed carbon, NOx pollutants from the air. By laying a sustainable green pavement it can absorbed the pollutants from the highly polluted area. Hence in our project the pollutants can be absorbed in certain level for 1 day,1 week and 2 weeks. so our main aim of controlling air pollution in highly polluted area is satisfied.

S. Naveen, Dr. K. Chandramouli, J. Sree Naga Chaitanya, (2021) Smoke fog, or smog for short, is a type of intense air pollution. This kind of visible air pollution is composed of nitrogen oxides, sulphur oxides, ozone, smoke and other particulates. It is mainly derived from coal combustion emissions, vehicular emissions, industrial emissions, forest and agricultural fires and photochemical reactions of these emissions. It is common in big cities with a lot of industry and traffic. So, there is a need of special engineering material that would neutralize the pollutants that cause smog. Thus, smog eating concrete comes into existence for tackle the smog emission problems in urban areas. These properties induced in cementitious material were mainly due to the photo catalytic action of TiO2, which under the influence of sunlight acts as a catalyst and triggers chemical reaction due to that decomposition of dirt particles take place on the concrete's surface, also it reacts with certain pollutants that contribute to smog, breaking it under the presence of sunlight and accelerating their natural oxidation process. It is found that it is very effective against the Nitrogen oxides (NOx), Sulphur oxides (SOx) and many other harmful pollutants, which are mainly released due to the burning of fossil fuels and is one of the major constituents of smog. In this paper, we shall discuss about the smog eating mechanism and its application in buildings, pavements, roof tiles and other miscellaneous structures.

Recent researches on photocatalytic cementitious material in the last two decades have shown that how these materials can reduce the urban pollution up to some extent in parallel of being aesthetically sober and cleaner. These materials can be used for various purposes like in concrete pavements, rooftops, paving blocks and paving plates, coatings on buildings and sidewalks, for tunnel lining and ultra-thin white topping, etc. India has such a vast network of highways and roadways which can also be used as a potential site for pollution reduction; thus making the environment cleaner and greener. These materials are known to perform better if the source is in the close vicinity of the material and also under UV rays. Also, the article discussed the formation of ozone as a by-product under a certain set of conditions, which is an alarming issue related to this material. This issue can be resolved by using materials like modified TiO_2, Pt and Ni-doped TiO_2 and by using TiO_2 nanoparticles. The case study of the Cermak road shows that, along with reducing atmospheric pollutants, it also reduces water dissolved hazardous compounds effectively. This material can prove out to be worthy if implemented on a large scale by reducing the contaminants as well as by enhancing the aesthetical quality. Also, both the case study clearly showed that the efficiency of this cementitious material was found to be more in the case when it was used as a coating 20-70% as compared to the use of mortar containing TiO_2, where the efficiency was just around 20%.

Ramya HN, Darshan MN, Naveen Kumar GS, Gangashree AB, Sagar KS, (2021) In today's world one of the major problems is pollution. In order reduce the pollution we need sustainable solution this sustainability includes socio economical equity. and environmental protection. To achieve 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 to 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 pollution reducer. It means which 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 Multi Gas Analyser machine and we compare the results with normal concrete

The blocks prepared by replacing cement with titanium dioxide will reduce the harmful pollutants such as carbon oxides (COx), nitrogen oxides (NOx), hydrocarbons (HC), particulate matter etc.

- As TiO_2 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 lives
- The percentage replacement of TiO_2 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_2.

Pranav P. Deshpande, Gaurav N. Pawankar, Aditya M. Chavan, Sheikh Avesh Rauf, Amit Dubey, Ashwani M. Lakhote, Pratiksha P. Mandulkar, Shweta Rokde, (2022) Our Project is about to study the ill effects of smog and air pollution and control it by using smog eating tiles. Our aim is to study the economy of this construction and contribute our part in "SWACHA BHARAT ABHIYAN". The rapid growth in pollution is due to excessive use of vehicles. Previous and growing Industries such as steel industries, thermal electric power plants, etc. These tiles are normal roofing tiles which are installed on the roof. The only thing which differs is titanium dioxide on it. The coating of titanium dioxide (single coat) is applied on the tiles which can be done in the form of paint. Titanium dioxide is available in the form of powder it is mixed with water and prepared in the form of paint. It is applied on the roofing tiles with painting tools. Cost of these tiles is just 25% more than the normal roofing tiles.
Benefits outweigh the costs.

Smog level reduction creates a healthier environment and inhabitants. Tiles reduce home heating and cooling costs. Recyclable tiles mitigate the amount of landfill waste.

Priyanka Gaikwad, Shamesh Rasal, Vinayak Desale, Saurabh Burud, (2022) Around the globe one of the biggest collective concerns is that of pollution. In such conditions, a cementitious material that has pollution-eating and self-cleaning properties when applied to infrastructural work will be very beneficial and can contribute in cleaning the environment and help in improving sustainability.

As TiO_2 is a cementitious nanomaterial so there is no change in the compressive strength of concrete. & We are able to use TiO_2 as an admixture also up to a specific limit. The percentage replacement of TiO_2 & AC in concrete shall be between 0.5% to 1%, which is the most economical and most helpful. The study framed that the TiO_2 & AC reduced the harmful pollutants from the air like NOX, HC, and COX. AC helps to extend the speed of absorption. As TiO_2 applies to structures with paint so it might be quite expensive but it reduces pollutants which saves thousands of lives. Also, we will use a photocatalyst sheet of TiO_2 as a replacement for paint.

III. Materials

A. Cement

The ordinary cement contains to basic ingredient namely argillaceous and calcareous. The argillaceous material clay predominates and calcareous material calcium carbonate predominates. In the present work 53 grade for OPC was used for plastering. The cement was uniform colour i.e. grey with a light greenish shade and was free from any hard lump.

B. Sand

Natural sand is available from any narby source of river. It is not completely free from mud or any impurities hence it is essential to washing with water. For this sand particle of size 1.18 mm was used.

C. Water

Water is an important ingredient of concrete as its actively participates in the chemical reaction with cement. Portable water is generally consider satisfactory.

D. Titanium Dioxide

Titanium Dioxide {TiO_2} has high absorbing capacity of air pollutants. So we used Anatase grade synthetic product material. Nano particle size of TiO_2 is used. It has self-cleaning photocatalytic concrete.

IV. Methodology

Photochemical smog is the chemical reaction of sunlight, nitrogen oxide and volatile organic compounds in the atmosphere, which leaves airborne particles and ground-level ozone.

Some major health problems are directly attributable to the NOx formed during any burning process.
The tiles are coated with titanium dioxide.

A. Casting of smog eating concrete tiles

1) Proportioning
2) Mixing
3) Curing
4) Drying

B. Water Absorbtion Test

1) Dry weight tiles test
2) Water absorption test

V. CALCULATION

Calculation of material of one tile (254mm x 381 x 12mm) for ratio 1:3 of concrete.

Density of cement =1440kg/m^3

Density of Sand=1600kg/m^3

A. *Cube Dimention:-*

B= 0.254m
L=0.381m
H=0.012m

B. *Dry volume of tile:-*

Volume = 0.254 x 0.381 x 0.012
Dry Volume = 0.001161m^3

C. *Wet volume:-*

Wet volume= 1.54 x Dry volume
= 1.54 x 0.001161m^3
Wet volume = 0.00178m^3

Use Ratio of concrete (1:3) mix ratio

. CEMENT = wet volume / sum of ratio x 1
= 0.00178/ 1+3 x 1
= 0.000445m^3
= 0.000445 x Density of cement
= 0.000445 x 1440
= 0.6408kg

. SAND = wet volume / sum of ratio x 3
= 0.00178/1+3 x 3
= 0.001335m^3
= 0.00178 x Density of cement
= 0.00178 x 1600
= 2.2672kg

. CHEMICAL ADMIXTURE= TITANIUM DIOXIDE(TiO_2) used for paint form.

. ONE TILE WEIGHT=2.5KG

VI. CONCLUSIONS

With the heavy demand for building material Benefits outweight the costs, Smog level reduction creates a healthier environment and inhabitants, Tiles reduction home heating and cooling costs. It has been observed that smog has been reduced to minimum level due to Titanium dioxide. Therefore, it is an eco-friendly advice to the industries that larger producers of smog. Through the result obtained, focusing on the research objective of finding tiles for popular housing. Concrete tiles are use full for roof tiles and use for designing in house.

REFERENCES

[1] Abhijeet Shukla, Rao Faraz Waris, Mohd. Arhab, Syed Sajid Husain, 2018, "A Review on Pollution Eating and Self-Cleaning Properties of Cementitious Materials", *International Journal of Innovative Research in Science, Engineering and Technology, 7(3), 2784-2792.*

[2] Banme Aayyaj J., Hawaldar Sayyad Alam A., Khalate Pawankumar S., Kotkar Prasad A. Prof. Sarika Kale, 2019, "Smog Eating Concrete", *Journal of Emerging Technologies and Innovative Research (JETIR)*, 6(4), 388-391.

[3] Sriman Narayanan K., Anupriya B., 2019, "Smog Absorbing Pavement", *International Journal of Engineering Research & Technology (IJERT)*, 7(2), 1-7.

[4] S. Naveen, Dr. K. Chandramouli, J. Sree Naga Chaitanya, 2021, "Study on Smog Eating Buildings", *International Journal of All Research Education and Scientific Methods (IJARESM)*, 9(7), 3284-3289.

[5] Amit Dhundalwar, Tauheed Naseeb Alam Ansari, Razaul Mustufa Khan, Sopan Sawant, Vineet Wasnik, Prof. Dr. P. S. Lanjewar, Prof. Ashish Moon, 2021, "Detailed Case Study about Smog Eating Tile", *International Journal of Innovations in Engineering and Science*, 6(7), 38-41.

[6] Ramya HN, Darshan MN, Naveen Kumar GS, Gangashree AB, Sagar KS, 2021, "Use of Smog Eating Concrete in Road Construction", *Journal of Material Sciences & Engineering*, 10(8), 1-3.

[7] Pranav P. Deshpande, Gaurav N. Pawankar, Aditya M. Chavan, Sheikh Avesh Rauf, Amit Dubey, Ashwani M. Lakhote, Pratiksha P. Mandulkar, Shweta Rokde, 2022, " Smog Eating Tiles as an Eco-Friendly Construction Material", *International Journal Of Innovative Research In Technology",* 8(11), 804-807.

[8] Priyanka Gaikwad, Shamesh Rasal, Vinayak Desale, Saurabh Burud, 2022, "SMOG ABSORBING CONCRETE", *International Research Journal of Engineering and Technology (IRJET)*, 9(5), 139-143.