Review Paper on Smog Eating Concrete and Conventional Concrete

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Abstract- **According to the paper, "smog-eating concrete" is an innovative approach to combat air pollution in cities. With the help of titanium dioxide (TiO□), the enhanced material breaks down toxic nitrogen oxides (NOx) and volatile organic compounds (VOCs) into innocuous byproducts via a photocatalytic process in the presence of sunlight. Unlike traditional concrete, it offers structural support while cleaning the air. Air pollution has severe health implications and environmental damage, especially in urban areas where the traditional mitigation methods, such as promoting public transport, fall short. This project aims to create eco-friendly construction materials that reduce pollution and enhance public health. Titanium dioxide is selected due to its confirmed ability to detoxify pollutants. The paper outlines ways to achieve a balance between the structural strength of concrete and the pollution-fighting properties of TiO□. Applications are roads, sidewalks, and building walls in highly polluted areas. Smog-eating concrete is expected to reduce pollutants significantly in sunny conditions while maintaining durability. Though the initial costs are higher, its long-term benefits, including better urban air quality and reduced health risks, justify the investment. Compared to conventional concrete, this material offers a sustainable solution for cleaner, healthier cities.**

Keywords- **Smog-eating concrete, Titanium dioxide (Tio2), Photocatalytic process, Air pollution reduction, Urban sustainability.**

I. INTRODUCTION

Air Pollution and Smog: Air pollution, which refers to the introduction of dangerous substances or contaminants in the air we breathe, thereby posing severe risks to people's health, the environment, and the planet's economy, is a global concern that is being intensified. In terms of industrial emissions, transport and construction activities affect air quality in urban areas. When pollutants such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) undergo photochemical processes, they result in the formation of smog that is toxic and engulfed in smoke and haze. This category of pollution is extremely harmful to metropolitan areas characterized by the presence of the sun along with high emissions from vehicles.

Health Risks: Air quality that is below standard has a direct effect on the health of humans. Every day people breathe enormous amounts of air, if pollutants are present in this air then they can enter the blood system, and subsequently respiratory diseases, cardiovascular problems, and even premature death will occur. Smog inflates asthma, allergies, and other respiratory diseases and long-term exposure may lead to the immune system getting weaker and weaker thus making a person more susceptible to infections.

Environmental and Structural Impact: Pollution in the air can both damage the environment and have a structural impact on the constructions- buildings and monuments, mainly those of limestone and marble. The chemical interactions that cause the pollutants to acidify the rain would, in turn, corrode the infrastructure and the decay process of the structures, which is an important part of culture and history, will be faster.

II. RELATED WORK

The development of smog-eating concrete has seen tremendous expansion and investigation, with researchers using a range of approaches to improve its viability and efficacy in reducing urban air pollution. This section examines and classifies previous research on smog-eating concrete, including methods for incorporating photocatalytic qualities into various urban infrastructure and material optimization and application tactics.

Reference [1] Name of Research Paper -Use of Smog Absorbing Concrete in Road Construction.

Author-Mr. G. N Chavan Patil, Mr. S.S Chokakkar (July 2020).

The purpose of this paper is to solve the ever-increasing pollution problem in today's world, a sustainable solution is needed. This sustainability includes environmental protection, as well as social

and economic equity. To achieve a fully sustainable solution, all three of these critical issues must be solved. The most promising solution to this problem is titanium dioxide-blended concrete. The material has similar structural properties to normal concrete, but because of the titanium dioxide, can remove pollutants from the air by decomposing them into harmless compounds. This solution provides a viable option to urban areas, where pollution levels are generally higher, due to the large potential surface area for the material.

Reference [2] Name of Research Paper-Smog Absorbing Concrete.

Author – Priyanka Gaikwad, Shamesh Rasal, Vinayak Desale (May 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.

Reference [3] Name of Research Paper-Detailed Case Study About Smog Eating Tile.

Author-Prof. Dr. P.S. Lanjewar Prof.Ashish Moon, Sopan Sawant, Tauneed Naseeb Alam Ansari (June 2021).

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.

Reference [4] Name of Research Paper-Eating Air Pollution Using Building Façade Technology.

Author-Batool Moafaq Al-Zaidi, Armin Sarkis Markaryan (Nov 2020).

The research is concerned with pollution in general and air pollution in particular. Through description and analysis, the research tackles the most prominent methods and means used in order to reduce air pollution using modern technologies. It also tackles the extent of the impact of the built environment on the natural environment. Thereby, the research seeks to reduce this effect through the architectural designer's utilization of technology systems. Thus, the general research problem is formed; showing a lack of knowledge on how to deal with the pollution problems resulting from vehicle exhaust. Further, the research tackles the studies related to the special research problem, which is the lack of knowledge of modern techniques such as (biological filters) used in the buildings, its importance in dealing with air pollution resulting from vehicle exhaust, and its impact on the local environment. The aim of the research is to study and describe architectural buildings that use such technologies and demonstrate their importance in improving local environment. This is made by forming a methodology that includes two parts; the first is represented by air pollution, its sources and cause and the second is represented by studying the technologies, indicating their types and differences and how the architectural designer used it in buildings to reduce air pollution caused by vehicle exhaust. The research reached many conclusions and recommendations.

Reference [5] Name of Research Paper - Smog Eating Concrete.

Author – Prof.Sarika Kale, Banme Aayyaj. Hawaldar Sayyd Alam, Kotkar Prasad (April 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

Reference [6] Name of Research Paper- Tio2- Based Photocatalytic Cementitious Composites

Author- Fatemeh Hamidi, Farhad Aslani. (Oct 2019).

Applications of heterogeneous photocatalytic processes based on semiconductor particles in cement-based materials have received great attention in recent years to enhance the aesthetic durability of buildings and reducing global environmental pollution. Amongst all, titanium dioxide (TiO2) is the most widely used semiconductor particle in structural materials with photocatalytic activity because of its low cost, chemically stable nature, and absence of toxicity. Utilization of TiO2 in combination with cement-based materials would plunge the concentration of urban pollutants such as NOx. In fact, cementitious composites containing TiO2 have already found applications in self-cleaning buildings, antimicrobial surfaces, and air-purifying structures. This paper aims to present a comprehensive review on TiO2-based photocatalysis cement technology, its practical applications, and research gaps for further progression of cementitious materials with photocatalytic activity.

Reference [7] Name of Research Paper- Photocatalytic Concrete – Environment Friendly Material.

Author- Gordana Toplicic Curcic, Dragica Jevtic, Dusan Ristic, Zoran Grdic (Apri 2017).

The phenomenon of dirty facades and elements of infrastructural facilities such as roads and bridges is becoming more prominent with the increase of industrial air pollution, which has a detrimental effect on the quality of urban environment and structural life cycle cost. New construction material called photocatalytic concrete is self-cleaning, and in addition it is a filter for air pollution and it is used for construction of the aforementioned structures. Self-cleaning is a result of the capacity of photocatalytic concrete enabling the façades, bridges, roads and other structures to retain their colour in time, and appear as new for decades. The primary catalytic ingredient of photocatalytic concrete is Titanium oxide (TiO2), a white pigment. When activated by the energy in sunlight, TiO2 creates a charge separation of electrons which disperses on the photocatalytic surface and reacts with external substances, decomposing organic compounds. Photocatalytic concrete reflects much of the sun's heat which reduces the heat gain of the structural surfaces during the summer seasons, reduces the air temperature in urban environments, and as a result, reduces the amount of smog. The paper presents the properties of photocatalytic cement, concrete and advantages of its usage as environment friendly material and its application on important structures in the world

Reference [8] Name of Research Paper – The Properties of Cementitious Composite Material -The Current State of The Art.

Author – PhD, Eng. Andreea Hegyi, (July2018).

Nowadays, raised awareness about the importance of sustainability and also the environmental impact of using concrete in the construction industry has led to numerous studies on how to create an environmentally friendly material, with self-cleaning properties and how to possibly use it in urban areas and to ensure a cleaner environment and reduce maintenance costs. Nitrogen oxide (NOx) is the air pollutant which is directly responsible for the air pollution due to smog, smoke, vehicle emission, etc. The self-cleaning process of concrete can be obtained by oxidizing the NOx gases into powdered or dust like particles by using the UV rays from the sun as resource and using a photocatalytic substance in order to obtain that effect. Self-cleaning concrete is a special material because the technology of producing it can only be applied by incorporating TiO2 into photocatalytic coatings for concrete specimens. When sunlight hits the surfaces most of the organic and inorganic pollutants are neutralized. This can lead to a higher level of cleanliness of the building's surfaces and the surrounding air pollution can be drastically reduced. The aim of this paper is to briefly review the self-cleaning concrete, to present the main principles on which self-cleaning concrete is based and also to present it current applications.

Reference [9] Name Of Research Paper – Titanium Oxide Based Photocatalytic Materials Development And Their Role Of In The Air Pollutants Degradation Overview And Forecast.

Author – Tao Zhang A B, Wei Zhao D, Ruijie Xie A.

Due to the anthropogenic pollution, especially the environmental crisis caused by air pollutants, the development of air pollutant degradation photocatalyst has become one of the major directions to the crisis relief. Among them, titania (titanium dioxide, TiO2) family materials were extensively studied in the past two decades due to their strong activity in the photocatalytic reactions. However,

TiO2 had a drawback of large bandgap which limited its applications, several modification techniques were hence developed to enhance its catalytic activity and light sensitivity. In recent years, other metal oxide-based materials have been developed as replacements for TiO2 photocatalysts. In this review, background information and developments from pure TiO2 to chemically modified TiO2-based materials as photocatalysts were discussed in detail, which covered their basic properties and their role in the air pollutant removal. It also proposes to solve the shortcomings of TiO2 by developing other metal oxide-based materials and predict the future development of TiO2 materials in future environmental applications.

Reference [10] Name Of Research Paper- An Analysis On The Effectives Of Nitrogen Oxide Reduction From Applying Titanium Dioxide On Urban Roads Using A Statistical Method.

Author – Sang Hyuk Lee, Jong- Won Lee, Moon Kyung Kim, Hee-Mun Park (July 2021).

The purpose of this study was to analyse the effect of titanium dioxide (TiO2) on reducing nitrogen oxide (NOx) concentrations using the statistical method of the Anderson-Darling test. To compare and analyse this effect, a spray-type form of TiO2 was applied to the asphalt pavement surface on urban roads. Data acquisition for NOx concentration was collected from a test section with TiO2 applied and a reference section without TiO2 applied. The probabilities of occurrence of the NOx concentration in the test and reference section were estimated and compared using the Anderson-Darling test. In sum, most of the NOx concentrations were probabilistically lower in the test section. The average probability of the NOx concentration in the test section in the 'low' range was 46.2% higher than in the reference section. In the 'high' and 'moderate' ranges, the average probability of the NOx concentration compared to that of the reference section was lower by 28.1% and 18.8%, respectively. These results revealed that the photochemical reaction from the TiO2 material applied on asphalt pavement was effective in reducing NOx.

Reference [11] Name of Research Paper- The Use of Titanium Dioxide in Concrete To Reduce Air Pollution.
Author – Alif Hawaldar, Shrutikarj Kumbhar, Prathmesh Sutar, Adesh Kolekar, Prathmesh Patil (July 2021).

In this study shows the results of experiment which is done in laboratory with concrete containing Titanium dioxide. The main aim of this study is to reduce pollution by absorbing the smog into the concrete as well as increase concrete structure strength durability. The favourable results are given by a distinct proportion of titanium dioxide addition. The concrete mixed with different percentage of titanium dioxide of powder content. According to IS 10262: 2009 and IS 456:2000, the M20-grade concrete mix proportions were obtained. In laboratory. The titanium dioxide mixed with concrete with 1%, 2%, 3% and examine the smog absorbing capacity of concrete. At 2% replacement of titanium dioxide (Tio2) by weight of cement, the maximum strength was achieved.

Reference [12] Name of Research Paper -Using Nano and Micro- Titanium Dioxide (Tio2) In Concrete to Reduce Air Pollution.

Author – N. Elia, Anindya, Ghosh, Amin K, Akhnoukh (2018).

A crucial element in construction, tunnels, roads, and more, concrete has become one of the most important materials in the world. At the same time, air pollution, particularly in crowded cities, is increasing, mainly due to industrial activity and transportation. Therefore, one possible approach to reduce pollution is to use "smart" construction materials, particularly those that incorporate photocatalytic active nano- and micro-size structures into concrete. Incorporating titanium dioxide (TiO2) in roads and pavements could degrade and reduce various pollutants under ultraviolet sun radiation. TiO2-infused concrete would also maintain its optical characteristics for far longer than traditional concrete mix. This study evaluated the ability of concrete containing nano- and micro-TiO2 to degrade organic molecules, as assessed by the concrete's ability to degrade Rhodamine B dye. The amount of nano- and micro-TiO2 in the concrete samples was 3, 6, 9, 12, and 15% of the cement composition. The resulting concrete blocks were exposed to sunlight for 24, 48, 72, and 96 hours. Both the nano- and micro-TiO2 significantly degraded the Rhodamine B dye, demonstrating the potential of this approach to benet the smart construction industry and, as a result.

Reference [13] Name of Research Paper – The Use of Titanium Dioxide in Concrete Materials To Filter Smog Pollution From Air.

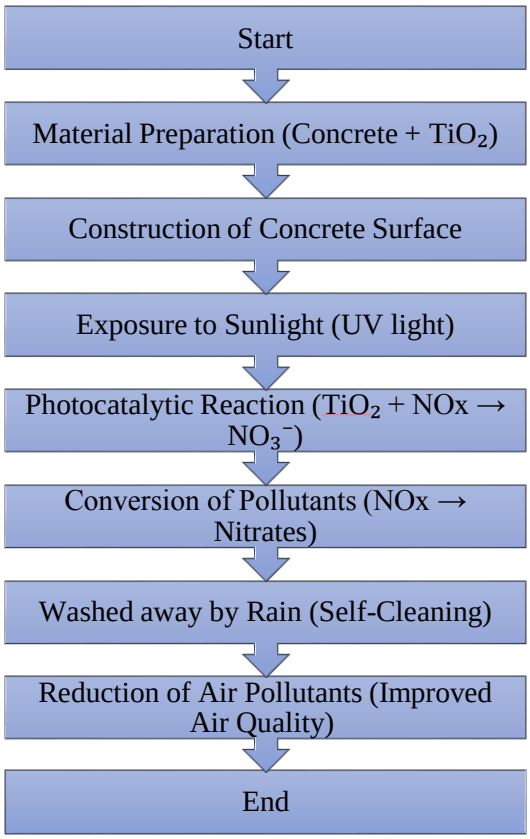
Author -Mark Garger.

With pollution ever-increasing in a rapidly developing world, environmental protection will rely on new innovations to remove pollutants. One such innovation is titanium dioxide-infused concrete and cement, which can remove smog from the air when exposed to ultraviolet light. To clean the air of smog, the nitrogen oxides present must be transformed into different, less harmful substances such as nitrate ions. The nitrate ions formed during the reaction then create nitric acid, which is reacted with grout to create a harmless neutral salt. The salt is then washed out by precipitation. While this reaction can occur naturally, it does so at a slow rate. The process is sped up by the presence of titanium dioxide, which acts as a photocatalyst, meaning it can speed up a reaction when light is also present. The technology has already been implemented into various structures and has been subject to performance tests. The titanium oxide-infused concrete has shown to have greater flexural and compressive strength than normal concrete, giving a structural as well as environmental advantage. Furthermore, the titanium oxide concrete proves to effectively remove nitrogen oxides as well as common volatile organic compounds (VOCs) such as benzene, toluene, and ethylbenzene. This material has been integrated into materials ranging from roofing tiles to main structural components of buildings, and proves to be a sustainable solution.

III. LITERATURE REVIEW

Sr no	Author name	Title paper	Name of paper	Place and date of publication	Conclusions
1	Prof. Sarika Kale	Smog Eating Concrete	Journal of Emerging Technologies and Innovative Research (JETIR)	Pune Maharashtra INDIA /APRIL.2019	Reduction in the Air Pollutants by using Tio2
2	Dragica jevtic	PHOTOCATALYTIC CONCRETE	International conference	Aleksandra, Serbia/April 2017	Formulation of cement which Ables to neutralize pollutions.
3	Armin Sarkis Markaryan	Eating air pollution using building's façade technology	Periodical of engineering and natural science	Baghdad, Iraq/20-11-2020	Reduce negative impact on environment by using close air filtration technology.
4	Saurabh Burud, Priyanka Gaikwad	SMOG ABSORBING CONCRETE	International Research Journal of Engineering and Technology (IRJET)	Thane, Maharashtra India. / May 2022	Activated carbon increase the speed of absorption of pollutants.
5	Mr. G.N. Chavan Patil,	Use of Smog Absorbing Concrete in Road Construction	International Research Journal of Engineering and Technology (IRJET)	Kolhapur Maharashtra. / July 2020.	Comprehensive strengths of concrete remain same by using TIO2 as nano material.
6	Fatemeh Hamidi	TiO2-based Photocatalytic Cementitious Composites	Nano- material	Western Australia /oct.2019	Minimizing the formation of harmful by-product's during photocatalyst activities.
7	Prof. Dr. P. S. Lanjewar	Detailed Case Study about Smog Eating Tile	International Journal of Innovations in Engineering and Science	Nagpur Maharashtra/ June 2021.	Titanium dioxide tiles can reduce smog and energy costs, promoting a cleaner environment.

IV. PURPOSES SYSTEM



V. METHODOLOGY

1. Making Photocatalytic Concrete: Combining The first step is to prepare the concrete mix using the selected formula. In smog-eating concrete, titanium dioxide (or other photocatalysts) is often mixed in as a fine slurry or powder. Generally speaking, the concentration falls between 1% and 5% by weight of the total cement composition. To ensure the photocatalytic agent is evenly distributed in the mixture, it is essential to blend the TiO2 with the cement or to mix it with water prior to incorporating it into the dry cement and aggregates.

2. The Casting/Placement Application Process: Smog-eating concrete can be used on roads, pavements, building facades, and various other surfaces, or it can be poured into Molds. To ensure the best photocatalytic action, it's important to start with a clean and prepared surface. Certain formulations of smog-eating concrete incorporate surface treatments that enhance the photocatalytic response and boost efficiency. After the concrete has set, these treatments can be applied through brushing or spraying.

3. Curing: Proper curing is essential for the concrete to achieve its maximum strength and durability. In smog-eating concrete, the curing process can also influence the effectiveness of the photocatalytic components. Typically, maintaining appropriate moisture levels and temperature for a period of seven to twenty-eight days is necessary for effective curing.

4. Photocatalysis – When the phenomenon of photocatalysis occurs, the titanium dioxide can be deposited on the surface of the chimney adorned with ultraviolet sunlight. In this light cruelty, hydroxyl radicals, superoxide ions, and other substances capable of decomposing hazardous air pollutants such as nitrogen oxides (NOx) and volatile organic compounds. When conducting smog-eating concrete, the photocatalytic activity of titanium dioxide is stimulated by ultraviolet radiation and positively charges the particle primary sintering, creating a variety of pore structures. These superior pore structures promote various photocatalytic reactions and interactions with air and stem molecules, including electron-hole pairs formed during the degradation of adsorbed moisture molecules. These reactive species decompose air pollutants on the concrete surface, converting harmful NOx into non-toxic compounds like nitrates, which are then washed away by rain or water.

5. On the concrete surface, these reactive species break down air pollutants like NOx, transforming them into non-toxic substances like nitrates that are subsequently removed by water or rain.

6. Surface Maintenance - Maintenance and Performance Monitoring: Dust, grime, and other impurities can build up in smog-eating concrete over time, decreasing its photocatalytic effectiveness. To keep the surface performing as intended, regular cleaning (such as pressure washing) would be required. Performance Evaluation: Track the area around the smog-eating concrete for a decrease in air pollution. Before and after the concrete is installed, use air quality sensors to detect NOx, ozone, and particulate matter in order to evaluate its efficacy.

7. Cost Analysis and Optimization - Cost vs. Benefit: Assess the benefits of improved air quality against the costs associated with producing and installing smog-eating concrete. This should include expenses for materials, installation, and maintenance, as well as potential long-term

VI. CONCLUSION

Reduction in pollutant levels: A measurable decrease in pollutants (NOx and VOCs) in the air near the concrete surface, especially in sunny conditions.

1) Durability and Longevity: Durability similar to traditional concrete, with little to no impact on the structural integrity due to the addition of Tio2.

2) Cost Analysis and Feasibility: Potentially higher initial costs due to the TiO□ additive, but with long-term environmental benefits that could make it viable for urban areas with high pollution.

3)Environmental Impact: Demonstration of a sustainable solution that can improve air quality in high-traffic areas, helping reduce health risks associated with air pollution.

4) Scalability: Insights into whether this material could be scaled for widespread urban use, based on effectiveness, cost, and manufacturing constraints.

VII. REFERENCE

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