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DEVELOPMENT OF AIR-PURIFIED CONCRETE BLOCK BY PHOTOCATALYTIC REACTION

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Abstract

Air pollution poses a significant threat to human health and the environment, urging the development of innovative solutions. This study focuses on the development of air- purified concrete blocks utilizing photocatalytic reactions. Titanium dioxide (TiO2), a widely studied photocatalyst, is incorporated into the concrete mixture to facilitate the degradation of air pollutants. The photocatalytic process triggered by UV radiation initi- ates the breakdown of harmful volatile organic compounds (VOCs) and nitrogen oxides (NOx) present in the surrounding air. This research investigates the optimization of TiO2 concentration, concrete mix design, and exposure conditions to enhance the efficiency of air purification. The synthesized concrete blocks demonstrate promising potential for mitigating air pollution in urban environments. Through this approach, we aim to con- tribute to sustainable infrastructure development and improve the quality of urban air.

Keywords: air purification, concrete blocks, photo catalytic reaction, titanium dioxide, urban environment.

1.Introduction

In recent years, air pollution has become a pressing concern globally, with adverse effects on both public health and the environment. Among the various pollutants, volatile organic compounds (VOCs) and nitrogen oxides (NOx) are significant contributors to urban air pollution. Traditional methods of mitigating air pollution often involve mechanical filtration or chemical scrubbing, which can be expensive and have limited effectiveness.To address this issue, researchers have been exploring innovative approaches that utilize photocatalytic reactions to purify air. One such promising avenue is the development of air-purified concrete blocks embedded with photocatalytic materials. These blocks have the potential to passively remove pollutants from the surrounding air through catalytic oxidation, offering a sustainable and cost-effective solution for improving air quality in urban environments.Photo catalysis involves the use of semiconductor materials, such as titanium dioxide (TiO2), which can harness sunlight or artificial light to initiate chemical reactions. When exposed to light, photo catalytic materials can generate reactive oxygen species (ROS), such as hydroxyl radicals (•OH), which have strong oxidizing properties. These ROS can oxidize and degrade various pollutants present in the air, converting them into harmless substances like carbon dioxide and water. The integration of photo catalytic materials into concrete blocks offers several advantages. Concrete is a widely used construction material, making it readily available for implementation in urban environments. Additionally, concrete blocks have a large surface area, providing ample space for photocatalytic reactions to occur. Moreover, the durability and longevity of concrete ensure that these air-purifying properties remain effective over an extended period, contributing to sustained improvements in air quality.

2. Literature Review:

1. Photocatalytic concrete for air purification

This review provided an overview of the development of photocatalytic concrete for air purification. It covers various aspects including photocatalytic materials, mechanisms, synthesis methods, and applica- tions in concrete blocks.

2. Recent developments in photocatalytic concrete for air purification

This review focused on recent advancements in photocatalytic concrete for air purification. It discusses the challenges, opportunities, and future directions in utilizing photocatalytic materials to enhance the air purification capability of concrete blocks.

3. Advances in the development of air-purifying concrete using photocatalytic nanoparticles

This review highlighted the recent progress in utilizing photocatalytic nanoparticles to develop air-purifying concrete. It covers topics such as photocatalytic mechanisms, material properties, manufac-turing techniques, and performance evaluation.

4. Photocatalytic cement-based materials for air purification

This comprehensive review discussed the use of photocatalytic cement-based materials for air purifi-cation. It provides insights into photocatalytic mechanisms, material compositions, manufacturing pro- cesses, and potential applications in concrete blocks.

5. Review of photocatalytic concrete for air purification and self-cleaning

This review provided an overview of photocatalytic concrete's potential for air purification and self-cleaning properties. It discusses the underlying mechanisms, recent advancements, and challenges in implementing photocatalytic technology in concrete block production.

6. Photocatalytic concrete: Recent progress and future perspectives

This paper reviewed recent progress in the development of photocatalytic concrete. It discusses vari-ous photocatalytic materials, synthesis methods, and applications in air purification. Additionally, it outlines future research directions in this field.

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7. A review of photocatalytic concrete: Mechanisms, properties, and applications
This review provided a comprehensive overview of photocatalytic concrete, including its mechanisms, properties, and applications. It discusses the effects of photocatalytic materials on concrete performance and explores potential applications in air purification.
8. Recent advances in the development of photocatalytic concrete for air purification and environmental remediation
This paper reviewed recent advances in photocatalytic concrete technology for air purification and environmental remediation. It discusses the synthesis of photocatalytic materials, incorporation into concrete matrices, and their effectiveness in mitigating air pollutants.
9. Photocatalytic concrete for air purification: Progress, challenges, and opportunities
This review discussed the progress, challenges, and opportunities in utilizing photocatalytic concrete for air purification. It covers topics such as photocatalytic mechanisms, material design, manufacturing techniques, and performance evaluation methods.
10. Emerging trends in photo catalytic concrete for sustainable infrastructure: A review
This review highlighted emerging trends in photocatalytic concrete for sustainable infrastructure development. It discusses recent innovations, challenges, and future prospects in utilizing photocatalytic technology to improve air quality and enhance the durability of concrete structures.

3. Methodology and Materials Used

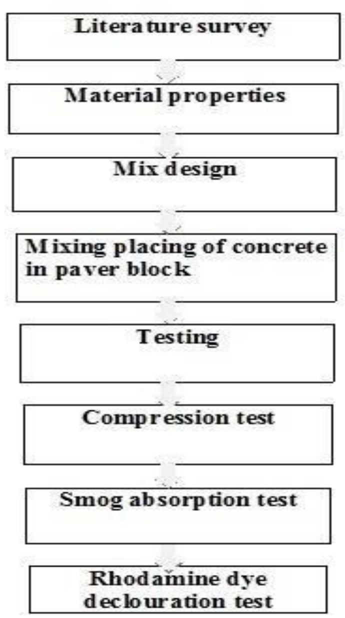

Figure:3.1 Methodology

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1. **TITANIUM DIOXIDE**

Titanium dioxide is a chemical compound, also known as titanium oxide or titania, is the naturally occurring oxide of titanium, chemical formula TiO_2.The photo catalytic activity, which is another property of TiO_2, is increased considerably through the high surface-to-volume ratio of the Nano particles.

Description	**Properties**
AVERAGE PARTICLE SIZE	**35**
SPECIFIC GRAVITY	**1.34-1.4**
DENSITY	**0.25**
PURITY	**99%**
COLOUR	**WHITE**

Table:3.1 Properties of Materials

2. **The Chemical Property of Titanium Dioxide:**

Titanium dioxide is non-toxic and chemical properties are stable. It almost has no reaction with other material produce under normal temperature. It is a partial acid. It has no reaction with oxygen, hydrogen sulphur, sulphur dioxide, carbon dioxide and ammonia and is not sol- uble in water, fatty acids, other organic acid and weak inorganic acid except for alkali and hot nitric acid. But, in some specific conditions, titanium dioxide can get reaction with some sub- stance. For example, these reactions as follows: Only in the circumstance of long time boiling can it be totally soluble in strong sulphuric acid and hydrofluoric acid.

The reaction equation is as follows:

$TiO_2 + 2H_2SO_4 = Ti(SO_4)_4 + 2H_2O TiO_2 + H_2SO_4 = Ti\ OSO$

In this project cement is replaced by 3%, 4% and 5% of titanium dioxide and further examined.

MIX	MATERIAL		CEMENT(KG/M3)	TIO2(KG /M3)	FINE AGGREGATE(KG/M3)	COARSE AGGREGAT E(KG/M3)	WATER(KG/M3)	W/C
	CEM ENT %	TIO2						
NM	100	_	3.94	_	819.22	1047.30	195	0.55
SACS 1	99	1	390.06	3.94	819.22	1047.30	195	0.55
SACS 2	98	2	386.12	7.88	819.22	1047.30	195	0.55
SACS 3	97	3	382.18	11.82	819.22	1047.30	195	0.55
SACS 4	96	4	378.28	15.76	819.22	1047.30	195	0.55
SACS 5	95	5	374.30	19.7	819.22	1047.30	195	0.55

Sl.no	**Type of paver block**	Compressive strength **(N/mm2)**
1	Controlled	31.5
2	Combination-1	32
3	Combination-2	35
4	Combination-3	36

Specimen type	**Number of blows required forthe first visible crack**	**Number of blows at which the specimen fails**	**%increase in resistance from first to ulti- mate crack**
Control	**2**	**3**	**66.5%**
Combination-1	**1**	**2**	**50**
Combination-2	**3**	**4**	**75%**
Combination-3	-	1	0

Type of Concrete paver block	**Dry weight (W1) (g)**	Wet weight **(W2) (g)**	**% of Water Absorption**
Control	5.07	5.15	1.45
Combination-1	4.99	5.07	1.5
Combination-2	5.18	5.25	1.33
Combination-3	5.18	5.29	2.1

RHODAMINEB DYE DECOLOURIZATION TEST

In this test the concrete containing TiO2 photo catalysts have been evaluated based on decolouri- zation under sun light, a standard test for self-cleaning cementious materials. Experimental data are discussed in relation to dye decolourization of 3%, 4% and 5% of TiO_2 replaced concrete under sun-light. On the surface of the casted concrete cubes 1ml of Rhoda mine dye is dropped on each cube sample and placed under direct sunlight and the results are recorded.

Monitoring Photocatalytic Concrete Using Sensors

Testing photocatalytic concrete using sensors involves monitoring various parameters related to its performance, such as air quality, pollutant degradation, surface proper-ties, and durability. Here's a general outline of how sensors can be employed in the testing process:

1. **Electrochemical Sensors:**
   These are commonly used for measuring gases like NO_2 and SO_2. Electrochemical sensors work by measuring the current pro-duced when the target gas reacts with an electrode.It can be integrated into the concrete structure or placed nearby to measure the air quality before and after exposure to photocatalytic concrete.
2. **UV-Vis Spectrophotometer**
   In photocatalytic activity sensing, they can be utilized to monitor changes in absorbance re- sulting from photocatalytic reactions. These changes can provide insights into the efficiency and activity of photocatalysts in breaking down pollutants or generating products under light irradiation.
3. **corrosion potential sensor" or "corrosion potential meter**.
   These sensors are used to measure the electrical potential of reinforcing steel in concrete structures, which can indicate the likelihood of corrosion occurring. They help in monitoring the condition of concrete structures and assessing the risk of corrosion-related damage.
4. **Data Logging and Analysis:**
   Data from these sensors should be logged over time to track changes and trends in the per- formance of the photocatalytic con-crete. Advanced data analysis techniques, such as machine learning algorithms, can be applied to analyze the collected data and extract insights

CONCLUSION

An admixture or surface coating of titanium dioxide (TiO_2) is added to concrete used for pavers and other structural applications to create photo-catalytic concrete. Using sunshine and moisture, titanium dioxide functions as a heterogeneous photocatalyst, absorbing nitro- gen oxides (NO and NO_2) and converting them into nitrate ions (NO_3^-). These ions can then be absorbed into the concrete to form stable compounds or rinsed away by rain..From above study it is concluded that the use of 3% of titanium dioxide in concrete sample gives the maximum the strength, decolourization and oxidation increases with increase in Titat- inium dioxide

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