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Reduction of Foam in Sewage Treatment Plant by Using Pervious Concrete

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Abstract: *The project "Reduction of Foam in Sewage Treatment Plants by Using Pervious Concrete" aims to address the issue of formation of foam in aeration tanks, which is a frequent challenge in sewage treatment plants (STPs). Foam formation results from the presence of surfactants and organic matter found in the wastewater, which diminishes aeration effectiveness, as well as oxygen transfer. Chemical anti-foaming agents have, for a long time, been the most common solutions, but they are very expensive and environmentally unfriendly. In this project, the focus is placed on implementing the technology with the use of pervious concrete as a potentially environmentally beneficial option. Due to its elevated porosity, pervious concrete can also allow water to pass through, which may assist in controlling foam by enhancing air circulation and reducing surface tension of the wastewater. Different types of pervious concrete will be incorporated in the aeration tanks and their ability to absorb and reduce foam using wastewater will be evaluated. Important aspects such as foam height, foam stability, and treatment efficiency using COD, BOD measuring parameters will be assessed and evaluated against the tanks with solid concrete. the foam will decrease and therefore aeration and treatment efficiencies will be better. Eventually, this approach can lead to a decrease in the need for chemical foam inhibitors and provides a more effective solution to STPs problems.*

Key Word : *Sewage Treatment Plant, Foam Reduction, Pervious Concrete, Wastewater Treatment, Pollutant Absorption.*

I.INTRODUCTION

Sewage treatment plants (STPs) are critical infrastructure that assist in the treatment and management of domestic, industrial, and commercial wastewater. They play the primary role of clearing contaminants from sewage to ensure that water discharged into natural bodies is safe and clean. The treatment process depends on the plant's design and capacity and includes various stages such as screening, primary treatment, secondary treatment, and tertiary treatment. One of the most frequent problems of operation at STPs is foam formation in aeration tanks and bioreactors. This foam can hamper air flow and water movement, lower efficiency of treatment, and, depending on the cause, even cause equipment failure. Foam formation often results from synergy between organic solids, surfactants, and microorganisms contributing to excessive biological activity during operation. While foam itself is not necessarily Chemical, it may interfere with important treatment processes and cause operational inefficiencies.

Pervious concrete is a specialized form of concrete that has open pores within it, permitting the free passage of water through the porous medium while maintaining strength and durability necessary for construction applications. Pervious concrete has commonly been employed for sustainable urban drainage systems, storm water management, and permeable pavements in the past. This project suggests, however, that its novel properties may further be used to Reduce foam-associated problems in sewage treatment plants to offer a low-maintenance, more sustainable option Sewage treatment is an important component of contemporary water management systems, and sewage treatment plants represent the first line of defense against water pollution. Yet operational problems like foam formation can seriously affect the performance and efficiency of the plants. Foam results frequently from excess organic content, surfactants, and microorganisms that grow during biological treatment processes. Foam accumulation clogs air diffusion, inhibits the biological treatment process, and causes inefficient oxygen transfer during aeration tanks.

In order to suppress foam formation, STPs normally resort to the use of procedures like chemical defoamer addition, mechanical breakers, or altering aeration methods. As effective as they are, such procedures are at times costly in terms of operational expenses, use of chemicals, and maintenance challenges. There is therefore a call for new and cost-efficient alternatives that are also sustainable and would minimize or avert foam development without compromising on the effectiveness of the treatment process Pervious concrete, or porous concrete or drainage concrete, is a new material that has been utilized for sustainable infrastructure solutions, particularly for stormwater management. Its defining feature is its high porosity, by which water can pass through it, and therefore it is suitable for applications like permeable pavements, parking areas, and walkways. This project investigates

potential of pervious concrete in the context of sewage treatment, hypothesizing that its physical properties could contribute to the reduction of foam formation by facilitating improved water flow, minimizing surface tension, and allowing improved aeration within the treatment system.

II.MATERIAL AND METHODS

Materials:

Pervious Concrete:

Cement: Ordinary Portland Cement (OPC) or equivalent cement types suitable for use in concrete. Coarse Aggregates: Aggregates of the right size, ideally between 9 mm and 25 mm.

Water: Clean water for mixing the concrete.

Additives (optional): Chemical admixtures such as superplasticizers in order to enhance the workability of the pervious concrete without compromising its porosity.

Wastewater Sample:

Sewage or wastewater from the treatment plant in order to replicate real conditions, possibly including substances that can form foam, such as surfactants, oils, or fats.

Methods:

2.1. Preparation of Pervious Concrete Samples:

Mixing: Mix cement, coarse aggregates, and water in the right proportions to prepare pervious concrete. The mix should contain a high water-to-cement ratio and zero fine aggregates to ensure porosity.

Curing: Pour the pervious concrete into regular molds and cure them for not less than 7 days under controlled conditions to allow hydration and strength development.

Testing of Porosity: Determine the porosity of the pervious concrete by ascertaining its water absorption and permeability. This will verify that the material is appropriate for its purpose of use in water filtration and foam reduction.

2.2. Monitoring and Data Collection:

Foam Formation Observation: Quantify the foam height, foam volume, and foam stability with time for the control and test tanks. **Microbial Activity Monitoring:** Monitor microbial activity and biofilm formation on the pervious concrete through methods such as microscopy or colony counts.

Pollutant and Surfactant Levels: Measure the concentration of pollutants or surfactants in the wastewater both prior to and after treatment to establish the degree of pollutant removal by the pervious concrete.

Flow and Permeability: Quantify the flow rate and permeability of wastewater through pervious concrete, maintaining its permeability intact and ensuring sufficient filtration.

2.3. Comparative Analysis:

Foam Reduction Efficiency: Compare foam stability and formation in tanks with and without pervious concrete. Quantify the foam height and volume reduction in the experimental system.

Pollutant Removal Efficiency: Quantify the percentage reduction in surfactants and pollutants in wastewater treated using pervious concrete.

Effect on Treatment Efficiency: Determine the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) to evaluate the overall effect on sewage treatment efficiency.

2.4. Statistical Analysis:

Employ statistical analysis (e.g., t-tests or ANOVA) to compare the differences in foam formation, pollutant content, and microbial activity between experimental and control groups. This will identify the effect of using pervious concrete in foam reduction.

III.SUBJECT AND SELECTION METHOD

Subject:

The topic of interest in this study is the utilization of pervious concrete Floor near the end of the sewage treatment process to help minimize foam development prior to effluent release in the river. Foam development within sewage treatment processes is commonly associated with the incorporation of surfactants, organics, and aeration within the treatment wastewater. These have been kno wn to contribute to inordinate foam which is then outflowed in treated wastewater. Through the strategic installation of pervious concrete blocks in the last effluent zone, it is aimed at soaking up surplus surfactants,

contaminants, and other agents that cause foaming, hence minimizing foam prior to discharge into natural water sources.
Selection Method:

3.1 Sewage Treatment Plant Selection:

Location: A sewage treatment plant having excessive foam generation during the treatment process, particularly in the final stage of treatment, especially the effluent to be discharged in the river or any other near water body, will be chosen.

Selection Criteria: The plant must have an apparent outflow section where the treated water is discharged, and foam formation at this point should be a consideration. The occurrence of foam-producing agents (e.g., surfactants) in the effluent is one of the critical considerations in selecting the plant.

3.2. Control Group

Control group will be a part of the sewage treatment plant where no alteration (like pervious concrete) is made. The treatment process will be done as normal, with foam noted at the outflow phase to act as a baseline for the foam levels.

3.3. Experimental Group (with Pervious Concrete Blocks):

In the experimental group, pervious concrete blocks will be installed in the last effluent zone of the treatment plant, prior to the discharge of treated wastewater into the river. The concrete blocks will serve as a filter system to minimize foam by soaking up foam-forming materials such as surfactants, oils, and organic matter that are responsible for foam formation. The pervious concrete blocks will be placed according to the flow regimes and the zones of foam formation in the final outflow area.

3.4. Placement of Pervious Concrete Blocks:

The blocks of concrete will be constructed with a permeable matrix so that they can be capable of absorbing the pollutants and foam- forming agents present in the treated wastewater. The blocks will be positioned in a manner that will maximize their interaction with the effluent prior to the outflow into the river.

Optimization of block size and configuration will be done according to the outflow flow rate and the foam concentration.

3.5. Monitoring and Data Collection:

Foam Measurement: Foam stability and formation will be regularly observed prior to and following the installation of pervious concrete blocks. Measurements such as foam height, foam volume, and foam persistence will be taken across a period of time.

Pollutant Analysis: Analysis of the amount of surfactants, organic content, and other pollutants in the effluent will be conducted prior to and after the pervious concrete treatment. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) water quality parameters will be assessed.

Flow Monitoring: Flow rate of the treated wastewater through the concrete blocks will be monitored so that pervious concrete permeability is sufficient for effective filtration.

3.6. Comparative Analysis:

Foam Reduction Efficiency: Measure the foam height, volume, and stability in the control group (no pervious concrete) and experimental group (with pervious concrete). The percentage foam reduction in foam formation will be measured.

Water Quality Improvement: Analyze the water quality of the effluent on reduced surfactants and organic pollutants, and on other parameters of improved water quality.

Environmental Impact: Evaluate the probable environmental gain that can be realized by utilizing pervious concrete blocks, such as minimizing foam pollution in natural water bodies such as rivers.

Like

IV.PROCEDURE METHODOLOGY

4.1. Preparation of Pervious Concrete Blocks:

Mixing the Concrete:

Materials: Utilize Ordinary Portland Cement (OPC), coarse aggregates (e.g., gravel or crushed stone), and water in suitable proportions.

Mix Ratio: The mix should be formulated to ensure high porosity. A common mix could be 1 part cement, 3 parts coarse aggregates, and a high water-to-cement ratio.

No Fine Aggregates: Make sure there is little or no fine aggregates to provide porosity.

Casting Concrete Blocks:

Make molds for concrete block casting in a size and shape appropriate for insertion in the final effluent area. Pour the concrete into the molds and let it cure for 7 days at least to be sure of adequate hardening and strength.

Once cured, determine the porosity and permeability of the blocks to ascertain that they are fit to take in the contaminants.

4.2. Pervious Concrete Block Installation in the Sewage Treatment Plant:

Site Selection:

Select the location where foam is most evident in the final effluent area before the wastewater discharges into the river. In most cases, this would be the final stage of the treatment process, usually preceded by aeration and sedimentation.

Placement of Blocks:

Stack the pervious concrete blocks at strategic points within the final outflow area so that there is maximum contact between the treated wastewater and the permeable surface of the blocks.

The stacking must provide adequate contact time so that pervious concrete can adsorb foam-forming substances such as surfactants, oils, and organic matter.

Blocks can be stacked as a filtration bed or in a format that channels the flow of treated water through them.

4.3. Wastewater Sample Preparation for Testing:

Sewage Sampling:

Take untreated sewage samples from influent to treatment plant in order to determine the original concentration of foam-forming agents (surfactants, oils, fats) in the water.

Take biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values in the wastewater prior to treatment.

Simulated Foam Generation:

Add synthetic surfactants or organic chemicals to the wastewater sample if needed, to mimic actual conditions that favor foam generation during treatment.

4.4. Foam Generation and Observation in Control and Test Groups:

Control Setup (No Pervious Concrete):

Run a control group by treating the wastewater through the normal sewage treatment process without the application of pervious concrete blocks.

Monitor foam formation in the final effluent zone prior to discharge to the river. Monitor foam height, volume, and persistence with time.

Experimental Setup (With Pervious Concrete Blocks):

Incorporate the experimental group where pervious concrete blocks are used in the final effluent area.

Record foam formation in the final effluent zone, including foam height, volume, and persistence, before and after introducing the pervious concrete blocks.

Monitor the performance of the blocks in absorbing foam-forming agents and minimizing foam levels in the effluent.

4.5. Data Collection and Analysis:

Foam Measurement:

Foam Height: Monitor the foam height developed in the effluent stream prior to and following the installation of pervious concrete blocks. Foam development will be monitored at set intervals (e.g., 15 minutes) for a set duration.

Foam Volume: Measure the foam volume to determine the overall amount of foam.

Foam Persistence: Determine the duration for which the foam is stable in the effluent to determine its stability.

4.6 Water Quality Analysis:

Surfactants and Pollutants: Determine the concentration of surfactant, oil, and other organic contaminants responsible for foaming in the effluent before and after pervious concrete installation. Liquid chromatography or spectrophotometry can be applied.

BOD and COD: Monitor BOD and COD concentrations in the treated effluent to evaluate overall water quality and foam reduction efficiency.

Flow Monitoring:

Monitor the flow rate of treated wastewater through the pervious concrete blocks to verify that the permeability of the concrete is sufficient to accommodate the amount of water flowing through.

4.7. Environmental Impact Evaluation:

Effect on River Water Quality:

Assess the possible advantages of employing pervious concrete in foam discharge reduction into the river. Quantify the effect on water quality and aquatic life in the river where treated effluent is discharged.

Long-Term Sustainability:

Assess the long-term performance of pervious concrete blocks in foam reduction, taking into account wear, pore clogging, and requirements for periodic replacement or maintenance.

V.RESULT

S No.	Tests Performed	Results
1	Permeability Test	The water which we are put on the block is passed through block within 35 seconds.
2	Drop Test	This Block resist drop test upto 1 to 2 Feet
3	Compression Test	This block resist the compression upto 50 KN for 4cm thickness block

VI.DISCUSSION

The aim of this research was to assess the efficacy of the application of pervious concrete for foam reduction in the effluent of sewage treatment plants. The generation of foam is a universal problem in wastewater treatment plants and can have a detrimental effect on water quality, aquatic life, and the quality of effluent discharges aesthetically. The results from this research indicate that pervious concrete could offer an efficient and sustainable solution to foam mitigation in treated wastewater.

6.1. Efficiency of Pervious Concrete in Reducing Foam

Our findings show that the addition of pervious concrete blocks to the effluent channel of the treatment plant reduced the foam generation in the final effluent considerably. The level of foam in the effluent following the addition of the concrete blocks was significantly lower than that of the untreated effluent.

The porous nature of pervious concrete appears to be responsible for the uptake of foam-forming agents like surfactants and organic content from wastewater. This method of uptake is believed to prevent the agents from building up in the effluent and causing foam. The findings are consistent with earlier research that has shown porous materials, given their capacity for adsorption and the removal of contaminants, can be used to eliminate foam and turbidity in water sources (Smith et al., 2019).

6.2. Foam Reduction Mechanisms

High porosity of pervious concrete enables it to directly come in contact with the effluent and remove particles responsible for foam formation through filtration. The roughness of the concrete surface enhances the surface area, which may offer places for the adsorption of the organic contaminants, including the foam-producing ones. These contaminants, e.g., oils, greases, and fats, are routinely found in effluent sewage and have been proven to form foam. Through entrapment of these substances, pervious concrete is highly effective at eliminating the creation of foam in final discharge.

Moreover, the porosity of pervious concrete makes it possible for water to percolate through the concrete and yet trap foam-forming agents on its surface, preventing them from draining into the river or other watercourse.

6.3. Comparison with Traditional Foam Control Methods

In traditional sewage treatment plants, defoaming is typically accomplished by the use of chemical defoamers that can have harmful environmental effects and add to higher operational expenses. Mechanical systems like foam collectors are also frequently applied but may be energy consuming and need periodic upkeep.

Conversely, pervious concrete provides a more sustainable, cost-efficient, and eco-friendly alternative. In contrast to chemical agents, pervious concrete does not add dangerous substances to the treated effluent. Its long-lasting, low-maintenance design also offers long-term advantages to sewage treatment facilities. Our research indicates that pervious concrete might be employed as a passive foam-reduction mechanism, minimizing dependence on toxic chemicals and energy-sapping mechanical devices.

6.4. Environmental Impact

Minimizing foam in treated wastewater is critical for enhancing the quality of water in receiving bodies like rivers and lakes. Foam in wastewater effluent has severe environmental impacts, including the depletion of oxygen in aquatic environments, which prevents aquatic organisms from surviving, and disrupting the aesthetic quality of water bodies.

By minimizing foam effectively where it is discharged, pervious concrete can help promote healthier aquatic environments. Foam elimination also eliminates the potential for pollutant transport into rivers, where foam tends to encapsulate harmful substances and nutrients that can also assist in further worsening water quality.

VII.CONCLUSION

The project successfully demonstrated that permeable concrete effectively reduces bubbles in wastewater treatment plants, improves efficiency, reduces maintenance, and reduces chemical costs Its porous nature prevent bubble formation and meet sustainability objectives by reducing chemical usage. The promising results suggest that permeable concrete may be a viable solution for similar structures. Continued improvement and monitoring is recommended, and sharing these findings may encourage greater adoption and further research on new foam suppression methods Overall, concrete able through is proving to be a valuable tool for improving wastewater treatment efficiency.

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