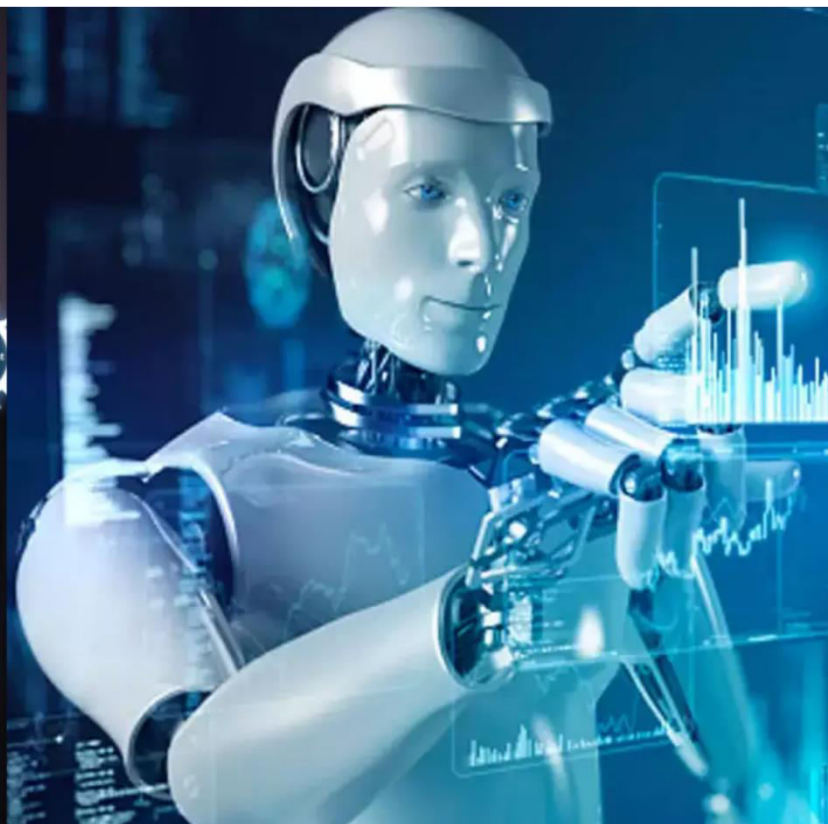




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# Reducing Urban Heat with Moss Concrete

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**ABSTRACT:** Moss Concrete offers a unique and innovative approach to creating sustainable and visually stunning structures, leveraging the natural insulation properties and striking appearance of moss. Integrating moss into landscape design, alongside ornamental and arboretum plants, is a crucial aspect of landscape architecture. Despite the numerous environmental benefits associated with moss growth, the random and uncontrolled growth of mosses and lichens on facades has traditionally been viewed as a negative phenomenon. However, moss is renowned for its ability to absorb carbon dioxide, filter pollutants from the air, and retain moisture, making Moss Concrete an excellent choice for architects and engineers prioritizing sustainability and green building practices. The scope of this paper is to inform and raise awareness among specialists about the various possibilities of using well-known moss species in landscape architecture, with a specific focus on Mumbai's weather conditions.

**KEYWORDS:** Moss concrete, Mosses, Lichens, Pollutants, Green Building.

## I. INTRODUCTION

Concrete is one of the most widely used construction materials globally, renowned for its strength and durability. However, despite its benefits, concrete production is responsible for 8% of global CO<sub>2</sub> emissions. One potential solution to offset this is to grow plants on concrete, facilitating CO<sub>2</sub> uptake. This concept involves designing a concrete material that can host small plant species and microorganisms without requiring a superficial layer, a process known as bio-receptivity.

Bio-receptivity refers to a material's ability to be colonized by one or more groups of living organisms without undergoing biodeterioration. In nature, bio-receptive surfaces are characterized by the presence of stress-tolerant microorganisms, such as bacteria, algae, fungi, lichen, and mosses, which form biofilms. Researchers from *Delft University of Technology in the Netherlands* have found that these microorganisms, despite being stress-tolerant, require specific conditions to survive and thrive on the substrate. Material characteristics that enhance bio-receptivity include high capillary water content, high surface roughness, a pH level below 10, and high open porosity. Additionally, the use of phosphorus has been found to improve the bio-receptivity of concrete by providing nutrients for biological growth.

Ongoing research aims to enhance bio-receptivity, particularly in materials like concrete, which is the most widely used building material. Bio-receptive concrete can be a solution for creating a more sustainable version of this popular construction material, contributing to the development of net-zero buildings.

## II. LITERATURE SURVEY

- 1. D.V.V. Satyanarayana et al. (February 2024):** In this research, they explored the concept of *moss concrete*—a new eco-friendly building material that combines the strength of concrete with the environmental benefits of live moss. They aimed to reduce the harmful environmental impact of traditional concrete by adding moss, which can help lower temperatures, purify air, and make structures look greener. The study included making concrete cubes of different grades (M20, M25, M30), applying a moss and buttermilk paste, and monitoring the moss growth over five weeks. They also tested the cubes for strength and temperature regulation. Results showed that moss concrete had slightly better strength, improved durability, and helped in cooling the surface. This shows moss concrete could be a promising step toward sustainable and healthy building practices.
- 2. Kazi Fahriba Mustafa et al. (July 2021):** In this research, they explored how the surface geometry of concrete panels can help moss grow in a more organized and self-sustaining way, creating eco-friendly building facades. They made six concrete panels using a special mix containing blast furnace cement, then shaped each one with different patterns using CNC-milled molds. Their goal was to test how different surface designs affected water

retention and moss growth. The panels were first tested in a lab to see how well they held water, and then placed in a greenhouse where moss was applied using a moss-and-buttermilk slurry. Over 12 weeks, they observed that panels with deeper grooves and flowing surface patterns helped moss grow better by holding more water and creating cooler, moist conditions. The study concluded that certain geometric designs can greatly improve the ability of concrete to support plant growth, offering a new way to make buildings greener and more environmentally friendly.

### III.METHODOLOGY

The methodology for creating moss concrete involves a systematic approach combining conventional concrete practices with biological integration techniques. The process begins with the collection of materials required for casting concrete cubes of various grades such as M20, M25, and M30. The primary materials include Ordinary Portland Cement (OPC) or eco-friendly alternatives, fine and coarse aggregates like sand and gravel, and clean potable water. These components are carefully mixed in specific ratios depending on the grade of concrete: M20 (1:2.13:2.93), M25 (1:1.9:2.62), M30 (1:1.6:2.34) and M40. After thoroughly mixing the concrete, it is poured into standard cube moulds and cured properly to ensure hydration and strength development.



Fig.1.0. Making of Moss Concrete

Once the concrete cubes are prepared and cured, the next step involves the collection and preparation of moss. In the IJCRT study, springy turf moss (also known as cushion moss) was chosen for its lush growth and adaptability to concrete surfaces. The collected moss is cleaned and blended into a slurry using two to three cups of moss, an equal amount of a dairy product such as buttermilk or yogurt, one to two tablespoons of sugar, and some water to adjust the consistency. This slurry is left at room temperature for a couple of days to allow the development of spores, which are essential for moss propagation.

After the slurry is ready, it is applied evenly to the surface of the concrete cubes. Prior to application, the concrete surface is cleaned to ensure better adhesion. Post-application, the cubes are misted regularly using buttermilk to maintain the required moisture level for moss growth. This moisture is critical for preventing the moss slurry from drying out or washing away. Over a period of 4 to 6 weeks, visible moss growth is monitored and maintained by gently misting the cubes daily. The moss growth is measured using vernier calipers, tracking weekly increases in coverage and thickness.



Fig.1.1. Making of Moss Concrete

In addition to monitoring the moss development, the moss-grown concrete cubes are tested for various physical properties. Compressive strength is assessed using a compression testing machine, while thermal insulation is evaluated using a metallurgical thermometer. The tests reveal that moss concrete not only maintains or slightly improves its strength over time but also significantly reduces surface temperature compared to regular concrete. This temperature regulation, observed to be up to 4–5°C cooler, contributes to reducing the urban heat island effect. The overall results demonstrate that moss concrete provides enhanced durability, temperature control, and eco-friendly benefits, making it a promising sustainable material for the future of construction.

#### IV.RESULTS AND DISCUSSION:

##### 1. Test 1: Sieve analysis for Fine Aggregate (Crushed sand)

Following are the results obtained from Sieve Analysis for Fine Aggregates,  
For IS Sieve 10 mm, 4.75 mm, 2.36 mm, 1.18mm, 600  $\mu$ m, 300  $\mu$ m and 150  $\mu$ m, the Cumulative % wt. passing is 100, 92, 76.8, 51.8, 29.8, 5.6 and 4.1 respectively.

All the values lie in Zone-I. The values are,

10 mm: 100-100  
4.75 mm: 90-100  
2.36 mm: 60-95  
1.18 mm: 30-70  
600  $\mu$ m: 15-34  
300  $\mu$ m: 5-20  
150  $\mu$ m: 0-10

Specific Gravity: 2.52  
Water Absorption: 3.60%  
Bulk Density (Loose): 1.44  
Density (Rodded): 1.73

##### 2. Test 2: Fineness Test (G.S.B Coarse II)

Following are the results obtained from Fineness Test (G.S.B Coarse II),  
For IS Sieve 53 mm, 26.5 mm, 4.75 mm and 75 micron, the % passing is 100.00%, 55.96%, 29.64% and 2.28% & the road specification requirements are 100-100, 50-80, 15-35 and 0-5 respectively.

Water Absorption: 1.73%  
Liquid Limit: Non-plastic  
Plasticity Limit: Non-plastic  
California Bearing Ratio: 47.11%  
Plasticity Index: Non-plastic

**3. Test 3: Initial and Final Setting Time**

Initial Setting Time: 1 hour 56 minutes

Final Setting Time: 4 hours 57 minutes

Following are the Average Compressive Strength obtained for OPC 53,

At 3 days: 17.66 Mpa

At 7 days: 23.48 Mpa

At 28 days: 35.71 Mpa

**4. Test 4: Slump Cone Test**

Grade of Concrete: M40 PQC

Grade of Cement : 53 OPC

Slump at Plant : 100mm and Slump at site : 55mm

Type of admixture used : Sikaplast 5203 NS

Minimum cement content : 360 Kg/m<sup>3</sup>

Cement Content : 400+67

Max. size of aggregates : 20mm

**V.CONCLUSION**

The experiment with moss concrete in the climatic conditions of Mumbai revealed significant limitations in the viability of this eco-friendly approach. Despite the potential aesthetic and environmental benefits of moss concrete, the high temperatures and predominantly dry spells of Mumbai proved unsuitable for sustaining moss growth. Moss naturally thrives in cool, moist, and shaded environments — conditions that are not consistently present in Mumbai's hot and humid climate. As a result, the moss on the concrete surfaces dried out and failed to establish itself effectively.

This outcome highlights the importance of climate compatibility when considering green building materials. For moss concrete to be successful in urban environments like Mumbai, modifications such as regular artificial irrigation, shading, or selection of more drought-resistant moss species may need to be explored. Until such solutions are developed and tested, moss concrete may not be a practical or sustainable option for this region.

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