# Living in anti-pollution Carbon Negative Green building: Mycelium Insulation

**Pratik Nag[1], Sougata Banerjee[2], Subhro Chakraborty[3]**

[1]*M.Tech scholar, Department of Civil Engineering, University of Engineering and Management, Jaipur*

*2Research Associate, Department of Civil Engineering, University of Engineering and Management, Jaipur*

[3]*Assistant Professor, Department of Civil Engineering, University of Engineering and Management, Jaipur*

## Abstract.

Increase in pollution for whatsoever cause has been a serious issue in recent years. The steep growing curve for the number of vehicles, factories and industries each year probes an immense reason for environmental pollution. Some densely polluted cities has now been a challenge to healthy human lifestyle. Degrading Air Quality Index (AQI) is now observed in many important cities all over the world, leading to increase in diseases, road accidents due to coagulation of pollutants in the environment. Latest method of living to be adapted by humans in order to sustain even in the most polluted zones of the World. Mycelium, a product made from the vegetative part of a type of fungi or mushroom, which can be blended to form mycelium-composite-insulation brick to be used in construction of building. This has shown insane capability of absorbing harmful pollutants like carbon dioxide, purifying air during its lifetime. They feed on agricultural and synthetic wastes, are natural fire retardant among many other useful features hold a strong point for its application in upcoming days. Implementation of mycelium-based product along with solar power systems has shown a positive result in the study.

**Keywords:** Pollution, lifestyle, Air Quality Index (AQI), mycelium-composite-insulation brick, mycelium.

# 1. INTRODUCTION

Living in a world packed with advanced features providing a much better facility towards easy and modern lifestyle has always been an area of development and innovation over these recent years. But, with advancement in facilities and technologies, pollution to the environment has been a direct threat due to more industries, factories, vehicles etc. Increase in pollutants in the air has been observed over the recent years containing mainly the oxides of carbon, that cannot be stopped. Newer methods for a healthier lifestyle to be developed to sustain healthy life by neutralizing the pollution from the environment. A naturally grown bio material, mycelium, could be used in construction purposes and as decorating materials like floor mats, facades or wall sheets that absorbs a huge amount of carbonthroughout its lifetime.[1][2][3][8] Solar energy to be used for electric and other power supplies in the building. Implementing solar energy system along with mycelium blended products onto a building that would be self sustainable and anti pollution as a carbon negative, safe and healthy green building would be a challenge to be researched in this study.

## *1.1 Mycelium*

"Mycelium is a bio-material that forms the root systems of fungi", *Pleurotus ostreatus,* which is bio compatible as well as fast growing.[4][5] Synthetic and agricultural wastes and by-products are identified to grow mycelium. This helps the environment from waste decomposing land fills and soil pollution.[3] This material saves energy usage in buildings by providing thermal insulation.[3] Thermal insulators available in the market are generally synthetic or petroleum based, such as glass wool, (Tatematsu et al., 2014), expanded polystyrene (EPS) (Lakatos and Kalmár, 2013), and polyurethane (PU) foam (Kuhn et al., 1992) etc., which provoke carbon footprints during their manufacturing process.[1] Even the content of harmful substances in synthetic and petroleum based products being the major issues for them to be used for building construction applications. Mycelium products are made to be carbon negative sequestering at least 16 tonnes of carbon per month by a sheet of size 1200 X 2400 mm.[3] As mycelium is fire retardant, make buildings somewhat fire resistant when applied. Thermal conductivity of mycelium has been found to be as low as 0.03 W/m.K, outperforming other thermal insulators available in the market. A very good acoustic insulation as high as 75% at 1000 Hz among other features, makes a strong reason for using mycelium based product in green construction.[3]

### *1.1.1 Features of mycelium*

***Thermal Capacity***

The ability of a material to conduct or transfer heat is referred to as thermal conductivity. Thermal conductivity as low as 0.03 W/m.K has been shown by mycelium blended construction materials, which makes it thermal resistant, meaning it is a bad conductor of heat. When applied in buildings, it works as thermal insulators especially in extreme hot and cold climate zones by regulating alternating heat within the building with respect to the conditions outside the building.[3]

***Fire Performance***

When exposed to fire, very less heat and smoke is being released from mycelium, unlike other synthetic and petroleum based insulators, which releases much harmful and toxic smoke, making it much healthier and safe. Spread of fire is being prohibited by mycelium products due to its charring behaviour. Thus, much safety to fire is provided by mycelium products in comparison with other insulators, making buildings fire safe to an extent.[3]

***Acoustic Performance***

Absorption of noise by a material when exposed to an environment is referred as acoustic insulation. It has been concluded from tests that acoustic absorption of at least 75% at 1000Hz(the typical frequency of road traffic noise) is being shown by mycelium products. Thus, mycelium products can be used as both thermal and mycelium insulator, making it advantageous over other insulating construction materials.[3]

***Sustainability***

Synthetic and organic wastes such as agricultural wastes and by products are being consumed by mycelium to grow into desired shapes to achieve ranges of moisture and mechanical properties. Environment is being helped by consuming the wastes and by-products which would otherwise fo for land fills polluting soil and ecosystems.[3]

***Durability***

“Research conducted by Munster Chamber of Craftson the long therm in-situ performance of mycelium has demonstrated that they are at least as durable as conventional materials and maintain their insulative properties over the course of their life.” When contact with soil, mycelium decomposes slowly over a period of six weeks. Favorable and stable conditions being maintained, lifespan as long as 20 years is being shown by mycelium even when in contact with soil. When exposed to air, mycelium products are made as to last as long as they are intended to be used.[3]

***Carbon Negative***

This is the most vital role played by mycelium in green building construction. Air is filtered of carbon as carbon dioxide both from outside and inside of the building by mycelium products. The main advantage of mycelium is that it can continue to absorb carbon dioxide over its lifespan.[4]

### *1.1.2 Limitation*

Though mycelium blended materials show a huge revolution in the fields of thermal, fire and acoustic isolation and most importantly carbon absorption, it is being limited in terms of load carrying capacity. Mycelium blended bricks can not be used in construction at places where huge load is to be transferred. They should be used only in the walls where much loads are not transferred. Rather, mycelium should be applied as facades, insulating sheets and mats for more efficient results.[2][5]

### *1.1.3 Application of mycelium*

Mycelium based products such as insulating sheets, mats, bricks, facades and clads can be designed according to desired shapes and sizes. Mycelium based insulating sheets are used on the outside walls of buildings as facades and cladding.[4][9] The insulating mats are used on the floors and walls on the inside of the buildings to provide thermal and acoustic insulation within the building. Though mycelium based bricks show good connection between moisture as Relative Humidity(RH) and its mechanical properties, but they have been limited to carry much loads. Thus they can only be used in construction where huge load is not being driven.[6]

## *1.2 Green Energy*

Implementation of green energy system in a building should be obvious to make it self-sustainable as well as regenerative that would prevent pollution to the environment to a great extent. Solar panels should be installed on the rooftops of buildings to make then self-sustainable and reduce the pollution by limiting the use of fossil fuels. Thin transparent solar panel films to be installed on the outer side of window panes which would increase the amount of energy for the buildings.

## 2. Research Gap

Earlier researches have dealt with their flexural strength, their physical properties like thermal conductivity, acoustic insulation, fire resistivity and relation of moisture with its mechanical properties. They lacked the implementation of features, capabilities and limitations together to form different mycelium induced or mycelium based products.Integration of all the properties together to bring out the best and most efficient ways of applying mycelium blended products to minimize environmental pollution by taking the limitations into accounts to find a better way of utilizing mycelium based

products and installing suitable green energy equipment into a carbon negative self-sustainable green building to make healthy life sustainable even in the most polluted cities in recent future have been the main motive for our research.

## 3. Observation and Conclusion

The study revealed that mycelium based products showed efficiency in cleaning air from pollutants by absorbing huge amount of carbon dioxide from the air. Use of carbon negative green building has shown great results by reducing pollution and also absorbing huge amount of pollutants from the environment. Mycelium blended bricks to be used in construction purposes only at walls where minimum load is transferred due to its inability of huge load carrying capacity. Other products like floor mats, wall sheets and facades are highly recommended to be used in buildings in recent future. With its brilliant acoustic, thermal and fire insulating features, it could be a revolutionary step towards a cleaner and greener world. Furthermore, proper and suitable solar panels and films to be installed on the rooftops of buildings and window panels respectively to make the building self-sustainable using green energy. With further upgrades in technologies, cost of materials could be lowered and used globally. Besides, some other features like terrace gardening would promote a better way of living in a cleaner, healthier and greener environment.

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## About the Author

PRATIK NAG received the bachelor’s degree in Civil Engineering from Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar and is pursuing Master of technology degree on the field of Structural Engineering from University of Engineering and Management (UEM), Jaipur.

SUBHRO CHAKRABORTY received the bachelor's degree in civil engineering from Visvesvaraya Technological University in 2011, the master's degree in structural engineering from Narula Institute of Technology in 2014 and pursuing PhD in structural engineering from the National Institute of Technology, Patna. He is working as Professor at the University of Engineering & Management, Jaipur. His research areas include building materials, structural design and construction technology. He has been contributing a lot to the research libraries.

SOUGATA BANERJEE currently working as Research Associate in University of Engineering and Management, Jaipur. He is also a M.Tech scholar. His area of research is Sustainability, Green Technologies, Building Materials and Automation in Civil Engineering. He has contributed 4 publications and 2 patents in his research field.