BIO-COMPOSITE BRICK FROM AGRICULTURAL WASTE AS GREEN BUILDING MATERIAL

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Abstract: In this paper, the environment is getting harmed by various industries and construction is one of the main contributors of pollution in the current scenario. This study, the use of agricultural waste with mycelium as the binder is studied and further research is being done around the world for the sustainable living that cuts the pollution of air and also acts as insulator against heat during extreme weather conditions. The aim is trying to reduce the carbon footprint by using mycelium-based bricks. For this purpose, mycelium bricks are grown, they are not made like traditional bricks. The scope is trying to achieve good compressibility of mycelium bricks depending on the constituent used in the bricks. Further research and work need to be planned meticulously to improve the thermal performance, water resistance and mechanical properties needs to be taken into consideration while manufacturing this particular brick. The utilization of nature which agrees to the condition; favors bio-diversity with minimal effort and does not require heavy workforce or modern material.

Introduction:

Mycelium is the vegetative part of fungus or fungus like bacterial colon consisting of a mass of branching thread like hyphae. Mycelium is a fast-growing organism and one of its primary use is to decompose organic compounds. Petroleum products and some pesticides are organic molecules as they are built on a carbon structure, so they can be a potential carbon source for mycelium. As part of a study, will continue with the potential of this material to make a big difference to the material world. This 100 percentage of the material has been gradually developed across multiple disciplines, with the agricultural and construction industry recently taking interest in its possible implications. Much like wooden furniture indoors it will be strong and sturdy whilst inside, but will break down after being overly exposed outside. The process of producing with mycelium brings a huge reduction in using fossil fuels. Mycelium products can provide other benefits such as termite proofing, it can attract termites but when eaten cause a fungus spore to activate within the termite killing it and creating a fungus whose spores repel other termites. The mycelium bricks are bulletproof and absorb carbon dioxide, making them a sustainable material for the construction of our future buildings.

Literature review:

The binding property of mycelium that is the root part of fungus is used as binding material to form various bio-composite materials which will use as construction material in future. The samples are then kept to grow under observation. Each sample was checked for the growth percentage at various time intervals. The selection of mycelium-substrate was based on the ratio of substrate utilization to the growth of mycelium. They come to know that, P.ostreatus mycelium grown on vine and on apple substrates give the best result among all the samples. They mentioned that there are some more tests are required to conclude the best results. They mentioned that the bio- composite material will be used in future as building material and will have various applications. (Noam Attias, et al. Sept 2017)

Study of growing and testing mycelium bricks as building insulation materials. In this study they prepared and tested alternative building insulation materials. They selected the species of basidiomycete fungi and used to grow mycelium bricks on straw waste. Use of dual needle probes was done to measure thermal conductivity and specific heat capacity. They concluded that, selection of fungal species, growing substrates and growing environment is important. Improvement of growing process should be done. Also, future research is essential in this area. (Yangang Xing, et al. Sept 2017)

Preparation of light weight mycelium brick as green building materials. Following process like spawn (mushroom spores) were collected and placed in PDA. Material for initiating the growth of mycelium fibers from spores. The fibers were transferred into the substrate and allowed then to grow for few days. Substrate and mycelium fibers were further condensed into a mould to form a brick. This brick was burnt to get a strong green building material, mycelium brick. Tests were conducted compressive strength test, water absorption test. They concluded that, this material can be used in constructing may be non load bearing wall until research will get required strength. (Santosh B S et al. 2018)

Preparation of block using rice husk also wheat grains which were passed through incubation process adding it with fungal material also glass fines. Prepared blocks by composite were tested for fire reaction testing and scanning electron microscopy and elemental analysis. The findings of this study show that mycelium composites are very economical alternative to highly flammable petroleum derived and natural gas derived synthetic polymers and engineered woods for applications including insulation, furniture and paneling. (Mitchell Jones, et al. April 2018)

Study of designing with mycelium based materials, following cycle, fungi to base plate growth to natural growth with fibers or particles to shaping to drying to mycelium composite. Tensile test results were plottedusing displacementversusstressgraphbystudy. The present paper explored the journey of master's product design students who searched for product application idea for mycelium based material. Their goal was to provide partial understanding of material growing process. Furthermore they provided at critique on the final outcome of design effort, in comparison to existing mycelium based product applications. (Elvin Karana, et al. 2018)

Study on the strength parameters of bio-composite material using mycelium as binding material. They form the structure of mycelium and the substrate and compressive test was taken on each sample. They observed that the compressive strength is very low. The straw based and mix based sample show a quite well elastic behavior. Sawdust specimen has quite well compressive strength. They also observed some advantageous properties of specimen like, all specimens are light in weight, also they are biodegradable, and renewable also. It cannot be replaced masonry due to low compressive strength. (Ali Ghazvinian, et al.2019)

Study on the utilization of biological growth for the production of mycelium brick rather than expensive manufacturing processes. It gave the manufacturing process as collecting agricultural waste, sterilizing waste, filling the material in the mould, allow the mycelium to grow and then drying the product for killing the bacteria in oven. The author concludes that though the current application of mycelium brick is limited due to growth restricting factors such as temperature, humidity with more research the mycelium bricks can be involved in construction process of building. (Neha Anukia, et al. 2019)

The usability of mycelium brick as replacement against standard modular bricks were studied. For preparation of mycelium bricks mushroom seeds, agricultural waste and water along with chemicals to stop the growth of microbes as the microbes may interfere with the growth of mycelium were used. After the growth of mycelium when the brick became ready it was tested for tests such as efflorescence test, compressive strength test, and water absorption test and the results were compared with standard tile brick. This showed that mycelium brick has better properties than standard tile brick which concluded that thoughithas better properties morestudyis required so as to grow mycelium faster and for utilization of mycelium bricks on larger scale. (Kishan, et al. April 2018)

Study of oyster mushroom by growing it on various substrate which were paddy straw, wheat straw, vegetable plant residue etc. and after the process of soaking, pasteurization, spawning, cropping, harvesting, and growing of oyster mushroom biochemical test were carried and the results of cultivation growth, protein content, lipid content, crude fiber contain, ash content, moisture content, total carbohydrate contain, total metabolizable energy of mushroom when grown on different substrate were given. (Sonali D. Randive 2012)

To evaluate the potential of bio composite material to use as commercial product and packaging material. The bio composite material was prepared by using fungus mycelium as matrix to bind cellulosic plant fibers. Then the physic-mechanical properties of bio composite was evaluated which include specific gravity, surface hardness, water absorption, coefficient of linear thermal expansion and resistance to tension and compression. The study showed that due to favorable properties of mycelium bio composites they can be used for packaging, shipping, and marine floatation application. Also the manufacturing process needs to improve so as to increase the scale of application of mycelium reinforced bio composites. (A. R. Ziegler, et al. 2016)

Conclusion:

Mycelium based bio-composites, as studied in this paper, are potential substitutes for masonry material in architecture with some desirable features, such as their lightweight, bio-degradability and renewability. In this study the compressive strengths of mycelium based composites cultivated using different substrates (saw dust, straw, saw dust + straw) are compared. Pleurotus Ostreatus (Gray oyster mushroom) is used to inoculate the substrates. The effects of using supplements (wheat bran) on the growth of mycelium and consequently on the load bearing capacity of mycelium based composites are also presented. The results show that although the straw-based and mixed specimens show quite well elastic behavior, their

compressive strength was very low to be used in masonry constructions. Moreover, while the saw dust based specimens yield higher compressive strength, they are also not strong enough to replace conventional masonry materials without introducing any reinforcement. Furthermore, the effects of having a variety of substrate sizes during cultivation can be studied. Environmental and process related parameters, such as relative humidity, temperature, and time of cultivation should also sought to be optimized. The process of drying/heating to stop the growth of mycelium and processing techniques can also be investigated.

Research needs:

The Mycelium brick is new concept no Indian standards are available hence detailed study of Mycelium brick is needed. Also the study is required so as to grow Mycelium faster, and to increase the range of application of Mycelium brick. Updating ourselves in this field also plays a vital role as newer techniques might bloom at any time.

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