Growing together: developing a mycelium based functionally graded material

Anastasia Cockerill*
A.cockerill@Newcastle.ac.uk
160377224
Supervisor: Martyn Dade-Robertson

Aims

1. Identify a series of successfully grown mycelium samples with varying material aspects.

2. Produce a Mycelium based composite with a distinguishable material gradient.

Context

As the topic of sustainability has become increasingly important, the architectural industry is beginning to explore the application of fungi based materials within design as they can be produced using very little energy and can be decomposed after use.
Mycelium based materials are made by cultivating mycelium within a mould and then processing (heating, drying or pressing) the final 'grown' product to produce a solid mass with varying material qualities.
Companies such as Ecovative and Mogu are exploring the abilities of mycelium based products and have already produced pure mycelium foam, acoustic panels, and insulation. David Benjamin has taken mycelium based bio materials even further in their 'Hy-Fi' tower. This temporary building used 10,000 mycelium bricks to create a 13 metre tall tower.
By utilising mycelium, I propose that we go further than creating individual prefabricated units with particular material qualities, and instead attempt to 'grow' a single unit with a material gradient which enables different functionalities.

Method

1.Organic material is sterilised

2.Organic material is mixed with Mycelium and placed in mold

3.Unit is then incubated

4.Fully grown composite is then dried

Results

In examining the six substrate samples, all but sawdust held their structure due to the mycelium growth although it is clear that hemp and coffee present the most successful results as the substrate is fully colonised.


Sawdust


Straw


Coffee grounds


Kapok


Luffa


Hemp Fibres

Hemp and coffee substrates present contrasting material aspects. Coffee presents a higher compressive strength due to sample stiffness, and hemp fibres present elastic qualities as samples can be compressed and then retract back to their original state.

By visual inspection under a microscope is is clear that hyphal growth is most dense on coffee grounds compared to hemp fibres

As the density of hemp fibres decrease, the hyphae length increases due to larger air spaces between the organic matter. Increased density of substrates results in increased hyphal bonding and therefore stiffer material composites.

Due to density gradient and material gradient of substrates, the final mycelium based unit has a distinguishable gradient between stiffness and elasticity.


Final functionally graded mycelium unit

Approach

To successfully produce a Mycelium based composite with a material gradient, a series of experiments were carried out:

Substrates identification:
To identify successful substrates with varying material aspects for further experimentation. Six organic materials were used as a substrate for mycelium growth: sawdust; straw; coffee; hemp; Kapok; and, Luffa.

Density analysis:
To identify if the reason for varying material quality was due to the the density of the substrate or the nutrients provided by the substrates. Hemp was divided into three varying densities from fine to coarse, and the compressive strength of samples were then analysed.

Gradient test:
Application of results from previous experimentation. Substrate density gradient and material gradient is produced in a mould before being mixed with mycelium. Unit is then left to grow.

Conclusions

1. The most successful substrates for producing structurally sound samples that present distinguishable material aspects to each other are hemp fibres and coffee grounds.

2. Increased density of substrates results in stronger material composites.

3. By using a gradient of hemp fibres to coffee grounds as a substrate, it is possible to create a Mycelium based composite which has an overall material gradient.