Mycocomposite

Samorost
Inovativní projekt Buřinky

Product sheet

Mycocomposite is formed by combining mycelium with an organic substrate containing cellulose.

Flexural tensile strength	**0.2 kN / 0.05 kN**
Compressive strength at 10% deformation	**1,96 kN**
Tensile strength	**100 kPa**
Fire resistance	E
Thermal and moisture behaviour	16cm of insulation meets the requirements for insulation materials for the construction industry

Biological description

Inputs: reishi mushroom, cellulose-containing substrate
Features: upcycled and biodegradable at the same time

Standards

EN 12390-5 (tension)
EN 12390-3 (pressure)
EN 319 (tensile strength)
EN 13501-1:2019 (combustion)
CSN 730540-2:2011 (thermal-humidity behaviour)

Uses

Construction, design

Benefits and limitations

— Excellent insulation properties
— Self-supporting and lightweight, yet strong
— Naturally surface hydrophobic
— More fire resistant than e.g. polystyrene
— Created from waste and fully degradable
— Beautiful and original structures
— Poor resistance to climatic conditions without treatment

Health safety

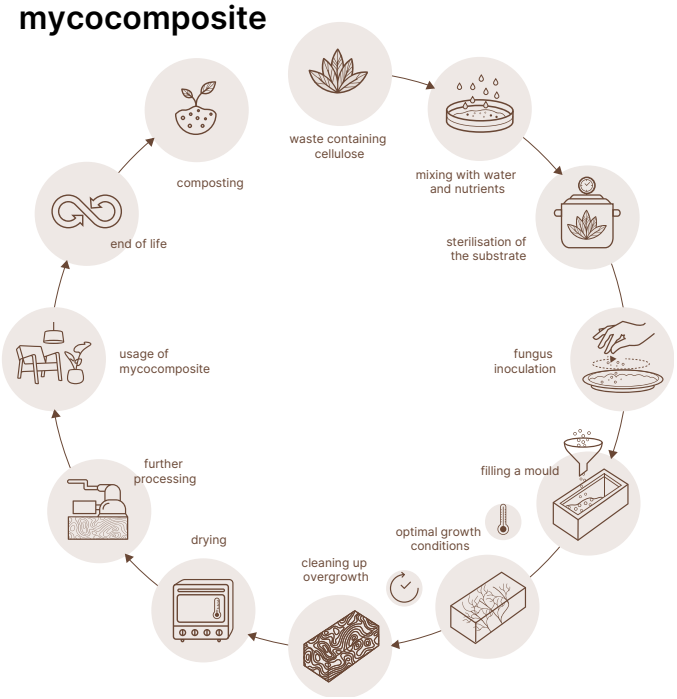
According to the expert opinion of RNDr. Mgr. Jaroslav Klán, CSc., the material is not toxic for humans or animals.

What is mycocomposite

The mycelium is the part of the fungus that grows underground and supplies the fungus with nutrients. It is a cluster of interconnected filaments called hyphae. When the mycelium is placed in an organic substrate containing cellulose, it begins to act as a natural glue. It binds the substrate together and makes it stronger.

The result is a completely natural, compostable and therefore sustainable material with properties suitable for use in construction and modern design. The result is a mycocomposite.

Sustainability and life cycle of mycocomposite



Biological and chemical description

The SAMOROST project uses the following inputs to create a mycocomposite:

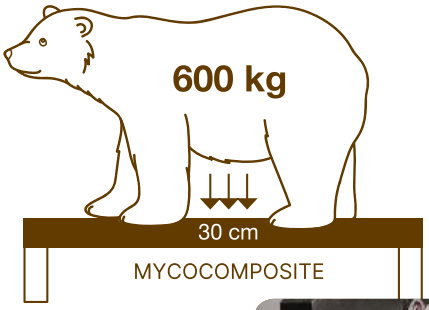
— Mycelium of the reishi mushroom
— Substrates containing cellulose, e.g. sawdust, cardboard or non-recyclable paper

Mycocomposite is an upcycled and biodegradable material.

Physical and mechanical properties

Tension

The flexural tensile test was carried out at the Faculty of Civil Engineering of the Czech Technical University in Prague in accordance with ČSN EN 12390-5. A 4×4×16 cm beam made of mycocomposite was supported at both ends and pressure was gradually applied to its centre by a press until it cracked.



The flexural tension, or flexural strength, tells us how the material will behave if it is used as a beam or girder, for example. This is important for the construction of ceilings and floors. The conclusions will help prevent, for example, everything in the room sloping away from the walls to the centre of the room. What is the maximum load a material can take before it starts to sag and crack?

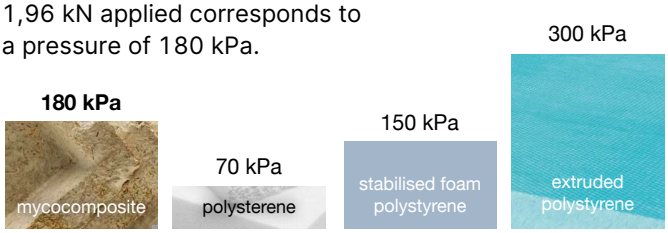
The modulus of elasticity describes the progression of deformation as a function of load.

The properties of mycocomposite are comparable to the strength of cork in this respect. It is therefore stronger than polystyrene but less strong than wood materials. Mycocomposite is not suitable for use as a beam or girder carrying additional loads. However, its low weight makes it self-supporting.

Pressure

The pressure test was carried out at the Faculty of Civil Engineering of the Czech Technical University in Prague in accordance with ČSN EN 12390-3. The test is carried out by gradually applying and increasing the force on a cube with an edge of 10 cm until its deformation reaches 10%.

In order to deform the cube made of mycocomposite by 1 cm, the press had to exert a force of 1.96 kN. This force corresponds to a weight of 199 kg. The testing of mycocomposite is specific. Mycelium shrinks in volume as it dries. Therefore, the cubes were placed in moulds that were 6 mm larger and, when dry, approached the dimensions of 10×10×10 cm. The individual sizes of the cubes were therefore slightly variable and the force of 1,96 kN applied corresponds to a pressure of 180 kPa.



The test results showed that the mycocomposite is more resistant to external pressure than both ordinary polystyrene and stabilised polystyrene foam. Only extruded polystyrene shows better results. Plain polystyrene is used to insulate the facades of houses, stabilised polystyrene foam is suitable for insulating floors and extruded polystyrene is used to insulate pitched roofs. Mycocomposite therefore has the potential to become an environmentally friendly substitute for polystyrene in this case.

Tensile strength

The tensile strength test was carried out at the Mendel University in Brno in accordance with the ČSN EN 319 standard. The tensile strength test demonstrates the internal cohesion of the material. How much force is needed to tear apart the material. It shows, for example, whether two boards glued together will tear sooner inside the material or in the glued joint. In practice, these results are related, for example, to the method of mounting on the wall.

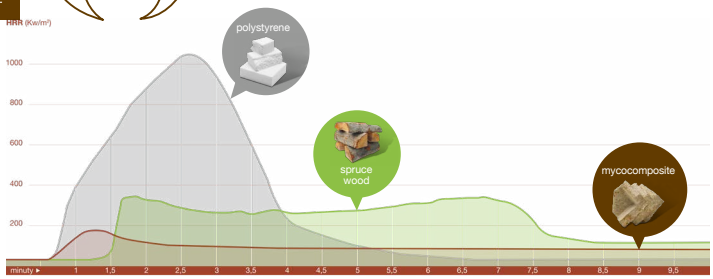
In order to split a mycocomposite board with dimensions 42×400×600 mm, a pressure of 100 kPa was required, which is similar to the case of 70F facade polystyrene.

Burning

The burn test (category E) was carried out at the Institute for Testing and Certification in Prague in accordance with ČSN EN 13501-1:2019. The burn test determines whether and how the tested material contributes to the spread of fire. The test confirmed the basic fire classification in category E.

The burning process of mycocomposite is most similar to wood. However, the fundamental difference is that wood burns easily and quickly, whereas mycocomposite gradually delaminates and loses its strength qualities more slowly. Thus, in the event of a fire, mycocomposite will provide a longer time to evacuate from a burning building. The material does not drip or spray hot droplets into the surroundings when burning.

In addition to sustainability, increased resistance to burning is one of the most important features that distinguish this revolutionary material from those currently used in the construction industry.



Vapour permeability

Testing of mycocomposite cladding for thermal and moisture behaviour was carried out in accordance with the ČSN 730540-2:2011 standard at the UCEEB CTU in Prague.

Two possible compositions of the mycocomposite wall were tested in a climatic double chamber. This is a device that simulates both the conditions inside one side of the building under test and the conditions on the outside of the wall exposed to the climate.

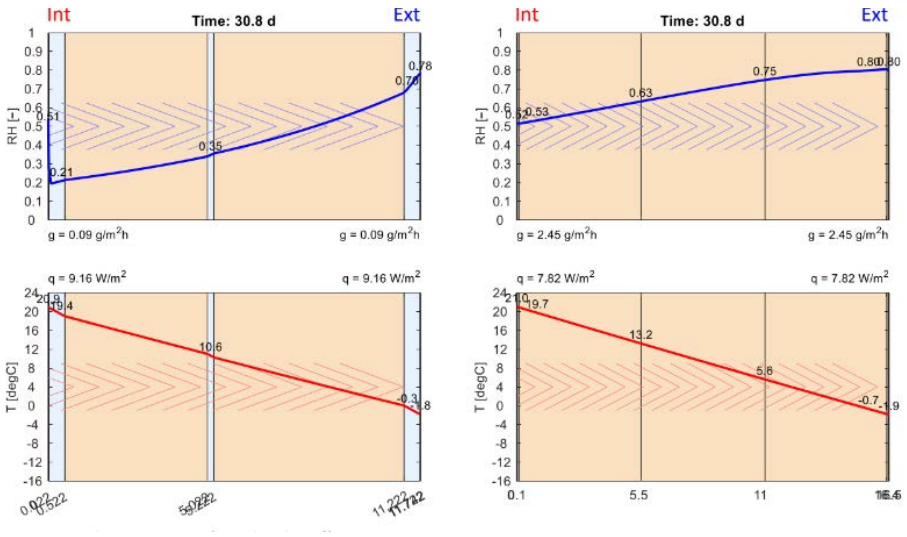
The first composition consists of three mycelial plates whose surface has been treated with chitosan. This was applied after plasma treatment of the surface of the plates to improve surface adhesion and bonding of the applied layer to the underlying mycelium in order to increase resistance to water vapour permeation, reduce the risk of growth of unwanted micro-organisms during vapour condensation and also reduce spatial changes caused by swelling of the material.

The second composition also consisted of three mycelium plates, but the composition was protected on the outside by a safety, diffusion-open insulation, while the interior was protected by a vapour barrier. An environmentally friendly paper-based diffusion-open insulation and a natural jute vapour barrier were used. This composition was designed with respect to the classical composition used in wooden buildings.

Both compositions were in a climatic double chamber for one month. The test started at a controlled temperature of 22 °C and 50 % humidity. Subsequently, the temperature in the exterior section dropped to -3 °C and 70 % humidity, followed by a further temperature drop to -15 °C.

The results showed that mycocomposite is a sufficiently efficient insulation material for building construction in our climatic conditions and achieves the values required by the standards. Insulation 16 cm thick achieves the required heat transfer coefficient of 0.3 W/(m2*K) for external walls, 24 cm of insulation meets the requirements for a low-energy house and 27-41 cm of insulation achieves the passive standard.

Profile of relative moisture and temperature in January: composition 2 with foils vs. composition 3 without foils



Here you can see the effect of the vapour barrier on the relative humidity. In the first graph, the water vapour concentration decreases rapidly and then gradually increases.

Weathering effects

Testing of the mycocomposite for weathering was carried out by our own experiment. We installed the boards on a wooden structure and placed this structure outdoors. The material was exposed to weather conditions for two months.

The panels were noticeably damaged by fungus and mould after a given period of time. Although this was not a deep infection, the test showed that mycocomposite is not suitable for exterior use.

Summary

The mycocomposite has been tested in accordance with the following standards:

EN 12390-5 (tension)
EN 12390-3 (pressure)
EN 319 (tensile strength)
EN 13501-1:2019 (combustion)
CSN 730540-2:2011 (vapour permeability)

Use of mycocomposite

Construction

The results of laboratory testing have shown that mycocomposite can replace almost any polystyrene in the construction industry: for insulating external walls, roofs, floors and interiors, for eliminating thermal bridges and for sound insulation. In addition, it shows far better results in combustion tests. It is more durable, does not spill hot droplets or drip. This provides greater protection when evacuating a burning building. Its greatest strength is that it is made from waste and is fully degradable. But it also has other key features. It is lightweight yet strong, self-supporting and surface hydrophobic. Mycelium-based material is the future of sustainable construction.

Design

In addition to its biological and physical properties, mycocomposite has something more. It is an original and unique structure that always creates new and visually beautiful surfaces. It is therefore also appropriate to use this material in modern design.
The SAMOROST project has used this property to create a collection of furniture and interior accessories.

Benefits and limitations

The main advantages of mycocomposite with regard to its use in construction and design can be summarised as follows:

— It has excellent insulating properties
— It is self-supporting and lightweight, yet strong
— It is naturally surface hydrophobic
— It is more resistant to fire than e.g. polystyrene
— It is made from waste and is fully degradable
— The surface forms beautiful and original structures

Restrictions:

— Without treatment, it cannot withstand the effects of climatic conditions

Safety information

Health safety

Mycocomposite is completely safe for humans, which is proved by the expert evaluation of leading Czech mycologist RNDr. Mgr. Jaroslav Klán, CSc., an expert in the field of construction (wood-boring fungi in buildings), health and toxicology (poisonous fungi and plants) dated 3 January 2023.

The overall conclusion of the evaluation is:

The submitted material, mycelial plates obtained by growing the wood-boring fungus reishi on spruce sawdust, is not toxic to humans or animals. The material cannot release allergenic diaspores. Volatile irritants are also not present. Boards produced using the mycelium of the wood-boring fungus reishi cannot harm human health during the production process or as a final product.

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