THE MATERIAL OF THE GODS

LOW-TECH BECOMES HIGH-TECH: *Sooner or later, natural materials such as bamboo and straw could replace concrete, sand and steel as building materials.*

Nobody watching a panda enjoying its young bamboo shoots would ever even think that this animal's favourite food could potentially be the building material of the future. And yet the use of bamboo for building is actually old hat. Centuries ago, Thailand, Columbia or Indonesia already built houses, palaces and even entire cities from the gigantic canes of the sweet grass plant, which predominantly grows in tropical regions around the equator. Although bamboo is a highly renewable raw material, the use of steel, glass and concrete has taken over in the construction of new buildings in these areas too.

What this development beyond facades can lead to becomes clear with the example of Ethiopia, where about 70 percent of all African bamboo stock is found: "Almost 80 percent of the considerable Ethiopian government deficit arises from the import of cement, steel, glass and machines that can process these materials", states a slightly concerned Professor Dirk Hebel from the research project Future Cities Laboratory of the ETH Zurich. "Taking a look at steel imports alone, you will discover that only two of all of the 54 African countries produce steel at all: South Africa and Egypt." All in all, sand and steel resources are dwindling. A fully-fledged trade war has broken out for sand, which used to be a ten-a-penny commodity, because increasing urbanism has resulted in a need that is hard to satisfy. For example Singapore, due to its exhausted sand deposits, has recently started to help itself to the holiday beaches of Malaysia, Indonesia, Cambodia and Vietnam – often even illegally.

Such developments have certainly encouraged Hebel and his colleagues to test the material properties of the robust bamboo grass. The result: Bamboo combines extreme hardness and high compressive and tensile strength with a high level of elasticity and low weight. The reason lies in the plant's constitution. As opposed to classic tree wood, where stability increases from outside to inside, bamboo behaves in exactly the opposite way – the hardest layers are on the outside. A further advantage is the high silicate content of the outer layers, which ensures fire resistance.

"Green steel" on its way to market maturity

Dirk Hebel and his researchers have been working for a long time on a building material that doesn't necessarily look like bamboo, but that combines all of the positive characteristics of this giant grass. For this, the extract of the stripped plant is mixed with a special resin gained from vegetable oils and subsequently pressed into a new shape. "The first tests were sobering: The material had far poorer properties than the original bamboo. Today, ten months after opening the laboratory, we are able to manufacture a material that has the same tensile strength as structural steel", says Hebel. Although the method is not really new, it is far more environmentally compatible than the chemical epoxy resins used to date due to the use of natural resins. The result: "Green steel".

Architect Georg Bechter *used straw as an insulating material for the straw house in Dornbirn and also for the supporting structure.*

The globally increasing demand for buildings and infrastructure requires a rapid change of attitude in terms of building materials and natural resources.

The fact that bamboo was for a long time considered as the building material of the poor, whose houses frequently collapsed after a while, is attributable to the susceptibility of the untreated stalks. Due to their high sugar content, they are literally easy prey for bacteria, termites and other pests. Rain too does not actually contribute to the durability of the buildings. This problem, however, can be solved by waterproof roofs. After harvesting, bamboo canes always need to dry for about 20 days. They are then submersed in a solution of water and the wood preservation agent borax, a natural mineral, for several days. This treatment gives the material a similar durability to conventional building industry products and also protects it from its predators.

Taking into consideration that the world population is expected to rise by about 2.5 billion by 2050, it isn't hard to imagine how the need for buildings and infrastructure will grow. And of the total of 9.6 billion people, 86 percent will presumably live in the less developed regions of the globe. The population growth rates in the cities in particular will explode. And apart from the scarcity of resources, this will also be a problem in terms of sustainability. And it is here that bamboo scores points as a perfect example of environmental compatibility: Due to its rapid growth, it binds tremendous quantities of carbon dioxide and produces more oxygen than many other plants. The widely spread roots also prevent soil erosion. Due to this multitude of positive properties, it is understandable that the Columbian architect Oscar Hidalgo-Lopez referred to the versatile grass in his encyclopedia, published in 2003, as "The material of the Gods".

Thick skin, flexible core – the straw bale house

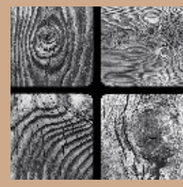
Whether straw is also a material of the gods or not is yet to be seen, but it is a fact that sustainable buildings can also be produced from this highly renewable raw material. The Austrian architect Georg Bechter presents such a building with his straw bale house in Dornbirn, a small town in the Vorarlberg region. The concept is extremely simple: The straw bales are stacked on top of one another and plastered on the outside with lime and on the inside with clay. The wooden roof construction is also insulated with straw. The load-absorbing straw walls do not need a wooden body and at the same time ensure optimum thermal insulation thanks to their stability and a thickness of 1.20 metres. This procedure reduces the requirement for technical building services to a minimum, completely eliminating the need for heat pumps and heating circuits, since a simple tiled stove inside the house is sufficient to heat the entire building. And if some day the house has reached the end of its service life and needs to be replaced with a new one, expensive disposal costs do not occur, since the entire straw wall construction is compostable.

Madrid-Barajas Airport (2006): *The extensive use of bamboo for the cladding of the curved roof structure gives the terminal an appearance of lightness and transparency.*

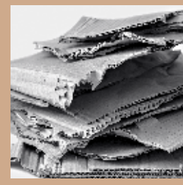
Light-flooded cardboard transition cathedral *in Christchurch, New Zealand. The Japanese paper architect Shigeru Ban has recently been honoured with the Pritzker Award.*

ALTERNATIVE **MATERIALS**

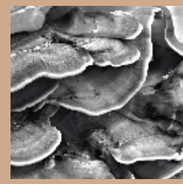
Bamboo and straw are not the only low-tech alternatives to conventional **BUILDING MATERIALS** *such as steel and concrete.*



WOOD: In the last few years, ecologically-oriented architects and engineers have considerably extended the design possibilities with the traditional building material. Examples are the Welsh parliament in Cardiff by Richard Rogers or the planned 34-storey building in Stockholm without nails and screws by the Swedish architects Berg/Möller.



CARDBOARD: Initially, cardboard buildings were only intended for the fast construction of emergency shelters after natural catastrophes. The Japanese architect Shingeru Ban, winner of the Pritzker Award 2014, is today considered as the master in the field of provisional buildings. However, his buildings do not have a long service life. His transition cathedral in Christchurch, New Zealand, from 2011 today shows signs of water damage despite several layers of lacquer.



FUNGI: Although nobody wants fungi in their building, they are beginning to find use as a construction material in innovative projects. Fungi panels are ideally suitable as insulating materials. Walls, ceilings and entire houses can be built from fungi panels. The fungus grows on agricultural waste and is compostable after use.

WASTE: Building with things that others have thrown away is not only a concept with a future for poorer regions. Disused consumer goods such as plastic bottles are ideally suitable for house walls. And windows, bricks, battens and laths from older houses can also be used again. Recycled materials play an increasingly important role.