How termites 3D print their homes

Although additive manufacturing is currently being hailed as a ground-breaking innovation, termites have been using this method to build their enormous mounds for millions of years.

Termites use sand, clay, and soil to construct their three-dimensional nests in layers. They then harden these structures with their saliva. Though a computer program must be used to control laser-hardening for technical 3D printing, termites are genetically predisposed to working with the necessary construction data.

“The mounds provide a home for around 2’000’000 termites.

There are well over 2’000 species of termites. And they build a wide range of nests – from ones the size of a soccer ball nestled beneath the Earth’s surface to gigantic, cathedral-like structures reinforced by a myriad of small towers. For example, African Giant termites build residential complexes that measure up to seven meters in height with walls that are between 30 and 60 cm thick and as hard as cement. Each of these complexes is home to around two million termites. Because termites are just a few millimeters in size, they are dwarfed by their homes. The equivalent for humans would be a structure the size of the Matterhorn, with enough space inside to house two million people.

Refined architecture

Termite mounds are built on top of large “cellar” vaults that extend meters below the ground. Columns extend upwards from the cellar floor; with the help of intermediate floors, they support the nest above. Meanwhile, the “attic” opens up onto another large, hollow space. There is a rock-hard chamber at the heart of the termite mound that looks like a giant potato with a few

Fig. 1 Worker termites serve the termite queen.

Fig. 2 Mounds of compass termites in Australia are oriented along the north/south meridian.

small holes bored into it. This is where the blue bloods live in captivity for their entire lives: A king just a few centimeters in size rests beside his queen, whose abdomen is swollen like a sausage. The queen (Fig. 1) acts as a breeding machine, laying an egg every one to two seconds. Over the course of twenty years, she gives birth to several hundred million descendants.

To meet their nutritional needs, the workers gather wood and plant material from their surroundings. Once they have digested their food, they layer their dung along the interior of the mound, creating compost heaps. Mushrooms grow on top of the compost. These secrete enzymes that break down cellulose. This, in turn, creates fortified food that is rich in vitamins and an excellent source of protein. The workers continuously gather small white mushroom heads from the mushroom crops on the compost heaps and use these to feed their young. The queen and king are fed a pulp made from the fortified compost, as are their coterie of soldiers, who can not chew due to their massive jaws.

Regulatory air-conditioning technology

Making mammoth termite mounds livable requires sophisticated building techniques. After all, thousands of liters of fresh air need to be fed into the mound each day, and the carbon dioxide produced by the termites and the mushrooms needs to be discharged. To meet both of these needs, the outer wall of the termite mound is built with a rib-like structure. A large number of air ducts are constructed just below the surface of the ribs, running from the mound's attic to the cellar. The warm air that rises at the center of the mound flows laterally out into the ribs at the attic and slowly sinks down through the ducts.

During the process, oxygen gets in from outside the mound, and carbon dioxide produced inside the mound is discharged into the surroundings. The regenerated air then collects in the cellar for its next trip through the nest. So that the air inside the mound remains at a comfortable 30 °C (86 °F) day and night despite significant vacillations in exterior temperatures, worker termites ceaselessly close or open parts of the air ducts with the standard building material.

Clever geographical optimization

The compass termites of Northern Australia demonstrate how efficiently these animals can adjust their air-conditioning technology to respective geographic conditions. This species needs to be prepared for temperatures that sink as low as 5 °C (41 °F) at night and reach tropical heights of 33 °C (91 °F) during the day. To cover both ends of the spectrum, compass termites construct a particularly striking type of nest. Its base contains a structure that looks like a slit eye, the longitudinal axis of which is precisely oriented along the local north/south meridian (Fig. 2). The mound tapers towards the top, forming a narrow ridge at the peak. All in all, the mound looks like the upward-facing blade of an ax that is lying on the ground. When the sun rises each morning, the entire broadside of the mound is exposed to its rays, giving the termites inside the warmth they need. At the sweltering midday, though, the sun is positioned above the narrow edge of the mound, which protects the nest from overheating.

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