FEATURE

TECH TALK – Termite Structures

A closeup look at one of our most important structural pests

Steve Broadbent

We have all observed termites building galleries, bivouacs and colony mounds using clay or 'mudding'. In some cases, we see termites, especially *Coptotermes* spp., place this clay to fill-in their excavations in timbers and trees. Have you ever stopped to wonder why? Generally, we have tended to accept that termites are master-builders and they build mud galleries to remain hidden.

We know that termites apply a mix of clay, saliva and faecal material to create these above-ground galleries and mud tubes, to hide the foraging workers and soldiers; and to create their mounds and bivouacs. In these situations, the clay clearly functions as a structural building material. However, the clay found inside hollowed wood does not appear to serve any structural or concealment purpose beyond, in trees, perhaps being a waste dump for the soil they remove when excavating underground tunnels.

Since moving clay is physically demanding, it is a behaviour that in nature, according to the rules of Darwinian evolution, should be selected against; since there appears to be no adaptive benefit. Why do subterranean termites expend this energy? With this in mind, stimulus was provided for a multi-disciplinary team to ponder why this behaviour is occurring and find out how the termites benefit from it.

Cellulose is one of the most abundant compounds in nature, with termites among the few organisms able to digest it. Some of this cellulose is under weight-bearing load, especially if it is located near the ground, where subterranean termites are most active. Subterranean termites generally eat wooden objects from the ground up, whether we consider logs, trees or buildings. We have all observed how termites hollow out trees from the root upwards, to create an inner core that is then often filled with mud.

The team considered that if termites ate a log or a standing tree low down, it would likely be structurally damaged, which might lead to its collapse. This would not be good for the termite colony. Which is perhaps why we rarely see trees destroyed by termites. In fact, in southern Africa, we often see healthy trees growing through the termite mounds that have been built around them.

Our buildings offer a similar situation, which perhaps explains why termites seem to avoid seriously damaging wood under load. Whilst we see extensive damage in some buildings, we rarely ever see a building that has actually fallen to the ground, or a roof that has fully collapsed due to the direct action of the termites. Most frequently, especially in the early stages of termite attack, we find termite damage is in timbers in low traffic areas, or in decorative or non-structural timbers such as window frames, skirtings, floorboards or in cavity walls. Termite activity in load-bearing timbers (bearers, joists, etc.) usually only appears once the colony is well established. We also routinely notice termite cartoning is present in these weight-bearing timbers.

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It is well documented that termites employ vibrational sounds. Worker termites use vibrations to determine how large a piece of timber is, to determine their location and to recognize their nest mates; while soldier termites use sounds to alert the colony to possible dangers. We have all heard the clicking of soldiers in galleries when disturbed.

Since denser or heavier timbers under load will have different vibrational characteristics; just as drums provide different vibrational sounds depending on how taut the drum skin is, or the size of the drum. The team therefore considered that termites might assess the weight load of the timber using vibrational acoustics and then use the clay to support the timber structurally, allowing them to consume the wood safely.

Working with *Coptotermes acinaciformis*, trials were established in the field and in the laboratory using paired groups of timbers, under load and without load.

Significantly less mudding was produced in timbers that were without any weight load. The mudding was very brittle and thin, less than 1 mm, and unable to support any weight. It just crumbled under gentle pressure. This was referenced as 'sheeting'.

In the timbers under a weight load, the mudding was more than 10 mm thick and relatively strong. This was referenced as 'walls'. In all the trials, the termites consumed significant amounts of timber, with more than 90% of the timber in the field trials eaten away over the 12-months' period of the trials.

Complex data analysis showed quite conclusively that the termites had substituted the timber eaten in the timbers under load with a closely similar amount of clay. It was also shown, through laboratory observations, that the termites commenced foraging in an exploratory fashion before they started to feed on the timber, and only once feeding was well established did they start to 'support' the timber under load with mudding.

There has been much research showing how termites identify different types of wood, based on the presence of various chemicals found in the different species of timber and the density of the timber. This is the first time though, that it has been shown that termites can recognise wood under load.

It is evident that the termites were able to determine whether the timber was bearing a weight load or not, and then react behaviourally in different ways, depending on their analysis of the timbers. The studies showed there was a clear preference for the more energy efficient option of consuming the no load timber before advancing upon the timber under load. This is as we observe in buildings, as mentioned above, and it fits with evolutionary modelling of adaptive behaviour. They take the most energy efficient feeding options first.

It is however apparent that the energy expended in structurally supporting timber under load with clay is offset by the amount of energy the termites get from eating the timber. So, the termites then start to exploit this load bearing timber too, replacing it with clay. Clay has very desirable building properties since it is low-shrinkage, waterproof, and very stable; which is why it has also been used by humans for thousands of years to build our homes. Even today we still use clay bricks.

The ability of *Coptotermes* to utilise clay in this manner allows them to access timbers in a manner that likely provides them with an evolutionary advantage over other 'lower termites' in the Family Rhinotermitidae. There are four species of *Coptotermes* that build mounds. The only other mound-building termites are the 'higher termites' of the Family Termitidae. From an evolutionary perspective, we know that the genus *Coptotermes* is the sister genus to the Termitidae (e.g. *Macrotermes* spp. and *Odontotermes* spp.). The latter are the most evolved and successful termites.

This work suggests that this ability to make use of clay was an important step in termite evolutionary development. ■

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