

## **Analysis of building materials damageable by termites in Hong Kong**

By

Shing Kwong Cheng and Siu Kin Ethan Cheung

City University of Hong Kong, Tat Chee Avenue, Hong Kong SAR, China

The Tenth Conference of the Pacific Rim Termite Research Group

Kuala Lumpur, Malaysia

26 February – 27 February 2014

### **Abstract**

The invasion of termites has always been a problem for humans and the troubles they make can cause a huge economic loss. So, there is a need to recognize what kinds of building materials can be damaged by termites so that when making a choice of building materials, this should be one of the factors to consider. For example, we may choose materials having a high resistance to termites for construction. Or, we may do some treatment to materials to enhance its resistance to termites. In this study, we focus on termite-damageable building materials and compare this with what we know about termite biology. By knowing the ecology of termites, we can have a better understanding of why some materials are more severely damaged. As *Coptotermes formosanus* is the most common species found in South China, this study mainly focused on *Coptotermes formosanus*. In order to get more information on termites, three groups of invited termite experts were interviewed.

**Key words:** severity of damage, *Coptotermes formosanus*, hardness test, wood, plastics landscaping

### **Introduction**

Termites have always been the most destructive insect pests in Hong Kong, owing to favorable temperature and humidity. The aim of this research was to collect data about materials damaged by termites; thus, to identify which materials are most susceptible to destruction by termites. Another aim was to analyze the severity of damage done by termites, such that it is expected to help discover the factors that influence infestation of buildings. Building replacement costs are high, the earlier the discovery of an invasion of termites, the less the economic loss. In terms of impact on buildings, termite infestation can affect the structural safety of the building, in particular timber structures and heritage buildings. Also, it can affect the appearance of the building.

Termites are a relatively wide topic. So, this research focused on damageable building materials and its analysis. In order words, the context of the research included the materials that are damaged by termites. In this research however, whether termites damage the materials for digestion or damage the materials by chance was not distinguished. By recording the damaged materials systematically, it

is expected to conclude the resistance to termites of different kinds of materials; hence, suggesting which kinds of material has the highest resistance to termite. The method used for this research was to combine what is in the literature and the knowledge gained from interviews with relevant authorities, in order to give recommendation for which kinds of construction materials are preferable in resisting termites.

### **Factors**

A building can provide food and present a habitat for termites and as a start it is useful to recognize common building materials. Termites need cellulose for digestion but not all building materials have this essential ingredient. The Hong Kong Standard Method of measurement of Building Works – Fourth Edition (HKSMM, 2005) defines and includes all types of building materials commonly occurring in Hong Kong. The classification includes excavation, concrete works, brickwork and block work, drainage and underground pipe duct, waterproofing, stone work, roof tiling, wood works, ironmongery, steel and metal works, plastering and paving, mechanical installations, electrical installations, communications, security and control systems, glazing, painting and landscaping. For the purpose of this discussion these seventeen types are further sub-classified into hard materials: concrete works, brickwork, marble and granite, structural steel, wall claddings, suspended ceilings, curtain walling, pipework, gutter, ductwork, glazing, acrylic and polycarbonate sheet and glass wall lining. And a second subdivision for non-hard materials: timber formwork, sheet membrane waterproofing, felt roofing, structural timber, flooring, doors, frames and linings, furniture, fittings, shelving racks, playground equipment, insulation material, conduit and cables, paperhanging, turfing, planting and boulders. The non-hard materials are usually susceptible to termite attack although hard materials can also be at risk.

The destructive power of termites is different under different circumstances. Thus, by creating an unfavorable environment to them, we can reduce and control the damage done by termites to materials. These four factors, i.e. temperature, humidity, light and gas directly affect the behavior of termites.

Termites and Temperature: For *Coptotermes formosanus*, Li (2001) states that the most suitable living condition for termites are temperature within 25°C to 30°C. The minimum temperature that the termites can withstand is -3°C. According to Skaife (1954), in between 12°C~30°C, the crawling speed of termites increases with increasing temperature.

Termites and Humidity: All living things on the Earth need water in order to survive. There is no exception for termites. In general, termites can acquire water from the ground, soil or timber. The nest of *Coptotermes formosanus* is usually located near the washroom, bathroom, sink or other places with a water supply. Li (2001) indicates that the average water content of the nest of *Coptotermes formosanus* to be around 33.3%.

Termites and Light: According to Skaife (1954), the place where termites live is always in darkness. Termites live in darkness from generation to generation. Marais (2010) states that, , the soldier and worker termites of *Trinervitermes* are all blind. Except alates, most termites are afraid of exposure to light. On the contrary, alates are attracted to light. The alates of *Coptotermes formosanus*, which are the prospective king and the queen of a new nest, often swarm during nightfall after a rain.

Termites and Gas: Li (2001) says that the carbon dioxide (CO<sub>2</sub>) content inside a termite nest is relatively high. For the nest of *Coptotermes formosanus*, the CO<sub>2</sub> content is 0.5% ~ 6.5%. For the nest of *Macrotermes*, the CO<sub>2</sub> content is 0.6% ~ 2.8%. The carbon dioxide in the Earth's atmosphere is around 0.039%. It shows that termites can tolerate a condition of high carbon dioxide content environment.

## Results and discussion

The Formosan Subterranean Termite, which is also known as *Coptotermes formosanus*, is the most infamous termite species in Asia. In Asia, probably most termite damage is caused by *Coptotermes*. In Hong Kong, there are 34 termite species in natural areas. However, most of the damage to buildings in Hong Kong is caused by *Coptotermes formosanus*.

In regard to *Coptotermes* species, several of them are able to develop huge colonies, while their foraging tunnels can extend up to 100m in length. Therefore, a single colony can reduce the woodwork of a whole block of houses into hollow skeletons within a couple of years. They are able to chew through plastic, foam insulation, copper, and asphalt to get food, which not only comprises wood, but also paper, cardboard or anything containing cellulose.

In general, the most frequently damaged indoor materials include non-hard materials as in door and window frames, wooden skirting, wooden flooring and wooden furniture like cabinets and cupboards. In heavy infestations, termites can attack wooden roofing, or even bite through cable and conduit in the wall. Outside buildings, *Coptotermes* are capable of attacking live trees, and this process may take a long time before the tree dies. One of the reasons why *Coptotermes* is most destructive is, they have the ability to replace their queen and king with secondary reproductives.

Li (2001) states that termites are capable of boring into underground plastic electric cable casings and electrical equipment. In South China, it is common to find that termites bore into underground electric cable casings and hence lead to power failure. In Hangzhou, there is a case that a 6-km length of underground electric cable made of PE (polyethylene) was destroyed by termites. In fact, because of destruction by termites, plastic electric cable casing can only function around 2 to 6 months after burying underground. And all this damage to plastic electric cable is done by *Coptotermes*.

In addition to plastic electric cable casing, wooden bridges used in gardening and wooden electric light poles are also the target of termites. Without any treatment to increase the resistance to termites, wooden electric light poles will be totally bored by termites. Termites also damage crops like cane, peanut, corn and wheat etc. *Coptotermes* are able of damaging trees resulting in an empty trunk.

### **Interviews with the relevant authorities**

Authorities on termite were interviewed or enquired into. They are Professor Junhong Zhong, Dr Partho Dhang, Dr Michael Lenz and Mr Paul Yuen. For a long time, the Guangdong Entomological Institute is an institute of endangered animals located in South China. It is also the only institute retaining termite research. It has the largest number of termite specimens with over 30 thousand termites. The Institute now has five *Coptotermes formosanus* nests with an age over 17 years. Those nests provide a steady source for research on termites. Professor Zhong asserts that although plastic is not a cellulose material, if it constitutes an obstacle to termites for finding food and water they are capable of damaging plastic. It is common to find polyethylene and polypropylene pipes for transporting gas damaged by termites.

Dr. Lenz states that there is a Shore D hardness test, which is a measurement for the resistance of a material against penetration of a needle under a defined force. It is determined as a digit from 0-100. The higher the number, the higher will be the hardness of the material. In general, for a PVC pipe, a Shore D hardness value of 80 is considered termite resistance.

Actually, termites are not capable of damaging hard building materials such as steel, glazing, porcelain, concrete and stone. Nevertheless, owing to their small stature, termites can penetrate these materials through small cracks. In a building lacking maintenance, it is not uncommon to find cracks in concrete beams, walls, etc. As termites penetrate these cracks they will leave traces, such as mud that can lead people to think termites made the cracks. In fact, this is not the case.

According to Dr Dhang, he postulates that the presence of landscape features is also a factor that will affect the severity of damage done by termites. He concludes that landscape and gardens around structures could serve as a source for moisture and food attracting termites to the area, indirectly making the structure prone for attack.

Mr Yuen adds that seasons, temperature, humidity and water source will affect the severity of damage by termites to materials. He asserts that in urban area, *Coptotermes* is the most destructive. However, in rural area *Odontotermes* is more destructive. He also says that the duration of infestation of termites cannot be estimated accurately because it can be affected by many factors.

### **Conclusions**

The literature review found that there are several factors affecting the severity of damage done by termites to materials. They include temperature, humidity, light and gas. The ideal temperature for termites is between 25°C to 30°C. It is coherent with Zhong's opinion that the ideal temperature for termites is 20°C-35°C. The other two experts on termites also pointed out that environmental conditions such as season, temperature, humidity, location, presence of landscape are also factors affecting the severity of damage done by termites to materials. Therefore, combining the literature and opinions from experts on termite, we can conclude that temperature, humidity, water source and

light are the main factors affecting the destructive power of termite.

As for the list of termite damaged materials, we can place them into four categories: crops, wooden materials, plastics and metal.

Crops	Canes, peanut, corn, wheat, coffee, tree, landscaping
Wooden materials	Formwork, doors frames, cupboard, flooring, skirting, cabinet, etc.
Plastics	PVC, polypropylene, polyethylene
Metal	Copper cable, aluminum cladding

In general, it doesn't take much to realize that wooden materials, such as cupboards, door frames, paper, wooden floors, skirting, etc., are the food preferred by termites. It is because these materials contain cellulose that termites need. Therefore, it is understandable that these cellulose-containing materials are damageable by termites. However, in order to obtain their food, termites are capable of destroying materials like plaster, PVC pipe, electric cables etc. Even some soft metals, for examples, lead, copper, aluminum, are damageable by termites. PVC pipe with a high Shore D hardness value (above 80), is termite resistant. However, if scratches are left by whatever reason on the surface, it provides a loophole for future attack by termites and under this circumstance, PVC gas pipes can be penetrated.

One point that is worth mentioning is termites are not able to damage concrete. And concrete itself has a very high resistance to termites as long as no cracks occur on the concrete.

### References

- Li, G (2002), *Termites and Their Control in China* (in Chinese) Beijing: Science Publication
- Marais E (2010), *A Chinese Translation of The Soul of the White Ant* originally published in 1937 in Afridanns: Owl Publishing House
- Skaife, S (1954), *Dwellers in Darkness - An Introduction to the Study of Termites*
- Su, N and Scheffrahn, R (2000), *Termites as Pests of Buildings*, in Abe, T. et al. (eds.), *Termites: Evolution, Sociality, Symbioses, Ecology*, 437-453 Netherlands: Kluweer Academic Publishers.
- The Hong Kong Institute of Surveyors (2005) *Hong Kong Standard Method of Measurement of Building Works – Fourth Edition*, Hong Kong: The HKIS