TERMITES AND ITS MANAGEMENT

Dr. B.S. Rawat* and Vineet Malik
Scientist –in- Charge*
Building Pests and Mycology Laboratory
Central Building Research Institute, Roorkee-247 667
Uttaranchal, India

The cost of building construction is increasing by 50 % over the normal inflation due to hike in cost of basic building materials and labour. Today, construction industry has entered into a revolutionary phase. Computer- aided-design, efficient and versatile machinery, highly sophisticated equipment, tens of kinds of concrete, amazing grades of cement, steel and eco-friendly substitute to the conventional materials are fast playing a pivotal role in changing the construction scene around the world. Yet, in India, the old and traditional line is being toed. Results: wastage, leakage, cracks, dampness, efflorescence and termite attacks.

One can not imagine his dream-house without wood , paper and cloth (the cellulosic materials). Wood is one of the most valuable commodities in the world commerce. Natural beauty and physical characteristic of wood are such that it has always been used as building materials both in homes and in commercial premises worldwide. Timber is probably the most versatile substance used by man everywhere in the world for the construction of building, furniture, boat , ship railway sleepers, and tramission poles, etc. The houses made up of wood and bamboos are preferred in earthquake prone countries. About one third of the timber produced worldwide is lost due to various biodegrading agents; termites are one of them. (Fig.1)

It is impossible to build structures so termites cannot cause damage. In fact timber has many advantages over the materials: for examples – it is easy to cut and shape , it has great strength for its weight and size and it is aesthetically pleasing to look at and to touch.. Worldwide demands for timber are steadily increasing as the population grows and more homes and furniture are needed. In U.S.A. alone, a large amount of wood is required as 2.5 –3.0 million new homes are built each year. Resistant verities of the timber are also exists, of which only heartwood is resistant. No timber is 100 per cent immune to termite attack because wood decaying fungi, bacteria and other organisms may initiate a heart wood rot that can enable termites to begin work. Wood has only one fault : it break down under biological attack.

PEST STATUS OF TERMITES

There are about three crores species of insects are found world wide, of which only a few thousands qualify for pest status. Termites in particular have a long history. Once the termite's pathways in to buildings are established, termite works 24 hours a day all year long. It is workaholics in the true sense of the word. Termite is silent destroyer of your sweet home. Never sleeping apparently timid termites become very much powerful to cause wide spread damage to costly buildings, once they get entry in to it. All termites need is a small crack in concrete basement, loose mortar joint or tiny gaps around pipe and their search for wood is on.. The damage caused by termites are more than all other natural disasters combined.. Termite become an economic pest , when their appetite for wood and wood products extends to human homes , building materials, forests, agriculture and other commercial products.

About 95% damage to buildings are caused by subterranean termites. Termite strikes more American structures than: FIRE. Termites cost Americans about $1.1 Billion Dollars per year, that is more than the, Combined Damage Done by: Tornadoes, Hurricanes, hail, flooding, and windstorms in U.S. As per CSIRO reports: Termite cause about $200 Million worth of Damage every year in AUSTRALIA. ONE in every FIVE Australian homes are attacked by Termites. In 1986, total $ 19, 20, 000 Thousand US Dollars were spent for Anti-termite treatment for Buildings of which $4,00,000 thousand U.S. Dollars were spent only in India. No construction materials Developed today can prevent Termite entry Into Buildings. Every Structure gets termites even with no wood. Termites do not know that there is no wood in your home. They live in the ground and its their job to look in every structure. So even though, you live in a concrete house, made completely of steel , glass and concrete, eventually termites will come to visit.

Termite problems in China

The capital of China's Sichuan Province, is suffering more than Three Million worth of damage yearly to its more up-to-date buildings. The termite also bore through underground cables to the extend that- some buildings in the capital Chengdu have been seriously damaged.Termites with a taste for reinforced concrete are threatening some of China's cities. This kind of experience has also been documented in Singapore.

Termites and Air Port

Air field have two main components: The ground buildings (Air traffic Control unit etc.) and Runways. Both these regions can be seriously compromised and weakened by termite galleries.

Attack of Termite in Multi-Storied Buildings

Heavy termite infestations have been recorded up to the 17th floor of a building in Brazil (Johson, 1981) .Termite Attack Within One year after Construction have been recorded. Also attacks on skyscrapers.

Termite in School Buildings

Orleans Parish School System spends more than 5 Million a year for repairing termite damage.

Whole Township Ruined

The whole township of Sri Harigobindpur in Punjab was reported to have been ruined by termites.

Damage to Boat and Ship by termites

In 1972, termites damaged U.S. Navy Ship SUNNYVALE. Damage was so severe that some timber could be punctured with a pencil.The damage was so severe that some timber could be punctured with A Pencil.

Distoration Of Monuments

Shristi Kanta Lokeshwor Temple At Nela NEPAL is infested with termites and recently treated with Chlorpyrifos. Ancient buildings , monuments and palaces and other cultural properties made up of wood are attacked by termites. A silent destroyer of monuments and palaces.

Materials Attacked By Termites

Leather goods, Thatch roof in village houses , wall coverings and wall papers ,synthetic fiber of Carpets, buried electrical, power cables, Railway Sleepers and Signal Systems ,Telephone or Telegraph, communication Circuits, Wooden Transmission poles, wooden bridge, Ammunition Boxes , of Army, tent and Bamboo Pegs of Army, railway coaches, clothing, art of work etc.

It causes damage to all kind of woodwork, furniture, furnishings, clothing, stationery, rubber, plastic, and even the lead coating of underground cables. The Formosan termite can attack Non-cellulose materials such as Thin sheets of Soft Metal (lead or copper): asphalt, plaster, mortars creosote rubber and plastic , foam, NU-wood, gyp-board, and cables etc.

Common Building Infesting Termites In India

1. C.domesticus,
2. H.indicola,
3. H.malabaricus,
4. C.heimi and
5. O. feae etc

Termites and Plastics or synthetic fibers

This is surprising because plastic have no food value. Termite Species known to damage plastics are:

1. Odontotermes assuthi,
2. Mastotermes darwiniensis,
3. Coptotermes acinaciformis,
4. Coptotermes havilandi and,
5. Coptotermes niger etc.

Termites can be damage Plastics any of them

1. Plasticized Polyvinyl Chloride,
2. Low Density Poly-ethylene,
3. Poly-styrene,
4. Poly-urethane foam
5. Cellulose Easters, and
6. Nylon

<u>Food habits of Termites:</u>

In Sydeny, *Coptotermes acinaciformes* species of subterranean termites are found. A mature colony of this species can contain over one million termites and can eat the

equivalent of the timber flooring of fifteen average sized rooms in one year. Termite attacks over 15 pounds of wood in a single week and one wooden pole within 12week after installation.

What is termite?

Insects were here on earth long before humans. The have existed on earth for a very long period of time some 350 million years ago. The first insects known from fossil records occurred in the *Devonian period* and the modern insect in the *Lower Permian.*Termites are very familiar to man from time immemorial and known to evolve from cockroaches about 150 Million years ago. They are popularly known as *White ants* but this name has been a misnomer as they are neither white nor belonging to the groups of true ants. They were also called as *KASHTA HARIKA* in Sanaskrit literature; which means wood feeder. Reference to termites has been mentioned in ancient Hindu literature like *Rigveda* and *Ramayana*. Even the name of the Sage *VALMIKI* has been derived from the termite's mounds as the mounds developed on him during the course of his meditation.

The name *"termite"* comes from the Latin word for woodworm. Vernacularly termites are called *DEEMAK* in Hindi, *UDAI* in Rajasthani and *Ooli* in Bengali. As much as 2,761 species are found, comprising about 300 genra; mostly tropical or subtropical, distribution generally between 48 degree North or South. Nearly 70% parts of the world's land area is infested with termites. (Fig.3)

Termite appears to be an ideal group of organism for bio-geographical analysis because of their antiquity, low dispersal capability and manageable diversity. Principal types of termites are – subterranean (nest in the soil) , damp-wood (infest damp-wood) and dry-wood termites(infest dry-wood). Among all, subterranean termites are the most destructive and frequently encountered kind of termite infesting buildings worldwide. Subterranean termites colony must have soil contact in order to survive.. Arial nests can occur without a ground connection if all castes of the colony are present and moisture is available. Termite mounds are also seen on trees.

BIO-ECOLOGY OF TERMITE

Termites belong to the Insectan order *Isoptera*. The name *Isoptera* derives from the Greek word: "*Iso*" and "*Ptera*"; means *equal winged insects*. Termites are blind, sexless, wingless and most primitive of social insects.

HABITAT

Termite lives in special structure called Termitaria, termite Mound or termite Nest. The nests of certain tropical species are huge mound like structures, often six meters in heights. The shape and size of mounds are characteristic of each species. Mound is constructed from soil mixed with sand and saliva. Each small pallet of sub-soil being pressed into position by the member of vast army of termite-workers. Termite spends their lives within the bounds of warm humid nests. The mud structure of mound with sun backed soil and saliva mixtures is extremely hard. Even elephants, who often use termite mounds as rubbing posts, fail to break the hard clay.

HEIGHT AND DEPTH OF TERMITE MOUND

The mound of *Nasutitermes triodidae* species of termite may be 20-25 feet tall and 10-12 feet in diameter. Mound of subterranean termites may be as deep as 20 feet below the soil surface. Subterranean termites have the ability to adjust the depth of their nest in soil depending upon the temperature and moisture requirements. The ground serves as a protection against extreme temperature and the moisture reservoir. Many species of *Nasutitermes* build their nests on trees or on transmission poles also. The termite mounds on decaying or weathering tree may be large and at height of sometime exceeding 20 meters, have internal contact with the tree interior and also to the ground in outer that food and water may be acquired. Nest of *Coptotermes acinaciformes* species of termite is large on tree stumps, sleeper, under slabs and other areas. Many subterranean termites build mounds, which are among the most impressive examples of animal architecture.Termite mound inspire design of Zimbabwe office complex.Some mounds are maintained probably 50 years or more.

Ground mound varies in shape from tall up right to the low dome shaped mound. They usually have a hardened outer casing to protect the inner central nursery area, which houses the queen and developing nymphs.

TUNNELS OR GALLERIES OF TERMITES

Termite is a highly social insect that requires a warm, constant environment with high humidity , thriving in enclosed nests serviced by networks of mud tunnels. Subterranean termites travel underground to reach food source. It enters into buildings at ground level. The routes of entry are usually via wall cavities joints or cracks in concrete or directly out of soil by way of protective earthen tunnels. If penetration of a surface by termite is not possible they starts making shelter tubes over impenetrable surfaces to reach their destination. These tubes are usually 1/4inches to 1 inch wide. In these tubes they can

easily pass over Cinder blocks, Bricks concrete , metal, even pressure treated wood.They can travel as far the second floor or attic of your home. The tubes are made in the same way as the nest; small particles of soil, sand or faecal pellets are cemented together with saliva to form a near – circular tube in some species or a wider flattened tube in others. The tunnels offer protection from predators , heat light and lack of humidity in the outside environment. Worker runs in these exploratory tunnels, quickly dying if venturing outside this controlled environment .Termites can build shelter tubes as fast as several inches in 24 hours and one foot over night.

COLONY OF TERMITE

As the colony grows, the workers expand the nest and the feeding area.It takes about 4-5 years for a colony to reach its maximum size. A termite colony consists: 90-95% workers, 5-6% soldiers, 2-3% immature castes, king and queen. The eggs are hatch after an incubation period of 50 to 60 days. Workers and soldiers mature within a year and live from 3-5 years. Workers make the largest segment of the colony, works day and night, feeding the colony and enlarging the nest. It is the castes that actually do the damage to timber with their power wood eating mandibles. Termite worker is the main culprit and responsible for all kind of damage. Soldiers serve to protect the colony from invasion by predators. Soldier caste, whose primary function is to protect the colony are equipped with well developed pincer shaped jaws enabling them to fight off intruders of the nest or gallery system. King's sole purpose is to fertilize the queen. King may live in the colony with his royal partner queen for over 10 years. Queen may be as long as 14 cms and 3.5 cms in diameter; it grows to an enormous size, sometimes as much as 20,000 times to the size of worker. The queen is essentially an egg laying machine, which can produce up to 30,000 eggs per day e.g. Queen of African termite *Macrotermes subhyalinus* species. The colony grows by the continuous production of eggs. A termite queen may live up to 25-40 years. Mature termite colony will contain minimum 50,000 to 60,000 and maximum 2 lacs to 20 lacs workers. Sometimes more than one king and queen are found in single nest.

For Example

Odontotermes obesus—04 Queens in a single nest, *Macrotermes michaelseni*—05 Queens and 02 Kings
Nasutitermes corniger—33 Primery Queens and 17 Kings.

LIFE SPAN

King-10 years, Queen- 25-40 years and Workers and Soldiers - 3-5 years

LIFE CYCLE

Life cycle of termites starts with the swarming. In the warmer and more humid months, they swarms and can often be seen in the early evening flying out of bush-land , to colonize new areas may be your home. Swarming is a seasonal event. It starts just prior to the rainy season. Some estimate have been made that – A colony of *Coptotermes lacteus* with ONE Million individuals produces 60,000 swarming alates per year. The flights of alates is generally rather weak despite their large wings. For most species swarming alates are in the air, for only two or three minutes, flying at heights up to about 15 meters. The distance covered is therefore quite short- two or three hundred meters is normal. Immediately after short flights of swarming the alate termite shed their wings, mating takes place and termite queen starts eggs laying, in some cracks of walls, cracks in mud plaster trees and in soil, rotting wood etc The queen termite stops eggs laying after the first batch and does not contimnue for many days or even months. Winged warmers emerge from colonies during daylight hours as spring temperatures arrive . Mating occurs during these flights and new colonies are fromed. Emergence of adults is stuimulated when temperature humidity and other environmental conditions are favourable usually on warm days following rainfall.

ENTRY OF TERMITES IN TO BUILDINGS

Termite population typically ranges from 2000 to 4000 individuals per square meter but occasionally run as high as 10,000 individual per square meter of land. South Carolina, has large population of termites with an average of about one termiter per cubic inch in the top 4-6 inches of soil. Studies have shown that termites from single colony may travel 200 feet from the nest to find food materials. A single ACRE of land may support many termite colonies. Although, this does not mean that they all are invading your home. Generally, termite enters into buildings through foundation walls but sometimes it attacks upper stories also in high rise buildings, leaving lower stories untouched.

Termite can penetrate through untreated gaps as small as 1/64 inch (as narrow as pencil lead in the soil. All termites need is a small crack in a concrete basement , a loose mortar joint or a tiny gap around pipe and their search for wood is on. In fact termites can pass through cracks on /30 second of an inch wide. Termites are able to detect wood odors from meters away. And can penetrate concrete floors. They have even be seen in the upper floor of the high rise buildings. Termites are known to survive at minus 30 degree temperature,in centrally heated buildings of colder countries.

TERMITE CONTROL IN BUILDINGS

The best control of termites is prevention and the best time to provide protection is during the planning and construction of a building.. Once the structure is in place, it is much more difficult to control termites. In India, The Bureau of Indian Standards (BIS) formerly known as Indian Standards Institution (ISI) , has following standards for termite control in Buildings: Code of Practice for anti-termite treatment measures in Buildings.:

Part-I: Constructional Measures:IS:6313 (2001)
Part-II: Pre-constructional Chemical Treatment Measures IS:6313
Part-III: Treatment for Existing Buildings IS:6313

The basic principles of all termite control is to break the line of contact between soil and wood. This can be done by several means includingstructctural changes , mechnical / Physical barriers and soil poisons using pesticides etc. Termite control in buildings is generally comes in two forms i.e. Chemical Control and Physical Control.

CHEMICAL CONTROL OF TERMITES

The conventional approach is to spray and inject pesticide into soil around the foundations thus creating a persistent toxic barrier. Because of variations in soil texture , moisture and restricted access, it can be very difficult to achieve uniform chemical barrier without the help of skilled Pest Control Operator.

Termite control in buildings became a major issue since chlorinated hydrocarbons were banned in 1988, because these chemicals are persistent and caused major environmental and health concerns. In India, the current method of termite control relies mainly on the use of persistent termiticides that are sprayed or injected into the soil to create a toxic chemical barrier. For the last forty years or so Aldrin, Chlordane, Heptachlor or Similar pesticides were used to treat the soil prior to finishing the foundation of buildings. These products were replaced with other pesticides considered to be more environmentally acceptable and less risky but are not as effective in the long term.

Only two pesticides i.e. Chlorpyrifos 20 E.C. and Lindane 20 E.C. are approved at 1.0 % concentration by Govt. of India as per IS: 6313 (Part-3); 2001, Code of Practice for Anti-termite measure in Buildings. Consumption of Chlorpyrifos in India in 1999 is 344 MT. in technical grade. Unfortunately, both the pesticides are already been banned in foreign countries. Strains of Chlorpyrifos and Lindane have recently been reported in the packed bottles of well known brands of cold drinks by CSE Laboratories of New Delhi.Residue of toxic pesticides are also reported in packed bottles of drinking water.Campaign to ban lindane has started Éurope. It is reported highly toxic as girls dies after eating minute amount of Lindane. Recently provisional approval has also been granted to few more pesticides for the purpose i.e. Imidachloprid (Premise) 200SL and Ethion 50 E.C.(Fosmite 50 E.C.).

Chemical prevention is normally guaranteed for 5-7 years and introduces toxins in the home environment. Moreover, it is relatively short-lived and require multiple re-applications during the life of the building to remain effective. It is extremely inconvenient to the building owners, builders, colonizers and Pest Control Operators worldwide. The Environmental Protection Agency (E.P.A.) of U.S.A. feels that consumers should not be subjected to the expense and risk of repeated termiticide applications. Apart from toxicity, none of the chemical gives life long protection from termites.

METHODOLOGY FOR ANTI-TERMITE TREATMENT IN BUILDINGS

Methodology for Anti-termite Treatment in Buildings is exactly as per IS:6313 (2001) , which is not revised as yet.

Termiticides Registered in Various Countries are

Australia: Bifenthrin (a synthetic Pyrethroid).

Florida:

Active Ingredient	Active Ingredient concentration in solution applied to soil
Bifenthrin	0.06-0.12%
Cypermethrin	0.25-0.50%
Fenvalerate	0.5-1.0%
Fipronil	0.06-0.125%
Imidacloprid	0.05-0.10%
Permethrin	0.50%

Other Countries

Prevail	
Permethrin	Cyren TC
Dragnet FT	Dursban TC
Prelude	Equity
Bifenthrin	Imidacloprid
Talstar/	Biflex TC
Fenvalerate	Phenyl Pyrazoles
Tribute	Fipronil
Termidor	Phantom
Cypermethrin	

Dose of termiticides (approved in foreign countries) and protection from termites in years

Termiticide	Dose %	Protection (in years)
Cypermethrin	0.5%	4-12 years
Permethrin	1.0%	3-10 years
Fenvalerate	1.0%	6-12 years
Cyfluthrin	0.5%	11 years
Deltamethrin	0.125 %	4-10 years
Chlorpyrifos	1.0%	6-12 years

TERMITES CONTROL BY PHYSICAL BARRIERS

Chemical treatments are relatively short lived and require multiple reapplications during the life of building to remain effective. With the increasing concern about the excessive use of pesticides, people are looking for non-chemical alternatives to soil termiticides, which can be installed as preventive barrier during constructions. After banning of organochlorine pesticides, architects, builders, and developers have become more aware of selecting effective termite barrier. Physical barrier separates the wood (food) from termites. The four main types of physical barriers are : 1. Termite Shield 2. Termite Barrier Sands 3. Stainless Steel Wire-mesh barriers and 4. Waterproofing Membrane Barriers etc.

1. Termite shields

Termite shields have been in use in some parts of the world for decades but the other physical methods have only recently become a focus of research and commercially developed. Termite shield have been placed on foundations walls, piers, stumps etc. to isolate the upper parts of the building from the sub-structure. Metal shield function as helpful termite detection device, forcing termites to built tunnels on the out side of the shield. It is also prevents dampness in buildings, which can result wood rot thus making the materials attractive to termites. The common types of termites shields are made up of PVC, Aluminum, Stainless, steel, Copper. Etc.

2. Termite Barrier Sands

Commercial versions of aggregate sands barriers have been developed in Hawaii and Australia in the last ten years. The majority of physical barriers are fitted by installers, who are licensed and accredited manufacturers of the approved systems. A sand barrier is generally more uniform than a chemical barrier and never requires reapplications. The sand barrier (particle size 1.7 – 2.4 mm) would be preferable to the chemical barrier from the stand point of reducing the health hazards associated with persistent pesticides as well as helping to reduce the load of toxic chemicals in the urban environment. There is a Australian Standard, which describes the minimum conditions for installations of such barriers. The commonly used sand barriers are : Volcanic Cinders, Sand Blast sand, Granite sand, Basaltic sand, Gravel and Glass Splinters, Fossilized corals and Horticulture sands etc.

(i) Granit-Gard:

This has been developed in conjunction with the Forestry and Forests Products Division of CSIRO of Australia. Each batch of Granit-Gard (granite stone particles) is graded to specifications to ensure impenetrability and tested for compliance is registered NATA Laboratories. There is Australian Standards AS:3660 to describe its uses. Granit gard is a long lasting barrier.

(ii) Basaltic Termite Barrier (BTB):

This barrier formed by placing a four inch layer of a granular materials between the building and the ground . The granule should be very hard and dense. The granules in Hawaii are currently being manufactured from the Basalt. Basalt has almost ideal characteristic for this type of use. Now basaltic barrier are is use in various countries.

3. Stainless Steel Mesh Barrier

A commercial version of stainless steel termite mesh barrier has been developed by an Australian Company- Termi-Mesh Ltd. Reports show that the stainless is 100 effective at

blocking termites. Termite can not penetrate, can not eat, and can not destroy the termi-mesh system. It is to hard for termites to chew through and is corrosion resistant also. Expected life of this material is 50 years.

4. Water Proofing Membranes

Recent laboratory tests indicates that rubberized asphalt types membranes and other bituminous membranes commonly used for waterproofing in exterior basement walls are also impenetrable to termites and could therefore be effective termite barrier if properly installed or retrofitted.

OTHER CONTROLLING ALTERNATIVES

The main purpose of termite control is to create a protective barrier at ground level through out the buildings in order to prevent possible future routes of termite entry. With the increasing concern about the excessive use of pesticides, people are looking for non-chemical and life-long alternative to soil termiticides. Various types of alternatives are available in foreign countries (not in India) keeping chemical related problems in view. For example:

1. Bait:

Bait station is placed into soil at intervals around building. Bait inside contains slow acting chemical. Individual feed on bait and return to the colony. Poison is passed on to other members, killing a portion of the exposed colony.

2. Chemical Fumigation:

Usually used for dry wood termite infestation. Removal of all chemical absorbent materials from building to be fumigated. Tent whole building. Evacuation of surrounding properties depending on legislative codes etc. Pump in fumigant and allow time to penetrate wood. Venting of gas. Remove tent etc.

3. Terma-Trac Technology:

Terma-trac works like a RADAR and DETECTS the presence of termite in your buildings. Saving your time and money.

4. ALTIS Irrigation System:

The ALTIS irrigation system allows for treatment of a building at any time after construction.

5. Bar-betty System:

It is a patented system, designed and developed in Hawaii.

6. Foam Application:

Some termiticide may be applied by mixing them with a foaming agent and using a small compressed tank which churns up the mixture into a shaving type foam and then pushes the foam into drilled opening.

7. Thermal Imaging for Detection of termites:

This method is developed in Australia.

8. Carbon-dioxide:

When termites are exposed to 95% Carbon dioxide for 60 hours, 100% mortality results.

9. Microwave:

Microwave generators are mounted against wall on a pole one foot apart. Remote switches start the generators. Heat generated by the microwave kill termites. Pole system is moved to next wall space to be exposed.

10. Freezing:

Not practical for treatment of large areas. Traps are used for larger areas like porches. Liquid nitrogen is pumped into the infected area chilling it down to Minus 20 degree (F) freezing the termites. Gas is vent off. Traps removed.

11. Electricity:

Infected damaged wood is exposed. Electro-Gun is placed on one side and ground on the other side of the infested timber. Electrical shock of low current (0.5 amps), high voltage (90,000 volts) and high frequency (60,000 cycles) jumps into termite galleries and ends at the ground. Termites in its path are killed.

12. Heat:

Heat treatment is another alternative to chemical fumigation for complete building treatment of dry-wood termites. Nylon traps are used to tent the building. Materials that

are not heat resistant are removed from the building and water is left running to protect plastic pipes. Large propane heating unit is connected to the tent by a large flexible hose and turned on. Hot air is blown in and around the structure to heat the walls from both the interior and exterior. Heat is allowed to reach 45 degree Celcious (120 F) for 35 minutes to 50 degree Celcious (130F) for one hour. Heat is shut off and tent is removed.

13.Biological Control:

Use of Nematodes: Nematode species which are suitable as termiticide are: *Steinernema carpocapsea and Heterohabitis bacteriophora* . Termites are potential hosts for these nematodes.

14. Termite Resistant Woods:

The woods that termite did not like include: Bald Cypress ,Western red, Alaskan yellow, Eastern red ,Spanish Cedar, Mahogany Sassafras, and Indian Rose wood etc .

15. Botanical Pesticides :

Some common Botanical Pesticides are: Pyrethrum, Rotenone, Sabadilla and Azadirachtin etc.

16. Use of Sniffer Dogs:

These Dogs are trained to detect termites. Termites produce vast amounts of METHANE in today's world.

Table : - Shows other alternatives for termite control

Name	Type	How to use
1.Crushed Volcanic Cinders	Phy. Barrier	Foundation Wall
2.Alunite- Collars	Phy. Barrier	Foundation Wall
3..Cavi-Guard	Phy. Barrier	Foundation Wall
4.Termite –Tie System	Phy. Barrier	Foundation Wall
5.Therma-Pure Method	Non-Chem. Method	Any-Where
6..T.T.R. System	Toxicant Based	Directly in Termite Colony

The Role of Central Building Research Institute, Roorkee

Now , it is clear that -Termite is a menace for home owners worldwide. Termites have seriously affected buildings in various parts of India after construction, even concrete foundations are susceptible. Therefore, there is an urgent need to search non-toxic, Eco-friendly and long lasting alternative of highly- toxic pesticides for the future. The Central Building Research Institute, Roorkee has taken initiative in this directionWorking for the last 15 years to control termites in buildings. Extensive studies and experimental work is in progress on development of herbal formulations, physical barriers, evaluation of alternative less toxic and safer pesticides for controlling termites in buildings.

Though, physical barrier are 100% safe , non-toxic and gives life long protection from termites, they are not popular in India. Furher , research in needed to find out suitable alternative for Indian conditions. Various synthetic pesticides were evaluated as termiticide for buildings and work on several others are in progress. Extensive studies and experimental work is in progress on the development of herbal pesticides. Two patents have been filed by CBRI few years back. Evaluations of various less- toxic and safer alternative pesticides for controlling termites in buildings are in progress. We have developed termite cultures in the laboratory for day-to-day experimental purposes. We can evaluate termite resistance of any material with in 2-3 weeks. No doubt "REVENTION IS BETTER THAN CURE."

A JOB OF PROFESSIONALS

Many of the potential termite entry points are hidden and difficult to access. Detecting an infestation often requires the trained eyes of a professional PCO inspector. The most experienced inspector can overlook hidden damage also. Termites control requires specialized training in the installation of an interception and or baiting systems as well as the proper use of supplemental treatments that may be employed, such as liquid chemical barriers, foams and wood protectants. Ridding a home of termites requires extensive knowledge of termiticide applied, pre-construction shall be applied in specific amounts , concentration and treatments area designated by the label.

Volume is important to allow uniform treatment of areas under the slab. Generally, the more volume the more uniform the coverage. Inadequate distribution of chemical, improper volumes of termiticide application or insufficient treatments of critical and non-critical areas are major causes of termiticide failure. More important than the brand of termiticide is that the treatment be performed by an experienced technician, backed by a responsible pest control firm. A safe and effective treatment requires an experienced technician, not some one who was hired a few weeks ago"Pest control is not a simple

business. To comply with the law and satisfy your customers requires study and dedication. Pest control works only when your training and knowledge, actions and attitudes are the best. The pesticides banned in India continue to flow into the marked despite government notifications. The small farmers prefer them because they are cost effective, are easily available and display a wide spectrum of bioactivity.

It also requires specialized equipment and the application of large amounts of termiticide. Ultimately, the quality of anti-termite treatment job depends less on the person who sells the job than the individual who does the job. Termite infestations can go undetected for years, hidden behind dry wall, paneling, floor covering, insulation or other obstructions. Subterranean and dry-wood termites requires completely different control methods, therefore, the termites must be correctly identified. Workers and immature are virtually impossible to identify. A full inspection is beyond the means of home owners. The job is therefore best handled by the licensed professionals. Given the substantial financial investments of home, termite treatment is a job of professionals.

REFERENCES:

1. Preventing termite penetration of foundation cracks ,News letter of the urban Entomology Program, University of Toronto, Number-8, September 1992.
2. Adams, A: 1998: Subterranean termite control-alternatives to conventional soil barriers. Pesticide Out look.9:2.
3. Anon, 1998: New Japanese termite control. For. Chron. 74. 677-677.
4. Anon. 1998: New system has termite control has covered. Pest Control. 66:70.
5. Anon, 1998: Stainless steel mesh – an alternative termite barrier? Pest Control 66:54.
6. Bonabeau,E.et al 1998: A model for the emergence of pillars, walls, and royal chambers in termite nests. Philos.Trans.Biol.Sci.353:1561-1576.
7. Henderson.G et al. 1998: Subterranean termites (Isoptera: Rhinptermitidae) attack on ground monitors around an apartment complex in fixed pattern placements versus conducive placements. Fla. Entomol. 81:461-464.
8. Panda, P et al 1998: Evaluation of some insecticides against termites on sesamum in Orissa. Ann. Plant. Protect.Sci. 6: 118-120.

9. Su, N-Y et al. 1998:Elimination of subterranean termite populations from the Statue of Liberty National Monument using a bait matrix containing an insect growth regulator ,hexaflumuron.J.Amer. Inst. Conserv. 37: 282-292.

10. Kashap SK, Bhatnagar VK. Scenario of pesticide contamination. In: Toteja GS ,Diwaker S, Saxena BN, Editors. Surveillance, Prevantion and Control of Food contaminants in India. New Delhi:Indian council of Medical Research, 1996:1-9.

11. Ramchandran M, Banerjee BD, Gulati M Grover A , Zaidi SSA, Hussain QZ. DDT and BHC residues in body fat and blood samples from some Delhi hospitals. Indian J MED RES 1984;80:590-3.

12. Siddiqui MKJ, Saxena MC, Bhargava AK , Seth TD , Krishnamurthi CR,Kutty D Agrochemicals in the maternal blood, milk and cord blood: Asource of toxicants for prenates and neonates.Environ res 1981; 24: 2432.

13. Choosing a termite treatment chemical, Michael Merchant, Urban Entomologist ,Texas Agricultural Extension Service, Roger Gold,Professor , Department of Entomology, The Texas A&M University System,Insect F@stsheets:House and Garden Series;F@stsheet Ent-1005.

14. Research report, Termite Control, Dr Brad Kard, USDA Forest Service, Mississippi State University Extension Service,Mississippi Agricultural and Forestry Experiment Station.

15. U.S.Environmental Protection Agency. Office of drinking water.1987. Endothall Health advisory. USEPA. Washington, DC.

16. Norman, E. Hickin, Termites - A world problem Huthinson and Co. London (1971).

17. Vaccaro, J.R., and Bhoh R.W., 1979, Evaluation of Air Borne Concentration of Chlorpyrifos, DES, DEDS, During and After Application to Dwellings for Control of Subterranean Termites, Atlanta, Georgia, Sept. 17-20, 1974, HEH 3.5 - 5 - 5 - 27(1).

18. Mouldin, Joe K., Jones, Susan C. and Beal, Raymond H., Soil Termiticides, A review of efficacy data from field test, IRG Secretariate, Stockholm, Sweden, Document No. IRG/WP/1323, March 31, 1987.

19. Shibahara t. and Kozuma, J. and Fuse, G., Evaluation of Lentrek Termiticide (A.I. Chlorpyrifos) for Termite Control in Kagoshima Japan, Research and

Development, Agricultural Production, Dow Chemical Japan Ltd., and Agricultural Chemistry Department, Kinki University, Dow Confidential Information.

20. Y. Singh and B.S. Rawat 1995. Effectiveness of agrochemicals as wood preservatives. Proceedings of the National Workshop on Termite Management in Buildings, C.B.R.I., Roorkee, February, 20-21, 1995.

21. Singh, Y. and B.S.Rawat. 1999. Studies on inert barrier to prevent entry of subterranean termites in buildings, Hexapoda, 11, (1&2). 91-95.

22. Rawat, B.S. 2002. Physical barrier :Non toxic and eco-friendly alternatives to hazardous termiticides for buildings,International Pest Control, Vol44, Number 4, 182-187.

23. Mathur SC Future of Indian pesticides industry in next millennium. Pesticide Information 1999;XXIV(4):9-23.)

24. Su, N-Y and R.H. Scheffrahn 1990; Economically important termites in the United stated and their contact Sociobiology 17: 77-94.

25. Termites in buildings by E. Edwards and Mill, A.E. 1986; published by Rentokil Ltd.

26. Singh.Y,and B.S.Rawat (1999) Studies on inert- barriers to prevent entry of subterranean termites in buildings. *Hexapoda* 11 (1&2), 91-95.

27. Assmuth,J.1915,Indian wood destroying white ants (Second contribution) J.Bombay.Nat.His.Soc. 23, 690-694.

28. Harris W.V. ,1965 Recent developments in termite control. Pest Articles News Summaries All, 33-43.

29. National Pest Control Association,1966. Protecting individual water systems from termites toxicants, Natl. Pest control association, Tech. Release. 7-66, 1-9.

30. O'Brien,R.E.,Reed,J.K.and Fox, R.C. 1965. Insecticide distribution in soil following application by soil injectors rods. Pest Control,33,No.2, 14-15,42, and 44.

31. Smith , V.K. 1968.Long term movement of DDT applied to soil for termite control . Pesticide Monitoring J, 2, 55-57.

32. Sperling R, 1967b.Protecting buildings against termites, Pest Articles News Summaries A13, 345-374.

33. Minoru Tamashiro, Inventor of Basaltic termite barrier, (BTB) Technical licensing group, University of Hawaii, 28, Woodlands, Drive, Suite, 280, Honolulu, HI 96822.

34. Anonymous 1994, Australian standards AS 3660:76.

35. Sen-Sarma , P.K. 1995. Recents trends and technologies in sub-terranean termites control in buildings. In. Termite Management in Buildings Ed. Y.Singh Tata McGraw Hill . pp. 1-21.

36. Anon 1984, TDRI, Developing an alternative methods of termite control , TDRI, News letter 3, Nov, 5-6.

37. Cavalcante, M.S.1976. Problems caused by termites in buildings in the state of Sao Paolo-Brazil. International Research Group on wood preservation IRG/WP/150.

38. Coaton , W.G.H. 1949. Infestation of buildings in South Africa by subterranean wood destryoing termites. South African Department of Agriculture Bulletin 299, :89pp.

39. E.P.A.,1983, Analysis of the risks and benefits of seven chemicals used for subterranean termite control , US. Environment Protection Agency Report No. EPA 540. /9,-83-006.

40. Hall, R. 1 1986. New termiticides are effective but less persistent . Pest control 54, (3), 24, 26, 30, .

41. Mauldin J.K. 1983. Alternatives to termiticides . In : Khasawinah, A..H. (Ed) Termiticide s in building Protection . Proceeding of a Work shop Washington D.C. Sept. 22- 23 , 1982:95-98.

42. Sternlicht, M. 1977. Damage to underground telephone and electric cables inflicted by termites *Callotermes flavicollis* (Fabr.) (Callotermitidae, Isop.). Zeitschrift fur angewandte Entomologie 83: 350 – 355.

43. Su, N-Y and La Fage, J. P. 1983. Estimates of wood consumption rates by termites. International Research Group on Wood Preservatives IRG/WP/1201.

44. Weidner, T. 1983. EPA issues risk / benefit analysis of seven termiticides. Pest Control Technology 11(12): 46,50, 52-53.

45. Singh, Y. 1995. Termite management in buildings. Proceedings of the National Workshop on Termite management in buildings, CBRI Roorkee, Feb. 20-21.

46. Indian Standard 2001. "Code Practice for Anti-termite Measures in Buildings". (Parts I & II), BIS, Manak Bhavan, New Delhi.

47. Edwards, C.A. 1976. Persistent pesticides in the environment, CRC Press, Ohio.

48. Mauldin, J.K., Jones, S.C. and Beal R.R. 1987. Soil termiticides , A review of efficacy data from field test , IRG Secretariat, Stockholm, Sweden, Document No. IRG/WP/1323, March 31.

49. Agnihotri, M.P., Pandey, S..Y., Jai, H.K. and Srivastava, K.J. 1977. Persistence of aldrin, dieldrin, lindane and p.p' DDT in soil. J. Ent. Res. 1(1), 89-91.

50. Ramesh, A., Tanabe, S., Murase, H., Subramanian, A.N. and Tatsukawa, R. 1991. Distribution and behaviour of persistent organochloine insecticides in paddy soil and sediments in tropical environment. A case study in South India. Environ. Poll. 74, 293-307.

51. Roonwal, M.L. 1979b. Termite damage to railway coaches in India (*Coptotermes helmi*). Ind. J. For. 2(4).307-310.

52. Feilden, B.M. 1982. Conservation of historic buildings, Butterworth Publication.

53. Zaitseva, G.A.1991. Control of insects in museums, The use of traps Biodeterioration of cultural property. Feb. 1989. Lucknow, India Eds. O. P. Agarwal and S. Dhawan, New Delhi, MacMillon India Ltd.

54. Your soft drink has pesticides:Study, Hindustan Times, Wednesday, August,6th, 2003.

55. Dhawan, S. 1991. Biodeterioration of Ajanta murals, Departmental communication.

56. Mauldin, J.K., Jones, S.C. and Beal, R.H. 1987. Soil termiticides, a review of efficacy data from field tests, IRG Secretatriate, stockholm, Sweden , Document No., IRG/WP/1323, March 31.

57. Roonwal, M.L. 1955. Termites ruining a township. A. angew. Ent. 38(1), 103-104.

58. Websites:

59. www.utoronto.ca

60. www.insects.tamu.edu

61. www.pctonline.com

62. www.pestcontrolmag.com

63. www.edis.ifas.ufl.edu

64. www.pestworld.org

65. www.granitgard.com