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SEARCH OF SUITABLE PHYSICAL BARRIER FOR TERMITE MANAGEMENT IN BUILDINGS

by

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Abstract

Termite or "white ant" is a highly destructive structural pest in India. The risks of its infestations are observed very high in warm temperate climatic zones. Like other social insects, they build a centralized nest from which they build radiating underground galleries to the food source and starts damaging human properties. Pest management professionals still rely on the use of toxic pesticides for its management. The termiticides like Chlorpyrifos 20 E.C. and Lindane 20 E.C. are recommended at 1.0% concentration for its control in latest Indian code of practice IS: 6313 (2001). According to recent experimental findings, being persistent in nature both the pesticides are considered highly toxic for the purpose. In the present investigation, a systematic study was carried out in the laboratory as well as in the field to check the movements of termites through various types of graded inert materials.

Keywords : : Termite management, Building, Pest, Physical barrier.

Introduction

Termites are well known major structural pest throughout the world. More than 2700 species of termites are known; according to Harris (1971) 148 species have been recorded as building damaging termites. In Indian subcontinent more than 348 species have been reported (Rathore 2003). Among all the four types, subterranean termites are considered most destructive to buildings as more than 95% damage is caused by this species alone. The major species are *Heterotermes indicola*, *Coptotermes ceylonicus*, *Coptotermes heimi*, *Odontotermes hemi*, *Microtermes obesi*, *Trinervitermes biformis* and *Microcerotermes beesoni* etc. Houses traditionally built with mud brick masonry with mud mortar are more susceptible to termite attack. They easily travel 60-80 meters to infest buildings (Rajagopal 2002) and infest structures by tunneling through the soil and enter into buildings unobserved at ground level from the foundations. Termites have the ability to locate small openings in concrete slabs and foundation walls. Depending on the size of colony, the foraging workers may locate several points of entry to a structure or more than one colony may infest a large building. Termites are responsible for destruction of wide range of materials and commodities. Much of the material termite destroy is not used by them as food but is damaged when they bore through it or when corroded by their body moisture or frontal gland secretions. It is likely that termite infestation would usually occur much sooner in houses built in old residential areas or on plots from which old houses had been removed. Old houses are more vulnerable than the new ones. Redd (1957) has observed instances in which damage has been caused before construction was complete. Generally, termite control methods employed are based on the destruction of termite colony using pesticides and isolation of building from attack. Application of alternate termite control methods have gained importance as a result of discontinuance of cyclodiene soil insecticides in most of the world and increasing

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environmental concerns. In the present investigation, two experiments were conducted to study the movement of termites through different types of graded materials developed from inert waste.

Materials and Methods:

I. No- choice test (*Laboratory experiment*)

(i) Study organism: *Microcerotermes beesoni*, Snyder species was used for laboratory experiments. Carton nests were collected from 'Sal' *(Shorea robusta)* forests. They are generally found buried in the soil with a small portion protruding out (Mathur & Sen-Sarma 1960). The size of carton nests varied from small (about 0.25kg) to medium size (1.2 kg) with approximate population of 7000 to 45000 (Sen-Sarma & Mishra 1969). The worker caste constitutes nearly 63.4-98.1 per cent of the total population (Sen-Sarma & Thakur 1978). Approximately, 1000 active workers were sorted out volumetrically with the help of 'filter paper technique' (Sen-Sarma *et al.*1975).The active workers preconditioned in dry atmosphere (5% RH) for 30 minutes, exhibit much quicker orientation to high humidity areas (Sen-Sarma 1983). Therefore, preconditioning induces test termite to enter into the moist culture medium quickly (Sen-Sarma & Chatterjee 1966b,1968).

(ii) Test block: Wooden test blocks (size - 25mm x 25mm x 25mm) were made from Mango wood (*Mangifera indica*). All the surfaces of test blocks were made jack-planed and uniformly smooth so that even slight nibbling could be detected. Test blocks with knots and other defects were rejected.

(iii) Test material: Inert waste materials are neither biologically nor chemically reactive. They do not decompose in the soil. Various types of inert waste like- granite waste, glass waste, fly-ash, ceramic waste and local sands were selected for the experiment. Except fly ash, all the materials were washed, dried and crushed into finer particles (particle sizes viz. 0.5mm-2.8mm) and sieved with standard test sieves (IS:460, BSS, ASTM).

(iv) Experimentation: Cylindrical glass jars of capacity 2.0 lit (internal height -200mm, basal diameter- 120 mm and top diameter 90mm) with plastic cap, were used for test. Approx. 10-12 holes of 2 mm dia. were made on the cap for proper aeration. Each jar was thoroughly washed, cleaned and dried. Lower half portion of jar was then filled with 1.0 kg of each material keeping test block in the centre. Upper half portion was then filled with 0.5kg of air dried sterilized soil taken from upper part of mounds of *Odontotermes obesus*, Rambur and having neutral pH 6.0-6.7. A small and almost empty nest piece (approx. 0.25kg) prepared earlier was placed in the centre of jar keeping 5% portion of it visible from the top. A thin feeder strip of perishable wood was placed adjacent to nest piece. Volumetrically, 1000 active workers were then released gently inside the jar. These experimental jars were maintained for 90 days or the death of colony whichever was earlier (AWPA 2006; Frederick *at el.*2011; Neelu & Kumar 2008).

(v) Results: Termites have started their activities within one week in 95% of experimental jars and started attacking test blocks. It was observed that termite increases their activities near border line of culture media after finishing feeder strip. The experimental jars without activities were discarded, again refilled and restarted. The termites were observed moving freely in experimental jars with finer particles (less than 0.5mm) of all the materials and carried away particles to deep inside their galleries (maximum up to 20 mm to 30 mm). Maximum weight loss to test blocks were observed in controlled jars (95%), then Badarpur sand (38.83%), Ceramic (31.0%), Granite (28.66%), Glass (23.66%), Local sand (20.33%) and Fly-ash (17.16%). More or less termite attack has also been observed on all the test blocks kept in experimental jars with particle size ranging from 0.6 to 1.4mm in all the materials. Termite activities were not observed in any of the experimental jars with particle size 1.5-2.0mm of ceramic, granite and particle size 2.1 -2.8mm of glass as weight loss of test block was nil in all the cases . The data pertaining to comparative wood consumption **(ii)**

within and between mounds of termites were also reported by Creffield *et al.* (1985). Feeding rate of *Microcerotermes*, Snyder species is maximum when moisture content of the culture medium in 15- 20% (Sen-Sarma 1983). It is very low in case on pure sand (2-4%) but is high in humus soil (15-25%) (Table 1,2) (Fig.1,2).

II. Choice test *(Field experiment)*

(i) Study organism: Active mounds of *Odontotermes obesus,* Rambur were used for field trial. This species of termite is extremely abundant and a common mound building termite of India. The mounds are built in unfrequented and isolated places in tea plantations and forests and vary considerably in shape and size. They feed upon old roots, tree stumps, fallen trees limbs and branches on the ground.

Table 1. Visual observations and percent weight loss of test blocks after experiment in the laboratory.

Sl No.	Raw materials		Particle size (mm)	Visual observation	% wt. Loss
1.	Ceramic				
		i	>2.9	A	1.83
		ii	2.1-2.8	A	2.00
		iii	1.5-2.0	NA	0.00
		iv	1.1-1.4	A	4.50
		v	0.6-1.0	A	11.50
		vi	<0.50	A	31.00
2.	Granite				
		i	>2.9	A	6.10
		ii	2.1-2.8	A	0.26
		iii	1.5-2.0	NA	0.00
		iv	1.1-1.4	A	8.30
		v	0.6-1.0	A	10.70
		vi	<0.50	A	28.66
3.	Glass				
		i	>2.9	A	5.10
		ii	2.1-2.8	NA	0.00
		iii	1.5-2.0	A	7.50
		iv	1.1-1.4	A	14.33
		v	0.6-1.0	A	18.24
		vi	<0.50	A	23.66

Abbreviations: A= test block attacked and **N.A**.= test block not attacked

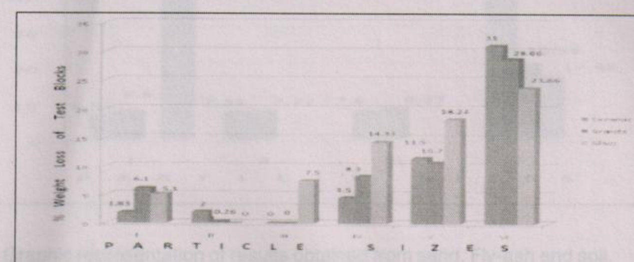

Fig.1. Graphic representation of results.

Table 2. Visual observations and percent weight loss of test blocks kept in sand, Fly-ash and soil.

Sl No.	Raw materials		Particle size (mm)	Visual observation	% wt. Loss
1.	Badarpur sand				
		i	>1.5	A	6.51
		ii	1.1-1.4	A	7.33
		iii	0.6-1.0	A	7.80
		iv	<0.50	A	38.83
2.	Local sand				
		i	>1.5	A	7.60
		ii	1.1-1.4	A	7.77
		iii	0.6-1.0	A	8.27
		iv	<0.50	A	20.33
3.	Fly-ash				
		i	>1.5	-	-
		ii	1.1-1.4	-	-
		iii	0.6-1.0	-	-
		iv	<0.50	A	17.16
4.	Soil				
		-	Control	A	95.00

Abbreviations: A= test block attacked and **N.A.**= test block not attacked

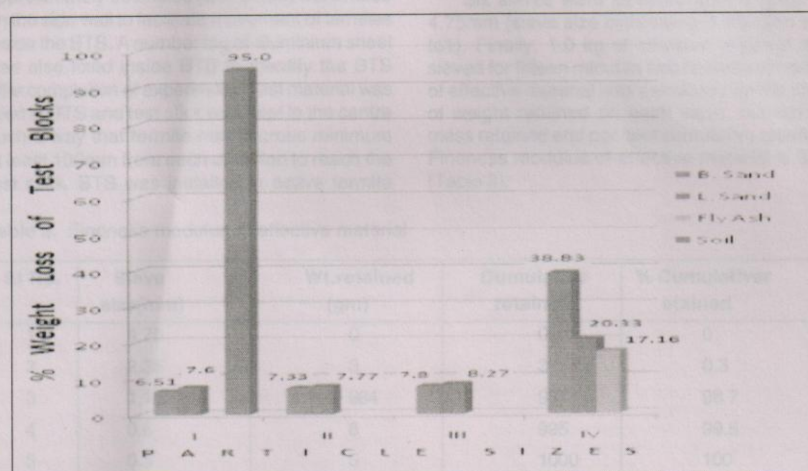

Fig.2. Graphic representation of results obtained from sand, Fly-ash and soil.

Test material: Ceramic waste was selected for field trial. It was selected on the basis of results obtained in the laboratory and availability of raw material. Approximately, 800 kg of material was crushed with the help of "Jaw Crusher" (fitted with plates of high manganese steel and electric motor of 10 HP). Crushed material was then sieved.

(iii) Test stick: Test sticks were prepared from Mango wood (*Mangifera indica*) (size- 100 mm, dia. 25mm). All the surfaces of test stick were made jack- planed and uniformly smooth so that even slight nibbling by termites could be detected. Test stick with knots and other defects were rejected. They were dried in hot air oven at 50 °C for 24 hrs to make constant weight.

(iv) Barrier Testing Station (B.T.S.): Barrier Testing Stations (BTS) were designed and developed in the laboratory. Cylindrical P.V.C. pipes (height-300mm, dia.-200mm and thickness-8mm) were selected. Top and bottom of each BTS was covered with fine wire mesh sieve and approximately 500 holes (dia.-3 mm) were made on the side wall to facilitate movement of termites inside the BTS. A number tag of aluminium sheet was also fixed inside BTS to identify the BTS after completion of experiment. Test material was filled in BTS and test stick was kept in the centre such a way that termite has to cross minimum at least 100mm from each direction to reach the test stick. BTS was installed in active termite mounds of *Odontotermes obesus*, Rambur and around termite infested buildings. From the research work carried out on *Coptotermes formosanus* in Hawaii; it is apparent that conducting replicated studies in the field required either placing test materials directly adjacent to known *C. formosanus* nest sites or attracting the termites to a test site area (Williams *et al.* 1999; Amburgey *et al.* 2002.

(v) Results: After six months, BTS were collected and brought to the laboratory. All the test sticks were cleaned, dried in the oven at 40°C-45°C and visually observed for termite attack. More than 95% damage has been observed on test sticks kept in controlled BTS and slight attack on test sticks kept in BTS with coarser material of particle size more than 2.8mm. However, the intensity of attack was reduced in comparison to no-choice test of the laboratory with *Microcerotermes beesoni*, Snyder species. Finally, the effectiveness of material was same with *Odontotermes*, Rambur species also.

Fineness modulus (FM):

Six sieves were selected from 0.15mm to 4.75mm (sieve size increasing in the ratio of 2 to1). Finally, 1.0 kg of effective material was sieved for fifteen minutes and fineness modulus of effective material was calculated on the basis of weight retained on each sieve, cumulative mass retained and per cent cumulative retained. Fineness modulus of effective material is 3.98 (Table 3).

Table 3. Fineness modulus of effective material

Sl No.	Sieve size(mm)	Wt.retained (gm)	Cumulative retained	% Cumulativer etained
1	4.75	0	0	0
2	2.36	3	3	0.3
3	1.18	984	987	98.7
4	0.6	8	995	99.5
5	0.3	5	1000	100
6	0.15	0	1000	100
			Total	**398.5**
			F.M. =398.5/100 = 3.8	

Discussion

The concept of use of uniform sized particle barrier for termite management was pioneered by Ebeling & Pence (1957) and confirmed by Smith & Rust 1990 and Lewis *et al.* 1996 etc. Later a Basaltic termite barrier was developed in Hawaii (Tamashiro *et al.* 1987,1991). Yoshiyuki *et al.* 2005 studied layer of crushed cement - stabilized sludge, palletized-stone powder, crushed glass and glass beads etc and found some of the particle size effective against *C. formosanus*. French & Trajstman (2003) studied the fine particles of granite and found suitable as physical barrier against *Coptotermes spps.* Width of termite head plays important role in termite's ability to penetrate the material (Su & Scheffrahn 1991,1992). Research efforts in this area are being performed and some commercial products are available in some countries except india (Sornnuwat *et al.* 1995; French & Ahmed 1997; Lenz *et al.* 1997, Peters & Fitzgerald 1997a, 1997b; Lina Nunes & Tania 2001; Singh & Rawat 1999; Rawat 2002). Other anti-termite physical barrier 'Termi-Mesh' has been designed and developed from stainless steel mesh (316 mesh, aperture size 0.66mm by 0.45mm) in Australia. It is found suitable for *C. formosanus* and *C.acinaciformes* Froggatt (Grace *et al.* 1996; Lenz & Runko 1994, Edward *et al.* 1991; Lenz *et al.*1997). Kordon Termite Moisture Barrier (TMB) is also used in Australia. Fibrous webbing of Kordon TMB is treated with deltamethrin. It kills termites, which comes into contact. Movement of termites is directly related to whether conditions (Chatterjee & Sen-Sarma 1962).The activities of termites are observed greatly reduced during extreme hot and cold months (Sen-Sarma & Mishra 1969,1986). Termites leave a scented trail that their nest mates can detect; the route through the barrier gap quickly becomes a highway (Suzanne 1996). The population dynamics of termite worker has an implication in its control strategy as during the course of food gathering, only worker cause significant damage to various kinds of human properties (Sen-Sarma *et al.* 1975).

The objective of particle barrier is basically the same as that of chemical barrier to create a continuous and uniform barrier around and under the structure. Its effective use may be limited to pre-construction only. Post construction application may not provide a sufficient level of protection. The effectiveness of an anti-termite barrier is dependent on the availability of food source in the foraging area. If hungry enough, termites may go to great length to penetrate a barrier. Each termite species require different particle size. Therefore, effort should be made to develop effective physical barrier suitable against maximum termite species (Grace & Yates 1999; Lina & Tania 2001).

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