Original Article

Effectiveness of foundation concrete slabs in preventing termite attack on wooden roof trusses

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ABSTRACT This article examines the effectiveness of foundation concrete slabs in preventing termite attack on wooden roof trusses. Twenty residential bungalow buildings, constructed with hollow sandcrete blocks, were investigated for a period of 5 years. The buildings were grouped into four. The first group belongs to buildings without foundation concrete slabs; the second group is buildings with foundation concrete slab constructed from bush gravel. The third group of buildings has their foundation slabs constructed with crushed granite, manually mixed, while the fourth group belongs to buildings with foundation concrete slab constructed from crushed granite but mechanically mixed. It was discovered that the fourth group of buildings had 100 per cent proof against termite penetration, the third group of buildings had high resistance to termite penetration, but not 100 per cent, while the second group of buildings had limited resistance to termite penetration, and the first group of buildings had no resistance against termite penetration.
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INTRODUCTION

The roof of a building is to protect the occupants from unwanted weather effects such as rain, direct sunlight, heat, grit and dust. In residential buildings, the most commonly used materials for roofing systems are timber for the roof trusses and corrugated iron or long span aluminum sheets (Olanitori, 2006). Added to this is the regulation of the inclement environmental conditions to provide a suitable environment. As important as it is, the roof is also the component of the building that is most abused and subjected to agents of degradation (Mijinyawa *et al*, 2007). Some of the agents of degradation that roof trusses are being subjected to are wood borers and termites.

Termites are split into two major types. The dry wood type, which is capable of flying, and the subterranean type. There are many species of both types. The termites usually operate under cover and it is only after the first signs of damage have appeared that its full extent is realized. It is usual for flying termites to enter the end grain of untreated timber and build up a colony from inside, finally devouring all the interior wood and leaving only a thin skin behind (Fullerton, 1979). Some subterranean termites, like ants, operate

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from a central colony or nest and travel in search of food. These nests or ant hills sometimes achieve great size and house millions of creatures. The paths to food are concealed where possible, otherwise a cover of tunnel is constructed (Fullerton, 1979). Subterranean termites normally construct their tunnel through the holes of hollow blocks to the top of the building, and finally to the wooden roof trusses.

Apart from wood borers and termites, disintegration of wood can be caused by alternate shrinkage and swelling due to rain, rapid change in temperature, humidity and the action of sun heat.

Timber may be protected to some extent from termites by using preservatives. There are many kinds of preservatives, the most widely used being creosote. It not only effectively resists pests, but, being moisture-proof, is very useful for timber below ground or in damp conditions. Creosoted timbers, however, cannot be painted and creosote, being bulky, can be expensive to transport if not manufactured locally. Waterborne preservatives contain poisons dissolved in water, which are cheaper than creosote and can be painted over if necessary. Other widely used preservatives, such as pentachlorophenal, contain solvents that evaporate after application (Fullerton, 1979).

Recommendations for preservative treatment and method of treatment are contained in the clause 4.8 of the Nigerian Code of Practice NCP 020, and clause 6 of BS 5268-5. Among the preservatives recommended by both BS 5268-5 and Nigerian Code of Practice NCP 020 are: copper/chromium/arsenic (CCA), boron diffusion and creosote. However, the conventional preservative chromated copper arsenate (CCA) is being phased out in North America and Europe, due to environmental concerns.

A non-toxic alternative to preservative treatment with furfuryl alcohol has been shown to provide high decay resistance. The major problems associated with the use of furfuryl alcohol are with the catalytic systems used. The use of zinc chloride as the catalyst can cause cellulose degradation and thereby affect the long-term strength properties of the modified wood (Hadi *et al*, 2005). This necessitated research on new catalytic systems for the furfurylation of wood, using cyclic carboxylic anhydrides, mainly maleic anhydride, as key catalysts. The catalysts were soluble in furfuryl alcohol without the addition of water and they have similar molecular size and polarity to furfuryl alcohol. The research led to novel processes based on stable solutions with good impregnating properties that produce furfurylated wood with several outstanding properties, including decay resistance (Westin, 1996). In addition, both laboratory and field tests carried on wood species such as scots pine, agathis and sengon using furfuryl alcohol indicated that the furfurylated wood is resistant to termite attack, provided that an adequate level of modification is achieved. A medium level of furfurylation (43 per cent total weight increased due to furfurylation) was sufficient to prevent attack by both dry wood termites and subterranean termites (Hadi *et al*, 2005).

To prevent termites from rising out of the ground into the building, two methods are in general use, mechanical barriers and poison. The mechanical barrier constitutes the construction of concrete slab on the foundation walls with minimum thickness of 100 mm. This slab provides an obstacle for termites to construct their tunnel through the hole of hollow blocks.

MATERIALS AND METHODS

Materials

The materials needed for this work are sand, bush-gravel, crushed granite with a maximum size of 19 mm, cement, portable water and petrol-powered concrete mixer.

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Methodology

In order to investigate the effectiveness of foundation concrete slabs in preventing termite attack on wooden roof trusses, 20 bungalow residential buildings were investigated. The 20 buildings were grouped into four groups, depending on whether there is provision of concrete slab or not, the type of gravel and mode of concrete mixing. The first group constitutes those buildings with no concrete slabs; the second group being those with foundation concrete slabs constructed using bush-gravel and manually mixed. The third group of buildings is those buildings with foundation concrete slabs constructed using crushed granite and manually mixed. The fourth group constitutes buildings with foundation concrete slabs constructed using crushed granite and mechanically mixed. The mix ratio of concrete for all the four groups is 1:2:4. The 20 buildings used for this work are located in Fatuase Estate, in Oba-Ile Akure, Ondo State, Nigeria. The 20 buildings were studied for a period of 5 years.

RESULTS AND DISCUSSION

Inspection of the roof trusses of the 20 buildings were carried out every 6 months for a duration of 60 months, that is 5 years. For the first 6 months, the inspection was carried out as there was no sign of termite attack on the roof trusses of any of the 20 buildings. The second inspection was carried out after 12 months. Traces of termite attack were noticed on the roof trusses of the first group of buildings, no traces of termite attack were noticed in the remaining groups of building.

The third inspection was carried out after 18 months. The effects of the termite attack on the roof trusses of the first group of buildings was now so pronounced that immediate chemical spraying of the entire roof trusses was carried out. For the remaining groups of buildings, no sign of termite attack was noticed. With the fourth inspection, termite attack was noticed on the second group of buildings, with no traces on the remaining third and fourth groups, while new termite attack on the first group is not noticed again after the first spraying.

The fifth inspection was carried out at the end of the thirtieth month. The effects of the termite attack on the roof trusses of the second group of buildings are now pronounced. Traces of termite attack are now noticed again on the roof trusses of the first group of buildings. Also traces of termite attack are noticed on the third group of buildings. Chemical spraying of the roof trusses of the first, second and the third groups of building is carried out. No traces of termite attack were noticed on the roof trusses of the fourth group of buildings.

After the sixth, seventh and eighth inspections, it was discovered that the cycle of the first 30 months was maintained, with decreasing effect of termite attacks on the wooden roof trusses of buildings in groups I–III, while there is no sign of termite attack on the fourth groups of buildings. At the ninth and tenth inspections, no traces of termite attacks are noticed in all the groups of buildings. Summary of the roof trusses inspections at six monthly intervals are given in Table 1.

Figures 1–5 show the pictures of the termite attack on the wooden roof trusses of one of the buildings in the first group. Figure 1 shows the attack of the termite on tie-rods connecting the ceiling asbestos to the roofing noggin. Figures 2–4 show the termite attack on the wooden noggin, while Figure 5 shows the general arrangements of the wooden roof trusses and termite attack on the noggin. From these figures it can be seen that the termite attack is limited to tie rods and the noggins and that it is yet to attack the main roof structural members such as the top chord, bottom cord, struts and ties, therefore requiring limited repairs such as removal of ceiling asbestos in order to change tie rods

Table 1: Summary of the roof trusses inspections at six monthly intervals

Groups/ Inspections	*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*	*10th*
I	N.T	T	P&S	N.T	T&S	L.T	L.T	L.T&S	N.T	N.T
II	N.T	N.T	N.T	T	P&S	L.T	L.T	L.T&S	N.T	N.T
III	N.T	N.T	N.T	N.T	T	T&S	N.T	N.T	N.T	N.T
IV	N.T	N.T	N.T	N.T	N.T	N.T	N.T	N.T	N.T	N.T

Abbreviations: N.T – No traces; T&S – Traces and spraying; T – Traces; L.T. – Limited traces; P&S – Pronounced and spraying; L.T&S – Limited traces and spraying.

Figure 1: Termite attack on tie-rods connecting the ceiling asbestos to the roofing noggin.

Figure 2: Termite attack on the wooden noggin.

and noggins of the affected areas. This type of repair is not a major one as it does not involve the removal of the roofing iron sheets.

CONCLUSION

From the results and discussion above, it can be seen that foundation slabs, constructed from crushed granite and mechanically mixed, has 100 per cent proof against

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Figure 3: Termite attack on the wooden noggin.

Figure 4: Termite attack on the wooden noggin.

Figure 5: General arrangements of the wooden roof trusses and termite attack on the noggin.

subterranean termites, whereas the foundation slab constructed from granite but manually mixed did not have full proof against subterranean termites. The foundation slab constructed from bush-gravel has limited proof, whereas buildings with no foundation slab have no resistance against the subterranean termites.

RECOMMENDATION

It is recommended here that in the areas prone to termite attacks such as the western part of Nigeria, to which Ondo State belongs, foundation slabs should be constructed to all buildings using crushed granite, mechanically mixed. If the concrete mix using crushed granite is not going to be mechanically mixed, then chemical spraying of the roof trusses of such buildings must be carried out at the end of the second year of completion of the roofing, so as to prevent the termites from attacking the roof trusses. This spraying should be repeated again 6 months later, so as to completely eradicate the termites.

For buildings with concrete foundation slab constructed using bush gravel, it is recommended that the roof trusses be sprayed at the end of the eighteenth month, three times at six monthly intervals. While for the buildings with no concrete slab, spraying of the roof trusses should commence 6 months after the completion of the roofing.

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