WOOD PRESERVATION FOR
TROPICAL HOUSING

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PEOPLE, HOUSES AND WOOD PRESERVATION

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Houses are built to shelter families of people. The wood components of houses are treated with preservatives to prevent premature biological and physical deterioration, as well as to maintain a satisfactory physical appearance.

Putting these two ideas together, we have that wood preservation is to maintain good sound attractive housing for People.

Thus any scheme to protect the materials of construction must take into account this question - for whom?

People of different social backgrounds, religion, education and family ties within countries and in different countries will require a different approach to their housing problem, and hence to the measures which may be taken to protect the components of their houses.

The story that many Englishmen store(d) coal in their bathtubs is so well known that it must be true. So, when designing houses for people in the groups likely to do this, it is better to give them a good coal bin than a bathtub!

From Australia we have recent reports that one family kept chickens in a kitchen cupboard while another spread soil on the floor of a spare bedroom and raised mushrooms. Needless to say these were homes rented from the government but it is reasonable to assume that certain classes of people will do most unlikely things in their homes. If the builder wants the home to last and is dealing with groups of people whose habits and background can be determined then due notice must be taken of these in the design stages.

Not all, in fact probably few of the problems arise due to what for convenience sake, we will call bad habits. Mostly they are due to social caused or arise out of straight forward poverty.

For instance in P.N.G., timber used in strip flooring in low cost houses is treated by a diffusion process with water soluable preservatives. Many if not all the families moving into these houses, especially when buying them rather than renting, are particularly houseproud and see that their floors are kept spotless.

To do so, the housewife scrubs the floor everyday and then washes it down with water from a garden hose. Within a very short time all the preservative can be leached out and the wet conditions result in fungal decay of the floor and supporting structure.

The simplest solution to this problem is to coat the flooring with a modern durable clear finish that will allow easy cleaning without lots of water. In the short term this is more expensive but not if we project ahead say 5 years by when maintenance costs will be very high.

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The alternative of vacuum pressure with C.C.A. is generally of little use because few of the tropical timbers used for flooring are treatable.

Another example is the installation of expensive slow combustion stoves in rural houses. Very few women will have had experience with such stoves and may build an open fire outside the house for cooking.

Traditionally in P.N.G. cooking is done in houses separate from living quarters (or perhaps the wife lives in a separate kitchen); this seems to be the case in most tropical countries and before the advent of the electric cooker and gas stoves, in most high cost houses the kitchen was physical separated from the rest of the house.

When the house is on high stilts and it is most inconvenient to go up and down stairs to an outside stove, the housewife may simply build an open fire place on a sheet of iron on the verandah. The result, apart from the high fire hazard, is a scorched floor and a blackened ceiling on the verandah.

It would seem much more appropriate to make provision for an open fire place with proper venting in the actual kitchen area and to only install stoves when requested to do so.

This is far cheaper than the fire retardant treatment which is needed and the repainting of the smoke affected wood.

THINGS TO LOOK FOR

Before deciding how to treat the wood, we must first learn what is the design most appropriate for the people with whom we are dealing and their location.

Architects have clearly set out in rules for this operation when dealing with individual and usually rich clients.

The Architect will delve into all aspects of his clients life to determine his needs - examining such aspects as - his and/or her religion, sex life, income, children, hobbies, reading habits, entertainment, transport, food and eating habits, clothing and footware, bathing habits, attitude to family nudity, phobias; colour preferences, physical dimensions (height, weight etc.), agility, health records and etc.

A good Architect will be able to tell you more about yourself (if you're his client) than you yourself know and presumably will use this information to help him design you an ideal home.

A very similar approach must be used when designing houses for ethnic groups.

The problem is not nearly so formidable as it might first appear. If a study is made of traditional housing you will find that the housing in a particular area is almost identical, and is laid down along fairly strict lines by the villagers governed by their culture and their conception of their requirements.

Although many colonial authorities and well wishing aid groups have more or less condemned the traditional village/tribal way of life, there is general acceptance now that it should be their role to assist people in living according to their own customs than trying to mold everyone to suit a particular fashion in advanced countries.

The obvious action is to find out what people really want in the way of housing and then do the best to provide it.

WHERE DOES WOOD PRESERVATION COME INTO THIS?

Reiterating what was noted early - the wood preservationist's job is to provide treatments which will help maintain good sound attractive housing for people.

Having learnt what the people want and how they will use a house, we are in much better position to design and specify the necessary wood protective measures, as was suggested by examples already given.

Our experience suggests that the wood preservationist must become involved at the planning stage.

It is not good enough to simply apply our technology to the Architects' finished plans. Like many areas of technology, wood preservation is a specialist field and even though all the available information may be expressed in standards, it is unrealistic to expect the average Architect or Engineer to read these standards, let alone understand them if they do read them.

This problem even occurs with, for example wood engineering groups, and other wood utilisation development groups.

In one research laboratory, a laminated timber arch has been made to demonstrate this particular technique, and installed in the grounds of the laboratory. Within a few years it was destroyed by termites - the engineers had no communication with the wood preservationists and as this was only a prototype - designed to show people what could be done with wood, preservation was not needed!

My first impression was that it showed that wood was good termite fodder! More seriously, it is unrealistic to prescribe wood glues without testing their compatability with the wood preservatives needed, so the building of this arch was rather pointless.

When Engineers erect a prototype bridge, they usually do so with no attempt to protect the wood in it. And of course they will often use the most durable timber available - this seeming to be a reasonable course. Unfortunately durable timbers are generally just not available in sufficient quantity to form a standard for bridges and non-durables may have to be used.

Because of problems of treatment and joint protection and etc. the wood preservationist often has a bigger-role to play in the design than the engineer, who will more than likely use a text book bridge design and this requires no engineering skills; but unfortunately there is no text book on wood preservation - not one that is which will give you a wood treatment procedure for the tropics.

We have roamed from housing to arches to bridges and find the same rules apply in all cases. Early and positive involvement of wood preservationists is required in the design stage of any project using timber. When considering homes, this involvement is especially important because we are dealing with people, and the building which may shelter them for most of their Lives.

WOOD PRESERVATION FOR TROPICAL HOUSING

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1. INTRODUCTION

One of the most depressing sights a wood preservationist will see in many parts of the wet tropics is the extensive decay of wood almost every building in which wood is used.

While many wood research groups fiddle around with long term trials to identify the few durable or relatively durable species available, and proceed to recommend species making up perhaps 10% of the Forest for building purposes, the bulk of the population uses whatever it can get at the least possible price and usually without any preservative treatment. The rapid decay which follows is inevitable and serves as a free advertisement for concrete and metal building materials.

A few years ago, I advised a customer that he should not expect C.C.A. treated hardwood posts to last very long because of soft-rot; he was a little shocked, the more so because the Forest Products Research Centre where I work had been promoting these treated posts for some 10 years, and asked for an estimate of service life. I replied "ten to fifteen and certainly not more than twenty years". I was astonished at how pleased he was by my reply but was brought down to earth very quickly, when I learnt that he had told his superiors that the treated posts would only last three years.

Although many of us have heard stories of the incredible durability of some tropical timbers, there are few people in the tropics who really expect wood to last very long in service, especially when exposed to the weather and/or in ground contact.

The sad and often humiliating thing about this attitude is that, with current practices in the tropics, the detractors are usually correct. Their ideas are based on what they have seen not what might have happened if every one concerned "had followed our recommendations".

This leads us to a general statement about deterioration of wood in the tropics:

1.1 No wood preservative treatment is known which can be guaranteed to result in a service life in ground contact of more than twenty five years.

1.2 Most people are pleasantly surprised if treated wood lasts even ten years in ground contact, and

1.3 Very little of our knowledge about wood decay and its prevention is actually being used.

Recently it has become quite apparent that the direct transfer of wood preservation technology from temperate regions to the tropics may result in massive premature failures of wood in service, particularly in ground contact or in the sea. When these failures are noticed the usual expert opinion is "the preservative retention is too low", "the wood was treated green," etc. I have seldom heard any suggestion that may be the preservatives developed for temperate conifers behave somewhat differently in tropical hardwoods and conifers, resulting in premature failure.

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It is almost traditional now to base performance projections for treated wood upon on ability to achieve "adequate" retention, penetration and distribution (macroscopic) of the fixing preservatives in the wood, irrespective of its source, and this tradition is difficult to break.

When clear evidence became available that this was not the case, as shown by the catastrophic effect of soft rot in electricity poles in Queensland, the immediate reaction was to question the treatment itself, then finally to hit upon the solution that this was a problem limited to Eucalypts in Australia and was supposedly caused by some rather unique set of properties in this large genus of trees but would not occur in other genera and was hence only a problem for Australians and more particularly for Queenslanders.

This "expert" opinion was not of course accepted by all and I can clearly recall a very definite statement by Professor Henningsson at the 1973 IRG/WP meeting in Finland to the effect that no preservative treatments were available commercially that (he believed) could give long term protection of Birch in ground contact from soft rot.

Recently I was able to undertake a brief survey of CCA treated poles in the Philippines and found that all the "traditional" Philippino pole species were effected by soft rot of sometimes massive proportions within 12 years or less of installation.

In Papua New Guinea, we have not found a single hardwood pole species which can be recommended for use in the ground when treated with C.C.A. unless specific measures are taken to protect the ground line zone from soft-rot.

It is clear then that we cannot safely talk about wood/preservative systems, nor can we make a division into temperate and tropical wood/preservatives systems where dealing with high hazard applications. We must talk about wood species/preservative/end use systems.

In spite of the complexities of such a notion, a very significant advances in the understanding of such systems has been made, particularly in Papua New Guinea where every species of commercial interest after treatment with C.C.A. and with creosote has been in field tests for more than ten years.

Although the problems of preserving wood which is not in ground contact are not nearly so great, we still have the situation where the notion of wood species/preservative/end use systems holds good; and it would seem that temperate countries which may restrict exports to tropical countries to one or two well known species have a distinct advantage over tropical countries where as many as three hundred species may be used commercially.

So in a sense we have two quite distinct problems. i. How should temperate countries treat wood destined for export to the tropics and ii. How should the tropics treat its own wood for local use and for export. It is hoped that these distinctions will become clearer as the paper proceeds.

2. THE CAUSES OF WOOD DETERIORATION IN THE TROPICS

There are two sets of interrelated causes of wood deterioration in the tropics and in general they are not all that different from those acting in temperate countries.

2.1 The first and I believe the major cause is the acceptance by Architects, Engineers, Builders, Carpenters and even Foresters of the inevitability of wood deterioration in the short term and their failure to take measures in design, wood treatment and construction methods to limit deterioration. It seems that one of the basic premises of building design schools is that because wood decays, eliminate it from structural use. Thus we have the situation in many major buildings where there is no wood deterioration because there is no wood used! While the specifiers insist upon galvanised iron for roofs and not pig iron, ceramic tiles for bathrooms and not plain bricks, special grades of steel, concrete, glass and so on for the many structural components of buildings, where wood is used (in Australia) it is usually simply specified as "hardwood" and treatment is often only used when it has been made mandatory by legislation such as the Queensland "Timber Users Protection Act".

In this first set a most significant cause of wood deterioration is the failure of other building components. The most common cause of decay in facia boards is the corrosion of metal guttering which results in wetting of the facia and often also the rafters and other structural wood components.

Leaking joints in plumbing hidden in walls will often result in decay of the wood in those walls.

Although aware of the "inevitable decay of wood", many Architects will specify untreated wood for exposed external "feature walls" and recommend some proprietary wonder (paint on) preservative brew which acts more as a sedative for the building owner than an effective wood preservative.

Thus I believe that improper design and construction and the failure of "permanent" building materials is the major cause of wood deterioration in the tropics.

When buildings are designed and prefabricated by a party with a vested interest in the good long term performance of the wood components, it is possible and indeed very desirable to take action to enhance the performance of the wood used, through both the thorough and sensible use of preservative chemicals and water repellants, through appropriate design and good construction supervision.

2.2 No matter how well a building is designed, the wood in it, if improperly treated, is still subject to rapid and very often destructive decay; the general nature of which is documented in every text on wood preservation.

For practical purposes we have four (4) types of organisms causing biological decay in wood in the tropics. These are in order of importance.

- 2.2.1 Fungi
- 2.2.2 Starchy sapwood eating insects
- 2.2.3 Drywood termites
- 2.2.4 Subterranean termites

2.2.1 <u>Fungi</u>. Fungi account for the most destruction of wood in service in the tropics of all the agents of biological decay.

Whenever wood gets damp, conditions of temperature and air supply are almost always near optimum for rapid and destructive fungal growth. All the classical (in layman's terms) forms of decay may occur; white, brown, wet, dry soft and just plain rot! It is really of little importance how fungal decay is classified, as exclusive protection against one particular type will only lead to prolific growth of another type.

What is required is some means of making the wood toxic to decay fungi and of limiting access to the wood of one or more of the two factors, water and air, necessary for decay.

The main points of entry of fungi into wood are through end grain, joints, nail holes and from behind leaking gutters and from leaking roofs. While the bulk of these problems are associated with external cladding and finishing, significant problems also occur inside houses from leaking plumbing, ill designed bathrooms, kitchens and laundries and last but not least by over enthusiastic use of water for household cleaning.

2.2.2 Starchy Sapwood eating insects. These insects, the Lyctidae and Bostrychidae will sooner or later infest and destroy all sapwood of hardwoods containing starch. Much work has been done on determination of the wood pore size appropriate to one insect, Lyctus brunneus but because of the prevalence of other Lyctidae and also Bostrychidae which have different requirements it is safest to assume that the presence of starch in a hardwood will result in its infestation with at least one or other of these types of insects.

2.2.3 Dry Wood Termites. These are probably the most destructive of all tropical wood eating insects as they attack both conifers and non conifers and more importantly, the destruction caused is seldom noticed until it is too late. Dry wood termites are not active in temperate regions and because they have relatively small isolated colonies and are difficult to maintain under laboratory conditions, they may not evoke much interest from entomologists.

Unlike the subterranean termites, drywood termites, once established inside a piece of wood, remain there, gradually eating away and expanding their galleries. There faecal pellets which are often speckled (depending on wood colour) and oval are poked out through a small opening to the outside during the quite of the early morning hours, probably when the relative humidity is near 100%.

Dry wood termites may completely destroy plywood, hardboard or timber leaving perhaps only an 0.5 mm veneer on one side and a coat of paint on the other so that the high humidity they require for survival is maintained.

It is safe to assume, when direct evidence to the contrary is absent, that all conifers, all low density hardwoods (say with basic density less than 0.5) and the sapwood of all hardwoods are susceptible to dry wood termites, and to take preventative measures.

2.2.4 Subterranean Termites. Few people would be unaware of the massive destruction of timber in the tropics which may be caused by subterranean termites.

These termites must maintain contact with the soil and their nests are usually in mounds above the soil, or under the soil but may also be inside a tree trunk or house stump, inside the wall of a house or high up on the outside of a tree. Where their nests are remote from the ground, the termites bring the soil with them. The explanation for this is that, unlike Drywood Termites which have symbiotic gut fauna to assist in cellulose digestion, subterranean termites must rely upon external agents such as fungi to digest cellulose and thus always maintain conditions in their nests which are optimum for fungal growth.

Subterranean termites are really of little concern in the wet tropics because chemical and physical control is relatively simple and effective, the more so because of the virtually infinite supply of easily accessible and more palatable wood apart from buildings.

However, in the arid tropics, subterranean termites may have only a very meagre supply of wood apart from that introduced by man for his buildings, railways etc. Thus in the arid north west of Western Australia, subterranean termites may eat their way through 10 mm or more of highly toxic wood to find the untreated "core" of a railway sleeper. Thousands of termites must die from eating through the toxic shell of wood but apparently their drive for survival is so great and wood in such short supply, that these losses can be withstood.

One of the most dangerous aspects of introducing wood to the arid tropics is that a very thorough search may not reveal any written records or verbal information confirming the presence of termites in a particular area. Finding termites any where in the tropics may be quite difficult. The only certain way is to put out baits of patatable wood and let the termites carry out "the search and destroy mission".

Notwithstanding the voracious termites in North Australia, control of subterranean termites may usually be effected by simply design and/or wood preservation techniques.

2.2.5 Miscellaneous Organisms. Any wood preservationist who had spent some time in the tropics could add to this short list of organisms responsible for decay of wood. However control of these organisms will usually result in control of all destructive organisms.

However certain animals use wood for nesting but do not ingest wood and so are immune to the stomach poisons normally used. Examples of these are Wood Peckers and Carpenter Bees. Carpenter Bees are about 20 mm long and in low density wood may drill out tunnels up to 15 mm in diameter and 200 mm long. While the damage they cause is thus often spectacular, it will seldom if ever result in structural failure because these bees avoid the heavier timbers normally used for structural purposes.

3. PHYSICAL AGENTS (OTHER THAN DESIGN) RESPONSIBLE FOR WOOD DECAY IN THE TROPICS

The high temperatures, insolation and rainfall in the tropics can result in rapid physical deterioration of exposed timbers by direct action and by indirect action through corrosion of metal fastenings followed by chemical decay.

Much of the purely physical weathering occurs in conjunction with degradation caused by fungi but ultraviolet light plays an important part as evidenced by the bleaching of wood which probably leads to increased susceptability to fungal decay.

Decay caused by metal fittings and fastenings is I believe solvable by changing the fastenings rather than "treating" the wood.

Other problems associated with the physical environment are distortion, checking and splitting of exposed wood.

4. PRESERVATIVE TREATMENT OF WOOD IN TEMPERATE COUNTRIES FOR EXPORT TO THE TROPICS

In this section I will restrict my remarks to wood used in houses and which is not in ground contact.

This is probably, or at least should be, one of the simplest of all wood preservation problems. For complete control of all the agents of biological decay of wood, ensure that all the wood used is

(a) coniferous
(b) completely permeable to waterborne salts
(c) treated to refusal by vacuum/pressure impregnation with a copper-chrome-arsenic type preservative (not CBK) to a retention appropriate to the hazard and that you
(d) retreat all timber exposed to the weather with a water repellent preservative (W.R.P.)
(e) apply water repellent (non film forming) preservative stains to all exposed wooden cladding.
(f) design for durability.

In the event that the timber selected is not completely permeable, carry out all moulding, sizing, cutting to length and other prefabrication prior to treatment.

Appropriate retentions for the tropics are believed to be: (based on Tanalith C)

Interior timbers not subject to wetting	8 kg/m^3
" " - " " "	12 kg/m^3
Exterior timbers on vertical walls	12 kg/m^3
Exterior timbers in horizontal (e.g. wooden shingles, verandah flooring and external stairs)	16 kg/m^3

This is obviously an oversimplification, although quite valid as far as it goes, and I will now proceed to deal with various wood building components step by step.

4.1 Framing. Usually house framing (scantling) is completely protected from weathering and not exposed to rain wetting. Thus the major hazards are termites and lyctus. (Bostrychid seldom infests seasoned wood in service). However in the wet tropics some decay hazard may result from the generally damp conditions.

In addition, the timber may be subject to repeated wetting during shipment and erection. Thus while the diffusing boron/arsenic based preservatives can give adequate in-situ protection, when fully permeable (to pressure) wood is available, v/pressure treatment with a fixing preservative such as Tanalith C or Boliden K33 and etc. is recommended.

However if a colourless preservative is required and/or the species to be used are not permeable under pressure (in the truewood) vacuum/pressure, diffusion treatment of the partially seasoned finished components with boric acid/arsenic pentoxide or boric acid/sodium fluoride or hydrogen fluoride/arsenic pentoxide is indicated. Retentions required are 0.2% boric acid and 0.1% arsenic pentoxide (based on oven dry wood).

A diffusion period of one week followed by air drying or alternatively three to six weeks followed by kiln drying will probably be sufficient to obtain adequate distribution of the preservative.

Irrespective of intention, the ends of rafters and the bearers beneath floors and kitchens etc. inevitably get wet and, especially with diffusible preservatives, but even with fixed preservatives, use of W.R.P.'s and, in the case of rafters, addition of mechanical protection, is warranted.

In order to save organisational problems of selecting just wat needs W.R.P. treatment and what doesn't, it may be prudent to treat all end grain by giving it a three minute dip in a W.R.P. External wooden joinery requires somewhat more complete treatment.

Ends of rafters and bearers etc., after W.R.P. treatment should be sealed with plastic or metal caps, while the bearers underneath baths, toilets, sinks etc. should be "painted" with a W.R.P. and topped with malthoid or equivalent to keep out moisture, irrespective of other treatments.

Any large structural timber member should be gang nailed at the ends where any likelihood of splitting exists.

Notching out of studs to take noggins and braces should be avoided if possible as this is usually done after treatment and may expose untreated wood. (Perhaps this type of fitting technique is unique to Australia.)

4.2 Strip Flooring.

The same overall remarks may be applied to flooring as to framing and it should be remembered that damage to flooring which is not under mats and carpets quickly becomes evident.

A floor which is to be sealed with "Estapol" or some hard wearing synthetic clear finish may be pretreated by a boric acid/arsenic type diffusing preservative. The preservative might best be applied to partially dried boards machined as nearly as possible to their final dimension after taking shrinkage into account.

Treatment of finished strip floored (seasoned and moulded) with P.C.P., T.B.T.O. or other proven pesticides in light solvent may be a valuable alternative provided the wood is completely permeable, and of course is given a sealing finish to protect the occupants.

Where the final green colour is acceptable or if not, can be covered by an acceptable stain, and the wood is permeable, vacuum pressure treatment with C.C.A. of the seasoned moulded flooring is a straight forward process that can give consistently reliable results with conifers.

4.3 External Cladding & Trim (Solid Timber)

In low cost housing we should seek to avoid the reliance upon film forming protective coatings (paints) for external solid wood cladding as their life in the tropics is very short indeed (4 to 5 years) and the high maintenance costs usually result in no or little maintenance. The result is a very poor appearance and a good market for prefinished aluminium "weatherboard".

Nevertheless we have had well maintained external cladding in P.N.G. of diffusion treated coniferous wood in service for more than twenty years with no significant failures.

However, it is prudent to build complete protection into your product rather than to rely upon others carrying out maintenance of surface coatings to protect a diffusable and hence leachable preservative.

Low cost housing cannot bear the cost of creosote or other oil type preservative treatments and the value of brush on preservative oils is generally illusionary. In high cost dwellings creosote would probably be unacceptable so we are left with oil borne or light solvent borne preservatives or C.C.A. applied by vacuum pressure impregnation.

There is little doubt that oil borne treatments will impart useful dimensional stability and provide protection from weathering.

However there is little published data available which gives any real indication of the service life of external cladding in the tropics treated with either oil borne preservatives or C.C.A.

For reasons of simplicity and in the absence of information to the contrary, I would recommend the use of a permeable conifer, premoulded prior to treatment, treated with C.C.A.

After redrying, all end-grain (and if feasible, the whole boards) should be dipped in a W.R.P. for at least three minutes. If a coloured W.R.P. is used the weatherboards will be "prefinished" by this treatment.

Although C.C.A. treatment does cause a measurable increase in brittleness of conifers exposed to the elements, it also imparts some resistance to the weathering. The extent to which this is because of reduction in fungal decay or of the effect of UV light is not clear.

The Canadian Forest Products Laboratory claims to have produced boards with remarkable weathering resistance using ammonical metal organo-sulphur compounds and this development might be a valuable adjunct to normal C.C.A. treatments.

One of the difficult problems with C.C.A. treated external cladding is disfigurement caused by corrosion of the metal fastenings (nails). Although the chromium content of C.C.A. is reputed to prevent or at least reduce corrosion of metal fastenings in treated wood, in P.N.G. every exposed nail (and eventually those covered by paint) is corroded and a disfiguring brown streak marks its location in C.C.A. treated wood.

As the wood and the treatment seem most satisfactory we suggest the use of plastic nails in place of steel nails and are at present looking for a supply of suitable plastic nails.

4.4 External Joinery

In this I do not hesitate to recommend double treatment using fully permeable species, first with C.C.A. and then with P.C.P. or T.B.T.O. along with water repellents in a light solvent by a "vac-vac" or "vac-sol" process or similar.

Once installed the joinery should be finished with W.R.P. "stain" containing a solid UV resistant pigment.

The design should be such that all nails are hidden; that is out of sight and not likely to be wetted by rain.

This double treatment is necessary to give both resistance to bio-deterioration and stability. Failure in both these areas has led to significant replacement of wood in external joinery by metal products which are aesthetically unsatisfactory.

Composite Board Products

Composite board products such as plywood, particle board and hardboard are all subject to fungal and insect attack in the tropics and all require treatment appropriate to their end use.

Insects may be controlled by incorporating arsenic trioxide, dieldrin, or aldrin in the glueline of plywood or in some other way introducing the appropriate amount into the finished product.

One of the greatest difficulties in this area of wood preservation is the pollution and toxic hazard problems associated with many methods of incorporating effective preservatives in plywood. The usual response from producers is that the tropics will have to accept untreated products because of these difficulties. This is a very negative and damaging attitude which should be strongly resisted.

If a composite board product cannot be given protection against biodeterioration then it should not be exported to the tropics for use in housing.

Having accepted this, it should be possible to get on with the job of finding acceptable preservatives and methods of application.

Plywood treatment presents the least problems and may be achieved in a variety of ways depending upon the type of hazard to which it will be exposed and the type of gluebond.

Protection against drywood termites and lyctus in interior grade (water resistant) plywood may be achieved by two methods;

(a) dipping fresh veneers in solutions of boric acid, sodium fluoride or C.C.A. and stacking for some hours to allow diffusion before drying or
(b) by incorporating arsenic trioxide in the glue.

Where fungal decay is an added hazard as in exterior plywood, around baths and kitchen fittings, C.C.A. treatment is indicated. Subject to compatability with the glue, C.C.A. "diffusion" treatment of individual veneers is probably the simplest; vacuum pressure treatment of the finished boards with either C.C.A. or a light solvent borne preservative can also give satisfactory results.

If there is any doubt about the durability of composite board products, do not incorporate them in houses destined for tropical use. By doubt I mean the absence of positive results from durability trials. It is not enough not to have noted complaints about lack of durability if a long term stable market is to be developed and maintained.

5. DESIGN FACTORS

In another paper I will deal with design factors from the human angle as they affect wood preservation and it is most difficult (for me) to discuss design to the exclusion of the people involved.

Too often when wood is used, other materials are found wanting and cause wood failure and rather than replace the other materials, the wood is discarded - designed out of future structures. One example of this is metal guttering, which in the tropics is far from satisfactory. In spite of the failure of metal guttering, the wood behind it, even if only treated with a diffusable preservative may be protected by W.R.P. and paint. However in almost all on site constructions, the guttering goes up before the W.R.P. or paint is applied.

This is a design and supervision problem, not so much one of wood preservation.

External verandahs and wooden staircases often protrude outside the roof line and are thus exposed to an unnecessary hazard from rain wetting. In the tropics no one wants an unshaded verandah anyway and to have to climb up and down stairs in the rain is unpleasant and unnecessary. This is a design problem.

Because of the general lack of permeable (to pressure) high strength woods in the tropics we are often forced to make do with diffusion treated timbers for these type structures. However, application of a W.R.P. and priming of the joints in the rails and at the end of the wooden treads will greatly extend the life of an exposed wooden staircase if for reasons of cost it cannot be under cover. Even when this treatment is specified it is seldom carried out because it is almost impossible to verify once the jobs is completed. This is a public relations and supervision problem which can reasonably be put under the heading of design.

Similar examples may be found in many other components of wooden houses, and if they are truly design problems, it is because we, that is those promoting the use of treated wood, have lost contact with the designers and builders.

Too often, our universities and technical institutes training those who specify and fabricate in wood, either fail to teach wood preservation at all or seem to base their teaching on information passed down by some ancient civilisation. Instead of being at the forefront of scientific development in this area, the universities seem to be in the dark ages.

Wood Preservation in the Tropics

With respect to development of wood preservation in the tropics itself, most of the responsibilities is vested in various national Forest Products Research Groups often under the guidance of an expert from an advanced industrial country. Two systems seem to be in use - either technology is transferred directly with little modification to tropical country from the advanced temperate country in which case there are likely to be massive premature failures - or a "vigorous" experimental program is set up to investigate natural durability and to field test various preservatives with one or two preservatives for a generation or so. This effectively delays the implementation of a commercial program of wood preservation until far in the future.

I would hesitate to suggest that this is the situation in all tropical countries but do maintain that it is perhaps the rule rather than the exception.

What can be done in the tropics is amply documented in the proceedings of "The Economy and Utilisation of Wood in the Tropics through Wood Preservation" a training seminar held in Papua New Guinea in 1975.

In brief my recommendation for tropical wood preservation is:

(a) Introduce a universal diffusion type treatment for all building timbers not exposed to leaching nor in ground contact.

(b) Use C.C.A. treated permeable conifers or low density hardwoods for external (exposed) cladding.

(c) Make wide use of W.R.P's wherever end grain is exposed.

~~(d)~~ Use C.C.A. treated hardwood poles for ground contact application provided the species have a wide sapwood and relatively durable truewood and apply a concentrated preservative to the pole from one foot above ground line to the butt and seal in reinforced coal tar, to prevent leaching a limit access by fungi.

(d) Use C.C.A. treated hardwood poles for ground contact application provided the species have a wide sapwood and relatively durable truewood and apply a concentrated preservative to the pole from one foot above ground line to the butt and seal in reinforced coal tar, to prevent leaching a limit access by fungi.

(e) Install field tests of <u>all</u> commercial species treated with one or two available preservatives which have commercial potential in sites representing the major hazards. Do not wait for the results before implementing a treatment program. Make cautious use of the best available information from all areas with similar wood species and hazards.

(f) Do not use wood where it cannot be given adequate protection unless no other alternatives are available.

(g) Strive for adequate quality control through regulations and for adequate training of Architects, Engineers and Builders in all aspects of wood utilisation.