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Study Group on Production Techniques in Wooden Houses
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WOOD PRESERVATION FOR TROPICAL CLIMATES 1/

by

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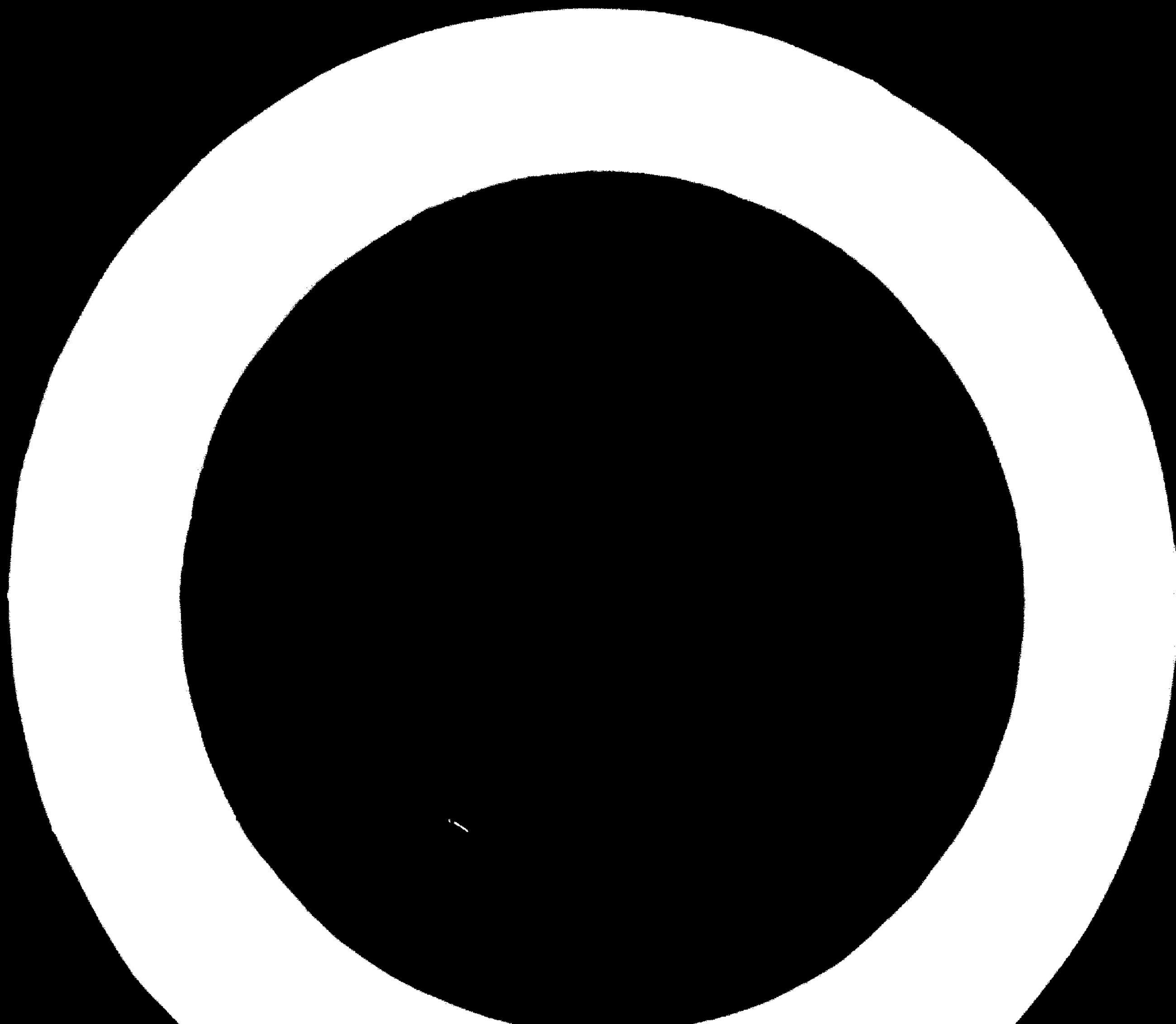


Introduction

In most developing countries, the architecture and layout of any village and town are obviously influenced by the building materials, which are readily available and what necessarily dictate the alternative forms of construction.

It is a necessity based on easily available and natural products -- soil for walls and floors, timber for roof and wall, straw, thatch, matting, etc., for roof covering that is usually used.

However intelligently these indigenous materials are used, they could be considered at best only temporary. They are seldom water-tight and require continued maintenance and have a limited life against white ants, etc. The desire for permanence to resist against storm, rain, termite, etc. is there.

Of all the materials readily available, timber ranks the highest. It has to be made durable or permanent by proper preservation methods, which is a 'must'. It is perhaps the only building material that can be used for an entire building without other materials, apart from steel fasteners. Therefore, preserved timber, properly used, will go a long way to improve the general status of house building in developing countries.

The Need for Wood Preservation

Timber, by new technical innovations, has staged a remarkable and an almost sensational come-back during recent years and is now a front bencher in the arena of modern structural materials. Its potential in the use of housing construction, inspite of other structural materials, has not dwindled. One of the main causes for its success has been the proven qualities, inspite of deteriorating influences under tropical conditions, of both dependability and durability.

This paper essentially scans through some of the successfully used methods in tropical countries in preserving chiefly second grade species of timber so as to protect it from all destructive organisms and to make it a useful building material.

What is treated wood? Treated wood is wood that has been impregnated under pressure or by any other means with a suitable wood preservative that has been developed by systematic and scientific research in the laboratory and in the field, for permanently protecting it once it has been applied. Such preservative treatment, should protect wood, irrespective of its species, for a period that synchronises with its chemical or mechanical life as determined by conditions of service. The treatment may be for protection against white ants, insects and fungi. It may be for protection against fire. It may be for stabilising wood so that its tendency to shrink and swell, due to atmospheric variations in temperature and humidity, is reduced to a minimum. It may be against teredo and other marine organisms. Almost invariably the treatment consists of injecting into wood, in a special plant, of a chemical or a mixture of chemicals, suspended either in oil or a water medium, so that the protecting chemical is dispersed deeply into the wood in an economic manner.

Life of Untreated (Indian) Timbers

Sapwood: The durability of sapwood of any timber in the world including such famous timbers, known for its durability, such as Teak, is very low. If such sapwood is placed in the ground, its life, in most cases, is only a few months. The durability of untreated sapwood may be taken as too low for structural purposes.

In the case of heartwood, the position is different. The durability of the heartwood of various structural timber varies widely, depending not only on the species, but on the locality of installation and the climatic and weather conditions to which it is exposed. Before it can be decided whether wood preservative treatment is justified for any specific timber, or what is the intensity of the treatment required, it is essential to know the natural relative durability and its amenability to pressure impregnation and/or other forms of preservative application.

As an example, in India where a large range of structural timber species are available, the Forest Research Institute at Dehra Dun, about 60 years ago, started a series of experiments to classify Indian timbers on the basis of their natural durability and the intensity of preservative treatment that would be required.

In the early Twenties, realising that there was hardly any authoritative data on the relative durability of heartwood of Indian timbers, a systematic test was started at the Forest Research Institute, Dehra Dun, under similar but severe conditions of white ant and fungus attack. These heartwood pieces (24" x 2" x 2") of timbers of commercial importance for structural purposes were submitted to test by "planting" them vertically in the special test yards of the Forest Research Institute with half their length buried in the earth and half projecting above. Periodical inspections were made at regular intervals and notes were kept regarding the extent of the damage done by white ants and fungi.

After about 10 years, a fund of valuable information on the relative susceptibility to white ant and fungus attack of these Indian timbers became available. A useful classification of these timbers on the basis of the intensity of preservative treatment required for them (as determined by their relative degree of durability) is now possible. It should be borne in mind that the classification is independent of the degree of amenability of preservative treatment of the various timbers, so that, for example, if the heartwood of a timber of Class C or Class D, in the present classification cannot be impregnated under pressure satisfactorily, it should not be placed in the ground (as a post in the square) in outside locations. In the case of round posts penetration into the heartwood is not necessary and if a deep and satisfactory penetration of preservative can be obtained in square heartwood timber based on its amenability to preservation under pressure, it could be safely used. The classification is given below where Class A refers to the most naturally durable timbers that are on par with Sal (Shorea Robusta). Unless they are used as poles or posts installed in the earth or with sapwood attached, no treatment is usually required. Such timbers include the known durable woods such as Teak, Sal, Pyinkada and Mesua.

Even the most rapidly perishable woods and the sapwoods of practically any timber can be made by proper antiseptic treatment, more durable than Sal (Shorea Robusta), Deodar (Cedrus Deodara), Teak (Tectona Grandis), Pyinkada (Xylia Dolabriformis) or Mesua (Messua Ferrea) and at that even the most naturally durable heartwood, provided it is treatable, requires preservative treatment under pressure for long service as a pole or as a post -- if a life of more than 5 to 8 years is required, as in the case of telegraph, telephone and electrical poles.

Under Class B, are grouped timbers which may be expected to be highly durable in inside and protected locations. In fact, these timbers are almost as durable under inside locations as Class A timbers could be in outside locations, so that in internal use (except when employed as floor-boards or when laid in direct contact with the ground) a superficial antiseptic treatment will do. Class B timbers, however, require to be treated with wood preservatives under pressure for service in out-door locations.

Class C timbers are less durable than those of Class B. These timbers require either low pressure treatments or atleast open-tank soaking treatments if they are to be used in interior sheltered locations, but thorough pressure treatment is essential for outside locations.

Class D timbers are very susceptible to white ants and fungus contacts, so that even for indoor or for out-door locations they have to be pressure impregnated to full retentions with reliable wood preservatives.

In the following classifications, it should be remembered that HEARTWOOD only is concerned, the SAPWOOD of all timbers (other than Deodar) being readily treatable with preservatives.

CLASS A: BRUSHING LIBERALLY WITH A FIXED PRESERVATIVE WHICH DOES NOT WASH OUT OR VOLATILISE, FOR OUTSIDE LOCATIONS ONLY. IF PLACED ON OR IN THE GROUND AND A VERY LONG LIFE IS DESIRED PRESSURE TREATMENT IS REQUIRED - OTHERWISE NO TREATMENT IN OUTSIDE AND INSIDE LOCATIONS IS NECESSARY (NOTE: FOR HEARTWOOD ONLY).

BOTANICAL NAME	COMMON NAME
1. Albizzia odoratissima	Black Siris
2. Cupressus torulosa	Cypress
3. Dalbergia latifolia	Indian rosewood
4. Dalbergia oliveri	Tamalan
5. Heterophragma adenophyllum	Koren wood
6. Hopea parviflora	Hopea
7. Melanorrhoea usitata	Thitii
8. Messu ferrea	Mesua
9. Pterocarpus dalbergioides	Andaman Padauk
10. Pterocarpus macrocarpus	Burma Padauk
11. Shorea obusta	Thitya
12. Shorea robusta	Sal
13. Tectona grandis	Teak
14. Xylia dolabriformis	Pyinkado
15. Xylia xylocarpa	Irul

CLASS B: PRESSURE IMPREGNATION FOR OUTSIDE LOCATIONS MOST NECESSARY. SUPERFICIAL TREATMENT SUFFICIENT UNDER SHELTERED LOCATIONS EXCEPT IN THE CASE OF GROUND CONTACT WHERE PRESSURE TREATMENT IS NECESSARY.

BOTANICAL NAME	COMMON NAME
1. Acacia catechu	Cutch
2. Albizzia lebbek	Kokko
3. Albizzia procera	White siris
4. Altingia excelsa	Jutili
5. Amoora wallichii	Amoora
6. Anogeissus acuminata	Yon
7. Artocarpus chaplasha	Chaplash
8. Artocarpus hirsula	Aini
9. Artocarpus integrifolia	Jack
10. Bassia latifolia	Mahwa
11. Bursera serrata (Syn. Protium Serratum)	Indian red pear
12. Calophyllum elatum	Poon
13. Calophyllum tomentosum	Poon
14. Calophyllum wightianum	Poon
15. Carapa moluccensis	Kyana
16. Careya arborea	..
17. Castanopsis tribuloides	..
18. Cedrela serrata	Toon
19. Deodara Cedrus	Deodar
20. Dalbergia paniculata	Tapauk
21. Dalbergia sissoo	Sissoo
22. Dichopsis elliptica (Syn. Palaquium ellipticum)	Palli
23. Dipterocarpus	Gurjun
24. Dipterocarpus indicus	..
25. Dipterocarpus tuberculatus	Eng (maiyang)
26. Dysoxylum binectariferum	..

BOTANICAL NAME	COMMON NAME
27. Dysoxylum malabaricum	White cedar
28. Eriolaena candollei	Salmon wood
29. Eugenia jamboloana	..
30. Eugenia knaarensis	Jaman
31. Gluta tavoyana	Gluta
32. Gluta tranancorica	..
33. Grewia tiliaefolia	Dhaman
34. Hardwicka binata	Anjan
35. Homalium tomentosum	Burma lancewood
36. Hopea cordifolia	Mendora
37. Hopea codorata	Thingan
38. Kayea assamica	Sia nahor
39. Lagerstoemia hypoleuca	Jarul
40. Lagerstroemia mocrocarpa	..
41. Michelia montana	..
42. Ougeinia dalbergiodes	Sandan
43. Parashorea stellata	Tavoy wood
44. Pentace burmanica	Thitka
45. Pentacme suavis	Ingyin
46. Pinus excelsa	Kail
47. Poeciloneuron indicum	Ballagi
48. Pterocarpus marsupium	Bijasal
49. Quercus lineatal*	Phalat
50. Schleichera trijuga	Kusum
51. Shorea assamica*	Makai
52. Shorea talura*	Talura
53. Terminalia arjuna	Arjun
54. Terminalia oliverie	Than
55. Terminalia paniculata	Kindal

BOTANICAL NAME	COMMON NAME
56. Terminalia tomentosa	Laurel
57. Vitex altissima	Milla

CLASS C: HIGH PRESSURE TREATMENT WITH FULL RETENTIONS FOR OUTSIDE USE AND FOR GROUND CONTACT UNDER INTERIOR LOCATIONS. SUPERFICIAL TREATMENT FOR INTERIOR THOUGH NOT IN GROUND CONTACT LOCATIONS.

BOTANICAL NAME	COMMON NAME
1. Acacia arabica (Sind)	Babul
2. Acrocarpus franinifolius	Mundani
3. Adina cordifolia	Haldu
4. Aegle marmelos*	Bel
5. Albizzia ludica	Tapria-siris
6. Albizzia stipulata	Kala siris
7. Anisoptera glabra*	Kaunghmu
8. Anogeissus lafifolia*	Axlewood
9. Artocarpus lakoocha	Lakooch
10. Bassia butyracea	..
11. Berrya amimonilla	Trincomalee wood
12. Bischofia javanica	Bishop wood
13. Bombax insigne*	Semul
14. Boswellia serrata*	Salai
15. Canarium Strictum*	White dhup
16. Castanopsis hystrix*	Indian Chestnut
17. Casuarina equisetifolia*	Australian beef-wood
18. Cedrela toona	Toon
19. Chekrasia	Chickrassy
20. Chloroxylon swietenia	Satinwood
21. Cinnamomum cecicodaphne	..
22. Cinnamomum inners*	Cinnamon
23. Cinnamomum inunctum	..
24. Cleistanthus collinue	..

BOTANICAL NAME	COMMON NAME
25. Crypteronia paniculata*	..
26. Cynometra polyandra*	Ping
27. Dillenia indica*	Chelta
28. Dipterocarpus kerrii*	Gurjan
29. Dipterocarpus macrocarpus	Hollong
30. Dipterocarpus obtusfolius	Gurjun
31. Dipterocarpus zeylanicus	..
32. Dipterocarpus zeylanicus	Hora
33. Duabanga sonneraciodes	Lampati
34. Eucalyptus globulus*	Bluegum
35. Eugenia gardneri	Jaman
36. Fraxinus floribunda*	Ash
37. Gmelina arborea	Gamari
38. Heritiera minor	Sundri
39. Holoptelea intergrifolia*	Kanju
40. Hopea glabra	Hong
41. Hymenodictyon excelsum*	Kuthan
42. Lagerstroemia flos-regainae	Jarul
43. Lagerstroemia lanceolata	Benteak
44. Lagerstroemia parviflora	Lendi
45. Lagerstroemia tomentosa*	Leza
46. Lophopetalum wightianum*	Banati
47. Machilus macrantha*	..
48. Mangifera indica*	Mango
49. Michelia cathcartii*	..
50. Michelia cathcartii excelsa*	Champ
51. Mimusops elengi*	Bulletwood
52. Mitragyna parvifolia	Kaim

BOTANICAL NAME	COMMON NAME
53. Morus alba	Mulberry
54. Morus serrata	..
55. Phobe hainesiana*	Bonsum
56. Picea morinda*	Spruce
57. Pinus longfolia	Chir
58. Podocarpus nerifolia	..
59. Podacarpus wallichianus	Thitmin
60. Polyalthia fragrance	..
61. Pterospermum acerifolium*	Mayeng
62. Quercus lamellosa*	Buk
63. Schima wallichii	Chilauni
64. Sterospermim suaveilens*	..
65. Stereospermum xylocarpum	..
66. Terminalia belerica	Bahera
67. Terminalia bialata	White chuglam
68. Terminalia chemila	Myrabolan wood
69. Terminalie manii	Black chuglam
70. Terminalie cmyriocarpa	Hollock
71. Terminalia procera	White bombay
72. Terminalia pyrifolia	Lein

CLASS D: HIGH PRESSURE TREATMENT WITH FULL RETENTIONS FOR USE IN OUT-DOOR AND INTERIOR LOCATIONS.

BOTANICAL NAME	COMMON NAME
1. Abies pindrow	Fir
2. Abies webbiana*	Fir
3. Acer campbellii*	Maple
4. Alstonia scholaris	Shaitan wood
5. Anthocephalus cadamba	Kadam

BOTANICAL NAME	COMMON NAME
6. Bauhinia refusa	..
7. Bombax malabaricum	White dhup
8. Butea frondosa*	..
9. Canarium euphyllum	..
10. Crataeva religiosa*	Brarua
11. Cryptomeria japonica*	Sujimi
12. Cullenia excelsa	Karani
13. Dillenia pentagyna	Dillenia
14. Diospyros melanoxylon	Ebony
15. Diospyros phrrhocarpa	Te
16. Eugienia praecox	Jaman
17. Fraxinus excelsior	Ash
18. Juglans regia	Walnut
19. Lannea grandis (Syn.Odina wodier)	Jhingan
20. Machilus gamblei	Ladder wood
21. Mallotus philippinensis	..
22. Miliusa velutina	..
23. Mitragyna diversifolia	Binga
24. Parishia insignis	Dhup
25. Parrotia jacquemontiana	Parrotia
26. Planchonia andamanica	Red Bombway
27. Sonneratia apetala	Keowra
28. Sterrospermum chelonoides	Padri wood
29. Sterculia campanulata*	Papita
30. Swintonia floribunda	Taung thayet
31. Ulmus wallichiana	Elm
32. Vateria indica	Vellapiney

Species marked with an asterisk are among the less durable of these.

In all cases, the wood preservative employed for out-door use must be "fixed" in the wood so that it gets neither washed out by rain, nor diffused into moist soil and will not volatise or bleed out in the sun during the hot months when the temperature of the surface layers of the installed wood could rise to over 150°F.

Since wood of almost all the species that have been examined and could be used for structural purposes can be impregnated with uniformity and ease, with a larger and better regulated amount of toxic preservative than nature has actually introduced into the so called "naturally" durable timbers, it follows that from the durability point of view, the sapwood of any timber (except a few species like Deodar), including those of the Class D, can be made to be more durable than the heartwood of Class A timber. There is also an added advantage with sapwood. It can not only be filled up with the preservative chemicals which make it more durable than Class A heartwoods, but it can also be fire proofed. Nature has already filled up the pores of Class A timbers with protective compositions, but these are not as efficient or as permanent as modern wood preservatives. Also, no new chemical for conferring any special property such as fire resistance or a particular colour or odour can be introduced into such timbers. On the other hand, the sapwood of easily treatable timbers is free to take any chemical for a specific purpose.

It is well to remember that the durability of untreated sapwood of all kinds of timbers is very low and as in practically all cases, it can be penetrated with wood preservatives very satisfactorily, irrespective of the species, it offers a structural material of standard durability that can be relied upon and that can be raised practically to any degree of durability by impregnating it with the requisite quantity of a suitable wood preservative. In the case of round seasoned timber, therefore, it does not matter what the natural durability of the heartwood core is. Provided, there is a sufficient external ring of impregnated sapwood which extends to a greater depth than that to which seasoning splits are expected to penetrate, the lowest Class of timber poles can be made to be as durable and as valuable as poles of the best Class. The treated sapwood of all timbers has, for the same depth and uniformity of impregnation and almost identical degree of durability against the attack of white ants and fungi.

As the standard of durability can be made higher than that of untreated durable heartwoods of even Class A, the aim should be to select a timber of any Class which is adjudged to be cheap and suitable and available in the local market. An envelope of treated sapwood should cover as much of the heartwood as possible for use in outside locations.

Durability of preserved secondary species:

1. Sapwood: The sapwood of any timber can be easily and thoroughly impregnated under pressure with a wood preservative specially of the water soluble type, which leaves it clean, paintable and will give permanent protection. Such preserved sapwood of practically any species (as also pressure preserved bamboo, split and unsplit) may be placed in any location inside or outside. The durability of such treated sapwood and bamboo will be well over 60 years in inside locations and not less than 30 years under exterior locations embedded in the ground. If not embedded in the ground and under exterior locations, such pressure treated sapwood of bamboo has a life of over 40 years.

In fact, if timber is to be laid in the ground or in contact with it, it is imperative to arrange that only pressure treated sapwood should be in direct contact with the ground or embedded in earth, unless very efficient drainage ot water is provided as in the case of railwey sleepers, where the stone ballast helps to drain off the rain water away. A natural corollary for this condition for getting the maximum life of treated sapwood is that, as far as possible, the treated wood laid in the ground or in contact with it should be in the round or atleast used as half rounds. When once pressure treatment is given, it will be observed that sapwood instead of being a liability and hence rejected, becomes a definite asset.

2. Heartwood: Most of the heartwoods that are treatable can be considered to be as good as Teak and even superior and will last well over 60 years.

Such timbers may be placed inside, and in contact with the earth. The heartwood of certain Indian timbers can be efficiently impregnated under pressure with wood preservatives and can therefore be safely laid inside the ground. As a rule, with the exercise of care and ingenuity, it should be possible to arrange that only treated sapwood is laid in or in contact with the ground. Placing untreated heartwood of any timber in the ground is a gamble. If such heartwood is to be placed under unfavourable conditions, it should be impregnated under pressure with high concentrations of wood preservative chemicals. It is therefore, not possible to give any specific figures for the durability of untreated heartwood of timbers if they are laid in the ground. Their life may range from 5 to a hundred years! If however, such treated heartwood is placed in the ground, the average life may be taken between 30 to 50 years depending on the variation of timber, humidity and of the locality in which such timber is laid.

Preservation Processes

Brush Treatment or Spray: For timber that is either in transit or in storage, several excellent wood preservatives will protect it from fungal and other forms of damage if these preservatives are either brushed or sprayed on to it. Millions of cu.ft. of timber annually can be saved if this simple precaution is taken.

Where timber is well ventilated and is in interior or sheltered locations, a surface treatment can be expected to lengthen the life of such timber. This treatment is however, not adequate for partially ventilated structural members like floors, ceiling boards, etc. and is not one of the measures usually included in standard specifications for the preservative treatment of wood. With such treatment, care must be taken that no untreated wood is left exposed, especially at the joints.

Equipment required: For superficial application of wood preservatives whether it is either painted or brushed on and in larger structures sprayed by means of a hand or machine operated sprayer, a nose protector or mask should be used. Such machines are easy to obtain in different sizes.

Operation: Atleast two coats should be given whether by brushing or spray. The second coat should be given after the first is dried. If the wood is to be painted or varnished, it should, prior to treatment be sand-papered or if greasy, cleaned with dilute caustic soda solution of about

2% concentration. Care should be taken to introduce plenty of the preservative solution in the crevices at timber joints, or into any splits or cracks resulting from seasoning. This is specially important where conditions are favourable for the growth of wood destroying fungi. Timber treated in this manner should be well seasoned. It must be remembered that any untreated timber surface is a potential danger spot, and for this reason all timbers should be cut to size and worked before any timber is treated. If any surface is to be planed, sawn or bored or cut, the surface should be retreated with the preservative.

Dipping or Soaking

Scope for this type of treatment: The method of treating timber by dipping is quite efficient and could be used by the small timber users who propose to use treated timber in building construction, but who have neither the facility for getting their timber treated in a proper pressure impregnation plant nor for purchasing pressure treated timber from the local market. The penetration of the preservative that can usually be obtained with this treatment is undoubtedly better than that resulting from superficial brushing. It offers, however, even in sapwood a more shallow and erratic treatment than obtained under pressure.

A thorough dipping or soaking treatment will however, give good results in dry outside locations or sheltered inside locations provided the timber is carefully selected and seasoned after treatment.

Precautions in selecting and preparing material for treatment:

Even where an open tank dip treatment is the only practical alternative, satisfactory results can be obtained by observing the following precautions in selecting, preparing and installing the timber.

(a) Select and employ, as far as possible only fairly dried timber (below 30% moisture content) preferably in the round so that the superficial surfaces of the timber exposed to the elements during service life consist practically entirely of the easily treatable sapwood.

(b) If timber in the square must be employed, select that which contains as large a proportion of sapwood as possible. There is nothing to be lost and everything to be gained by using as much sapwood as possible in the treated timber structure provided the sapwood is sound at the time of treatment.

(c) If the timber in the square contains only a small portion of sapwood, instal it in the structure in such a way that the more porous and hence better treated sapwood is in contact with the soil or with the channels of possible white ant attack.

(d) When it is impossible to obtain square timber with a large proportion of sapwood, select if possible, a specie of timber that does not tend to split much and is easily penetrated by the preservative.

(e) If there is no other alternative, but to use a timber that has not penetrated easily by a preservative solution, small holes (usually about 1/8" to 1/4" in diameter and about 1/2" deep) may be drilled into the wood in those portions that are most directly exposed to the severe conditions of white ants and fungus attack spaced at about 2" intervals perpendicular to the axis of the member in the side surfaces of the timber. Their pitch in the longitudinal direction of the side surfaces may vary between 3" and 9" depending on the timber specie and local conditions. Instead of drilling holes, a chisel about 1/8" of thick, may be employed to cross cut the longitudinal fibres to a depth of 1/2". The timber should always be cut, bored, etc. to the final finished sizes before the treatment is done.

Plant required

The plant required for soaking and dipping is of the simplest possible character as only a container of the requisite depth or length for holding the solution is necessary. For great many purposes, such as fence posts, etc., a container of about 2½ to 3 ft. deep (atleast a fourth of the length of the post) can be easily made by removing the top and bottom of oil drums and soldering them, one to another. With such containers, about 6 gallons of the solution will be sufficient to treat a dozen posts at a time. Larger containers could be easily made by using sheet iron welded to specific tank sizes.

Operation

The treatment is given by soaking the timber for 6 to 12 hours in the solution. Treated timber is then allowed to airdry. Where a more thorough penetration is required, a hot and cold dip process, where, the timber is left soaked in a container containing hot water and then allowed to cool in the wood preservative solution container, could give better and more penetration of the preservative.

Diffusion Treatment

Scope for this type of treatment: Diffusion treatment is essentially for green timber and untreated heartwoods, as also for green bamboo. Using water soluble salts, a partially fixed salt is applied in a concentrated form. In this process, the toxic chemicals in a paste form are coated over the surface of green peeled timber. In due course, which could take many weeks, this preservative enters into the timber and in some cases upto its heart. As with the other non-pressure treatment methods mentioned, there is very little control over either the quantity of preservative that enters into the wood as also the depth of penetration with this type of treatment. The C.S.I.R.O. in Australia have formulated a Boron fluoride mixture which is now being used in a fairly wide scale in the New Guinea, on a commercial scale in preserving hitherto untreatable or difficult to treat timbers used for house construction.

Operation

The operation consists basically in carefully cleaning the timber of both outer and inner part and keeping it as green as possible over which the toxic chemicals in the form of a paste is coated. The timber after coating is carefully covered to prevent moisture loss. It is then left, depending upon the size and species of timber for about 30 days. After this period of time, the timber can be considered as treated and used.

Remedial treatments

Most remedial treatments, where timber is in situ, use the diffusion treatment methods using bandages or plugs. Such remedial treatments give a good line of defence and substantially increase the service life of the timber in question, but must be considered as stop gap protection methods.

Pressure or Dump Treatment of Wood or Bamboo

General: Irrespective of the efficiency of the wood preservative used, it is important to remember that outer ring should be well preserved, by which is meant, that the depth of the preservative as well as the net retentions should be consistent to standard requirements. These conditions can be met provided the timber is pressure impregnated.

Preparation of timber for pressure treatment

(a) **Round timber:** Although it is not necessary to air dry timber for several months after it is freshly cut, atleast one/two month's air seasoning to ensure its becoming fairly dry (about 30% moisture content or less) is recommended before the timber is submitted to pressure treatment. Kiln seasoning, can be used to shorten air drying timbers before pressure treatment.

Prior to seasoning, round timbers should be debarked carefully and very special attention should be paid to the removal of all the underbark. This is very important. The timber should then be piled horizontally over brick or timber supports, which should be large enough to raise the bottom tier of posts by atleast 1' or 18" off the ground. Prophylactic brush or spray treatment with any approved preservative, should be given to prevent any liable attack by either fungus or borers during its drying time.

Once the timber pole reaches to the desired moisture content, it can be cut to size and as far as possible all the framing completed before it is pressure treated. After pressure treatment it should be piled generally a little closer than before. After a fortnight's drying, in this manner, the timber can be used at locations.

(b) Square timber: In the case of square timbers to be used in timber structures, the members should be first cut and finished to sizes, drilled and framed and should then be dis-assembled for preservative treatment. If this is carried out according to proper and predetermined plan, there should not be any need for much of the surface of the treated wood to be cut or exposed later during the actual installation of the structure. Here also the moisture content should be less than 30%.

The strength of a chain is its weakest link. If in a treated timber structure, there are areas of untreated wood exposed to elements or to the soil, such danger spots will provide direct channels for the ingress of fungus spores and insects, and this may lead to the ultimate destruction of the structure. Hence in really efficient wood preservation, as in any efficient work, there should be no weak links or unprotected spots. There are, however, bound to be some cases where supplementary boring or slight cross cutting of a treated wood member at the time of erection is necessary. In such cases, where the ultimate dimensions of the structural pieces cannot be determined with precision in advance, it is necessary to apply a few liberal brush coatings of the preservative to the exposed surfaces. Although it is obvious that this aspect of pre-framing and pre-treatment is extremely important and very often determines the life of a treated timber structure, it is unfortunately very difficult or impossible for a commercial wood preservation plant or a retailer of treated timber to stock all the sizes required for different structures and this limits the sizes that can be kept in stock. This is, however, not an insuperable difficulty, as with the proper initial pressure treatment coupled with a local treatment of freshly exposed portions, the usual structural sizes commonly required can be carried in stock.

For timber to be properly pressure treated with an actually efficient preservative, a vacuum-pressure cycle is necessary. It can be protected to a very much greater depth than even metal, to which paint affords, but a veneer of protection against corrosion, oxidation, electrolysis, etc.

To sum up, a thorough pressure treatment is unhesitatingly recommended in all cases where treated timber is to be used for either outside or inside locations or under marine conditions.

Preservatives and their properties

Several preservatives, notably creosote and arsenic-copper-chrome compositions, have given decades of excellent service in India as well as in most tropical countries. The rationalisation of preservatives depends on many factors, and is discussed later. Generally speaking, it may be said that creosote on the one hand, and arsenic-copper-chrome compositions on the other, tend to represent the two fields of wood preservative treatment with all the oil-borne and water-borne preservatives tending to polarise themselves around these two preservatives.

Creosote:

Creosote has been probably used for the longest period in South East Asia. This is mainly because wood preservative treatment in these countries, had been originally used for railway sleepers. Creosote with its excellent termite and fungal resistance, has also very good anti-splitting properties, a factor which counts greatly in the selection of wood preservatives for treatment of sleepers. It was noted that the service life of sleepers tended to be short more on account of the loss of mechanical strength caused by surface checking and splitting than by the action of wood destroying organisms. All the railways in these countries use creosote extensively for treatment of sleepers. (The Malayan, Ceylon and East African Railways have experimented recently with the so-called "Rolls-Royce" treatment where both water-borne and oil-borne preservatives are impregnated in a two-shot treatment of sleepers). This is, by far, the largest single use for creosote treatment. Creosote has been used in marine timber. For constructional purposes it cannot be used at all on account of its offensive odour and its colour, and difficulties encountered in regard to painting of timber after treatment. Creosote being a by-product of the coal-tar distillation industry, has created problems in regard to its availability especially in countries where coal is not mined. Even in India, where large amounts of coal is available, the quantity of creosote produced for wood preservative purposes is so limited that it is exclusively used for railway sleepers only. In Malaya, Thailand and other countries, the problem is compounded as creosote has to be imported into the country. Due to its bulk, as compared with the water-borne preservatives, this adds to the cost of treatment. It is interesting to note here that to conserve creosote, the Indian Railways, for example, dilute creosote with fuel oil by as much as 50 per cent. Tests which were recently conducted, have shown that while the fuel oil does not add any preservative properties, it does give a "blanketing" effect, which tends to disperse creosote more uniformly throughout the timber. It is said that the blanketing effect is as much as 50 per cent, meaning thereby that virtually half the quantity of creosote can be used with the same toxic effect. Further, fuel oil has excellent anti-splitting properties, and this adds to an increase in service life in the case of railway sleepers. Creosote requires more expensive treating equipment when compared with water-borne preservative treating equipment, as well as the addition of a boiler. Treatment has to be done at a temperature of about 180 to 200°F in order to obtain adequate retentions.

Oil-borne Preservatives

Under this heading will also come solvent base preservatives such as Penta-Chloro-Phenol and Copper Naphthenate. Fuel oil is generally used for this purpose, but if a clean surface is desired, a solvent such as kerosene can be used for the purpose. South-East Asian countries have not had much experience in the use of preservatives such as PCP or Copper Naphthenate. Perhaps the problem here again, is that they cannot be used for joinery construction when dissolved in fuel oil because the timber gives off an offensive odour and cannot be painted, and the use of solvent such as kerosene tends to make their use expensive. By and large, these preservatives have been used for surface application only for limited service life such as for prophylactic treatment or for packing cases and crates. PCP, however, is recommended for pressure impregnation in many countries dissolved in fuel oil and can be used for sleepers, mining and marine timbers. Much service data does not exist on its use. In India, the Indian Standards recommend PCP and fuel oil for such purposes, to be pressure impregnated. But Copper Naphthenate, for example, is not recommended for such timber uses. It is only recommended for timbers, which are not in direct contact with ground or water. Zinc Naphthenate is also recommended for such purposes. The inhibiting factor, as mentioned earlier, in the case of such preservatives, is its high cost of treatment and comparative lack of service data on its effectiveness and leaching properties for, say, 20 years under actual service conditions.

Water-borne Preservatives

As mentioned earlier, the leading contender are the Copper-chrome-arsenic compositions, and all other preservatives tend to polarise around this. The Arsenic-copper-chrome composition, which is originally invented by the late Dr.S.Kamesam in India, is, in fact, the largest single water-borne wood preservative used throughout the world. It is extensively used in India for all treatment other than the treatment of railway sleepers. It is used by the Malayan Railways for two-shot treatment, first with Copper-chrome-arsenic and then with creosote. It is also used for joinery timber, in Malaya, Thailand, Philippines, Africa and South America. The chief quality of Copper-Chrome-Arsenic compositions is that it has a wide spectrum effectiveness against a whole host of wood destroying organisms. It has excellent termite and fungal resistance. Also, resistance against marine organisms such as Lymnoria and the Teredo-beetle. Copper-chrome-arsenic compositions have also excellent anti-leaching properties, in fact, one of the best among all water-borne preservatives. It is for this reason that it is one of the few preservatives recommended for cooling tower timber, where the constant washing action of hot water can quickly leach out the toxic elements of the preservative, if the preservative is not of a fixed type. It is, used more for joinery construction than any other preservative. The timber, thus treated, can be easily painted or polished. The preservative colours the timber slightly yellowish green, but this can be seen only when the timber is light coloured.

Copper-chrome is also a well known preservative and has excellent toxic properties, though it does not have the coverage that the Arsenic-copper-chrome compositions have, due to lack of arsenic pentoxide. These two preservatives are perhaps, the most widely used in South East Asia with the accent on Copper-chrome-arsenic compositions. These preservatives do not confer any anti-splitting properties on timber. They can, therefore, not be used for treatment of railway sleepers, unless a two-shot treatment such as that is practised by the Malayan Railways, wherein water-borne preservative treatment with the Copper-chrome-arsenic composition is first carried out on sleepers and thereafter, the sleepers are treated with creosote to give an outer envelope of timber with anti-splitting properties. Recently, however, a new method has been investigated, by which a wax emulsion, dispersible in the water-borne wood preservative solution, can be used, so that timber can be treated at one shot with the water-borne preservative, while at the same time endowing the timber with anti-splitting qualities such as obtained with creosote. The timber thus treated, can also be painted. Unlike creosote treatment, there is no offensive odour, while at the same time the timber has excellent anti-splitting properties as well as the main characteristics of Copper-chrome-arsenic treated timber. It is a patented product of Hickson's Timber Impregnation Co.(GB)Ltd., U.K.

Liquified Gas-borne Preservatives:

This method presents many advantages in the impregnation of highly refractory timber species. Preservatives such as Tri-Butyl-Tin-Oxide has been successfully used along with butane for impregnation of Douglas fir where penetration was obtained through and through. Normally it is difficult if not impossible to treat fir by any other method of impregnation to get through and through penetration of the preservative. In America, this process is called the "Cellon" process and in England "Drilon". The disadvantages of this process, however, are high initial cost of equipment as well as of treatment, due to a certain irreducible minimum loss of butane which cannot be recovered after treatment. Further, only such preservatives as can be dissolved in butane, like PCP, etc. can be used, and this automatically reduces the number of preservatives which have already been time tested, from being used. TBTO is a most effective preservative, but unfortunately adequate service data on it does not exist. The Cellon or Drilon process may be of great interest after another decade or so, but for the purposes of the present paper further details are considered unnecessary.

Rationalisation of wood preservatives

Unlike Western countries, the developing countries in Asia, Africa, etc. produce a peculiar problem of their own in that the choice of wood preservative is limited both by the countries' ability to either produce it or import it. Creosote may be excellent for railway sleepers, but if it is to be imported all the way from Europe or America, the cost of treatment may not justify such a course. For the same reason the lack of service data in tropical conditions (under which most under-developed countries will come) may preclude the use of Copper Naphthenate and PCP. Water-borne wood preservatives such as the Copper-chrome-arsenic compositions may ultimately appear to be the best compromise in that they have produced excellent results for more than three decades under severe tropical conditions and can be economically made available to most countries in South East Asia, without a premium on their supply, due to the fact that they are manufactured from easily available chemicals. There is no penalty to pay, also, in terms of freight as the bulk of preservative is extremely small when compared with creosote or oil base (or solvent base) preservatives due to the fact that the solvent (water) is locally available, and does not have to be brought from a distance. Modern methods of increasing the effective use of wood preservatives such as a one shot treatment which includes anti-splitting components in the water-borne wood preservative solution, discussed earlier, can be used. The type of preservative to be used for most purposes, should also be looked into, from the point of view of the equipment that is required. Once it is accepted that the only method of permanent and effective treatment is by pressure impregnation, then the comparison between say, the creosote plant and water-borne preservative treatment plant becomes meaningful. A creosote plant costs more to purchase, requires a boiler, specially designed pumps, specially trained operators and chemists and so on. A water-borne preservative treatment plant can be, quite simply, a pressure cylinder, a storage tank and a pump. Everything appears to point to the water-borne preservative as an all-round compromise. From the point of view of life, cost of treatment, convenience and ease of treatment, and low investment in equipment, the water-borne preservative is the best buy for the money.

Standards

Quality Control of Treated Timber: From experience it has been found that it is not difficult at all to follow the standards laid down for controlling specifications of timber treatment, followed by industrially advanced countries.

Depending on species of timber, their natural durability and permeability to preservatives, the retentions of preservative depends on the country of use. If standards of retentions are available in such countries, this may be used as a guide. If not, the standards already existing for such countries of a similar nature, i.e. climatic and soil conditions, etc. can be followed till such time, as the specifications can be drawn up based on indigenous timbers and when treating characteristics are established by local Research Organisations. In India, where such timber treatment was started almost from nothing, about 20 years ago, the following steps are taken to ensure that timber is treated according to the specifications of plant and/or wood preservative suppliers or to Indian standards. The steps are:-

1. The Full Cell Process is followed.

2. Ensuring that the plant supplied will treat with an initial vacuum of atleast 26" Hg., a working pressure of not less than 150 psig. and a final vacuum of 18 to 20".

3. Plant installation is, as far as possible, carried out by the plant suppliers who also train the operators in handling of the plant.

4. That log sheets are periodically returned for every plant and checked by the plant suppliers and/or wood preservative suppliers.

5. Technical servicing of plants is carried out by the plant suppliers' personnel who periodically visit all plants in their area without warning and prepare a report, which is sent to the plant owning authority, this being followed up by the necessary action to rectify any defects.

6. The wood preservative supplier in his turn ensures that the preservative is to accepted specifications. He also analyses treated timber samples from various plants to determine the ratios of chemicals in the timber and maintains an adequate field staff who can collect treated timber samples from various plants, but also from the consumers of treated timber for regular analysis and necessary corrective action.

Schools run by the plant and/or preservative manufactures give essential technical training not only to the plant operators, but also to the executives of the plant owning authority to keep them aware of the necessity for correct treatment. Periodical seminars are conducted with the help of Forest Research Institute wherein Government specifying authorities are also called for discussions not only on how to achieve optimum treating conditions, but to also enable such authorities to carry out simple tests of treated timber to check the quality of the treated timber they buy from commercial plants.

7. Simple tools such as the Increment Borer, which removes a plug of timber upto a depth of about 1", the staining reagent which can detect the presence of chemicals comprising the preservative in those plug samples, solution strength meters, and soforth which are valuable as simple but effective accessories, can be carried in the field by inspectors.

8. A general tendency to encourage overtreatment rather than undertreat this, when in doubt, considering the homogeneous nature of timber where it is sometimes difficult to be sure of treating specifications.

9. Preservative and/or plant manufacturers, as far as they can, plant owners to come to them for any help they require at no obligation to the latter. The same attitude with the treated timber consumer also helps him to clarify his doubts without any cost to himself, in regard to whether timber has been treated correctly or not.

These, then are some of the methods by which it is possible to impose a control on the specifications of timber treatment. It is essential that commercial organisations which undertake to supply plant and preservative, should be fully involved in a check on quality, if possible with the help of local Government specifying authorities or Research Organisations. Ultimately it is only the plant and preservative suppliers who can keep an eye on the quality of treatment, since it is in their interest to ensure correct treatment is carried out.

Evaluation of the Performance of Wood Preservative

This sphere has always been traditionally left to Research Organisations especially Forest Research Institutes who have, ever the last three or four decades compiled a wealth of data on the testing of wood preservatives. Recently, however, accelerated tests have been developed, so that it is possible to predict the efficacy of wood preservatives in a short time without actually studying them under service conditions. Wood-preserving Organisations have now started evaluating the performance of old and new preservatives in their own laboratories and thus are collaborating with Government Research Organisations in their testing. Commercial Organisations supplying plants and wood preservatives also undertake studies in the evaluation of wood preservatives. For example, in a cooling tower survey recently conducted, a large quantity of certified timber samples from cooling towers were extracted and an analysis made with the use of an X-ray Spectrometer to determine the wood preservative leached out of timber, as well as the distribution of chemicals inside the timber, etc. Though this work was carried out almost completely by commercial organisations, the electricity authority of that country, which was vitally interested in the life of its cooling towers, co-operated and collaborated in the findings. Analyses led to recommendations in regard to treatment of cooling towers as also acceptable species which have been useful to other countries too.

Selection of Treatment for Housing Components:

This was discussed earlier under "Preservatives and their properties" wherein the choice of treatment was narrowed down to water-borne preservatives for reasons given there. Especially in the case of housing components, it is essential that thought must be given to the following aspects.

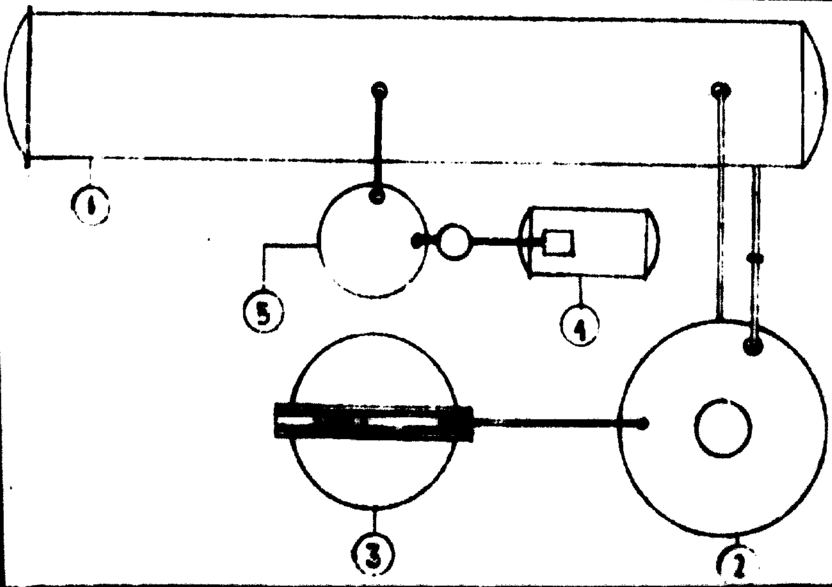
1. Clean odourless treatment, and fully "fixed".
2. Treatment that is non-poisonous (timber surface should sufficiently be free of any chemical, which may be considered poisonous to human beings and animals).
3. Ease of treatment
4. Treatment that will not make the timber surface unpaintable

Creosote and oil base preservatives can be straightaway omitted from the list. Even solvent base preservatives such as PCP in kerosene will produce problems of smell, skin irritation, even though kerosene may ultimately evaporate from the timber. Arsenic-copper-chrome compositions as well as Copper-chrome compositions may contain arsenic, but are considered non-poisonous after impregnation. This is because there is no deposit of chemical on the surface of timber since timber is quite clean after treatment. There has been no single reported case where human beings or animals were poisoned by timber treated with Arsenic-copper-chrome compositions. However, certain countries do have restrictions in the use of Arsenic compound in preservatives, and in these cases, the Copper-Chrome compound may be readily used. Treatment is quite simple and is described later. All the water-borne preservatives have one disadvantage especially for housing components, in that after treatment the moisture content of timber tends to go up somewhat and the treated timber has, therefore, to be seasoned to an acceptable low moisture content (equilibrium moisture content) for that country. It is in this respect that seasoning will also play an important part and in fact, is considered to be an integral part of timber processing especially for housing components. Another factor that greatly influences the selection of treatment is the ease, with which treatment can be carried out. Most tropical countries cannot have centralised facilities for treatment and hence, the need arises for mobile plants, which can be taken from place to place. It appears it is better in under-developed countries to take the plant to the timber rather than the timber to the plant. Digressing slightly from the present discussion on standards, some details are given on mobile plants and mini-kilns, which have been used with considerable success in India and now to be installed in Ceylon and Kenya. They are almost exclusively used for treatment of housing components. Some of the mobile plants have been also used for treatment of building timber and posts, for game reserves, soil and forest conservation areas, etc. where the mobile plant is towed from Depot to Depot and where fence posts are stored and distributed after treatment, for erection. The mobile plant lends itself admirably to the use of water-borne wood preservatives. It works on the Lowry Process for ease of operation and consists of a pressure cylinder with door, about 2' or 3' in diameter and 10 to 12' long, an integral storage tank and a pump, which is operated by a diesel or petrol engine. It is fitted with wheels and can be easily towed by a jeep, tractor or even by a pair of bulls. These plants can carry out treatment of housing components quite easily to acceptable standards.

The Mini-Kiln has also been developed as a need for housing components, again the idea of decentralisation in mind. The unit is a fully assembled and all the components are housed. It may be taken on a truck from place to place. It requires electricity for operation though gas fired and oil fired kilns have also been developed.

The kiln is a forced-draught side-circulation type and has a capacity of about 50 cft. per charge. Sketches of the plant and mini-kiln are also reproduced here. These are several of the models that are produced in India and lack of time makes it difficult to show more than one type.

Some Standard Units, using fixed water soluble preservative.



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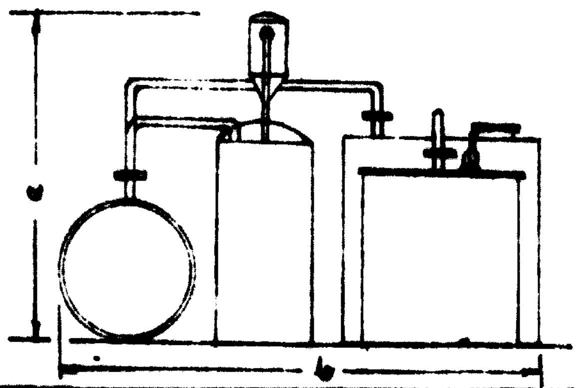
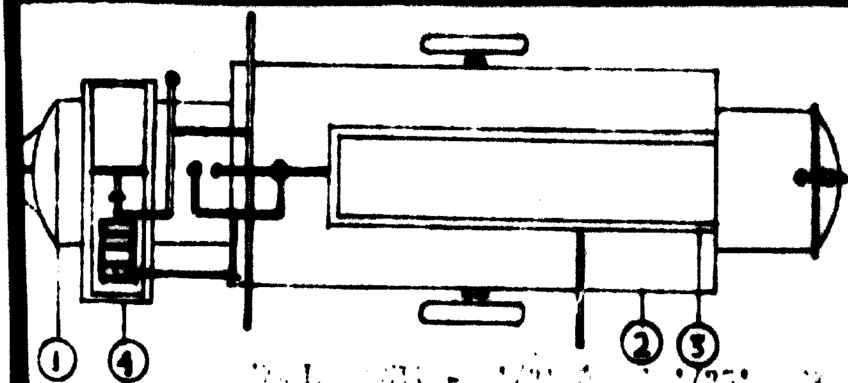
Vacuum Pressure (cylinder 1 m Ø X 12 m. long) -





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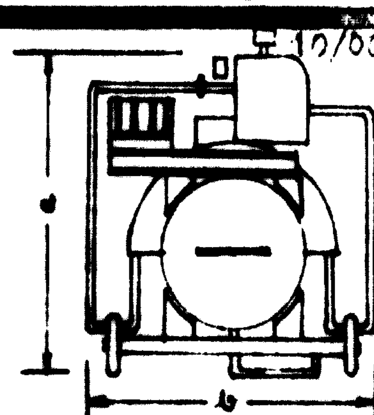

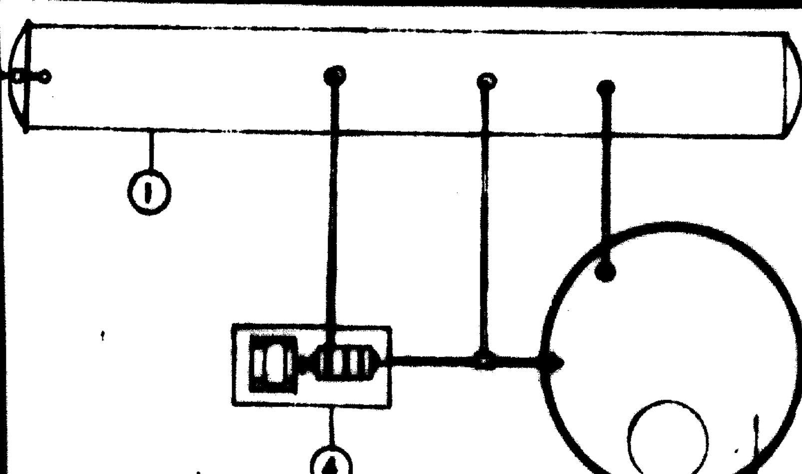

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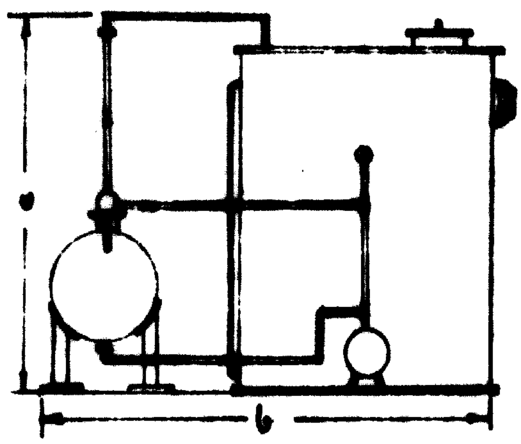

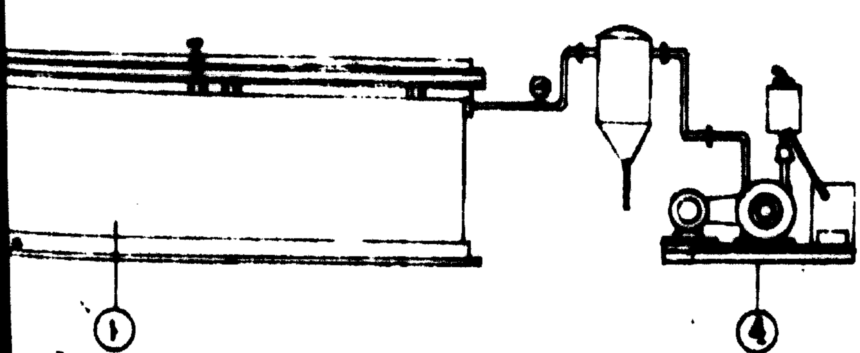

... Immersion only (no pressure ... joinery timber)

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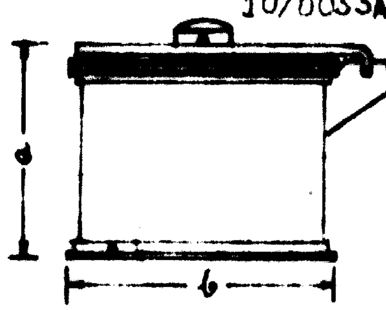
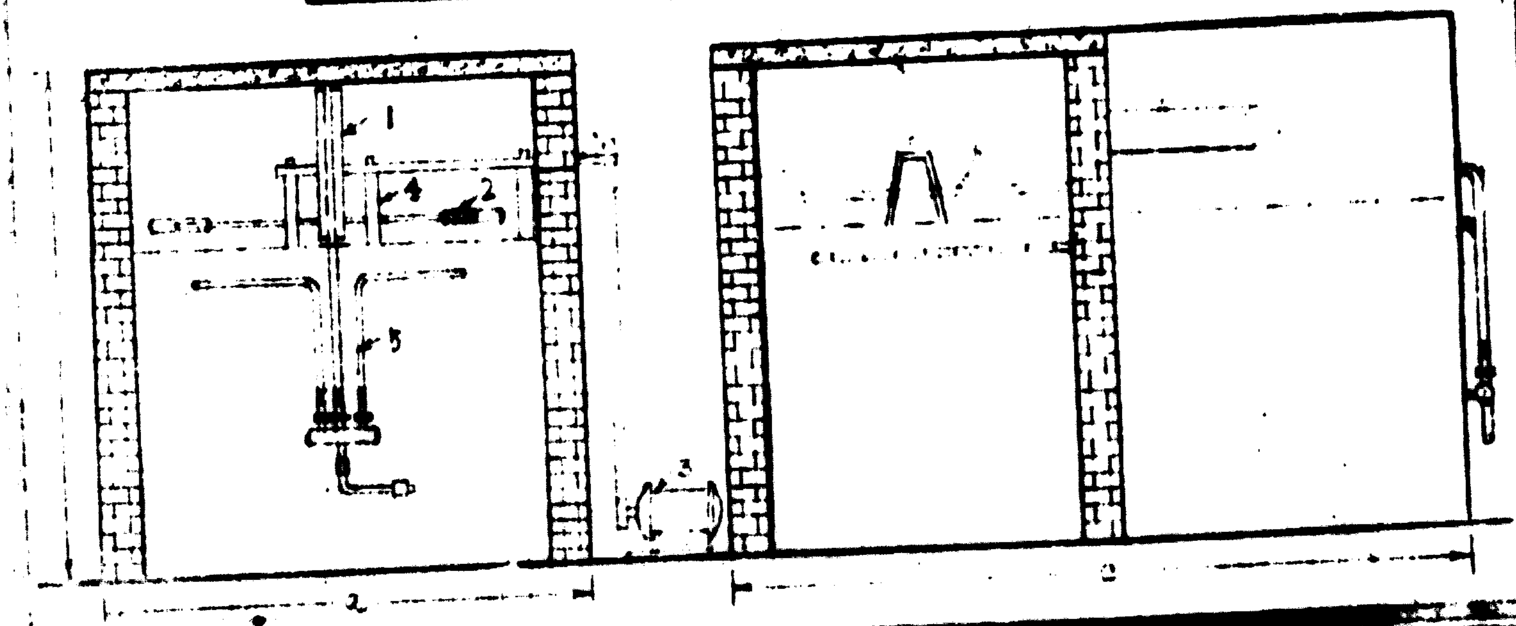
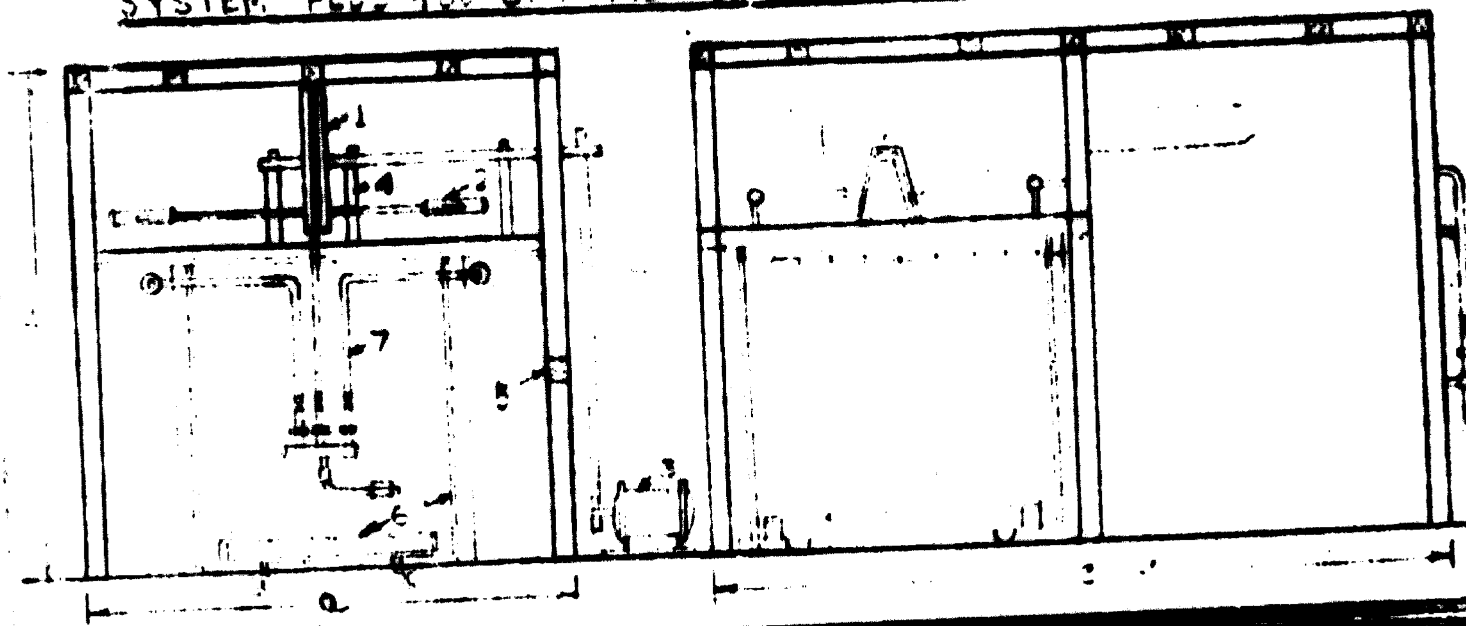


SYSTEM PLUS MASONRY 400 CFT KILN



SYSTEM PLUS 400 CFT KILN CHAMBER : WOOD PLY CLAD.



SYSTEM PLUS 400 [illegible] PRE FAB KILN-METAL CLA

Treatment of Round Timbers

In most cases, the largest single treatment of round timbers, is for electric and telegraph transmission poles and for pole framed structures. Fence posts are also treated, but this may not represent a very large quantum of the total treatment of round timbers. The treatment of round timbers does not pose any separate special problem both in regard to the plant or wood preservative. The plant should be capable of working on the Full Cell Process with a minimum working pressure of 150 psig. Its pressure cylinder should have a minimum length sufficient to take telegraph poles or transmission poles. The common length for the latter is a 40' length pressure cylinder. Since most round timbers especially transmission poles are used outside, the retentions are fairly heavy and it is essential that fixed type preservatives such as the Arsenic-copper-chrome compositions is used. The design of bogies inside the pressure cylinder is slightly different from the normal bogies which are used for say, sleepers or for joinery timber. The usual method is to have two bogies, one at each end of the cylinder, each with a swivelling base running on a bearing, so that the poles will straddle the bogies. This arrangement enables the bogies to negotiate rail points and crossings outside the cylinder, so that the untreated and treated poles can be kept at a distance from the treatment plant and brought into the cylinder when required. Such plants, can also be used for general treatment for housing components, etc. If the poles are sufficiently large (they may weigh upto half a ton), some arrangement such as a mono-rail with a hoist, has to be utilised to lift poles from the ground and deposit them into the bogies. Very frequently two types of bogies are maintained for such treatment plants, so that either poles or sleepers and other timber can also be treated.

Capital Costs of Plant

Treatment plants are manufactured in tropical countries such as India and Malaysia. Specifications of such plants closely follow those of British Standards or American Standards and the plants are, in every way, as good as those that can be supplied by these countries. The costs of locally manufactured plants are generally lower, mostly because of cheaper labour, and the reduction of sea-freight which would be a significant factor in the import of plants from industrially advanced countries. A further factor that has to be considered, is that many countries do not allow the import of plants from hard currency areas. India, in particular, has had this experience of not being able to import any item from outside and consequently had to rely on itself to produce its own treatment plants and allied equipment such as seasoning kilns. As a result of 20 years experience, the plants that have been developed range in sizes from 2' to 6' dia. pressure cylinders, upto 80' long. The type of plant manufactured includes Vacuum Impregnation Plants, Vacuum/Pressure Impregnation Plants for both water-borne preservatives as well as for creosote. Further, special types of plants such as Mobile plants, which fill a definite need in under-developed countries, have also developed with indigenous know-how and materials. Some idea of the cost of plants is given herewith for reference purposes. These plants are only made in India. Lack of time does not permit more details of plants manufactured in other countries to be given here.

Treatment Plants

Pressure cylinder size	Type of Plant	Cost f.o.b. Calcutta	
		U.S.$	U.K.£
1) 2' dia x 12' long	Mobile Plant Water-borne	4100	1800
2) 2' dia x 15' long	"	4600	1950
3) 3' dia x 12' long	"	5500	2300
4) 3' dia x 15' long	"	6000	2500

5) 2' dia x 12' long	Stationary Plant Water-borne	4000	1700
6) 2' dia x 15' long	"	4200	1820
7) 3' dia x 12' long	"	4500	1900
8) 3' dia x 15' long	"	4800	2100
9) 3½'dia x 26' long	"	8000	3250
10) 4½'dia x 40' long	"	13000	5750
11) 6' dia x 40' long	"	21500	9000
12) 6' dia x 60' long	Creosote Plant	53000	22000

<u>KILNS</u>

1) Mini-design Prefab, electrically operated - capacity 50 cft.	2500	1000
2) 400 cft. Prefab - steam heated	5100	2100
3) 1000 cft. kiln components	4900	1900

The experience of designing and prefabricating treatment plants without any outside help, meaning thereby, technical know-how from industrially advanced countries has produced several simple designs of treatment plants which were considered necessary for two reasons. In the first place, sophisticated automatic controls or specially designed pumps and compressors were not available to the under-developed countries which intended to manufacture its own treatment plants. Secondly, it was considered essential to simplify not only the process systems of the plant and use locally available pumps, etc., it was also considered essential that the equipment could be left in the hands of relatively unskilled operating personnel. Automatic controls, for example, can be easily damaged and an expensive imported pump, if damaged for any reason, could not be easily repaired, perhaps because spare parts would not be available in the country. In India, for example, centrifugal pumps are easily available and therefore no plant in India utilises piston-type pumps which are the generally accepted pumps for use with treatment plants. As it is turned out, centrifugal pumps have given a very good account of themselves and can easily be repaired by a village mechanic, if necessary. Since Vacuum Pumps are not available, here again, air compressors which are easily available in India were converted to run as Vacuum pumps. These give excellent vacuum and pose no problems. High pressure pumps have been done away with, in the later series of plants by the same air compressor which creates pneumatic pressure in a dash pot, which is also a measuring tank and which, therefore, serves to pressurise the preservative solution in the pressure cylinder, and at the same time serves as an accurate measure of the quantity of preservative that has been absorbed by the timber at any instant. Quick opening doors, trolleys for special needs such as for piling timber, poles, sleepers, etc. have also been manufactured and found quite satisfactory from the point of view of use and service life. An example, given below, serves to illustrate the point that the treatment plants manufactured by manufacturers for Western countries may not suit under-developed countries.

The bogies of treatment plants in England for example have a flat bed. This is because the loading of timber is done by a fork-life truck. In India, loading of timber on bogies is done manually and it is therefore, possible to have a curved bottom for the bogie, so that the cylinder space can be better utilised. Thus, while the plant in England may have more treatment charges in a day, the same plants with modified bogies can have fewer charges and yet give the same off-take of treated timber.

A Note on the Mobile Plant & Mini-Kiln developed in India:

Mobile Plant: Decentralisation, as mentioned earlier, appears to be absolutely essential in tropical countries. The concept of a mobile plant developed in India about five years ago, has proved to be very successful in the treatment of timber at isolated places. The Mobile Plant, is a full-fledged plant on wheels. Its working pressure and other details meet the basic treatment requirements. In the Mobile Plant the Storage Tank is integrally fitted to the pressure cylinder itself and the space above the storage tank is utilised for both a small mixing tank as well as for the components of the plant, such as the pump and engine as well as pipelines. The pump can also be run with an electric motor, if power is easily available. But it is preferable to have an engine either of diesel or petrol to make it completely self-sufficient.

The cylinder of the plant acts as a chassis. It also carries the axle and wheels. Axle and wheels are regular heavy duty members carrying the design load and suitable for running on road at a speed upto 20 mph. The Mobile Plant has towing arrangements at the front, so that it can be hooked to a jeep or tractor. At site the plant is raised on jacks and made ready for treating operations.

The capacities of mobile plants can vary from 25 cft. to about 150 cft. Very large mobile treatment plants defeat the purpose, as their mobility is restricted.

Mini-Kiln: The Mini-Kiln again fills a need especially for small Saw Millers as well as for seasoning of timber at isolated places where the off-take of seasoned timber is not sufficiently great to establish a permanent seasoning kiln. The capacity of the mini-kiln at 50 cft. per charge is considered sufficient for this design and use. The kiln, basically, is an insulated panel chamber manufactured of mild and aluminium sheet with insulation. It houses a timber used in housing components. One end of the chamber also houses a reversible type aluminium fan, which is fitted with a frame containing electric heating components. Air circulation is sideways and can also be periodically reversed. Humidity is controlled by a constant level water-box in which an electric heating component is located. Both the dry heat and production of steam for humidity are controlled by thermostats, so that operator has only to set the temperature conditions which he desires. The Mini-Kiln, as a whole, is extremely compact and is sent as one piece, so that it can be simply put up for operation, after connection of electricity and water mains.

Cost of Preservative Materials

Only two preservatives are compared here since they represent the main preservatives used. Further for the purposes of this paper, the comparison is given only for India, where costings are known. For the Railways the cost of preservative, is approximately 3 Cents a Pound. Fuel oil is also 3 Cents a Pound approximately. The Arsenic-copper-chrome compositions cost about 36 cents per Pound. In these costings, the cost of freight of preservative has not been taken. This is likely to be quite a significant factor, since creosote has a bulk of approximately eight times that of Arsenic-copper-chrome compositions and, therefore, the freight rates are likely to be that much higher. The problem is also further aggrevated by the need in storage space of eight times more - in the case of creosote and if supplies are to be kept on hand at a treating plant centre, say, for three months, then an appreciable area has to be kept aside for this purpose.

Operating Cost

Here again, we shall compare the cost between Creosote treatment and Arsenic-copper-chrome composition treatment.

Creosote

Steam: It is estimated that atleast 3 lbs. of steam is required for every cft. of timber treated by creosote. The cost of steam depends on the fuel used. If the country has coal, coal burning may be the best for the boiler. Many boilers for creosote plant use wood and coal (50:50), so that the boiler can be started on coal only and run on a wood-coal combination. The capacity of boiler will have to be increased in such a case as the calorific value of wood is 60% of that of coal. Crude oil (furnace oil) is also used. This depends on the country's local resources for its economic use. The cost of steam generation per cft. in the case of coal and wood combination would be about 4 to 5 Cents per cft.

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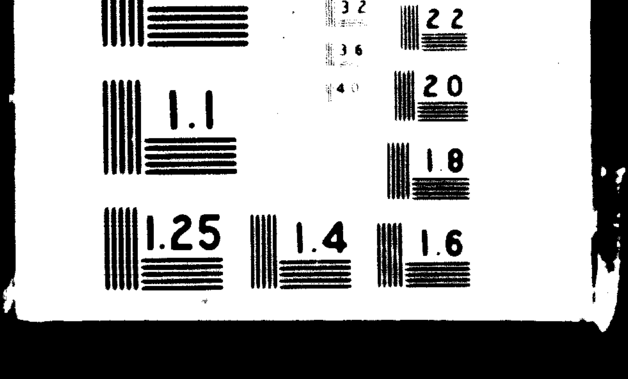

Comparative Note Between Treatment With Creosote and Treatment With Arsenic-Copper-Chrome Composition

	Creosote	Arsenic-Copper-Chrome Composition like ASCU
1. Retention specified for housing components, per cft.	5 Lbs.	0.5 Lbs.
2. Cost of preservative per cft.	20 Cents	23 Cents
3. Personnel hire charges amortised per cft.	4 Cents	3 Cents
4. Steam required, per cft.	4 Cents	Nil
5. Plant depreciation, interest on investment, etc.	5 Cents	3 Cents
Therefore, Total cost for treatment per cft.	33 Cents	29 Cents

TABLE OF SUGGESTED RETENTIONS FOR ARSENIC-COPPER-CHROME AND COPPER-CHROME COMPOSITIONS GENERALLY FOLLOWED IN INDIA

Class	Description	Hazard	Example	Arsenic-Copper-Chrome composition: Net retention lbs/cu.ft.	Arsenic-Copper-Chrome composition: Dry Salt kg./cu.m.	Copper-Chrome composition: Net retention lbs/cu.ft.	Copper-Chrome composition: Dry Salt kg./cu.m
A	Interior timbers	Decay and/or insect and/or termite attack.	Structural timber joinery in termite infected areas.	0.33	4.8	0.75	12.01
B	Interior timbers	Severe decay and/or insect and/or termite attack.	Wet processing industries:- 1. Dye & Chemical Bldgs. 2. Refrigeration & Cold Storage. 3. Industrial bldg.open to wetting	0.5	8	1.00	16
C	Exterior timbers	Decay and/or insect and/or termite attack.	1. Window frames, sashes, casements and sills 2. External door frames & sills. 3. Builders poles & planks 4. Shop fascias & signs 5. Car, bus & lorry bogies & trailers 6. Railway wagons. 7. Cable troughing & capping 8. Gates, weather boarding fence boards. 9. Glass houses, Dutch lights and hen houses & other wooden structures for farms	0.5	8	1.00 Not recommended for severe conditions.	16

contd. on next page.

Class	Description	Hazard	Example	Arsenic-Copper-Chrome composition: Net retention lbs./cu.ft.	Arsenic-Copper-Chrome composition: Dry Salt Kg./cu.m	Copper-Chrome composition: Net retention lbs./cu.ft.	Copper-Chrome composition: Dry salt Kg./c/m.
C (contd.)			10. Horticultural & agricultural implements 11. Bridge, pier & jetty, decking 12. Ships hatch covers & barge ceilings. 13. Ships cabin linings & decks.				
D	Exterior timbers in the ground	Severe decay &/ or insect &/or termite attack.	1. Railway sleepers & crossings.	Sawn Timber 0.50 to 0.75	8.0 to 12.81	Sawn Timber 1.00	16.0
				Round Timber 0.75 to 1.00	12.01 to 16.0	Round Timber 1.5	24.0
E	Exterior timbers under-ground	Severe decay and/or insect attack.	All Mining Timbers	0.50	8.0	1.00	16.0
F	Exterior timbers in fresh water	Severe decay &/or insect &/or termite attack.	Lock gates, jetty piling & revettments on inland waterways	0.5	8.0	Not Recommended.	
G	Exterior timbers in sea water	Attack from marine organisms, decay&/or insects	1. Sea defences work 2. Piles & pier construction.	1.5 to refusal	24.03 to refusal.	Not Recommended.	
H	Tropic proofing	Attack from termites, decay &/or insects.	1. All classes of packaging for tropics	0.33	4.0	0.33	4.8

Promotion

To promote the use of preserved wood, so as to guarantee or predict, its service life, etc. permeability tests combined with field data under actual conditions of use have to be conducted and made. All major timber research laboratories in developing countries are geared to such tests and their results in most cases is available. It is now not left to guess work as to the type of treatment, including the preservatives that could be used with confidence, which could be given to timber, bamboo, etc. and in the most economical manner as far as retentions are concerned so as to arrive at definite conclusions as to the type of protection as also the life that could be expected from such treated timber used for building and other purposes.

Such information has been made available for over 80 species in India, during the last 50 or 60 years. It has now 5 Regional Research Institutes, connected with the forestry service in Dehra Dun, located in five different types of climatic and ground conditions where graveyard stakes, both treated and untreated of the more commonly used species, as also preservatives, are under observation. These tests have been started approximately 7 years ago and are already yielding valuable results. Similarly, almost all the major Ports in India have test panels of treated secondary wood species of timber using various preservatives and retentions which are under continual observation.

Combined with this type of "laboratory" experiments, if the wealth of data that could be collected from authentic sources where treated timber has been used during the past and recent past in each country, such "service" data will provide a final and definite proof of the ultimate economy in the use of secondary species of timber.

The promotion of treated timber in its final analysis is basically dependent on three factors:

(1) Dependability: We have to establish that processed wood is durable and dimensionally stable and provide proper strength factors for design in using them.

(2) Availability: In many cases, processed timber and its use is fully acceptable, but it is not available and hence suffers. Here, mobile treatment units, will be very useful.

(3) Reports discussing the economy of using such processed wood in direct comparison with naturally durable timbers and also as alternatives to conventional building materials such as RCC and steel should be published from time to time and circulated to Engineers, Architects, Builders and last but not the least to financial institutions and financial advisers of housing projects, etc.

Today's engineers and builders, more than ever before work in close harmony with their financial counterparts. Economy, is worked out on a combination of "return on investment" and the "factor of obsolescence". These are perhaps the factors that ultimately decide the building material if used for any housing projects.

Example, it is said, is the best form of Precept. Economic studies where specific examples in the use of treated secondary species of timber (and where necessary kiln seasoned), giving design methods, and all other specific informations required so as to ensure the quality of processed wood, has to be made available to Architects, Engineers and others. Central Government Bodies should be flooded with such information discussing the project, specific savings that have accrued in the use of processed wood and be provided with processed wood.

This is important. Whereas a vast fund of data in the form of handbooks, tables, charts, etc. is available as far as steel, concrete and other conventional building materials are concerned, in the case of wood such publications are issued few and far in between. Most developing countries have to depend on timber and allied products such as Bamboo, etc. to meet their house building requirements. There seems to be no doubt, whatsoever, that the local authorities will use preserved timber, as the concept of preservation is readily accepted by them, provided, ultimate economy based on easy availability and on design data, is made available to them at all times.

A small timber library worth having for reference

1. Empire Timbers, Her Majesty's Stationery Office, London - gives for over 70 timbers wights; shrinkage; bending properties; strength; resistance to attack, Fungi, Borers, Insect; susceptibility to Marine Borers; permeability; wood working qualities; kiln schedules; mechanical and physical properties; specifications for teeth and circular saws.

2. A Manual of The Timbers of the World, Alexander L. Howard, Macmillan & Co. Ltd., London.

3. Wood Handbook, U.S. Department of Agriculture, Washington D.C.

4. Wood Preservation, George M. Hunt & George A. Garratt, McGraw-Hill Book Co., New York.

5. Wood Preservation During the Last 50 Years, Dr.H.Broese Van Groenou, H.W.L.Rischen & Dr.J.Van Den Berge, A.W. Sijthoff's Uitgeversmaatschappij N.V., Leiden, Holland.

6. Dry Kiln Operator's Manual, Edmund F.Rasmussen, Forest Products Laboratory, U.S.Dept. of Agriculture, Washington D.C.

7. Timber Design & Construction Handbook, F.W. Dodge Corporation, New York.

8. An Introduction to the Seasoning of Timber, W.H. Brown, Pergamon Press, London.

9. A wealth of uptodate information on timber is available from:

a) Forest Research Institute, Bogor, Indonesia
b) Forest Products Research Laboratory, Princes Risborough
c) Forest Research Institute, Dehra Dun, India
d) Forest Products Laboratories of Canada
e) Forest Research Institute, Sentul, Malaya
f) Division of Forest Products, C.S.I.R.O., East Melbourne, Australia
g) Branch of Forest Products, State Forest Service, New Zealand
h) Forest Products Institute, Pretoria West
i) University of Peurto Rico, Ris Predias, Peurto Rico.
j) Forest Products Research Institute, Laguna, Philippines.

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