Wood Preservation in India.

By S. Kamesam, M.I.E. (Ind.),
Forest Research Institute, Dehra Dun.

IN spite of all the efficient salesmanship and propaganda of cement and steel interests in India, wood is still very widely used for construction purposes. At the same time, for some years, wood has been gradually losing ground as a structural material. When timber was more plentiful, and steel and cement were less easily available and were more expensive, the urge for its proper use was not so apparent. In these days of competition, wood is used only in places and for purposes where it is not only initially less expensive than steel and cement, but where it is also cheaper in the long run. If a much longer life than what can be obtained with most raw untreated timbers of India cannot be secured, wood will be rapidly ousted out of the structural field. It is this aspect that brings us face to face with wood preservation by the application of physical and chemical principles. Naturally non-durable wood has to hold its own not only against non-cellulosic structural materials that are available in the market, but against the more naturally durable timbers.

A tree saved is a tree grown. It is wood preservation that makes one tree serve the purpose of even four or five trees, as with most Indian timbers, wood preservation augments the life by 400 to 500 per cent. Hence the wood preserver is not only aiding forestry, but is making forestry pay by the conservation of forest resources, and by the elimination of waste to a minimum.

What is a handicap with raw untreated timber becomes an asset when once wood preservation is employed. The so-called "katcha" timber for which people hardly pay anything in the timber-yard at present becomes very much more valuable than the expensive heartwood when once it is chemically preserved, as being almost invariably much more porous, it absorbs more preservative and to a greater depth. The aristocratic position held by the naturally durable timbers like teak and deodar in India is due to a poison with which they are endowed by Nature. In a scientific age like the present, tables have been turned by creative chemistry against a number of natural materials by superior and artificial materials that are more suitable and efficient for coping with certain specific conditions encountered in practice. When once timber is submitted to modern wood preservation processing, most of the porous timber that is despised and rejected at present will be more valuable than the so-called hard and durable timbers which cannot be filled up by impregnation with fire-proofing chemicals, dyes, etc. While the ordinarily despised pine can be fire-proofed, teak cannot be.

There are in the Indian forests several woods that are mechanically strong for almost any structural purpose, and stronger than pine and fir which have been widely employed for even railway bridge construction in the United States of America and Canada, but owing to their want of resistance to white ant and fungus attack, they are not used for construction work. In some cases, wood has got a bad name by its having been used unwisely. It can give only a short life if not chemically preserved. The same is the case with leather. Raw hides perish very much more rapidly than tanned skins. Unpainted or ungalvanised steel or iron perishes rapidly in a moist climate. Even cement concrete, unless special chemicals are included and unless properly made and cured, cracks under frost, and the cement is dissolved out if it is in contact with water for several years. Even the best of structural materials requires some kind of protective chemical treatment for resisting the disintegrating forces of Nature.

Besides fire, the two most important agents that tend to destroy wood, especially structural timber during service, are wood-boring insects and fungi. As iron and stone disintegrate through inorganic processes, unprotected wood is destroyed through decay. It is only Nature's cycle of creation and destruction that is incessantly going on. Decay is caused by low forms of plant life which, being incapable of photo-synthesis, feed on carbohydrates that have already been formed and are available. They produce an acid that dissolves organic substances, facilitating assimilation. The four requirements for the growth of fungi are oxygen, moisture, a favourable temperature and food. When submerged in water, or in the earth below the "level of water of saturation", wood has been known to last hundreds of years. In perfectly dry

situations, it is not affected by fungus for an almost indefinite period. A damp condition, accompanied by poor ventilation, offers very favourable conditions for fungus attack. It is for this reason that timber fence posts and joints, where water tends to stagnate, etc., decay rapidly. Wood destroying fungi cannot grow at very high or very low temperatures. There is hardly any wood destroying fungus that can live above 40° C. while very few can live below 15° C. Most fungi—especially the so-called "wet" fungi like *Coniophora cerebella*—grow vigorously between 20°C. and 25° C. A few of the so-called dry fungi like *Lenzites thermophila*, which attack the tops of poles and posts, thrive vigorously between 30° C. and 35° C.

The wood itself supplies the fourth requirement—namely food. It is interesting to note that some fungi attack only the cellulose component of wood while others the lignin component.

To prevent fungus attack, it is obviously necessary to deprive it of one or more of the four above mentioned requirements. In all outside locations and in most indoor locations, it is impossible to deprive them of air, or to keep them at a very high or very low temperature. The best and most practicable way is, therefore, to poison the food supply. This is the principle on which successful wood preservatives are based.

Wood-boring insects, including white ants, attack timber almost irrespective of its moisture condition, although a certain minimum moisture content in wood appears to induce insect attack more readily. The action of wood preservatives on wood-boring insects is similar to that on fungi which cannot feed on poisoned wood without being killed.

Modern wood preservative treatment performs three kinds of service. Firstly, it increases the durability life of wood by over two or three decades even on exposure to very severe conditions saving several times the cost of replacing the structure, and the inconvenience involved in such frequent renewals. Secondly, it makes the present worthless sapwood even more durable than the heartwood of even the most naturally durable species. This removes the necessity for imposing restrictions on sapwood content and distribution in structural timbers. It, therefore, permits closer utilisation. Thirdly and lastly, it enables our so-called jungle-woods and poles in the round, which are invariably of low natural durability, to be used widely for construction purposes.

A successful wood preservative should be toxic enough to kill wood-boring insects as well as fungi. It must be available in large quantities and be of uniform composition. It should be also not high-priced. Also, the preservative should neither volatilise nor get washed out from wood when exposed either to running water or to moist soil.

There are several wood preservatives on the market to-day. The Forest Research Institute, Dehra Dun, has tested several dozen wood preservatives against fungus and white ants during the last about 25 years. Most of the preservatives that were tested gave good results for the first year or so, but owing to either volatilisation or leaching, the treated specimens of wood commenced to fail rapidly after that period.

Generally speaking, there are two kinds of wood preservatives. One kind is represented by oils like coal tar creosote. Such preservatives are almost insoluble in water, but tend to volatilise. Coal tar creosote has given excellent results as a wood preservative, but is very expensive in India besides giving out a pungent odour. The other class consists of water-soluble salts. These are very useful for outside moist locations only if they can be "fixed" to wood. Five of the most important inorganic elements that have been employed with success in the past are zinc, fluorine, mercury, copper and arsenic. The first two elements have not been found to be very effective against white ants, while proving efficient against fungi. They are, therefore, almost useless for Indian conditions. The mercury wood preservative is too expensive compared to the remaining four, and also cannot be employed for pressure impregnation in steel cylinders. Therefore, our choice falls on copper or/and arsenic.

On account of wide variations in temperature and humidity in India, wood, almost invariably, splits under service conditions so that as deep a penetration of the preservative as possible should be secured if treated wood is to give efficient service in outside locations. This necessitates a pressure impregnation. The most recent experience in India and abroad has demonstrated that for a unit of money, an optimum combination of copper and arsenic affords the most efficient protection to wood against white ants and fungi. Such a preservative, to be successful, should not only be easily soluble

in water, but while forming a compound in wood that is almost insoluble in water, like limestone, the compound should be soluble to form a lethal dose, in a very dilute acid of a pH-ion concentration of between 4 and 5, an acidity corresponding to that produced by wood destroying fungi when they attack and assimilate wood substances in Nature. It may be stated that the acidity corresponds to about $\frac{1}{3}$ per cent. concentration of concentrated acetic acid in water. The preservative should not only be stable in contact with steel and cement, but should not corrode steel. A successful wood preservative satisfying all the above conditions was recently developed by the writer at the Forest Research Institute, Dehra Dun. It is called *Ascu*.

The next aspect that merits consideration is the method of applying wood preservatives. Generally speaking, there are three methods. The preservative may be either impregnated under mechanical pressure, or be introduced into wood by allowing it to soak for several hours in the preservative fluid. A third method of application is either with a brush, or a spray pump. Where timber is employed in sheltered locations, if it has been well air-seasoned to start with, it can be treated with success either by soaking or brush-painting. For use in outside locations as with railway sleepers, especially when timber is partially buried in the earth, as in the case of a pole or post, it should be pressure-treated for obtaining the best results. Otherwise, timber splits and cracks. The planes of cleavage thus formed will serve as channels for the ingress of white ants and wood destroying fungi spores.

From the point of view of distribution and content of preservative fluid in wood cells, there are two general methods of wood preservative impregnation, one is the "full-cell" impregnation in which the cells, after displacing the air in them, are filled by the preservative fluid. In the "empty cell" processes—the second general method—wood cells are only lined with a coating of the preservative so that by employing them, a considerable saving in the cost of preservation results. Up to about 80 to 90 per cent. of the preservative originally introduced under pressure can be recovered. Each method has got its own field of application. While in the "full-cell" processes, exposing the timber to a vacuum, or boiling it in a vacuum are the common lines of procedure; in the "empty-cell" processes, either the air that is contained in wood is compressed by superimposed hydraulic pressure, or air from outside is injected under pressure into wood before the antiseptic fluid is forced so that a high pneumatic pressure is, initially, created in the wood. When the superimposed hydraulic pressure is broken, compressed air inside the wood comes out rapidly bringing with it a large quantity of the antiseptic fluid that has gone in due to the hydraulic pressure. The two most popular "empty-cell" processes are called after Lowry and Rueping, the latter having the distinction of being the inventor of the most effective "empty cell" process—which involves the initial injection of air into wood—known to-day.

If the best service is to be obtained from treated timber, not only expert technical advice is necessary as regards the selection of the most suitable wood preservative, but also regarding the most efficient and economical method of treatment. Several specifications for treatment as well as preservatives are known. A selection is imperative. A thorough knowledge of the structure of the timber to be treated is essential. Also, considerable experimentation regarding the treatment characteristics of the timber in question is a necessary prelude for obtaining the best results.

As far as India is concerned, about a hundred of the more important commercial timbers and bamboos have been subjected to investigation during the last twelve years by the Wood Preservation Section of the Forest Research Institute so that the public may write for advice regarding any problem connected with the preservative treatment of Indian timbers and bamboos.

The next factor that requires consideration is the cost of antiseptic treatment. Usually actual cost of pressure treatment which includes interest and depreciation on the investment on the erection of a suitable plant, the cost of handling timber in the yard, etc., works out at about 2 annas to 4 annas per cub. ft. whereas the actual cost of the preservative is very variable. In the case of most preservatives, it varies between 2 annas and 8 annas per cub. ft. With the soaking and brush treatments which are not very effective for outside locations the cost of treatment is naturally very much less.

Timber or bamboos can also be "fire-proofed" which enables the cellulosic material to resist the tendency to burn. The material merely chars so that the charred portion

protects the interior strata from combustion. The three main principles underlying an effective fire-proofing treatment are the impregnation into, or application to, wood of a chemical that would either form a kind of glassy material by fusing on exposure to heat, and thus prevent the access of oxygen to the wood, or will liberate either water vapour or inert gases when the temperature of the wood rises above 150°C. or 200° C. As the water vapour or inert gases dilute the oxygen around the timber, combustion is retarded. The most popular and representative fire-proofing chemicals are sodium silicate, borax and ammonium salts. The practical method of fire-proofing timber is similar to preservative treatment. The cost is also about the same per cub. ft. Some of the more important uses to which chemically preserved timber can be put to with economy not only initially, but in the long run in India are noted below :—

1. *In the railways.*—Sleepers, crossing-planks, roof-trusses, posts, joists, ceiling, planking, doors, windows, partitions, fences, trestle bridges, overhead and foot bridges, culverts, telephone and signal poles, sign-posts, carriage and wagon superstructures, conduit planks, cooling structures, platforms, bulk-heads, water tanks, pile foundations, flooring planks, paving blocks, etc.

2. *In the highways.*—Truss bridges, trestle bridges and bridge approaches, culverts, sign-posts, bulk-heads, retaining walls, guard rails, fence posts, bridge floors (especially of pontoon bridges), etc.

3. *Overhead electrical construction.*—Transmission, distribution, lighting, telegraph and telephone poles, cross-arms, insulator pins, pole struts, guy-blocks.

4. *Building construction.*—Pile foundations, doors and windows, joists, rafters, wall-plates, sub-floors and floors, shingles, roof-trusses, garden structures, summer houses, garages.

5. *Rural construction.*—Posts, poles, bamboos, rafters, joists, flooring, cart-wheels, doors and windows, cattle shed roofs, poultry houses, aqueducts, irrigation channels, garden creeper and vineyard stakes, bamboo supports to sugarcane and other crops.

6. *Factory and mill construction.*—Roof-trusses, building timber of various kinds, wood tanks and chutes, etc.

7. *Marine construction.*—Wharf and pier timbers, fenders, sleepers, roof-trusses, ship and boat building, breakwaters, causeways, overhead bridges, loading docks, etc.

8. *Mine construction.*—Head-frames, shaft houses, gallery lining, tipples, sleepers, coal bunkers, flumes, trestles, tanks, conduits, electrical supports, permanent haulage ways, etc.

The relative economy of treated timber in India may be gauged from the fact that while any species of timber has, weight for weight, about the same strength as iron and steel, it costs, especially in the round, only a fraction as much as metals. Also the cost of working timber is considerably less than that with metals. Since in most cases, even in outside locations, as properly treated timber can be confidently expected to give a life of about 25 to 30 years (a period which synchronises with the "obsolescence" period of most structures), treated timber appears to be not only the most up-to-date structural material but the most efficient and economical building material in India. In these days of engineering and scientific progress, accompanied by a corresponding rapid change of æsthetic ideas and fashions, there is a very strong case for the use of chemically preserved wood in India for structural purposes. Commercial wood preservation has just been born. The Indian Railways and the Mysore Government have treated in their pressure plants several lakhs of railway sleepers and electrical poles. The Government of Madras have been operating, for some time, two small *Ascu* wood preservation plants. The Government of Travancore are putting up shortly a large wood preservation plant. The Government of Bhopal will be shortly using several thousand cub. ft. of *Ascu*-treated timber. The Government of the United Provinces are installing a few thousand electrical distribution *Ascu*-treated poles. The *Ascu* Wood Preserving Agency, the only private wood preservation company, has been operating two large wood preservation plants in Northern India.

With efficient and extensive organisation, wood preservation will prove to be a great blessing to this tropical country, where fine timber is not only a rapidly growing crop, but cheap and efficient wood-working labour is available throughout the country.