BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA,

WOOD PRESERVATION

Over 150 species of timber are produced in India. Several of these are known to have physical and mechanical properties suited to building construction, but a few of them are specially favoured. Their pre-eminence is due to their ability to remain sound under adverse conditions for long periods.

Wood is an inherently stable material and under proper conditions can last very long. It is however an organic material which can support the life of other organisms if the environment is suited to their growth. The most serious among these are wood-rotting fungi, wood-boring insects, particularly the termite, and marine borers. Wood can also be destroyed by other agencies such as fire, chemicals, mechanical wear and, very slowly, by weathering. This Digest briefly discusses wood-destroying agents and protective measures that can be adopted.

Natural durability of timber.

Timbers differ considerably among themselves in their resistance to deterioration by fungi and insects. Some woods like mango and *semul* last only two years at the most when in contact with the ground, whereas durable timbers like teak and *sal* have 20 to 30 years life or more. Moderately durably timbers may have a life of 5 to 10 years. The durability of some timbers is due to the presence of various toxic substances which are formed in the cell cavities of the wood when sapwood changes into heartwood. Sapwood, or the usually lighter coloured zone of the outside wood from a tree, does not contain these toxic substances. Sapwood of all species are therefore perishable.

Fungi. Wood-rotting fungi do not attack timber unless its moisture content is above 20 per cent approximately. Besides water, fungi need both air and warmth for their growth and if any of these conditions is lacking decay of wood will not occur. Dry wood containing less than 20 per cent moisture can be kept sound for centuries. Waterlogged wood is also not attacked because of the absence of air. Properly dried or seasoned wood used in a building can be kept below the moisture content at which there is risk of fungus attack. Unfortunately in so many cases, both construction and maintenance of buildings fall short of what is desirable. Wood is constantly adjusting itself to changes in the humidity of surrounding air. Dry wood will absorb moisture from damp air and its moisture content may rise to over 20 per cent in persistently damp atmosphere. Condensation can make the position worse. Wood in contact with the ground, at or below the D.P.C., wholly enclosed in brickwork, concrete or masonry, and in situations where the humidity is persistently high due to inadequate ventilation will be at a moisture content high enough to promote fungus growth. Summer temperatures also favour fungus growth. In winter growth may be retarded or fungi may become dormant. When conditions are favourable spores or "seeds" of fungi which are invisible to the naked eye develops on timber. They are carried everywhere by wind and other agencies. Wood attacked by fungi lose strength, and become soft or punky.

Termites : Of the various wood-destroying insects the termite is the most injurious. There are two general types : subterranean termites and drywood termites. The subterranean termites, often called white ants, are responsible for most of the damage to wood and related materials in buildings. They live in the ground and enter the wood either directly or through earthen tunnels or runways. These earthen runways, which protect the termites from the drying effect of direct exposure to air, indicate their presence. Timber is hollowed out by termites from the inside leaving a thin outer shell. The attack is therefore often not discovered until all the wood has been destroyed. Building Digest 30 and 55 describe measures to control and eradicate termites from buildings. Subterranean termites are found all over the country except at high altitudes.

Dry wood termites, found in the coastal regions, live in small colonies in dry wood in buildings, furniture, etc. They eat away the wood excavating longitudinal chambers leaving only a thin outer shell. Faecal pellets of partly digested wood pushed out through holes in the infested wood reveal their presence.

Wood-borers : Powder-post beetles which attack the sapwood of all species of hard woods are the most injurious among this group of wood destroying agents. The larvae of these beetles bore tunnels in all directions in sapwood resulting in complete destruction of the interior wood fibres and their conversion to a mass of fine flour-like powder. Some of this powder is generally found on or beneath attacked wood. A thin outer shell of wood which is left intact often hides the destructive

presence of the borers. Seasoned hardwood in any form may be attacked, for example, stored timber, woodwork and furniture. Seasoned bamboo is very susceptible to powder-post beetles.

Marine borers : Timbers used for structures in salt or brackish water are liable to attack by marine borers. There are two kinds, one which enters wood through pin holes and grow to a large size inside and bore holes upto 30 cm long and 2 cm in diameter. It can be a hidden menace in marine piling and wooden boats. The second type bores just beneath the surface causing its erosion by sea allowing fresh surface to be exposed for attack. No timber is completely immune from the attack of marine borers.

Protecting wood from fungi and insects

From the foregoing discussion it is clear that while the heartwood of some timbers is resistant to attack by fungi and insects, the heartwood of others and the sapwood of all are not resistant. Unfortunately, the durable timbers are expensive and it is often necessary to use the less durable ones. When non-durable wood is to be used it should be protected by treatment with substances poisonous to both fungi and insects. Since sapwood of all species is perishable, timber containing sapwood will require treatment even if the heartwood is durable. All non-durable timbers are not equally amenable to preservative treatment. For a preservative to be effective it must be injected into the timber to a minimum depth of 6 to 25 mm so that if the wood splits or abrades no untreated wood is exposed. Variations in the structure of heartwood of different species affect the penetration of preservatives. Pressure impregnation alone gives satisfactory results with some species while some others are practically non-treatable.

Timber for preservative treatment should be dried to a moisture content of 25-30 percent for waterborne and 8 to 20 per cent for oil type preservatives. All shaping, boring, cutting and machining should be done before treatment. Any surface exposed by unavoidable cutting after treatment should receive a liberal application of preservative by brush or spray.

Preservative treatment does not affect the strength characteristics of timber. Creosote treated timber will normally increase in weight by 80-320 kg/cum (5-20 lb/cu.ft.) according to the net retention and species. Water-borne presrvatives will cause an immediate increase in weight of 240-480 kg/cum (15-30 lb/cuft). After drying the increase will generally be less than 5-30 kg/cum (0.3-2 lb/cuft.).

Wood preservatives : There are three main types of wood preservatives : (1) Tar oil, (2) water-borne, (3) organic solvent-borne.

Among the oil type, coal tar creosote is the most important. It is highly toxic to fungi, insects and marine borers. In resistance to leaching makes it particularly suitable for treating timbers for exterior work in water or buried, e. g. railway sleepers, poles, fencing and marine piling. It is however unsatisfactory for timber for interiors of buildings, because of its dark colour, odour, tendency to stain and unsuitability for painting. Creosote is normally mixed with an equal volume of fuel oil before impregnating wood.

Water-borne preservatives are mostly salts dissolved in water. They have good penetration, are usually odourless, non-inflammable, do not stain and may be painted over when treated wood has dried. Water causes swelling of wood during treatment and treated wood requires redrying. The earlier water-borne preservatives were mercuric chloride, copper sulphate, zinc chloride and sodium fluoride which are easily leached out of wood and also cause corrosion troubles. These problems were overcome by the use of multi-salts mixtures which get "fixed" in the treated wood. A copper-chrome-arsenic formulation widely used in India is *Ascu* based on copper sulphate, sodium or potassium dichromate and arsenic pentoxide. Other compositions with similar properties are acid copper-chrome, copper-chrome-boric, etc. Sodium pentachlorophenate used for prophylactic treatment of sawn timber against mould stains and borax and boric acid used for protection of wood against borers, are other important water-soluble preservatives.

Organic solvent-borne preservatives are toxic chemicals which are dissolved in a volatile oil or spirit solvent for treatment of wood. After treatment the solvent evaporates leaving the preservative in the wood. These preservatives are non-leachable and nonstaining, do not corrode metals and may be painted over when the solvent has evaporated. The solvents are inflammable but do not cause swelling of wood. Some have however a strong odour. Solvent type preservatives have good penetrating power and are generally applied by brushing, spraying or dipping. Chief among them are copper and zinc naphthenates and pentachlorophenol. Water repellents such as silicones, synthetic resins, waxes and drying oils; and insecticides such as DDT, Dieldrin and BHC are incorporated in special proprietory formulations.

Application of preservatives

Successful preservation of timber depends on proper application of preservative. Several instances are on record where treated wood has remained in sound condition for over 50 years in contact with the ground. The depth of penetration of preservative and quantity-retained in the treated timber, both of which are important, can be controlled. It is also important to choose the best type of preservative for the job in hand on the basis of effectiveness, permanence, chemical stability, ease of handling and application, non-corrosiveness to metals, colour, odour, subsequent swelling, painting characteristics of treated wood, and cost.

There are four main methods of applying preservatives to sawn timbers : (1) Surface treatment, (2) Dipping and steeping, (3) Hot and cold open tank

treatment, and (4) Pressure treatment, Surface treatment, by brushing or spraying is the simplest but least effective. It is generally adopted for seasoned timber, *in situ*, where better methods cannot be employed. The preservative is applied liberally taking care to fill all cracks and checks. Oil type preservative may be applied hot for better penetration. Several applications should be given, allowing time for the absorption of one coat before the next is applied.

Dipping for a short period in a bath of preservative gives a slightly better penetration than brushing or spraying. Steeping for periods varying from a few hours to days or weeks is resorted to for long exterior life than that obtained with dipping or surface treatment. The depth of penetration varies with the species.

The hot and cold open tank treatment consists of submerging the timber in a tank of preservative which is heated for a few hours at 85-95°C and then allowed to cool while the timber is still submerged. Efficient protection is given to easily treatable timbers and to sapwood by this method which is next best to pressure treatment. Coal tar creosote is particularly suitable for application by this process. Several variations of this process exist, each adopted to a particular preservative or situation. An open-topped drum partly filled with preservative and heated by a fire lit underneath can form a simple treating tank for the butt ends of fence posts.

Impregnation under pressure is the most effective way of treating timber but it requires special treating plant. Pressure impregnation is essential for preserving non-durable timber in places where danger of fungal, insect or marine borer attack is high or persistant. The treatment may be of the "empty cell" type when good penetration is obtained with a minimum net absorption of preservative or of the "full cell" type when absorption is maximum.

The Boucherie process makes use of the hydrostatic pressure of the preservative itself for injecting it into the wood. A simplified form of the process may be used when it is desired to treat a few freshly felled poles or bamboo. The poles with bark on (or bamboo with leaves) are laid with the butt ends slightly tilted upward and a length of motor car or cycle inner tube, which serves as a reservoir for the preservative, is slipped on to the butt end. A water soluble preservative is poured into the tube and it slowly displaces the sap and appears at the thin end of the pole after a few days.

Wood and fire

In large sections wood burns very slowly. Even in a fire it is often found that large wooden members have only charred to a small depth and are otherwise sound. This is because the low thermal conductivity of wood does not permit enough heat to be transmitted into the interior for decomposition and combustion to take place. In "mill type" fire resistant constructions wood of 12 × 12 cm and larger sections are therefore used.

Wood cannot be made "fireproof" but its resistance to ignition, flaming combustion and smouldering can be increased by impregnation with fire-retardant chemicals, chief among them being mono-and diammonium phosphate, ammonium sulphate and boric acid. Fire-retardant chemical formulations specially designed to reduce the corrosion of metals to a minimum are available. Pressure impregnation of wood by fire-retardant chemicals to obtain deep penetration and heavy retention is necessary. The chemicals are soluble in water and treated wood should not be used in damp locations. Resistance of wood to spread of flame can be increased by application of a fire-retardant paint.

Chemical deterioration of wood

Wood is moderately resistant to acids but less resistant to alkalis. Neutral salts have very little effect on it. The degrading action of acids and alkalis is limited to the extent of their diffusion into the wood. Wood of low permeability are therefore preferred where chemical attack is feared. Coating or impregnation treatment with bituminous compounds or synthetic resins can significantly increase its service life. The treatment prevents contact of chemicals with the wood or reduces the rate of penetration of the chemicals into it.

Iron nails rust rapidly in wood exposed to weather and produce a severe brown or black stain around it. The rust may cause local degradation of the wood and loosening of the nail. Corrosion-resistant nails such as galvanised nails should therefore be used to avoid such difficulties.

Mechanical wear

Wood that is subject to traffic e. g. wooden floors and pavements deteriorates by mechanical wear or abrasion. The serviceable life of wood subject to abrasion can sometimes be extended by attention to design and selection of the most suitable timber in the first instance. Experience has shown that for flooring blocks, quarter sawn timber has a longer life than flat sawn timber, and paving blocks usually last longer when laid on a resilient rather than on a rigid base. For very heavy traffic end grain flooring blocks last longer. Where decay combines with abrasion to cause failure, the wood should receive suitable preservative treatment before installation.

Weathering of wood.

When wood is exposed to weather the colour fades and slowly turns grey. Alternate shrinking and swelling under different weather conditions, combined with the action of sunlight causes slow disintegration of the surface. This is a combined mechanical and chemical action not directly influenced by wood preservatives.

Paint prevents weathering by protecting the surface from sunlight and by reducing the rate of moisture up take and loss and the accompanying stresses. It should however be maintained in good condition.

Paint is not a wood preservative in the true sense since it is not poisonous to fungi and insects. It does not protect wood from decay even if toxic chemicals are incorporated. But mould stains and discolouration due to dust, handling, etc., are reduced. Paint protects wood by preventing deposition of eggs by woodboring insects in the pores on the surface.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the 59th in the series. Readers are requested to send to the Institute their experience of adopting the suggestions given in this Digest.

UDC	634.0.84/85
SfB	Di

Compiled by : K. Damodaran & Joseph George

Published by : P. L. De
Central Building Research Institute, Roorkee.
September, 1968

Security Printers Saharanpur, (India)