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Preservation of Timber - Code of practice

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Foreword

This Ethiopian Standard has been prepared under the direction of the Technical Committee for Bamboo and Bamboo products (TC 99) and published by the Ethiopian Standards Agency (ESA).

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Acknowledgement is made to the Bureau of Indian Standards for the use of the said publication in preparing the standard.

Preservation of Timber - Code of practice

1. Scope

This Ethiopian standard covers types of preservatives, their brief description, methods of treatment, choice of treatment for different species of timber for and number of uses and determination of degree of penetration. Prophylactic treatment of logs and sawn timber during storage is also covered.
Treatment for different species of timber for a number of uses and determination of degree of penetration; Prophylactic treatment of logs and sawn timber during storage is also covered.

This standard includes only such preservative and methods of treatment which have given satisfactory results under the Ethiopian conditions of service.

2. References

No references

3. Types of preservatives

Preservatives shall be of the following three types.

3.1 Type 1—Oil Type

Coal/Lignite tar creosote with or without admixture of coal tar petroleum oil, fuel oil or other suitable oil having a high boiling range.

3.2 Type 2—Organic Solvent Type

Copper and zinc naphthenates, copper and zinc abietates,trichlorophenol,gamma-BHC(Lindane),chlorpyrifos and synthetic pyrethroids.

3.3 Type 3—Water-Soluble Type

3.3.1Water-Soluble (Leachable) Type

Zinc chloride, boric acid, borax, sodium pentachlorophenate, gamma-benzene hexachloride (water dispersible powder), sodium fluoride, chlorpyrifos and synthetic pyrethroids.

3.3.2 Water-Soluble (Fixed) Type

Copper-chrome-arsenic composition, acid-cupric-chromate composition, copper-chrome boron composition, zinc meta-arsenite, berated copper-chrome-arsenic composition and ammonia calcopper-arsenate composition.

4. Description of various preservatives and their properties

4.1 Oil Type

Coal/Lignite Tar Creosote (CTC/LTC) is a fraction of coal tar distillate with a boiling point range above 200”C and is especially suitable for treatment of timber, products, etc, for exterior use. It may be used alone with a suitable admixture as mentioned in 3.1. While petroleum fuel oil as such has practically no toxic properties, its presence in the mixture to the extent of 50 percent by weight ensures stability to creosote against evaporation and leaching from the treated

material. In addition, admixture of oil gives a certain amount of protection to it against splitting and cracking. In place off fuel oil, coal tar is recommended for admixture with creosote for treatment of marine timber.

4.1.1. The advantages of using creosote as a preservative are that it has high toxicity and relatively high permanence and is non-corrosive. It offers good protection against termites. Creosote is, however, not cleantohandle, has an unpleasant odor, and the material treated with it is difficult to be painted.

4.1.2. Creosote used for preservation under Ethiopian conditions shall conform to national regulation. Any grade off fuel oil generally may be used with creosote. However, if treatment is to be done by a hot and cold process and if HV grade fuel oil is used, appropriate diluents may be added to bring down the viscosity to the level of LV grade.

4.2 Organic Solvent Type

These preservatives are dissolved in suitable organic solvents and may be used separately or in combination. The choice of the solvent depends on the volubility of the preservative and the use to which the treated material is put to. These preservatives are permanent and the treated material is clean to handle when light organic solvents are used.

4.2.1 In most cases treated material can be painted, waxed or polished. As some of the solvents are inflammable, care is necessary in handling the solutions, and in such cases, the preservative shall be applied cold.

4.2.2 Copper and Zinc Naphthenates/Abietates

These are copper and zinc salts of naphthenic acid and abiotic acid.

4.2.3 Trichlorophenol(TCP)

It is a chlorinated derivative of phenol.

4.2.4 Gamma-BenzeneHexachloride

It is gamma isomer of a fully additive chloro-compound of benzene known as gamma-BHC.

4.2.5 Chlorpyrifos

It is suitable for use in prophylactic treatment against borers.

4.2.6 Synthetic Pyrethroids

Synthetic pyrethroids such as cypermethrin and deltamethrin are suitable for use in prophylactic treatment against borers.

4.3 Water-soluble (Leachable) type

These preservatives are inorganic or organic salts soluble in water. These preservatives are, however, subject to leaching, that is, the amount of preservative in the treated material gets gradually depleted owing to the dissolving effect of water. This leaching of the preservative can

be, to some extent, reduced if a water proof paint coating is applied on the treated material and is maintained properly.

4.3.1 These are generally odorless, and involve little fire hazard. Material treated with these preservatives can be painted or varnished or waxed, when dry.

4.3.2 Boric Acid and Borax
These have been used successfully against Lyctus borers, sap stain and some species of termites and are especially suitable for protecting veneers, plywood and packing case timbers for tea chests and for packing edible articles. They are also used as glue line protestors.

4.3.3 Sodium Fluoride
It is a good fungicide and is used for protecting glue line.
4.3.4 Sodium Pentachlorophenate(Na-PCP)

Lt is effective against fungi causing mould and sap stain.

4.3.5 Gamma-BHC (Water-Dispersible Powder)
It is suitable for use in spray or brush treatment as prophylactic against borers.

4.3.6 Chlorpyrlfos
It is suitable for use in prophylactic treatment against borers.

4.3.7 Synthetic Pyrethroids
Synthetic pyrethroids such as cypermethrin and deltamethrin are suitable for use in prophylactic treatment against borers.

4.4 Water-soluble (Fixed) Type
These preservatives consist of mixture or various salts having broad-spectrum efficacy against a variety of organisms and a fixative salt, usually sodium or potassium bichromate. The role of chromium is to fix the toxic element, arsenic, copper, boron, etc, in the timber, so that the toxic salts become difficult to leach by the action of water. It is, however, necessary that the treated material be allowed to dry for 2 to 3 weeks to complete the fixation process. These preservatives shall be applied cold; as these are liable to get precipitated when heated, particularly in the presence of reducing substance in timber.

4.4.1 Timber treated with these preservatives may be used outdoors and can also be painted.

4.4.2 Copper-Chrome-Arsenic Composition (CCA)
The preservative shall conform to national requirements. The preservative is especially recommended in heavy termite and marine borer infested areas and in cooling tower timbers where soft rot is the chief deteriorating factor.

4.4.3 Acid Cupric-Chromate Composition (ACC)
The preservative shall conform to ES 6421. It is basically effective against fungi and recommended for interior use (out of ground contact) in areas with no termite hazards.

4.4.4 Copper-Chrome-Boron Composition (CCB)

The preservative shall conform to ES 6422. The preservative is recommended for general use, including timber in cooling tower.

4.4.5 Zinc-Meta-Arsenite

This preservative comprises arsenic trioxide (AS_20_3) and zinc oxide (ZnO) in the ratio of 3:2, and acetic acid just sufficient to keep zinc-meta-arsenite in solution under operating conditions.

4.4.6 Berated Copper-Chrome-Arsenic Composition(BCCA)

This preservative is recommended where CCB is used.

4.4.7 Ammoniacal Copper Arsenite (ACA)

Recommended for treating refractory wood species like eucalypts, This preservative can be used at elevated temperatures to reduce treating period.

5 Prophylactic treatments

5.1 Freshly felled timber is liable to be immediately attacked by fungi and insects and may also develop splits and cracks. These can be avoided or minimized if prompt action is taken.

5.2 Splits and cracks develop because of wide difference in the moisture content in the fresh logs and the relative humidity of the surroundings and this becomes pronounced in the hot and dry season and least in the rainy season. This may be controlled by end coats and also by pending the logs in fresh water. In the case of logs of decorative species like teak, rosewood, padauk, walnut, etc, Bark shall be removed altogether and an artificial bark of a bituminous composition containing preservatives created to protect both mechanical and biological damage. This composition is amenable to removal after warming at the processing centers for reuse.

5.3 In the case of logs of non-durable species, while the bark in some cases gives protection against damage by insects and fungi, in most cases, attracts and harbors pests and diseases. In such cases, the bark shall be removed and all the surfaces shall be sprayed with preservatives and also end coats applied. This shall be done at the felling site, if the logs are not removed quickly to storage yards.

5.4 In case the logs require to be stored for long periods, these shall be ponded in fresh water, if such facilities exist, or these shall be properly stacked high above the ground and continuously sprayed with water preferably containing insecticides and fungicides. To economize the process the drips shall be collected in a suitable reservoir for recirculation. If the log ponds are connected with sea water or back waters or sewage waters where marine borers and bacterial damage are a threat, the logs after debarking shall be well painted on all surfaces with a concentrated solution of the preservative and further protected by end paints, both being not soluble in water or easily washed away.

5.5 The above procedures be come in effective and uneconomical if the damage (mechanical and biological) has already taken place due to delay and negligence. If however, the

insect/fungal attack is superficial and light, the only method to arrest the same is to sterilize the logs by boiling in hot water or steaming. Thereafter, the prophylactic treatments shall be undertaken to prevent fresh infection. Mechanical damage, particularly in the case of tracks sleeper, can be controlled by metal straps and end 'S' holds. These shall also be used in the case of costly logs,

5.6 Periodic inspection of stacks shall be carried out and, if necessary, the treatment shall be repeated.

6. Preparation of material for treatment

6.1 Whatever the method of treatment adopted, material for treatment shall be sound .Except in the case of treatment by diffusion, Boucherie or alternating pressure method (APM), material shall be dried to appropriate moisture content. Any wood working to be done, including cutting to size, boring, etc, shall be completed prior to treatment. Approximate permissible moisture content prior to treatment of material is given in Table1.

6.1.1 While treating thicker sections of timber in which heartwood is non-durable and refractory to treatment, all the surfaces, other than the ends should be incised to a depth of 12 to 20mm for proper penetration of preservative.

6.1.2 The material shall be air-seasoned to fibre saturation point (see IS 1141).

6.2 The green timber which is easily liable to decay by fungi during the course of air-seasoning in warm and humid climates shall be subjected to steaming. The treatment consists of steaming the timber at 1.5 kg/cm^2 pressure for a period depending on the size and moisture content of the material and then subjecting it to vacuum. The cycle of steaming and vacuum is repeated till the moisture content of the material reaches the required limit. The charge shall then be subjected to any one of the types of preservative treatments described in 7.

6.3 Where a further reduction in the moisture content is desired before preservative treatment, as in the case of certain species of timbers used for sleepers, poles, these may be dried (conditioned) by the Boulton process (see 7.6).

6.3.1 This consists of heating the timber under vacuum applied gradually in the presence of a suitable high boiling liquid. This could preferably be the preservative itself for example; creosote-fuel oil mixture may be used if the timber is to be ultimately creosoted. In such a case, pressure process (see7.5) is recommended for preservative treatment.

6.4 Treatment with water soluble type preservatives is possible even at high moisture content by alternating pressure method.

7. Methods of treatment

7.1 Surface Application

This is done by brushing .For the oil type of preservatives, the moisture content in the material shall not be more than 20 percent, With aqueous solutions ,moisture content of 20 to 30 percent is permissible. At least two coats should be applied; the second and subsequent coats are to be

applied after the first has dried of soaked into the wood. Where practicable, the treatment is done hot. Surface treatment has a limited scope, and is used mostly for treating material at site and for re-treatment of cut surfaces. This may be repeated periodically.

Table1 Permissible Moisture Content at the Time of Treatment of Timber (Clause 6.1)

SNo.	Timber	Process	Approx Moisture Content Percent
	Poles, fence posts and Timber belonging to and cold process treatability grades(a) and (b)	Open tank hot	15-20
	All other classes of timber Whether included in (i) Above or otherwise	Pressure treatment	Less than 25 fibre [below Saturation point']
	Poles, fence posts (with branch/ bark intact)	Boucherie treatment	Green, freshly felled
	Round or sawn	APM	Green, freshly felled, than 60

NOTE—the moisture content specified shall be that of the outer layer of the sleepers/poles to a depth of about 20mm and may be estimated by suitable moisture meter or by means of conventional oven drying method. In the case of sawn timber of lower dimensions, the moisture contents shall be an average of the entire cross-section.

I) A very rough estimate of this point may & made by taking aborting with an increment borer and scoring its surface with a copying pencil. The free moisture above fibre saturation point is indicated by the deeper color, thereby giving an approximate idea of the extent and depth to which the relative drying has occurred.

7.2 Soaking Treatment

In this, the material is debarked thoroughly (in the case of round timber), and the treatment is carried out by submerging it in the preservative solution for a sufficiently long period until the required absorption of the preservative is obtained.

Normally, soaking of veneers in the preservative solution for a period of 1 to 2 min is adequate for thickness up to 1.8mm in the case of refractory species and upto 3mm for other species. Prefinished joinery /furniture components /items can also be treated with light organic solvent type wood preservatives by this process.

7.3 Hot and Cold Process

The timber is submerged in the preservative oil or solution, which is then heated to about $90^{o}C$ and maintained at this temperature for a suitable period, depending on the charge. It is then allowed to cool until the required absorption of preservative is obtained. During the heating period, the air in the timber expands and part of the moisture is converted into vapour and is expelled; during cooling, the residual vapour/ air in the timber contracts, creating a partial vacuum, which causes the preservative to be sucked into the timber.

7.3.1 This treatment also ensures sterilization of the material against fungi and insects that may be present. In the absence of facilities for pressure treatment (see7.5) ,this process is recommended for material containing sapwood, easily treatable heartwood, etc. With water soluble (fixed) type preservatives, however, there is a possibility of the chemicals precipitating at higher temperatures and in contact with the extractives in timber. To overcome this difficulty, two baths are used, the first containing water where the hot treatment is given, and the second, the cold bath, containing the preservative into which the material is transferred immediately after heating.

7.4 Boucherie Process

Treatment of sapwood of almost all green round timbers, soon after felling with the bark on may be carried out using any of the inorganic water soluble preservatives. The treatment is carried out by attaching to the butt-end of a pole, a rubber hose connected to a reservoir containing the water borne preservative solution and placed at a sufficiently higher level. The pole is held in an inclined position, generally at an angle of 45° to the horizontal. Due to hydro static pressure, the preservative displaces the sap which is then forced out at the narrow end. The treatment is stopped when the concentration of preservative in the drip is nearly the same as that of the solution in the reservoir .If an air pressure of 1to2 kg/cm^2 is applied on the surface of the preservative in the reservoir, the reservoir, need not be raised high above the ground and the treatment can be hastened to an appreciable extent. Pressure up to 5kg/cm^2 may be used for treatment of green poles with specially designed pressure caps.

7.5 Pressure Process

Pressure process may be employed with any type of preservative .In the case of oil type preservative, a temperature of 80 to 90°C shall be maintained during the pressure period.

7.5.1 Full Cell or Bethel Process

This process is used when maximum absorption of the preservative is desired ,that is ,filling up the cells and saturating cell walls with the preservative. The charge is introduced into the cylinder .In the case of thin plank sand plywood, spacers or grills should be used to separate the pieces. The door is tightly closed and then a vacuum of at least 56cm of mercury is created and maintained for half an hour. The object of this operation is to remove as much air as possible from the cells. At the end of the vacuum period, the preservative is introduced into the cylinder, with the vacuum pump working.

When the cylinder is filled with the preservative, vacuum pump is stopped and the cylinder is subjected to an antiseptic pressure of 3.5 to 12.5 kg/cm^2, depending on the species, size, refractory nature of the material, etc. This injects preservative into the timber .The pressure is held until the desired absorption is obtained, after which the preservative is withdrawn from the cylinder and finally a vacuum of 38 to 56 cm of mercury for about 15 min is once again applied to free the material from the dripping preservative .Specified retention of toxic chemicals during treatment may be obtained by a proper election of the concentration in the treatment solution and the duration of pressure and vacuum periods. This method is recommended to treat refractory material or material needing high preservative retention.

7.5.2 Empty Cell Processes

These processes aim at a maximum penetration of the preservative with minimum net absorption .Two processes, namely Lowry process and Rueping process are given under 7.5.2.1 and 7.5.2.2

7.5.2.1 Lowry process.

The cylinder is loaded with the material and then closed. It is then filled with the preservative; an antiseptic pressure of 3.5 to 12.5kg/cm^2, depending on timber species, size, etc, is applied until slightly higher than the required absorption is obtained. When the pressure is released, certain amount of the preservative is expelled due to the expansion of the entrapped air in the cells. The cylinder is then drained off, applying a final vacuum as described in 7.5.1. This is especially recommended for thatch, ropes, etc and for a and b treatability class timbers.

7.5.2.2 Rueping process

In this process an initial air pressure of 2.0 to 5.0 kg/cm^2. Diffusion Process is applied for a specified period, depending on the sapwood content and is maintained during the subsequent stage of filling up the cylinder with the preservative. When the cylinder is filled, an antiseptic pressure of 3.5 to 12.5 kg/cm^2, depending on species, size, etc is applied until sufficient absorption is obtained. This is followed by vacuum, as described in 7.5.1. In this case, the preservative expelled on the release of the antiseptic pressure is considerable and also there is a low net absorption. This process is especially recommended for treating timber of mixed species and also timber containing sapwood and treatable heartwood.

7.5.3 Fast Fluctuating Pressure Process (FFP) /Alternating Pressure Method (APIW)

In this process, even the freshly cut green material can be treated with water soluble wood preservatives .An initial vacuum of approximately 56cm of mercury is created and maintained for 3 min and the preservative solution is introduced. Usually a higher strength solution ,6 to10 percent ,is required, as the water present in the wood tends to dilute the concentration .

In the APM, a pressure ranging between 7.0 and 12.5 kg/cm^2 is created and maintained for 10-15 minutes and abruptly dropped to zero. The pressure is again raised and maintained for 8-10 min and dropped .Several cycles of raising and dropping pressure are carried Several cycles of raising and dropping pressure are carried out and holding pressure time is decreased in subsequent cycles.

In FFP method, a pressure of 1 2.5 kg/cm^2 is created and immediately released. Several pressure cycles are repeated depending on the thickness of the material and moisture content .The FFP is quicker than APM and leads to better distribution of preservatives through out the thickness .Finally the preservative solution is withdrawn and a final vacuum for about 30 min is given to free the material from dripping. Complete penetration with adequate loading of preservative is obtained easily in easy-to-treat species like rubber wood, khasipine, poplar, etc.

Round timbers (fence posts, poles, etc) like eucalypts having adequate ring of sapwood canals adequately treated by this process. The methods are especially suited to perishable species

which are attacked by fungi/insects immediately after felling and during drying if proper prophylactic treatment is not given.

7.6 Boulton Process

It is a combination of conditioning of wet material by boiling and drawing vacuum till the desired moisture is taken off and treating the material subsequently in the same cylinder, generally using creosote-fuel oil mixture (see6.3).

7.7 Diffusion Process

The diffusion process is a method of treatment of timber (pole and planks) and other plant materials like bamboos, canes, palm leaves, veneers, etc in green condition. It lends itself best in the case of timbers which are not easy to impregnate under pressure in dry condition, and also, where there is danger of timber getting deteriorated during seasoning, particularly if air-seasoning is adopted .It is carried out as follows:

a) Momentary dipping in concentrated solution and then close stacking under cover. For refractory veneers over 1.6mm, 15min soaking and 1 to 2 h stacking is necessary. It is essential that the glue used for subsequent bonding is compatible with the preservative.
b) Prolonged immersion in dilute solution and then close stacking under cover.
c) Application of a paste of the preservative over all the surfaces of the timber and then close stacking under cover. This is especially recommended for treatment of refractory species like fir generally used as sleepers and beams.
d) Injecting the paste in to timber through incisions on the surface of timber.

7.7.1 In all these cases, the inorganic toxic ions diffuse into timber from the place of application at high concentration to other zones through the medium of water contained in it. Thus, by giving sufficient time ,the toxic ions spread to almost the entire volume of the green timber. Thus depth of penetration and the amount of preservative absorbed in the diffusion process depend on the concentration of the preservative, the diffusion rate of the ions, the period of diffusion, species of timber, its moisture content, atmospheric/preservative temperature, etc.

8 Choice of treatment

The choice of treatment is governed by the timber to be treated ,its sapwood content and the use to which it is put to. Treatment is necessary in the case of

a) Sapwood of all species of timber including durable species ,when it is used indoors, out doors or in wet location,
b) Heart wood of non-durable species ,and
c) Heart wood of durable and moderately durable species, if timber members are required to give long life under severe conditions of service.

8.1.1 For marine structures, all materials shall be pressure treated .In the case of refractory species of timber, treatment shall be done to refusal (after incising) using full-cell process.

8.2 The recommended practice with regard to the choice of preservative, treatment process absorption and penetration of the preservative for various uses, including prophylactic treatment, are given in Table 2.8.3

8.3 Information with regard to durability (seeB-2) and grade of treatability (seeB-3) of different species of timbers is given in Table 3.9

9. Testing

9.1 The purchaser or his agent shall have access to all parts of the plant used in the preparation and treatment of the timber, including records thereof, and shall be free to be present, whenever he desires to see that the treatment is carried out as specified .

9.2 Before the treatment is carried out the moisture content of the materials shall be determined by the method given in Annex C.

9.3 The strength of the preservative solution shall be determined by analysis. An approximate idea can be had with a hydrometer duly calibrated for the preservative solution.

9.4 The net absorption of the preservative in the timber shall be determined by chemical analysis (wherever possible) of the treated timber as selected by the method described in 9.5 and this shall be compared with the figure obtained from service tanks readings or' weight of the charge before and after treatment.

9.4.1 The net absorption of oils shall be expressed as kilograms per cubic meter employing temperature 'corrections, wherever necessary; in the case of salts,----weights of dry chemicals in kilograms including the water of crystallization per cubic meter, shall be given.

9.5 After treatment, the purchaser or his agent shall examine the charge and select material at random to be bored or cut for determining the extent of penetration of the preservative by one of the methods given in Annex D and for chemical analysis for the determination. Of absorption, as mentioned in 9.4, sufficient number of samples shall be selected depending upon the volume of the charge so as to obtain reasonably accurate value of the efficiency or treatment.

9.5.1 Boring shall be taken approximately midway between the ends of the pieces selected, avoiding checks, knots, pitch pockets, shakes and splits. An increment borer is recommended for this process. The bored holes should be filled with preservatives and then plugged with tight fitting cylindrical pieces of treated timber.

10. Inspection of plant equipment

10.1 Plant Equipment Plant equipment shall be checked frequently to determine its reliability. Any error which exceeds the limits specified under 10.2 to 10.4 shall be entered in the records till the equipment is restored to normal working order. As far as possible recording instrument shall be used.

10.2 Thermometers

Thermometers shall be checked against a standard thermometers certified by the National Physical Laboratory, and a variation up to +1^{o}C shall be permissible.

10.3 Pressure and Vacuum Gauges

These shall be compared with standard gauges certified by the National Physical Laboratory and a variation up to 0.5 kg/cm^{2} in pressure and ± 2.5 mm of mercury in vacuum shall be permissible.

10.4 Track and Track Scale Balance

Track scales are used for weighing the timber charge before and after treatment for calculating the absorption of the preservative. Tank scales are used to determine the absorption of the preservative per charge by taking the reading of the depth of the preservative in the service tank before and after treatment of charge. Small balances are used for the determination of the moisture content of specimens of timber prior to treatment, bigger ones being used for weighing preservatives and chemicals for making solutions. All the scales and balances shall be checked and a tolerance of ± 2 percent shall be permissible.