PRACTICAL ISSUES IN FOREST AND WILDLIFE RESOURCES MANAGEMENT

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H. M. IJEOMAH
&
A. A. AIYELOJA

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BASIC PRACTICAL PROCEDURES IN WOOD SCIENCE

O. Y. OGUNSANWO*, Ph.D. AND A. O. OMOLE, Ph.D.
Department of Forest Resources Management,
University of Ibadan, Nigeria
**corresponding author: oy.ogunsanwo@mail.ui.edu.ng*

INTRODUCTION

Wood is a major product of complex bio-chemical processes occurring in woody plants. The complicated nature of the activities involved in wood formation, the complex nature of the various units making up the wood tissue and the influence of varying externalities; have resulted in great variability often observed in the structure and properties of woods.

Variation in wood properties as a result of extrinsic and intrinsic factors have been found to exist (a) within growth rings, (b) from pith to bark, (c) from base to top, (d) around the stem, (e) with growth rate, (f) between trees of the same environment and (g) between geographical locations and sites. In order to reduce errors and bias usually introduced by sampling procedures in wood property evaluation, efforts should be made to account for various sources of variations. This can be achieved through a multi-stage sampling procedure as illustrated in figure 1.

The first order sampling is taken along the vertical axis of the tree to account for variations along the tree height. The second order (2^{nd} level sampling) takes care of variations across the bole, the procedure for sampling at this level varies depending on the interest of the researcher. Sampling could be aimed at identifying variations among wood types (outerwood, middlewood, innerwood) (Ogunsanwo and Onilude, 2000); it could also investigate sapwood, transition wood and heartwood. Wood discs

could be dividing into radial zones using number of rings from bark (Ajala, 1998; Oluwadare, 2001). Very often, variations exist within the 2nd level sapling units usually between growth rings. This is investigated in the 3rd order sampling (inter ring variation). In most species especially softwoods and some hardwoods, marked variations exist within the growth ring in properties such as fibre dimensional characteristics and wood density. This necessitates the 4th level of sampling known as intra-ring variation.

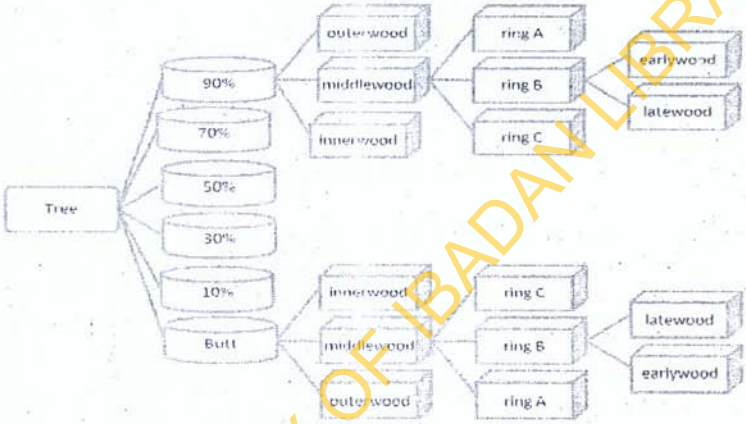

Figure 1: A typical 4-level sampling procedure in wood science experiments

Macro features of wood

Features of wood which are visible to the naked eyes or with the aid of hand lens are called macro features of wood. They are often used in indentifying wood with the aid of distinguishable external features such as those shown in figure 2

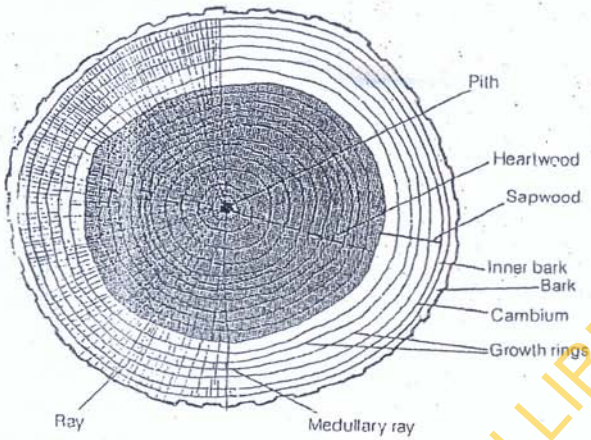

Figure 2: A cross section of wood showing macro features

Bark – This is the outermost part of the cross section of the disc of woody plants. The bark consists of layers of phloem deposited from year to year through the activities of vascular cambium. The dead outer layer is made of dead cortical cells while the living inner part consist of accumulated layer of phloem in which sieve tube no longer function. The bark is responsible for protection of wood against adverse weather conditions.

Pith - This is the central core of wood. It is of primary parenchymatous tissues formed by the apical meristem of the growing tip. It is found in the stem and sometimes in roots. The shape and diameter of pith sometimes help in identifying the species of tree producing the wood e.g. in oak the pith has a ray star and in beech it is triangular in shape.

Growth rings - These are concentric rings of wood seen on the transverse surface resulting from periodic growth of the tree.The visibility of these growth demarcations is possible because of the variations in the nature of cells formed under these different growth conditions.

Sapwood and Heartwood - Sap wood is the outer portion of a wood stem, trunk or log usually distinguishable from the core or the heart wood by its lighter colour. It is the part of a living tree in which some of the xylem cells are living and therefore physiologically active. It may be a few growth rings thick or it may cover a considerable portion of the tree volume after a variable number of years, depending on the genetic composition of the tree, species and the growth condition.

DETERMINATION OF ANATOMICAL STRUCTURE

Anatomical Properties of Wood

The usefulness of wood anatomical structures in wood science has been documented (Lowe, 1981, Awoyemi 1984, Cote and Kollman 1968). Timber identification, end-use predictions as well as variations observed in wood properties is a function of different distribution pattern of microstructures of wood, arrangement, size and dimension of component cells. The utility of a piece of wood for a specific purpose is highly dependent upon its properties which are in turn influenced by its structural characteristics. Of the cells present in woods, vessels, fibres (hardwoods), trachieds (softwoods) and wood rays predominates the anatomical organisation, and as such constitute the major contributors to the properties exhibited by wood species. An in-depth study of these elements gives good and reliable information on the end use classification of wood.

There are various methods of wood anatomical study; the procedures listed below have been helpful in characterising the structure of wood.

Determination of cell proportion

This is the relative proportion of different element present in wood. The value could be rendered in percentage or in fraction.

Procedure

Step 1- Sampling and preparation of test samples

Prepare a 20 x 20 x 20 mm wood cube from predetermined sampling unit of wood along and across the tree length

Step 2- Sectioning

Soften wood sample by boiling with water under intense heat for 48 hours to make cutting easy and to avoid peeling or splitting of individual cells. The softening is necessary to get uniformly thin section needed. Then cut thin sections of about 10 microns from the wood block radially, tangentially and at the cross section using the microtome.

Use methylated spirit to moisten the block cutting and slide the sections along the knife using a brush for collection.

Decant the methylated spirit and stain with a simple Safranin in water for about 1 minute. The staining is done to bring out the different anatomical features of importance under study. Ensure accelerated dehydration process by adding moderate quantity of 95% ethanol and allowing it to stay for about 50 seconds.

This is necessary because the mounting agent is only compatible with alcohol and not miscible with water.

Through the process of dehydration, the staining materials (having already exposed the structures) will be washed away and the section became brittle

Moisten the section by adding drops of clove oil or other clearing agents like cedar wood oil to the section in the Petri dish to prevent rolling, coiling and drying of the section.

Step 3- Slide preparation

Lift each section with a forceps onto a slide and trimmed into smaller size (about 10 x 10 mm) using the same forceps.

Use filter paper to mop the excess clove oil, add a thin line of Canada balsam across the sections and cover the section with a cover slip if permanent slides are intended

Slightly warm the slide in order to expel all air bubbles, to make the Canada balsam run freely and to enable the cover slip press flatly.

Reference the slide by labelling with a wax pencil and the slide and leave the slide to harden.

Step 4- Quantitative characterisation
This could be achieved through cell frequency count and dimensional study of anatomical elements; fibre and trachieds, vessels, axial parenchyma and ray cell. This could be achieved using various equipment such as light microscope, electron microscope and other sophisticated image analysers with software designed which are to meet various objectives.

Cell count
Place the slide on the microscope and figure out the different cells present, their distribution patterns and alignment.

Super-impose predetermined gridline on the image from the slide, making sure that sampling grids are strategically positioned across the growth rings.
Adjust magnification at each slide to ensure that the grid square is approximately equal to the size of the largest vessel.

Record every structural element falling on each grid point in point method (Ifju,1983) or grid square in square method as cell estimate per square (mm).

Please note the following guidelines for vessel count, Frequency is not computed for ring-porous woods. Count all vessels in at least 5 fields (preferably 10) depending on the size of the vessel Include vessel in the count only if 50% of the body is within the field. It is preferable to count at least 100 for frequency study in a species. For fibre count. Determine the nature and distribution of fibre pit.

Determination of cell size

Sizes of different cells present in wood are better measured after maceration. Cell maceration is the removal or dissolution of lignin in wood using suitable chemical substances.

Procedure

Step 1: Fibre maceration

Remove thin slices of wood called sliver across growth rings from the wood blocks. Introduce slivers into wash bottles containing equal volumes of glacial acetic acid and 30% hydrogen peroxide. Label the bottles and put in the oven for 20 minutes at 103°C to become bleached. Decanted the chemicals and wash the bleached wood severally with distilled water.

Macerate cells by shaking the bottles containing the slivers and glass beads.

Remove the beads and keep the macerated fibres for microscopic analysis.

Step 2: Cell measurement

Determine the length, diameter, wall thickness and lumen diameter to the nearest millimetre or micron depending on the parameter being measured in each cell.

. Please note the following guidelines:

Vessel measurements

Measure vessel diameter in transverse section. Measure at least 25 vessels in ring porous woods and more than 25 vessels in semi-porous woods. Measure the whole length of each vessel from one tail to the end.

Fibre and Trachieds

Measure at least 25 fibres or trachieds to compute mean and standard deviation. Sample the middle of the growth rings for woods with distinct growth rings.

Chemical properties of wood

Chemical constituent of wood have often dictated wood behaviour in many respects (du Plooy, 1980), Lloyd (1980); Akpofure (1992), and Takabe *et al.* (1995).Information such as pulp yield, lignin content which are indicators of suitability of species for pulping and paper production have been predicted from wood chemical properties. Of the chemical components of wood, cellulose, lignin and extractive content are commonly investigated because of their importance in the determination of end-use requirements of wood.

Determination of Extractive Content

Procedure

Collect wood sample from designated positions along and across the tree length depending on the objective of the experiment. Pulverise the wood using a hammer mill to produce wood dust. Sieve the dust in order to give a standard size which passed through No. 60 (250 μm) sieve and retained on a No. 80 (180-μm) sieve.

Weigh approximately 10 grams of the dust into an extraction thimble covered with cotton wool extracted in Alcohol-Benzene solution of 1:2 volumes respectively for 8 hours using a soxhlet apparatus.

Extract the samples again in 95% alcohol for 4 hours and wash the sample in hot water.

Air-dry the extracted samples, weigh and estimate the extractive content as percentage of initial dust before extraction, using the formula.

$$EC = \frac{W1 - W2X100}{W1}$$

Where W^1 = weight of dust before extraction

W^2 = weight of dust after extraction

This is in accordance with the standard method of determining extractive content of wood provided by American Society of Testing and Materials ASTM D1107 (1972).

Determination of Lignin Content

Lignin content in this practical guide is in accordance with ASTM D1106 (1966), which described standard method for testing lignin in wood.

Procedure

Extract wood in accordance with ASTM D1107. Introduce one gram of air dried extractive free wood into a beaker. Add 15 ml of cold 72% H_2S0_4 while stirring constantly for two minutes. Allow to stand for two hours with frequent stirring over a water bath

Wash the mixture into 1 litre beaker and dilute to 3% concentration by adding 560 ml of distilled water and boil for 4 hours under reflux condenser.

Allow the insoluble material to settle and filter into a filtering crucible that had been dried at 105°C.

Wash the residue acid free with hot water and oven-dry the crucible and content for 2 hrs at 100°C. Cool the residue in desiccators with the stopper removed. The weight of the content of crucible is given as lignin in percentage of extracted wood and calculated as:

$$LC = \frac{Wr \times 100}{Wd \quad 1}$$

Where

Wr = weight of residue
Wd = Weight of dust
Lc = Lignin content

Determination of Cellulose Content

Cellulose content was determined in accordance with the procedure described by Cross and Bevan and summarized as follows:

Procedure

Take 5 grammes of extractives free dust (ASTM D1107) and cook for 30 minutes in 1% sodium hydroxide (NaOH). Wash the cooked dust thoroughly with distilled water. While in this moist condition, pass chlorine gas through the cooked dust for 45 minutes.

Wash the residue thoroughly with distilled water to remove HCl and add 2% solution of sodium sulphite (Na_2SO_3). Boil slowly for 5 minutes over a hot plate, and add 0.2% of NaOH and allow to stay on hot plate for another 5 minutes.

Repeat this procedure severally until the sample is completely bleached. This occurred at the point where additional chlorination could no longer effect any colour change, indicating that lignin had been completely attacked by chlorine.

Place on the filter cloth and wash with hot water while adding 0.1% of sodium hypochlorite for complete bleaching. Leave the bleached pulp pad to dry under room temperature. Oven dry the pulp pad in a petridish for 2 hours at 100°C.

Estimate percentage cellulose content as:

$$Cc = \frac{Wp}{Wd} \times 100$$

Where

Cc = Cellulose content
Wp = Weight of oven dry pulp and
Wd = Weight of extracted dust

PHYSICAL PROPERTIES

Physical properties of wood are very basic to the general behaviour of wood. Basically, all the physical properties of wood are determined by the factors inherent in its structural organisation. Panshin and deZeeuw (1980) reported that physical properties of wood are expressed in terms of the amount of (a) cell wall substances present in a given volume of wood, (b) the amount of water present in the cell wall, (c) the proportional

composition of the primary components of the cell wall as well as the quantity and nature of extraneous substances present, (d) the arrangement and orientation of wall materials in the cells and in different tissues and (e) the kind, size, proportion and arrangement of the cells making up the woody tissue.

Essentially, physical properties of wood are commonly observed in its specific gravity or density, moisture content, and dimensional stability, among others.

Moisture content determination

The moisture content of wood is defined as the percentage amount of water in a given wood.

Procedure

Sample wood from designated positions based on the aims and objectives of the study. Determine the weight of each sample using sensitive balance. Dry the wood samples in the oven at 110°C for about 24 hours to a constant weight

Calculate moisture content using the formula given below

$$\text{Moisture content MC} = \frac{Ww - W_0}{W_0} \times 100$$

Where W_w = Wet weight of piece of wood

W_0 = Oven dried weight of wood piece

$$= \frac{Wt\ of\ water\ in\ wood}{Oven\ dry\ weight\ of\ wood} \times 100$$

Moisture content (wet basis) = (total weight of wet wood – oven dry weight) total weight of wet wood x 100

Moisture content (dry basis) = (total weight of wet wood – oven dry weight) oven dry weight x 100

Determination of wood density

Sampling - Sampling for wood density study is done such that every part of the wood is covered as much as possible. In non-destructive sampling, small pieces of wood are extracted from the tree using a device called an **increment borer**.

This equipment comes in three parts (figure 3): a handle, a borer bit, and an extractor. An increment borer is like a hollow auger, extracting a small dowel-like piece from a tree.The handle is hollow, and the drill bit and extractor can be stored inside the handle when not in use.

The extractor is a long half-moon shaped blade that slips inside the hollow auger and allows you to pull out the core sample.

The coring bit is made of a special alloy and is very hard. However, it remains the most fragile part of the equipment and breaks easily if the user attempts to force the device into a dense wood with too much force.

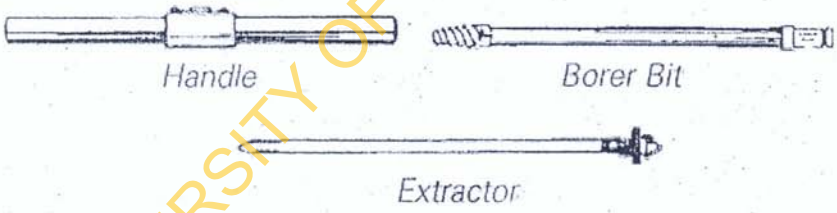

Figure 3: The three components of an increment borer

Procedure

Identify and mark sample tree within the forest under study and measure the dbh. Trees to be cored should normally be of 10-30 cm dbh.

Clean the tree with knife and debark the portion to be cored at the height which is stable enough to push the instrument into the wood. Make the instrument ready for use by attaching the three

components together. Hold the bit just behind the threads and lean into the borer to provide as much body pressure as possible.

Slowly turn the bit until the threads have become fully engaged without having to use brute force. After the threads have engaged, you may step back from the increment borer and turn the handle in.

When the proper depth has been achieved, back the bit out one full turn, then insert the extractor into the hollow increment corer bit.

Note: place a slight up-pressure on the back of the extractor to ensure the leading tip stays under your sample.

Insert the extractor to its full length. Depending upon the species, this may require that you apply some pressure with the heel of your hand near the end and not with any instrument.

Slowly withdraw the extractor from the increment handle to retrieve an intact core.

Immediately place the core into a plastic drinking straw, seal the ends, and mark the straw with the sample ID number If the core breaks, you may choose to keep only two or three of the largest parts.

Store the straws in a protective container while in the field. Increment borers should be cleaned between sample collections, and before storage.

The collection of good increment cores from trees, poles, or ties depends mainly on the condition of the increment borer.

Tree sap in species of Sapotaceae, euphorbiaceae, Apocynaceae and moraceae produce sap which could damage the instrument.

Cleaning with any light oil and a tissue or cloth could protect the instrument.
As with other cutting tools, the increment borer must be well sharpened to perform suitably.

A well sharpened borer will, if properly used, cut numerous cores before resharpening is required.

High-density woods will dull the borer sooner than will lower-density woods.

Make sure that all of the parts are dry prior to storage. To store the borer, push the flip lock in the opposite direction and take out the bit. Put the bit back into the handle and put the extractor inside the bit and screw the knob tight. Make sure to store the borer in a dry place.

Laboratory measurements

For measurements of green volume, the sample should be maintained at constant humidity. In the laboratory place the full core into water for ½ hour to ensure adequate swelling. Green volume can be measured using two different methods:

(1) In the dimensional method, one calculates the volume of a tree core assuming a regular cylindrical shape. This requires measuring both the total length and its diameter at different points, with a calliper, avoiding pressure of the calliper blades on the wood.

If L is total length of the sample and D the mean diameter, then the volume of the sample is given by the formula:

$$\frac{\pi}{4} D^2 L$$

(2) The water-displacement method allows for easy and reliable volume measurement for irregularly shaped samples.

A container capable of holding the sample is filled with water and placed on a digital balance of precision at least 0.01 g. The balance is then re-zeroed (the reading should be zero).

The sample is then carefully sunk in the water, such that it is completely underwater.

The sample should not contact the sides or bottom of the container, and it should be forced underwater with a thin needle.

The measured weight of displaced water is equal to the sample's volume (since water has a density of 1).

The electronic balance should be re-zeroed after every measurement.

Oven-dry weight is measured from the same sample by drying it in a well ventilated oven until it achieves constant weight (this usually takes 48 to 72 hours).

The samples should be weighed immediately after being taken out of the drying oven, because tropical air is often water-saturated.

Specimen dimension – Dimension of test specimen for wood density varies greatly depending on available material. A typical dimension of test sample for density determination is 20 x 20 x 20 mm

Methods – Methods employed for density studies depends also on the shape of materials, sometimes, it could be dusts, granules, slivers, strands. Regular shapes such as cubes, cylinders and cones are also used in wood density determination.

Procedure

$$D = \frac{M}{V}(kg/m^3) \quad \text{..... (1)}$$

Where: D=Density

M = Weight of the wood

V = Volume of wood (ASTM, 1983)

Determination of Specific gravity

The specific gravity of wood is also known as the relative density or density index. It is the amount of wood substance per unit volume and has been described as the most important physical property of wood, (Kellog 1981) and the most useful descriptor of wood quality (du Plooy 1980; Kubler, 1982; Nicholls, 1984; Seth *et al.* 1989).Various methods such as gravimetric, densitometry, photometric, radiation technique and acoustic methods have been developed for specific gravity determination. For the purpose of this guide, the gravimetric method developed by Smith (1954) is applied.

(SG) was obtained by removing cubes of 20 x 20 x 20 mm from the upper part of each of the test specimens. They were subjected to a gravimetric procedure developed by Smith (1954) in which specimen were completely saturated with water by boiling. Each cube was removed from water, blotted to remove excess water, weighed and oven-dried to a constant weight at 103^{0}C. Specific gravity was determined using the formula:

$$G = \frac{1}{\frac{WO - WS}{WO} + \frac{1}{1.53}}$$

Where G = specific gravity
Ws = saturated weight of wood
Wo = oven dry weight of wood
1.53 = constant developed by (Stam, 1929) as the actual weight of wood substance

Determination of Percentage Shrinkage

Shrinkage in wood is a measure of its dimensional. Direct implications of shrinkage properties on end use potentials especially in structural applications have been documented by Panshin and deZeeuw (1980) and Ogunsanwo and Onilude (2000). Suitability of wood for end uses has been linked with

Tangential/Radial shrinkage ratio T/R. Low value of T/R is synonymous with high suitability of wood for end uses.

Size of specimen
Size of test specimens vary depending on standard being used

Specimen dimension of 20 x 20 x 40 mm is commonly used for shrinkage test.

Procedure
Specified dimension of wood samples such as indicated above are prepared.
They are aligned to represent the three principal planes of wood i.e. radial, tangential and longitudinal. Soak samples in water for 48 hours in order to get them conditioned to moisture above Fibre Saturation Point (FSP).
Remove sample one after the other and measure their dimensions in wet condition to the nearest millimetre.
Oven dry the samples to constant weight and measure the dimension again.
Determine the percentage shrinkage using the formula stated below:

$$S = \frac{D_S - D_O}{D_S} X100 \ldots\ldots$$

Where: S = shrinkage %
D_S = dimension at saturated condition
D_O = dimension of oven dry condition

$$VS = S_R + S_T \ldots\ldots$$

Where: VS = Volumetric shrinkage
S_R = Radial shrinkage
S_T = Tangential shrinkage

This is in accordance with approximations done by Dinwoodie (1989).

Strength properties of wood

The term strength as it applies to wood refers to the ability of the material to resist external loads or forces tending to change its size and alter its shape. These changes in size or shape are known as deformation or strain. The parameters that are often used for the determination of strength properties of wood include impact bending, modulus of rupture MOR, modulus of elasticity MOE, maximum compressive strength parallel to grain MSC//, maximum compressive strength perpendicular to grain MCS 1, others include, hardness test, shear and cleavage.

Impact strength

The impact bending test measures the ability of wood to resist suddenly applied load. The impact bending test could be carried out using the, Hatt-turner impact tester BS 373 (Figure 4a) or Frank pendulum impact tester 53780. The procedure described in this manual is given after Hatt-Turner impact tester BS 373.

Figure 4a: Hatt-turner impact tester BS 373

Procedure

Standard test specimen 20 x 20 x 300mm is supported over a span of 240 mm on a support radius of 15mm, with spring restricted yokes fitted to arrest rebounce.

Subject the specimen to a repeated blow from a weight of 1.5 kg at increasing height initially from 50.8mm, and then every 25.4mm, until complete failure occurs. The height at which failure occur is recorded in meter as the height of maximum hammer drop.

Modulus of Rupture (MOR)

The Modulus of Rupture test is described in accordance with British Standard Method BS 373. This involves the use of standard test specimens 20 x 20 x 300 mm, using a Hounsfield Tensometer (Figure5a).

The load is applied at the rate of 0.1 mm/sec, with the growth rings of test specimen parallel to the direction of loading. The bending strength of wood expressed as (MOR) is calculated using the formula:

$$MOR = \frac{3PL}{2bd^2} \quad \text{.....(4)}$$

Where:

P = Maximum load at failure (N)

L = Span of the material between the supports (mm)

b = Width of the material (mm)

d = Thickness of the material (mm)

The unit of MOR is N/mm^2

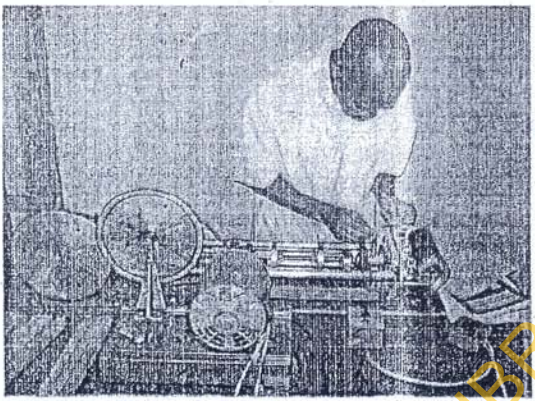

Figure 5a: Tensometer

Modulus of Elasticity (MOE)

The modulus of elasticity is calculated from the values obtained at the point of failure recorded during tests for MOR.

The MOE is calculated using the formula:

$$MOE = \frac{PL^3}{\Delta bd^3} \quad \text{.....(5)}$$

Where:

P = Maximum load at failure (N)
L = Span in (mm)
b = Width in (mm)
d = Depth in (mm)
Δ = the deflection at beam centre at proportional load

Delta (Δ) which is the deflection of beam centre at proportional limit, is calculated as the gradient of load-deformation curve plotted during MOR test.

Determination of Maximum Compressive Strength// to grain (MCS//)

The maximum compressive strength parallel to grain is determined using test specimen 20 x 20 x 60 mm (BS 373). Load is applied at the rate of 0.01 mm/sec until failure occurs and the corresponding force at this point is recorded.

The Maximum compression parallel to grain MCS// is then calculated using the formula:

$$CS = \frac{P\max}{ab} \quad \ldots\ldots(6)$$

Where:

CS	=	Compressive strength (N/mm²)
P max	=	Maximum load (N)
a	=	length of sample (mm)
b	=	breadth of sample (mm)

Wood preservation

Wood as a construction material is liable to deteriorate in service as a result of attack by macro and micro organisms which utilise wood as food. The serviceable life of individual pieces of wood varies considerably, depending on the species concerned, the amount of sapwood present, the use to which the timber is put, and the situation and the atmospheric conditions to which it is exposed.

The ability of timber species to resist biological degradation for a period of time is known as 'natural durability' or 'natural resistance'; it is determined by how long the heartwood is able to resist attack by specific types of wood destroying organisms. Less naturally durable wood species require treatment or impregnation with preservatives to increase their resistance to wood destroying organisms. The effectiveness of a preservative treatment in protecting a treated wood product against subsequent biological attack is dependent on the following:

- The fungicidal and pesticidal activity of the preservative.
- The thickness of the outer shell of treated wood surrounding the untreated core.
- The amount of chemical retained in the treated zone.
- The continuity of this shell of treated wood.

Test of wood durability

Durability of wood can be natural or artificial, natural durability is conferred on wood by the heartwood which has in it chemical substances capable of inhibiting activities of agents of biodeterioration. The extent of durability therefore depends on the proportion of heartwood present in wood and the potency of chemical substances in the heartwood. Artificial durability on the other hand is to make non-durable species of wood durable by impregnating them with chemicals capable of conferring protection against agents of attack on the wood.

Accelerated durability

This type of test usually takes between 8 to 24 weeks in the laboratory or on the field if samples are to be exposed to termite attack. Samples for natural durability tests are obtained from sapwood and heartwood portions of untreated wood (wood not impregnated with any chemical substance), while samples for artificial durability is obtained from impregnated wood samples. Artificial wood durability test is actually used to test for the efficacy of chemical preservatives.

Sample dimension – This depends on the method of efficacy to be adopted in the study. A sample dimension of 20 x 20 x 60 mm is commonly used; this is because of the flexibility of the size in use for both crushing and weight loss experiments.

Procedure

Prepare wood samples as indicated above and oven dry to a constant weight.

Impregnate samples with chemicals by pressure or non-pressure method.

Expose sample to known biodegrading agent for a period of time (8-24 weeks).

Processes of exposure to biodegrading agents

Prepare nutrient medium, usually about 35 grammes Potato Dextrose Agar (PDA) in distilled water. Sterilize by autoclaving at 0.1 N/mm^2 (120^0C) for a period of 20 minutes.

Lay the bottles sideways so that the medium is retained in the neck of the bottle and inoculate with the test fungi within 6 days.

Place the wood blocks into bottles containing growing mycelia of the test degrading agents.

Incubate the bottles containing the wood blocks at 27 $\pm$ 2^0C for 8-24 weeks. Remove the wood blocks at regular intervals to monitor degradation rate. Determine efficacy using weight loss, crushing strength and cell damage.

Weight Loss Determination

Carefully remove test blocks at the end of each incubation period and weigh.

Oven dry the sample and reweigh to determine weight loss.

$$\text{Percentage Weight loss} = \frac{\text{Initial dry weight} - \text{Final dry weight}}{\text{Initial dry weight}} \times 100\%$$

Graveyard experiment – The graveyard experiment is also called the field test, the procedure for inoculation and incubation of test fungi is basically the same but differ in specimen dimension.

Test sample dimension is 25 x 50 x 500 mm in accordance with EN 130 Standard. The period of exposure is also longer.

Test of efficacy is done subjecting the samples to either weight loss or strength property test after the period of exposure.

Jointed specimens – This is also called lap-joint experiment. It consists of two overlapping parts (joint members) held together mechanically and placed horizontally, out of contact with the ground and exposed to the weather. The extent of microbial attack on the external surfaces and within the jointed areas is rated according to a specified rating system.

Specimen dimension – The dimension of each lap-joint at 12% moisture content is 300 x 85 x 38 mm with an overlapping close fitting part mid-length of 60 mm.
Number of lap-joints per experimental unit – Prepare at least 10 lap-joints for each test parameter.

Procedure
Assign unique identification number to individual members of each lap-joint.
Tag each specimen with a material which is inert to the wood and the preservative at the lower side of each member of the joint away from the joint area.
End-seal the specimen with a material which is resistant to the penetration of the preservative solutions. Polyvinyl acetate (PVAc) glue is commonly used for many organic solvent formulations, while epoxy-resin/pitch compound is used for water proof applications

Treatability of wood
After treatment, the blocks are drained and reweighed to determine the rate and level of absorption and retention/penetration.

$$\text{Absorption Kg/m}^3 = \frac{10^6 \text{ x weight of preservative absorbed}}{1000 \text{ x volume of wood}}$$

$$\text{Retention Kg/m}^3 = \frac{10^6 \text{ x weight of preservative absorbed x concentration}}{1000\text{x volume of wood x } 100}$$

Determination of Lumber Recovery LR
The volume of log input was given by
Basal Area = $\pi d^2/4$
Where d = Basal diameter

The Actual Volume for each log is calculated from the formula

$$V = h \frac{(Ab + Au)}{2}$$

Where:

V = Volume of log
h = height of log/Length of log
Ab = Cross sectional area at the base
Au = Cross Sectional area at the top

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Volume of sawn timber (m^3)
Vg = L x T x W
Vg = green volume of sawn timber
L = Length of Sawn timber in M
T = Thickness of Sawn timber in m
W = Width of Sawn timber in m

etermination of lumber recovery factor (LRF)

Lumber recovery factor = Vg =

Where $\sum$Vg = Summation of volume of sawn timber.

Wood waste partitioning

(a) Determination of volume of sawdust generated:

SD = L x W x K x T

Where SD = Saw dust
L = length in m
W = width m
K = kerf thickness
T = thickness

(b) Volume of bark determination.

$V_B = V - V_1$

Where V_B = Volume of Bark
V_1 = Volume of log under bark
V = Volume of log

(c) Determination of volume of Slabs:

$Vsl = V_t - (V_B + V_s)$

Where V_{sl} = Volume of slab
V_t = total log volume
V_B = Volume of bark
V_s = Volume of sawdust

CONCLUSION

This write-up is meant to provide a guiding principle for basic practicals in wood science. The approach identified areas where basic skills are needed in forestry and provided necessary tips that would enhance the student's capacity to function as trained personnel in forestry and related discipline. Efforts have been made to collate information from all aspects of wood science and technology; however, there are variants, modifications and other applications of these procedures which are not covered.