METHODS OF VOLUME ESTIMATION

There are three main methods of volume estimation.

1. Analytical Volume Estimation
2. Volume Estimation by Displacement of Water
3. Graphical Method of Volume Estimation

ANALYTICAL METHOD

Solid volume is approximated to three dimensional models e.g. the following formulae for calculating volumes of different geometric solids could be adopted:

Where V = volume, A = area of lower base

A_m = area of mid-section parallel to A_b and midway between Au

Au = area of an upper section.

Cylinder $V = A_b h$

Cone $V = 1/3\ A_b h$

Frustum of Cone $V = h/3\ (A_b + Am + Au)$

Sphere $V = 4/3\ r^2 h$

Frustum of a Paraboloid

$$V = \frac{A_b + Au}{2} d$$

Paraboloid $V = 1/2\ A_b h$

Frustum of Neiloid

$V = d/b(A_b + Am + Au)$

Neiloid $V = 1/4\ A_b h$

DISPLACEMENT METHOD

In this method, xylometer are used for obtaining absolute measures of solid volumes. It is the most accurate method and it is based on the principle of fluid displacement.

The xylometer is in form of a water tank with a device for measuring water volume.

GRAPHICAL ESTIMATION

The graphical method is suitable for both felled and standing trees. Overbark and bark thickness measurements are taken at various points of the stem. The closer the points of measurement, the greater the accuracy of the volume obtained. Diameters squared of sectional areas are plotted against length as the abscissas – x – axis.

Volume is obtained by area enclosed by the curve. An estimate is therefore obtained which is more accurate than the analytical method.

Basal area

Horizontal, 1cm = 2m Length (m)

Vertical, 1 cm = 0.01m2

ANALYTICAL METHOD

This is the most favoured method although the basal sections may be troublesome. Still and buttresses are normally not measured. A buttswell may be estimated by approximation as stump volume of a stem of uniform taper. Volume is estimated in sections.

Volume is estimated in sections of straight and non-straight stems. The crown and branches (branch wood) require smaller sectional lengths. The relation between section volume and stacked volume is used and is usually labour saving.

Analytical Method Formulae:

1. Newton's Formulae

$$V = h/6 (A_b + 4a_m + Au)$$

$$h \frac{(Ab + 4am + Au)}{6}$$

Where V = Volume I cubic meter or other units
h = Total height above stump – 6m
A = Sectional area at the base $0.4m^2$
A^b = Sectional area at the middle $0.3m^2$
Au^m = Sectional area at the top $0.2m^2$

Newton's formula is the most flexible for determining volume of a whole stem or portion of it. The formula is applicable to any of the three possible stem forms, be it Neiloid or Paraboloid or Conoid.

2. Schiffel's Formula:

$$V = h(0.16 A_b + 0.66 A_m)$$
$$= h(0.16A_b + 0.66 A_m) \text{ where } Au = 0$$

This is a modification of Newton's formula. It is only used for determining total stem volume i.e. volume from ground level of stump height to the tip of the stem. (Au) tip's cross sectional area is equan to zero.

3. Smalian's Formula:

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

This deals with frustum of a paraboloid.

4. Huber's Formula:

$$V = h.Am$$

This also deals with the volume for frustum of a paraboloid.

Both Smalian and Huber's formulae give inaccurate estimate of volume of stem section which are not truly frustum of paraboloid. Smalian's formula tends to overestimate while Huber's formula under-estimates. The error due to using Smalian's formula is usually twice that of Huber's formula. Smalian's formula is apparently easier to apply especially with regards to felled logs.

The accuracy of estimating total or merchantable stem volume by means of either Smalian and Huber's formulae is increased by dividing the stem into a number o short sections and adding together the sectional volumes.

5. Pressler's Formula

$2/3 (Ab \times H \times \frac{1}{2} D)$

$2/3[Ab + H \times D/2]$

$V = 2/3 (A_b \ H1/2D)$

Where H = height above ground

1/2D = half the basal diameter

$2/3 (A_b \times H \ D/2)$

6. Hossfeld's Formula

$V = h/4 (3 \ A1/3 + A_b)$

$h/4 (3 \times A/3 + A_b)$

where A1/3 = the cross sectional area in square units at one third of the height above stump.

The two formulae above i.e. 5 and 6 aim at reducing the amount of work necessary in obtaining requisite measurements. These formulae refer essentially to cubic measure.

OTHER TYPES OF VOLUME ESTIMATION

1. Board Foot American
2. Mill Tally Volume
3. Hopus Foot – British

These are known as allowance measures.

They derive volume in terms of utilizable portions of the log.

BOARD:

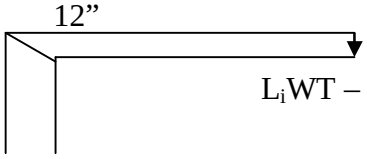
It is a unit of volume measurement commonly used in North America to estimate the actual volume of wood utilized in form of sawn timber from the stem or portion of it. The unit is applied to planks produced from Saw mills and also to estimate the utilizable quantity of timber from a standing tree.

The definition of Board Foot is a unit of 12 inches long, 12 inches wide and 1 inch thick. The generalized formula for the volume of a sawn board is L_i WT

Where Li = Length in inches

W = Width in inches

T = Thickness in inches



One inch

L_iWT – Volume of a sawn board

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