**Unit-3: Measurement of Form**



Figure 31: Tree form

**Tree Stem Form**

* Form is the rate of taper of a log or stem
* It is the decrease in diameter of a stem of a tree or of a log from base upward.
* The taper varies not only with species, age, site and crop density but also in the different parts of the same tree.
* The basal portion of the tree corresponds to the frustum of a neiloid, the middle portion to the frustum of a paraboloid, and the top portion to the cone
* Trees often are combinations of form.

**Metzger’s Theory or Girder Theory**

* Several theory put forward to explain variations in taper from tree to tree and in the same tree as well
* Metzer’s theory assumes that the tree stem should be considered as a cantilever beam of uniform size against the bending force of the wind.
* The wind pressure acts on the crown and is conveyed to the lower parts of the stem in an increasing measure with the increasing length of the bole.
* Thus, the biggest pressure is exerted at the base and there is a danger of trees snapping at the place, to counteract this tendancy, the tree reinforces itself towards the base.
* The pressure of wind crown keeps on changing as the tree is growing in open crowded portion.
* Tapering increase if it is an isolated area, an area where largest density, in the area tapering decreases.
* Though tapering is the natural process which can be controlled by human interference. If competition increases, tapering decreases.
* Trees growing in complete isolation or exposed situation have short but rapidly tapering boles while the trees growing in dense crops, which are therefore subjected to lesser wind pressure, have long and nearly cylindrical boles.

Mathematically,

Let,

p= a force applied to a cantilever beam at its free end

l= the distance of a given cross section from the point of applications of this force

d= the diameter of the beam at the point

s= the bending stress in kg/cm2

By the rule of mechanics,

As the force p in case of trees consists of components

W= wind pressure per unit area, F= crown area, than p=w\*F

Then,

* For a given tree w, F, s can be considered as constant, therefore d3= kl, where k is a constant
* Thus, the diameter raised to the third power increases proportionately with lengthening of the lever or with the increasing distance from the central point of application of wind force
* According to this logic, the tree stem must have the shape of a cubic paraboloid.

**Methods of studying form**

1. By comparisons of standard form ratios (form factor and form quotient)
2. By classification of form on the basic of form ratios and
3. By compilation of taper table
	1. **Form factor and its type**
* Form factor is the ratio of the volume of a tree or its part to the volume of a cylinder having the same length and cross section as the tree.
* It is the ratio between the volume of a tree to the product of basal area and height.

**Types of form factor**

**1. Artificial form factor**

* Known as breast-height form factor
* Basal area or diameter measured at dbh and the volume refers to the whole tree both above and below the point of measurement.
* It is not reliable guide to the tree form.
* Diameter measurement is fixed, but no fixed relation exists to the height of the tree and portion above the breast height.
* Trees of same form but different heights will have different form factor.
* Universally used for its handy measurement and standardization of diameter at breast height.
* A useful application is for quick-and-dirty volume estimates, assuming a constant form factor.

**2. Absolute form factor**

* It is the ratio between the volume of the tree above the point of diameter or basal area measurement with the cylinder which has the same basal area and whose height is equal to the height of the tree above that point.
* Basal area is measured at any convenient height and the volume refers to that part of the tree above the point of measurement

**3. Normal form factor**

* Basal area is measured at a constant proportion of the total height of the tree, e.g 1/10th , 1/20th etc. of the total height and the volume refers to the whole tree above ground level.

**Disadvantages**

1. The height of tree to be determined before the point of measurement can be fixed.
2. Point of measurement very inconvenient in case both very tall and short trees.

Absolute form factor and normal factor are no longer used. Unless stated, form factor implies artificial form factor whose basal area calculated at 1.3 m. The natural form factor corresponding to the total volume of a stem is generally between 0.3 and 0.6.

**Uses of form factor**

1. To estimate volume of standing trees

* Form factor compiled in tabular form to give average form factor of different dimensions by dbh and height classes.
* Table used to estimate volume by measuring dbh and height.
* Table prepared from measuring large number of trees, so application to individual tree not satisfactory, however used to estimate volume of group trees.
* Uses limited to similar growing conditions

2. To study laws of growth

* Gives insight to laws of growth, particularly to stem form of trees.

**Kinds of form factor**

Depending upon volume represented, form factor may be of following kinds

1. Tree form factor
2. Stem timber form factor
3. Stem small wood form factor

**Form Height**

It is the product of form factor and total height of the tree.

Volume is calculated from under bark measurements and the basal area is calculated from dbh (ob). Form height is used to determine how far is it reasonable to assume that volume is proportional to the basal area. If form height remains constant with increasing diameter, then it is clear that the assumption is justified.

**3.2 Form quotient and its type**

**Form Quotient**

* It is the ratio between the mid-diameter and the dbh.

* Taper depends upon form quotient (A. Schiffel)

**Types of form quotient**

1. **Normal form quotient**
* Ratio of mid-diameter or mid-girth of a tree to its diameter or girth at breast height.
1. **Absolute form quotient**
* Ratio of diameter or girth of a stem at one half its heights above the breast height to the diameter or girth at breast height.

Form quotient is the third independent variable of volume table that can be used to predict the volume of a tree stem.

**Form Class**

* Form class is defined as one of the intervals in which the range of form quotients of trees is divided for classification and use.
* It also implies to the class of trees which fall into such an interval.
* Trees may be grouped into form classes expressed by form quotient intervals such as 0.50 to 0.55, 0.55 to 0.60 and so on or by mid-points of these intervals such as 0.525, 0.575 and so on.

**Form Point Ratio**

* It is defined as the point in the crown as which wind pressure is estimated to be cantered.
* Form point ratio is defined as the relationship, usually expressed as a percentage, of the height of the form point above ground level to the total height of the tree.
* Form point ratio bears a consistent relation to the form quotient.
* If form point ratio is known, the form quotient and form class of a tree can be determined.
	1. **Taper table and formulae**
* It provides the actual form by diameters at fixed points from the base to the tip of a tree.
* Volume tables can thus be prepared from taper tables in desired unit.

**Use of taper table**

1. Volume of the average tree for each diameter and height class can be found readily in office without direct measurement. The only measurement that will be needed is the dbh (ob) and the height of standing tree.
2. Volume table can be prepared from taper tables in desired units.

The ultimate purpose of all taper tables is to show upper stem diameters, which can then be used to calculate the volume of the sections of a tree and the entire tree. Taper tables can assume several forms.

**Types of taper table**

1. **Ordinary taper table or diameter taper table**
* It gives the taper directly for diameter at breast- height without reference to the tree form.

 2. **Form class taper table**

* This tables gives for different form classes the diameters at fixed points on the stem expressed as percentage of dbh (u.b)

**General formulae or equations for tree form**

* Taper equation represent the expected diameter as a function of height above ground, total tree height and dbh irrespective of tree species and generalized for form class
* Many different forms of taper equations have been developed as no single one can adequately represent all species in all situations. The use of taper equations allow us to obtain volumes for any desired portion of a tree stem by predicting upper stem diameters.

**Hojer’s formulae**

* It determines the diameter quotient (i.e the ratio of the diameter of a stem at any given height to its breast-height diameter) for each form class
* It gives the percentage of the length of the tree between breast height and top

**Behre’s formulae**

* This formulae is more consistent

**Bark Measurement**

* The thickness of the bark and its percentage of volume in the tree or log are important parameters in mensuration because most measurements on standing trees have to be made on over bark.
* Some species have very thick bark. In general, bark thickness varies with: species, age, genotype, rate of growth and position in the tree
* The bark thickness of the living tree may be measured with little damage to the trees using a Swedish Bark Gauge

