



ESTIMATING STRENGTH LOSS FROM DECAY



In TREE TRUNKS AND ROOTS

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Measuring Strength Loss from Decay

Estimating the strength loss from decay is based on measurement of the amount of sound and decayed wood (exclusive of the bark) in the trunk or stem of a tree. Determination of the location to make these measurements is a matter of judgment by the investigator. Usually the area with the greatest visual symptoms of decay, the location that is most likely to fail or, or where multiple defects exist are typically selected.

A minimum of four measurements, one in each quadrant of the tree, is usually needed to make an estimate of the amount of decay. Additional drilling can increase reliability of measurements.

Tools to measure decay are fairly limited. Drilling with a hand drill and small diameter drill bit, using an increment borer, and the Resistograph® are the most common methods used in the industry. The increment borer and the Resistograph produce a visual display and allow direct measurement of the amount of decay. However, these methods also wound the tree and theoretically could break barrier zones and increase decay. Picus Tomography and Tree Radar are non-destructive methods for decay assessment.

Estimating Strength Loss from Decay

Once measurements are obtained, an estimate of strength loss can be made using a number of relatively simple formulas. Wagner's (1963) formula is acceptable if there are no cavities. The formula proposed by Smiley and Fraedrich (1992) is useful if cavities are present. A measurement of the circumference of the cavity in the same location that the tree is being drilled for decay is needed. It is generally accepted in the industry that 33% strength loss or greater is the break off point for removal.

The Smiley and Fraedrich (1992) formula was arrived at by measuring trees that failed in high winds in hurricane Hugo. The study was restricted to southern oak species. Many people use the formula for other tree species as well. However, weak wooded trees should be given extra consideration when strength loss values approach the 30 % range. A major problem with all formulas is that they estimate strength loss based on a central column of decay.

Estimation of strength loss should always be considered in conjunction with other tree risk analysis factors before a judgment is made to retain or remove a tree. Weak wooded trees, tree health, the presence of other defects, tree exposure, target analysis, and site conditions are some other factors that should be considered.

Using Common Strength Loss Formulas for Trunks

1. Wagner W. 1963. Judging hazard from native trees in California recreational areas: A guide for professional foresters. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station. Research Paper PSN-P1.

$$\text{Strength Loss Percent} = \frac{(\text{Diameter of Decayed Wood})^3}{(\text{Trunk Diameter})^3} \times 100$$

Example:

30 inch tree with 18 inch decay column

$$\text{Strength Loss} = \frac{18^3}{30^3} = \frac{5832}{27000} = 21.6\%$$

2. Smiley, E. Thomas and B. Fraedrich. 1992. Determining strength loss from decay. J. Arboriculture 18 (4): 201-204.

$$\text{Strength Loss} = \frac{(\text{Diameter of Decayed Wood})^3 + R (\text{Diam. trunk wood}^3 - \text{Diameter of decayed wood}^3)}{(\text{Trunk Diameter})^3} \times 100$$

R= Cavity opening/Trunk wood circumference

Note: Reduce trunk diameter by thickness of the bark

Example:

30 inch tree with 18 inch decay column and external cavity of 10 inches

$$= \frac{(18^3) + (10/94) * (30^3 - 18^3)}{30^3} \times 100$$

$$= \frac{5832 + (.106) (27000 - 5832)}{27000} \times 100$$

$$\text{Strength loss} = 30\%$$

3. Mattheck, C and H. Breloer. 1994. Field guide for visual assessment. Arbor. J. 18:1-23.

Calculate the following: t/R where **t= (sound wood excluding bark)** and **R = Trunk Radius (minus bark)**

If greater than .3 the tree is considered "safe"; less than .3 remove it. This is really a stem breaking threshold and not a strength loss formula. It does not consider wood strength, tree exposure, or other risk assessment features.

Examples:

30 inch tree with 18 inch central cavity

$$6/15 = 0.4$$

But a 22 inch central cavity

$$4/15 = 0.26 \text{ Exceeds the threshold and you may want to remove it.}$$

Estimating Strength Loss in Buttress Roots

Introduction

Determining the impact of decay on large structural roots is difficult because:

- Roots are covered in soil or mulch and cannot visually assessed
- Excavation with supersonic air tools is often needed to expose roots
- Root decay progresses from the bottom of the root to the top and is not visible even in exposed roots
- Decay may be localized in one portion of a root

The methods to test decay in roots are not well researched. The following presents a useable method that is based on research on decay in stems.

Method

Step 1. Root crown excavation

In most cases it is necessary to excavate the root crown to expose the full length of the buttress roots and large support roots. Excavations are best performed with an air tool (Air Knife or Air Spade or similar and a 185 cfm compressor). Limited scope excavations can be done by hand when the tree has exposed buttress roots. Care is needed not to damage bark when excavations are being done with hand tools.

Step 2. Test roots with a Resistograph or hand held drilling

Once roots are exposed they can be tested for decay. Drilling should be done perpendicular to the root surface. It may not be necessary to test all the roots (see below). In addition, it is only necessary to drill into the root the equivalent of t when $t/R = 0.3$. Once this depth is reach and there is no decay, drilling can stop. If decay is found in $t/R = 0.3$ then the root is considered decayed.

Strength Loss Determination

To determine the relative risk level of the tree from the root decay the following procedures can be used.

Step 1. Count the number of main structural roots.

Step 2. Determine the number that have decay in excess of $t/R = 0.3$.

To make this determination, determine the radius of the tree (without the bark) and multiply it by 0.3. This gives the minimum amount of sound wood needed to count the root for support. For example, a 32 inch tree with 1 inch of bark has a radius of 15 and a minimum $t = 4.5$ (15X.3) inches. Any root with more than 4.5 inches of sound wood can be counted.

Step 3. Determine if more than 1/3 or 1/2 of the total roots are decayed.

This calculation is done by counting the number of main buttress roots and drilling these roots to determine the number with decay in excess of $t/R = 0.3$. If the decayed roots exceed more than 1/3 of the total, the tree is considered high risk and more than 1/2 the tree is serious risk.