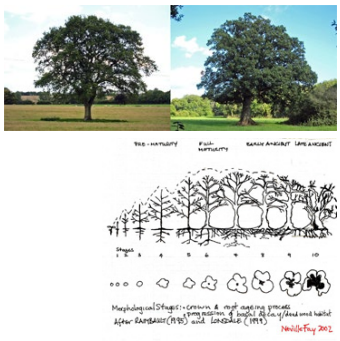
Safety factor v strength loss

Think safety factor before strength-loss

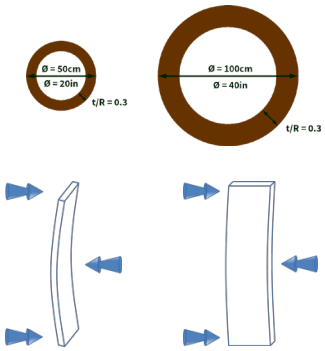


The early-mature tree on the left has a Basic Safety Factor of 2. The mature tree on the right has a Basic Safety Factor of 10. If the mature tree lost 60% of its strength because of decay, it would have a Residual Safety Factor of 4 (10 – 60%). Even though the mature tree has lost 60% of its strength, with a Residual Safety Factor of 4 it is twice as strong as the early-mature tree that has no decay.

A tree's Basic Safety Factor is a measure of how much stronger it is than it needs to be, and changes during its life. The crown height and spread does not alter significantly during the mature phase, which means there's little change in the Load. At the same time, the stem diameter, and therefore the Basic Safety Factor, is increasing as the tree grows older. Here's why.

Section modulus

The broader the better

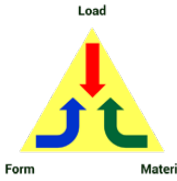


Both these stems are the same species and have the same crown size. They are both hollow, with a residual wall thickness (t) that is 30% of the stem radius (R) - a t/R ratio of 0.3. The 100cm diameter stem on the right is stronger and stiffer. It can carry x8 more load in bending than the 50cm diameter stem on the left. This increased strength and stiffness is explained by a geometric property called 'section modulus', which Statics uses in Form.

Bending a wooden ruler shows you how section modulus works. There's an increasing mechanical advantage as the distance from the neutral axis, at the centre, grows. The cross-section of the ruler is stiffer and stronger when face-on (right), than side-on (left). The amount of wood is the same, the difference is where the wood is distributed. Similarly, the outermost wood in a tree is the most important for providing it with stiffness and strength.

Statics & residual wall thickness

Why t/R ratios can't work alone



Statics applies basic engineering principles by considering the three components that affect a tree's Safety Factor. When we assess t/R ratios, or residual wall thickness, we're only looking at one part of the 'Form' in the triangle of Statics; without taking account of the geometric properties of shape or absolute diameter. The Load or Material inputs are not even considered. What this means is, you cannot make a credible decision about stability and likelihood of failure based on residual wall thickness alone.

TreeCalc

What's the *Basic* safety factor?
What's the *Residual* safety factor?

TreeCalc helps you appreciate the value in Safety Factor assessment above looking at strength-loss in isolation.

TreeCalc can help you by calculating 'base-rate' Basic and Residual Safety Factors. When you use TreeCalc, don't forget the limits of the model. They're uniform material properties, simple circular geometry, and hollowing. Also, failure is in compression, and not cross-sectional flattening or cracking.