1 Think Safety Factor, not Strength Loss

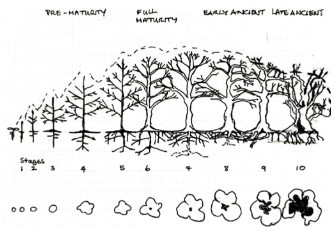
What is a tree's Safety Factor?

1 A tree's Safety Factor (SF) is a measure of its strength for a known wind load. A SF of 2 means the tree is x2 stronger than it needs to be.

2 Advanced Assessments on these trees calculate their SFs at 1.0m above ground. The early mature tree (left) is 17m high with a stem diameter of 60cm. It has a Height/Diameter (H/D) ratio of 28, and a Basic Safety Factor (BSF) of 2. The late mature tree (right) is 20m high with a stem diameter of 120cm. It has an H/D ratio of 17, and a BSF of 10. Your clue the late mature tree has a much higher BSF than the early mature tree is it has a much lower H/D ratio.

3 Our early mature tree has no decay. It's lost no strength. So, the Residual Safety Factor (RSF) 2 is the same as its BSF 2. Our late mature tree has extensive decay, is 80% hollow, with an open cavity. It's lost 60% of its strength. This tree has a BSF of 10, and a RSF of 4 (60% loss = 10 to 4). Even though the late mature tree has lost 60% of its strength from decay. With a RSF of 4, it's twice as strong as the early mature tree (RSF 2) with no decay. Which tree most concerns an Arborist?

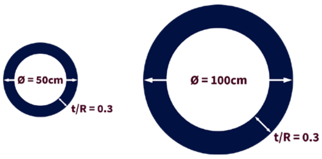
1.1 Investing in Basic Safety Factor



4 A tree's BSF changes during its life. Once a tree gets to its mature phase, crown height and spread don't change significantly. So, there's little change in wind load. Meanwhile, the stem diameter and BSF increase as the tree grows older. A tree with a high BSF can afford a lot of strength loss from decay. With **VALID**, when you carry out a Detailed Assessment on a late mature tree, that hosts significant decay, and has a low H/D ratio. You'd colour **A for Anatomy** 'green' in your Likelihood of Failure decision. As well as being green, A for Anatomy usually has the greatest influence on **Likelihood of Failure**, and is your 'base rate' colour.

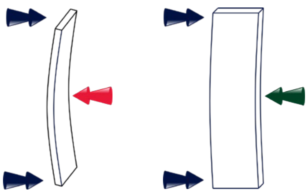
1.2 Section Modulus - why it's so important

Which stem is stiffer and stronger?



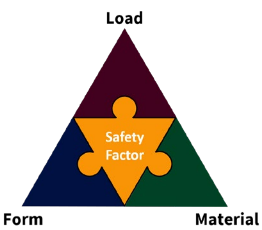
5 Section modulus is a geometric measure of the stiffness and strength of a tree's stem cross-section when bent by a wind load. The stems on the left are the same species (same material properties) and have the same crown size (same wind load). With a residual wall thickness (t) that's 30% of the stem radius (R), they have a t/R ratio of 0.3. Both stems are 50% hollow. Because of its section modulus value, the 100cm diameter stem is much stiffer and stronger. It can carry x8 more load in bending than the 50cm stem, even though they have the same t/R ratio.

Bend a ruler to see how it works



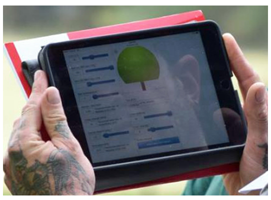
6 Bending a wooden ruler shows you how section modulus works. As the distance between the neutral axis, at the centre, to the ruler's edge increases it enjoys an increasing mechanical advantage. The further material is from the neutral axis, the more load it can carry in compression. When you put the ruler under a bending load, it's much stiffer and stronger face-on (right), than edge-on (left). The material properties are the same. The load is the same. The only difference is the geometry, and its section modulus. For the same reason, the outermost wood in a tree is the most important for its load bearing stiffness and strength.

1.3 Statics & residual wall thickness



7 Statics applies engineering principles to measure a tree's Safety Factor. We've illustrated the Statics Triangle as a puzzle on the left. When we assess t/R ratios, or residual wall thickness with tomograms or micro-drills, we're only looking at one part of the 'Form' in the puzzle. We're missing the geometric properties of shape and absolute diameter parts of the Form. The Load and Material property parts of the puzzle are completely missing. What this means is you can't make a credible decision about a tree's likelihood of failure, or the risk, based on the residual wall thickness from tomograms or micro-drills alone.

1.4 TreeCalc



8 If you have a tree with decay and significant strength loss. **TreeCalc** helps you work out your Tree's BSF. From there, you can model how hollow the tree needs to be before its RSF gets too low. If the RSF is too low, TreeCalc shows you how much height you need to reduce the tree by. When you use TreeCalc, don't forget the limits of the model. Material properties are uniform. The Geometry of the stem and hollowing is circular. Failure is in compression, and not cross-sectional flattening or cracking. Only use TreeCalc to assess how decay affects the RSF.

Acknowledgements
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