SIA - Method - a Destruction-Free Method for Tree Assessment

The SIA-Method (SIA= **s**tatics **i**ntegrating **a**ssessment) is a system designed for practitioners to assess the breaking safety of trees. The SIA method is widely used in Germany and other European countries. It allows for quick and destruction-free tree assessment. The procedure is very simple for practitioners and no expensive tools are required.

After having assessed more than 3000 trees all over Europe with engineering based and statics integrating pulling tests it was found that all inspected trees follow similar patterns which are calculable.
Every practitioner who has experience in hazard tree assessment knows that tree trunks sometimes are very hollow without having failed in gale force gusts. Therefore the question is: How hollow may a tree be without being considered unsafe or even hazardous?

From calculations based on individual tree data it can be derived that a 75 foot (=25 m) high English Oak tree in a wind exposed area with a dense crown and a trunk diameter of 40 inches needs residual walls of only 2,5 inches (= 56mm) to withstand a gale gust of Force 12 (Beaufort scale = 32,5 m/s). The same tree with a trunk diameter of only 27 inches (=670 mm) has already reached its safety limit and if hollow, should be considered as hazardous.

Why is that?

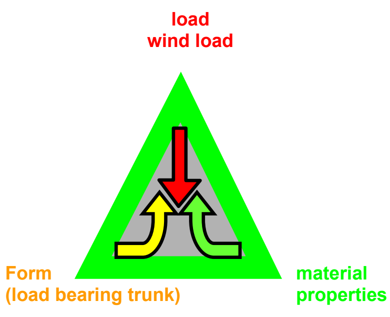
Wind speed increases naturally above ground level and therefore the uppermost parts of a tree crown are exposed to a higher, exponentially increasing wind load during gusts.

Also the diameter of a tree trunk has a significant influence on the stability of a tree. According to the formula for the resistive bending moment: $W = d^3 * \pi/32$** it can be calculated that a trunk of 40 inches (=1000mm) has an eight times higher load bearing capacity than a trunk of only 20 inches (500 mm). The thicker tree is also 16 times stiffer than the thinner one.

Consideration must be also given to the fact that material properties differ between the species. In systematic material research at the University of Stuttgart it was found that trees from Germany have compression strengths between 14 N/mm² (*Aesculus hippocastanum*) and 28 N/mm² (*Quercus robur*).

All three components of the triangle of statics, wind-load, material properties and load bearing geometry (diameter of the trunk, extend of hollowness) have to be considered in a tree safety assessment, neglecting only one component leads automatically to wrong results.

Fig.1 Triangle of statics

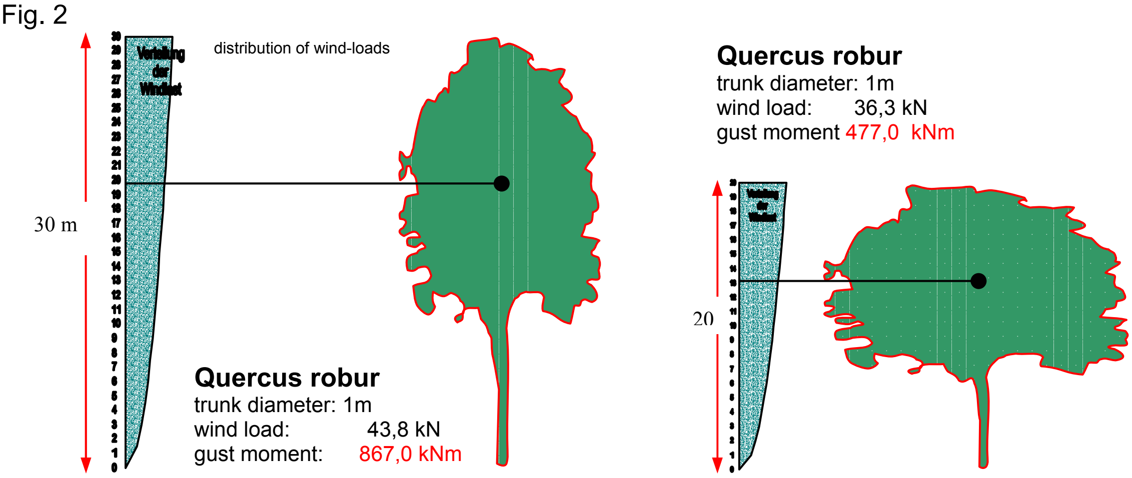


Before constructing a load bearing structure (e.g. bridge) an engineer has to calculate or determine the impacting forces and loads, then an optimzed form of the structure has to be chosen to avoid material waste. High strength properties allow for a more fragile construction and weak material requires a more massive construction.

Neglecting one component must lead to wrong results .

A small tree with a thick trunk is exposed to less wind loads and therefore has a high basic safety which allows for a higher degree of hollowness.

Fig. 2



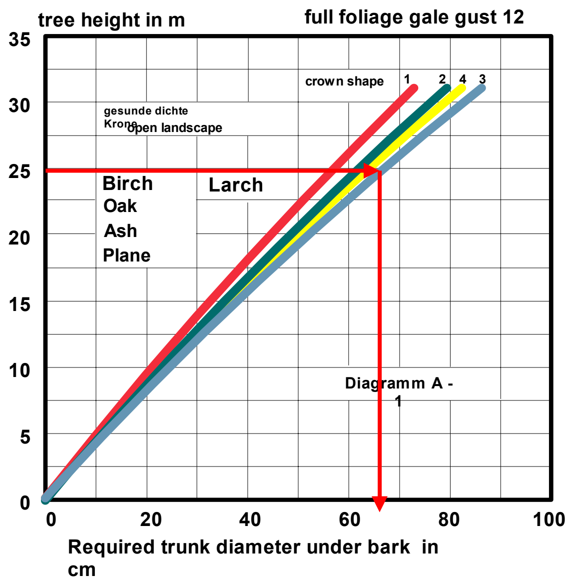
Due to its height the tree on the left is exposed to 1,8 times higher wind loads than the tree on the right. The breaking safety obviously cannot be measured with a static ratio of e.g. residual wall/ trunk radius (t/r) > 33%.

<u>Which tools are required for the use of the SIA -Method?</u>

First the height has to be measured exactly with an inclinometer, then a caliper or measuring tape is used to determine the trunks diameter. For a simplified load analysis the crown shape has to be estimated. The obtained values are transferred to a table system (SIA-Tables) and calculated with a simple pocket calculator.

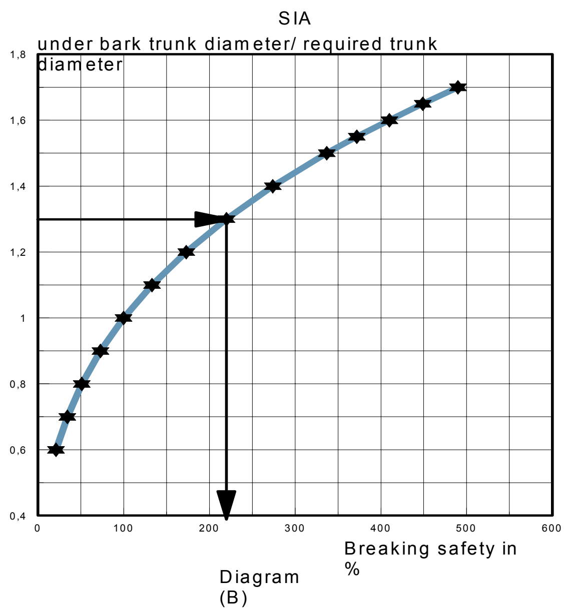
SIA- Diagrams

Fig. 3 A-Diagram



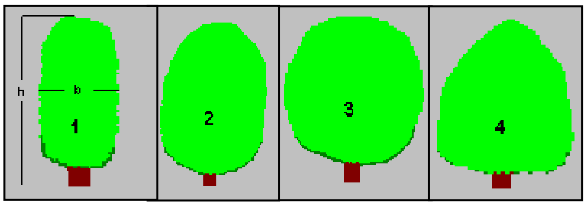
With the A-diagrams which contain the most common tree species the required trunk diameter can be obtained.

Fig. 4 B- Diagram



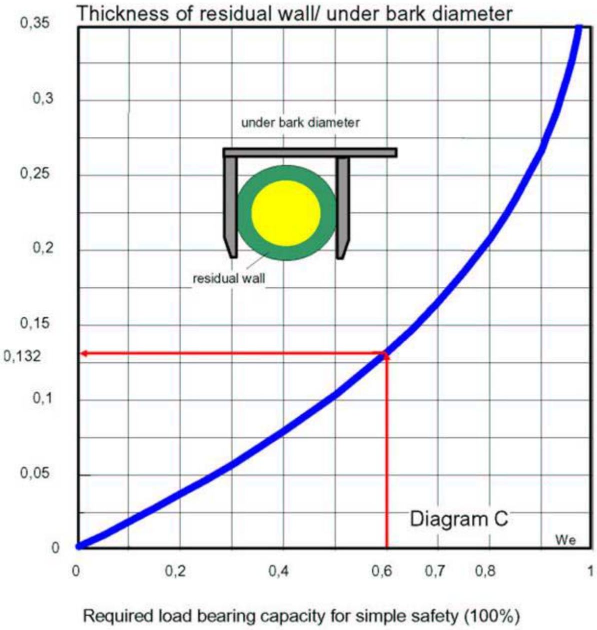
With B-diagrams the basic safety can be obtained by dividing the measured under bark diameter through the diagram A diameter.

Fig. 5



The load analysis, as an essential part of the SIA-method, can be carried out by choosing standard crown shapes.

Fig. 6 C-Diagram



In diagram C the thickness of the required residual wall can be calculated by dividing 100% through the required minimum safety by the basic safety derived from diagram B

Fig. 7 D- Diagram

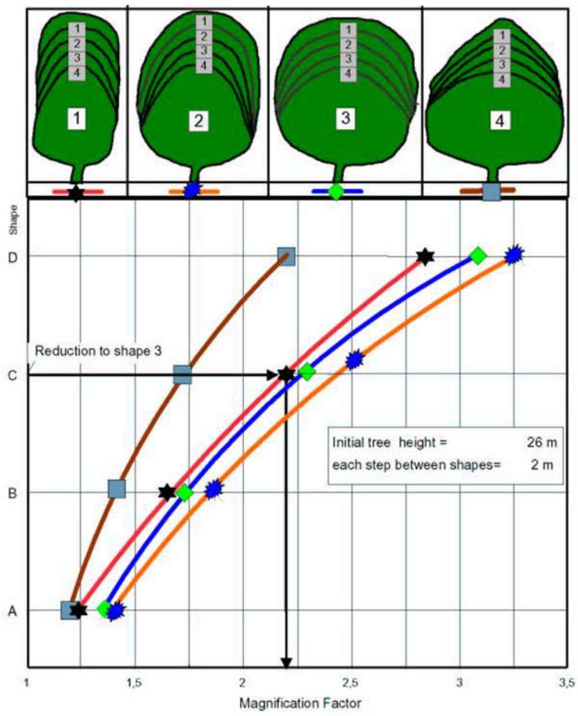


Diagram D shows the influence of crown reductions on the breaking safety.
If trees are tall often only a little crown reduction increases the breaking safety of the trunk by the factor 1,5 or even 2 (= 100%). Extreme overpruning destroys trees and raises the aerodynamic drag coefficient thus leading to increased resistance in a storm.

**Abbreviations:

W	= cross section modulus or resisting moment against bending in a cylindrical structure
d	= diameter of trunk at 1 m height
2,5 cm	= 1 inch
3,3 feet	= 1 m