Fracture Diagnosis of Trees

Part 2: statics-Integrated Methods - Statically-Integrated Assessment (SIA)

The Practitioner's Method of Diagnosis

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Introduction

Statics-Integrated Methods of measurement (SIM) like the Inclinometer and Elastometer are the final stage in diagnosing the safety of important trees. Before this the practitioner should be able to make an on-site decision on the safety of the trees as regards traffic, in accordance with the statics situation and German Standard DIN 1055 by analogy with the measurements for building constructions. Load, wood-material and cross-sections are not of equal importance however. Evaluation of the influences in the safety diagnosis has shown that a radical re-think is needed: first the load must be determined. This procedure is absolutely essential in practical tree care, in view of the 800/25/25-75 ratio for load/material/geometry (Fig. 13) described in the preceding Part 1 (Stadt und Gruen 1995, No. 6).

The practitioner too must have access to the three elements of the statics triangle. With SIA the fundamental thought is first to get to know **the basic statics substance** of the tree. Only then can we get a picture of the influence of any damage identified as regards traffic safety.
As Fig. 14 clearly shows, the measurement of tree height must be very precise in any safety diagnosis. Any error will have a very disproportionate effect. **Therefore a merely visual assessment of the crown is quite inadequate.** Measurement of the stem diameter is just as important. It does not matter that two trees as shown in Fig. 14 occur in nature and have identical material strength. The basic safety of the one tree may be a good four times greater than that of the other, without this being apparent in a visual assessment.
Therefore, the method of Statics-Integrated Assessment (SIA; in Switzerland SIB) has been developed on the basis of many hundreds of practical measurements and safety surveys of trees. The cw-value of a normally crowned tree and the elastic limit of the green wood of the particular species are automatically incorporated using the Stuttgart Strength catalogue.

The basic statics substance of the tree is decisive.

The basic question is: **what stem diameter does a tree of given size need on its site so that it can withstand a severe storm (hurricane) with safety?** If it has a larger diameter than necessary, it possesses enough substance to avoid damage. If it is so slender as a result of release and competitive growth that it is just sufficiently safe, it can be allowed no damage place or large cavity in the stem.
The wind load on a tree depends on its absolute size, crown form and wind permeability. It has been found that we can work with four basic forms of crown appearance: a slender cylinder on a pillar, a ball on a pillar, an ellipsoid on a pillar, and a heart-shape. Tree species can be grouped when their wood strength differences and wind resistance coefficients are equalized (Fig. 15).
The tree's site is assessed using Davenport's soil boundary-layer equations: whether the tree is in the open, in a village or in a town. It is clear that the free-standing tree in a field needs a larger stem diameter than the tree standing protected in a town. This difference is less than expected, however, because of the greater gustiness in towns.The compression strengths of the individual woods according to the Stuttgart Strength Catalogue are also a basis of the SIA, as is the different wind permeability of the crowns (always assuming the tree has normal foliage). If this is not the case, the SIA result is a useful guide.
Just one example is taken from diagram A (Fig. 15), while diagrams B and C (Figs. 16 and 17) contain geometrical facts and are thus valid for all trees.

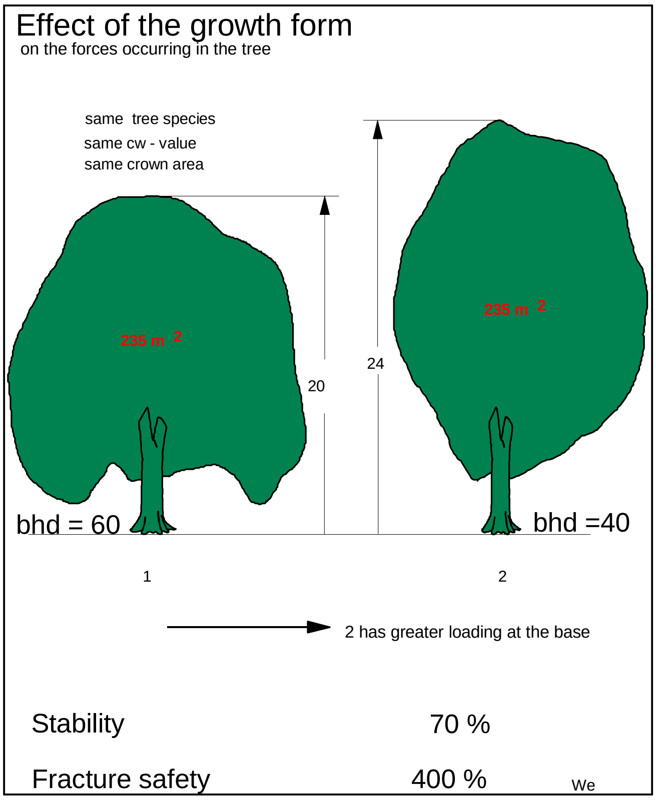

Fig. 14

This shows the influences to be taken into account in the safety analysis. Quite different loads are produced with an identical cw-air-resistance value and identical crown projection area. The stress on the taller tree is four times that on the lower one. This initial situation must first be explained before going on the damage assessment.

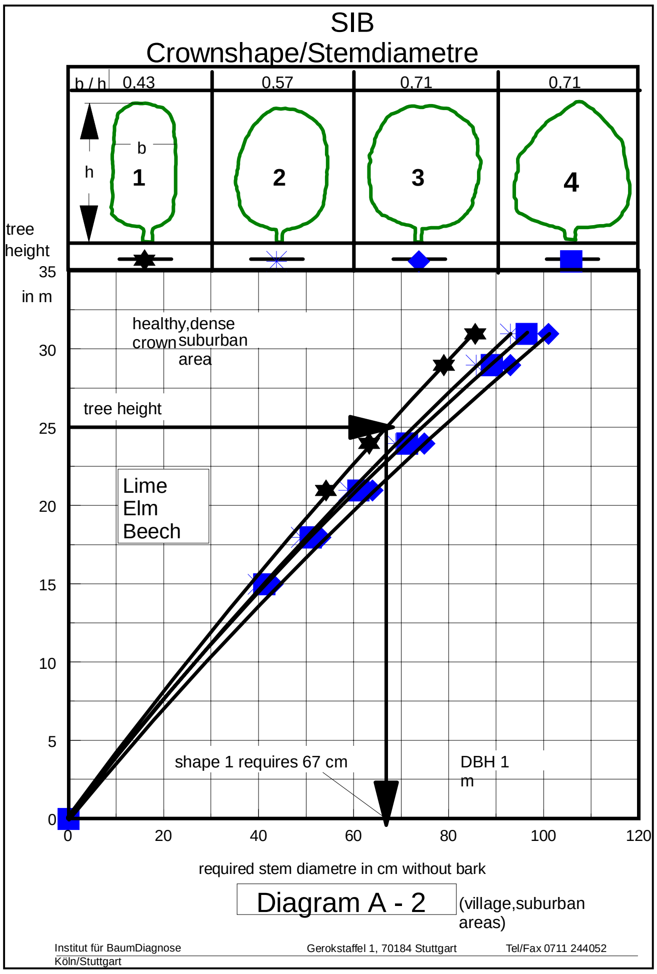

Diagram A

What stem diameter does the tree need for a given size and crown form on its site? Measure the stem diameter at breast height and also the tree height on the ordinate and go accross to the appropriate curve. Perpendicularly down from there read off the under-bark diameter requirement. Now compare the measured diameter with required one, and find the ratio of these two values. Take this ratio to diagram B.

Procedure

Accurately measure the stem diameter under bark at breast height and also the tree height; then in diagram A (Fig. 15) go along the ordinate, find the appropriate height and crown form, and go across to the appropriate curve. From there, read off vertically downward the required diameter under bark. Now compare the measured diameter with the required diameter and find the ratio of the two values. Find this value on the ordinate in diagram B (Fig. 16), go across horizontally to the curve and then vertically down. This gives the basic safety of the solid stem.

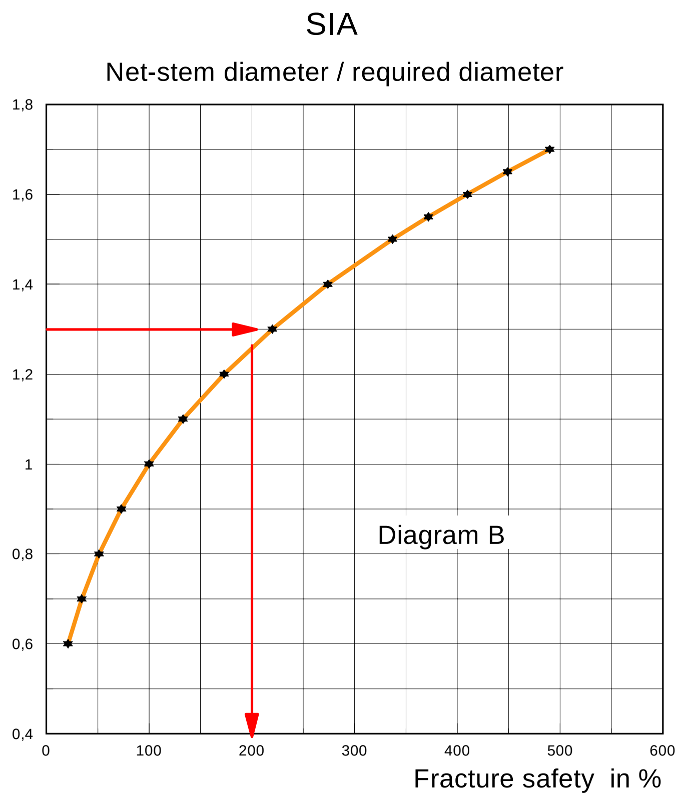

Fig. 16

Diagram B

Here, read off the basic safety value of the lower solid stem. If it exceeds 150%, the safety is adequate. If it is well above this, the tree can lose substance to the fungus. How much can be read off in the next diagram.

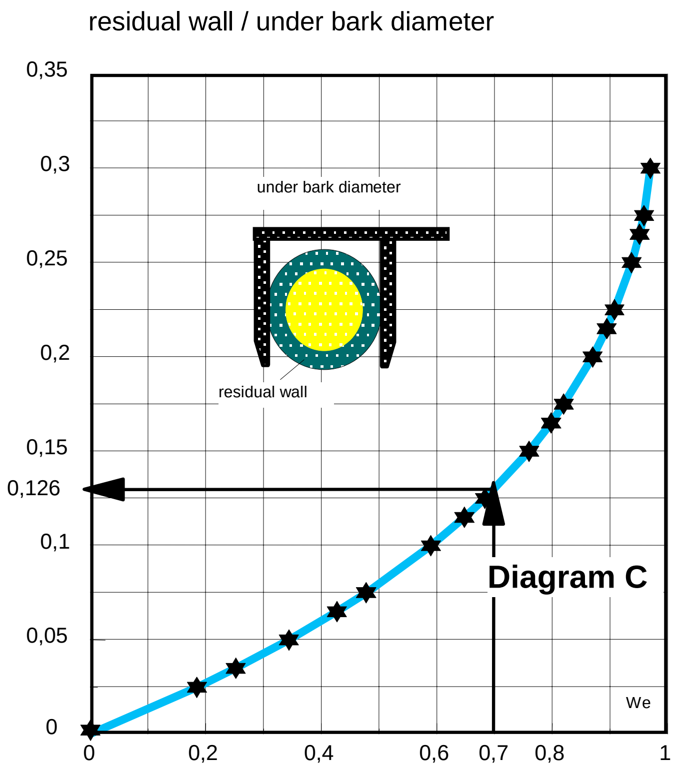

Fig. 17
Diagram C
This is the cure of geometric load bearing capacity with increasing hollowness.Here we can read off how big the necessarry residual wall thickness must be for the tree to be still safe against fracture. Divide 100 by the safety value read off in B. Find this value on the horizontal axis, go from there to the ordinate, and read off the value. Multiply this by the stem diameter under bark and get the necessarry mean minimum wall thickness which the tree needs to withstand a severe storm safely.

If the value found exceeds 150%, the safety is satisfactory. If it is well above this, the tree can afford to have some fungal decay. How much can be read off in the next diagram C (Fig. 17). The value of 150% is aimed at in order to be on the safe side in case of inaccuracies.

Diagram C shows the geometrical carrying capacity with increasing cavity size. Here we can read off how great the necessary residual wall thickness must be for the tree to be still safe against fracture. Divide 150 by the safety value read off in B. Find this value on the horizontal axis, go from there vertically up to the curve, go left horizontally and read off the appropriate value on the ordinate. Multiply this by the stem diameter under bark. This gives the necessary mean minimum wall thickness which the tree needs to withstand a severe storm (hurricane) safely.

Now the practitioner can seek indices providing information on whether the tree has the necessary wall thickness. In many old trees the necessary wall thickness determined in this way is so small that knowledge of biological and mycological relationships is sufficient for a visual assessment. One example: if a required wall thickness of 3 cm is determined for an old beech tree, this can often be seen with the naked eye. It is also known that depending on the tree species the fungus has the greatest difficulty in advancing in the sapwood zone. If the sapwood width of the tree is known, an adequate assessment is possible here too. If the safety is less than 150%, the crown must be reduced. By how much can be estimated roughly from diagram D (Fig. 18).

Effect of crown reduction

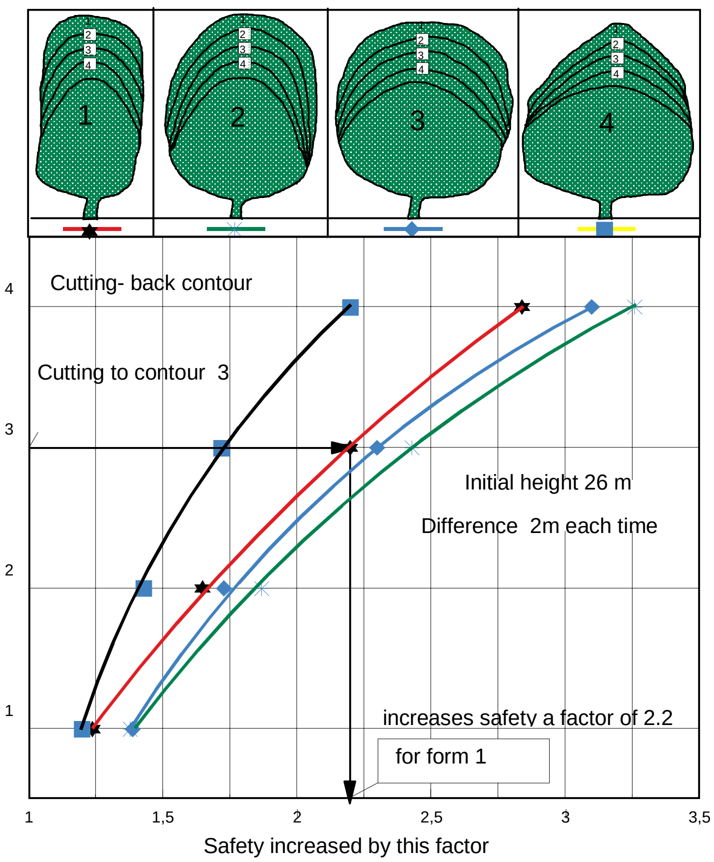

Diagram (D)

Fig. 18

Diagram D

This is a rough indicator of the effect of looping back. if the projection area of the tree is to be reduced, the cutting should be done as far up as possible. The effect is greatest here because the lever to the ground is longest and the storm force at greater height. The whole thing is only a rough indication because the looping naturally depends on the particular on-site situation.

Diagram D (Fig. 18) gives a rough indication of the effect of lopping back. When the projection area of the tree is reduced, the cutting should be done as far up as possible. The effect is greatest here, because the lever to the ground is greatest and the storm has more force at a greater height. The whole thing is only a rough indication because naturally the cutting depends on the on-site situation.

The SIA method provides a usable estimate of the statics situation for all free-standing trees, irrespective of whether they are unlopped, lopped or released.

Summary

With Statics-Integrated Assessment, the practitioner has an easy tool available. With it he can take account of all the aspects important for safety assessment. Above all, for the first time it takes into account the most important factor for tree diagnosis, i.e. the wind load which depends on tree height and crown form. For as was shown in the previous part of this article, load analysis is by far the most important.

The method is simple to learn. In just five minutes the practitioner can record the basic carrying capacity of the tree by means of three curves. This requires only a caliper, a hypsometer of adequate accuracy, and a small pocket calculator. This basic statics estimate will show whether tree-care measures are needed and how.

In contrast to the usual methods, this procedure which determines the basic statics substance first and only then incorporates the damage, has great advantages (Fig. 19). The practitioner gains safety.

Practical experience with SIA has shown that in most cases the visual assessment of vitality and basic statics substance is sufficient. Even with old hollow trees a further step is unnecessary if for example one calculates a required residual wall thickness of 3 cm, but one sees or knows that for biological reasons the fungus is facing an insuperable barrier 5 cm before the cambium. Accordingly, like the Statics-Integrated Methods (SIM), this method too accords with the 1992 ZTV Tree Care (published by FLL, Troisdorf) for an injury-free procedure. If the situation cannot be definitely settled with SIA, then the SIM are always available, like the Elastometer method for example.

Determination of the basic statics substance of the trees should sensibly form part of any tree assessment or survey.

It should also precede any intervention in the crown, such as crown securing for example. For this does not help if the basic statics substance of the tree is not sufficient for traffic safety.
However, we must point out again that the SIA method does not make precise fine control possible, but it does help to define the safety problem with the least expense. It will be only a part of a whole evaluation, and vitality assessment and long-term observation by experienced practitioners are of great importance.

The SIA method provides the necessary complement to all visual methods. It can be learnt for example in the **Statics Tree Diagnosis Course** at the Cologne/Stuttgart Institute for Tree Diagnosis.

The new way with SIA

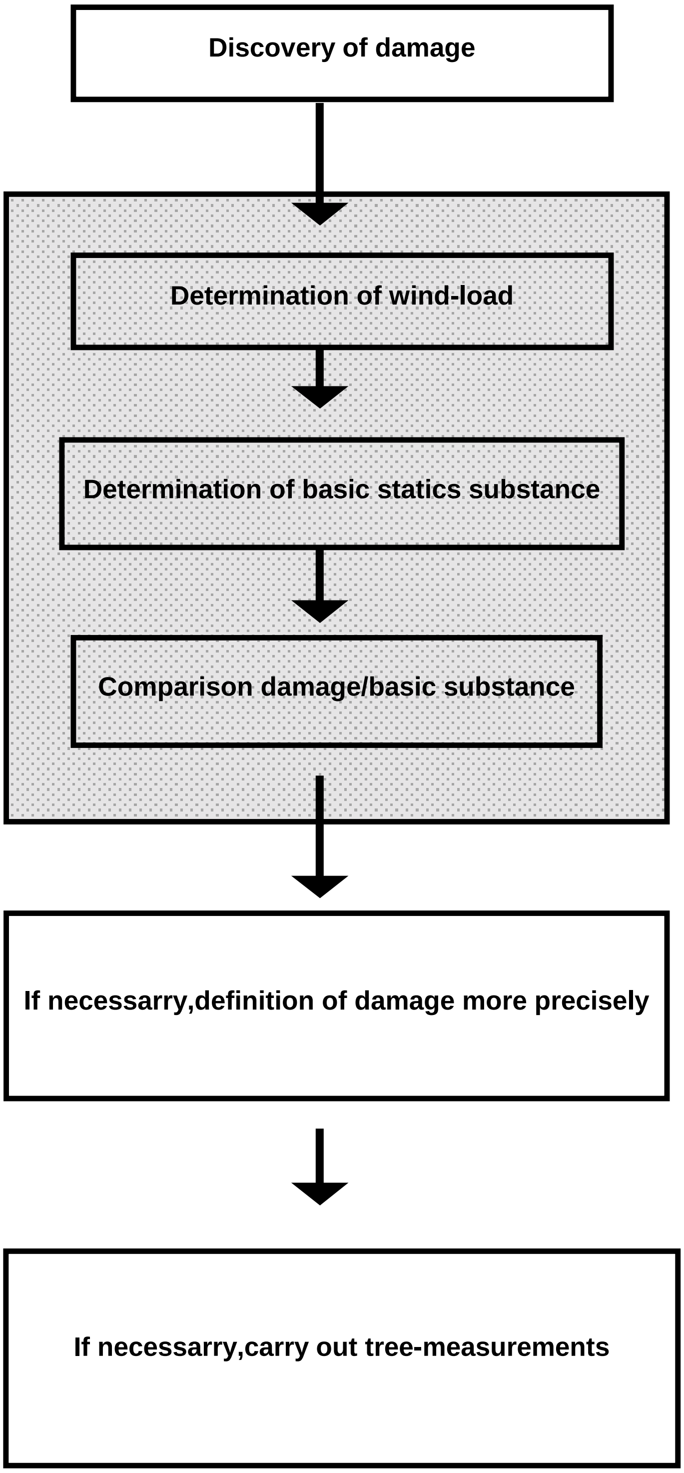

Fig. 19

The flow-diagram shows the new way of thinking:
first access the tree from its basic substance and not concentrate on the damage or symptoms.
In most cases this saves time and expensive investigation. The SIA method simplifies determination of the basic substance; the practioner only needs to measure tree height and stem diameter precisely.
A simple form guides the user all the way through.