Cabling tree crowns

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Failure frequency of trees

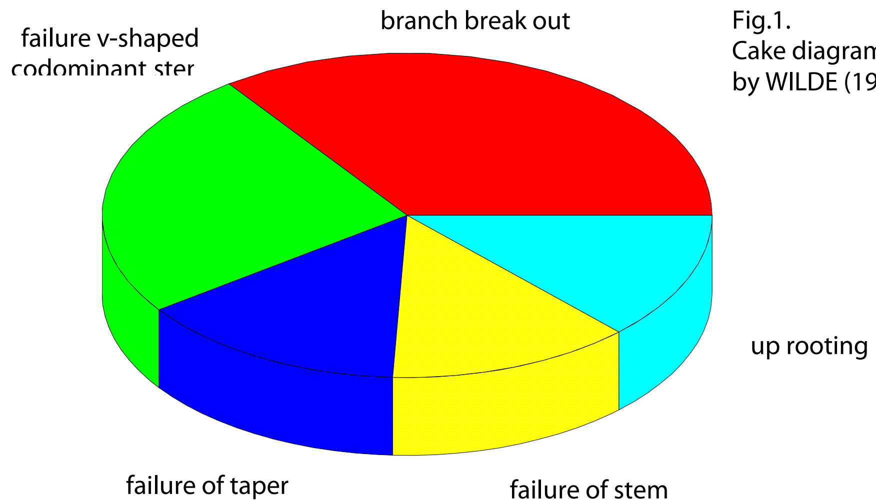


Fig.1.
Cake diagramm
by WILDE (1996)

During a students dissertation at the University of Osnabrück, WILDE had recorded the failure frequency of trees by interviewing some municipal garden departments. The resulting final diagramm shows that the most frequent failure is an outbreak of the crown. To avoid such failure without an immediate mutilation or even excavation of the tree, cabling systems had always been used. In the beginning, steel cuffs and cables girdling the tree were used which later constricted the tree endangering it and later on, threaded rods with ring nuts and steel cables inserted into a branch were used. Both systems had been very rough on the tree and did not respect their needs of motion for a healthy growth or for compensation and in the worst case provoced the karate effect caused by their stiffness.

Development of bracing systems

Not only the tree diagnosis itself had gone (once again in Europe) through a rapid development with the use of non-injuring tensile strength tests that had been integrated into the static (Inclino and Elasto method) for experts of SIA and VTA and users. New methods had also been found for cabling trees. SHIGO and later on, LIESE and DUJESIEFKEN, REINARTZ & SCHLAG postulated to avoid injuries on the trees and to respect the tree's shielding barrier. The ZTV-tree care of 1992/1993 considered this as advice. It was logical that the bracing methods had to follow up with corresponding developments. The renunciation of bolted rods and steel rods started in 1989 with SINN, who was the first to propose girdling systems during his cooperation with one of the authors. Polyester girth-webs at a width of 5 cm with corresponding clasps removed from a container anchoring were applied on the tree without special adjustment. A solution, that tried to show the right way but was not completely satisfactory. This was due to the strange visual effect but as well to the missing friction sleeve, a reason why this system could damage itself or the tree through friction. Besides, in the worst case, the metal clasp at 250 g could fall off and endanger human beings, private cars, etc… The fascinating feature on the application of this system was that the arborist could leave his tools at home (in contrairy to an installation of threading rods) and could cut the girth-web in desired lengths by knife or scissors from the rope coil. Thus, bracing methods could be directly realized in a cost saving way. The double rope system introduced by Schröder was an almost parallel development. It is characterized by a large specially sewn polyester rope which integrates an antiskid device on the stem (double rope system). First, steel cables connected both girth-webs that abruptly limited the oscillation of the tree parts with increased forces (karate-effect). To avoid this, multiple threaded -polyester hollow braids with smooth characteristics were used. The big advantage was the application of the insert splice. The solid connection is reached by simple splice of the rope. This connection is comfortable and much more efficient than a knot. It has nearly the same strength as the hollow braid itself. Thus, a clasp is unnecessary. A further advantage was the large surface. However, the disadvantage was, that a hollow needle and a pusher had to be used because of the rope's softness. Mainly, when climbing, these two tools are bothersome. Because of the manual production of the double ropes they were rather expensive. Because of its graduated braid length, this system was less adaptable than the girth webs cut into lengths. Both systems had been imitated at reduced prices and at partially reduced quality.

Efficiency of a modern bracing system

All advantages of the cobra tree bracing system introduced and patented in 1993 should be bundled and all disadvantages avoided. Further on, requirements were to be met which had little or no consideration in the previous solutions: recycling, simple inspection, promotion of the compensation growth, automatic growth animation, friction sleeve and low costs per connection. Cobra had been constructed in a way that it could be cut into length directly from the rope coil and could be installed without tools as already proposed by SINN. This was possible since a special construction of polypropylene

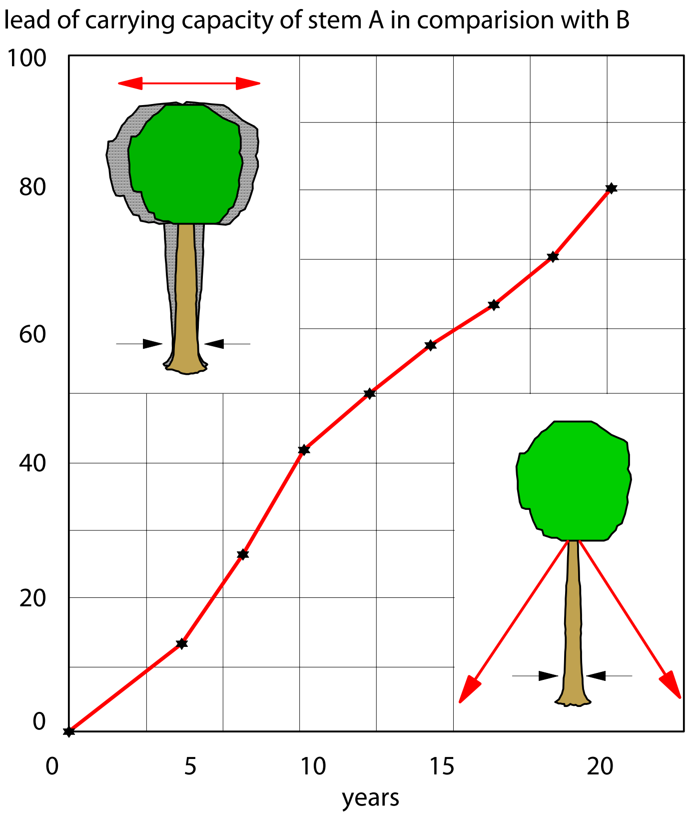


Fig. 2 Reinforcement by self oscillation

monofilament was used as hollow braid rope. This kind of material is much more deflection resistant than the multiple threaded polyester, made of thousands of filaments. Thus, its top is stable enough to stand the necessary pressure of threading in the inner rope. So, it is possible to establish a connection close to its strength without pusher and hollow needle. To stretch the connection, additionally to secure and inspect it, the rope end is pulled out of the mesh and inserted again on the other side by leaving a loop behind. The installation date was recorded by the yearly changing color of the rope end, too. However, the possibilities of the hollow braid rope were still not exhausted. To be able to work without cables in the girdling area, a rope of the same material had been developed which flattened the round cable when inserted at the girdling area in the inner rope and in consequence reduces pressure on the cambium. The friction sleeve of polypropylene is shoved. When recycled, it does not need to be separated since both can be melted together.

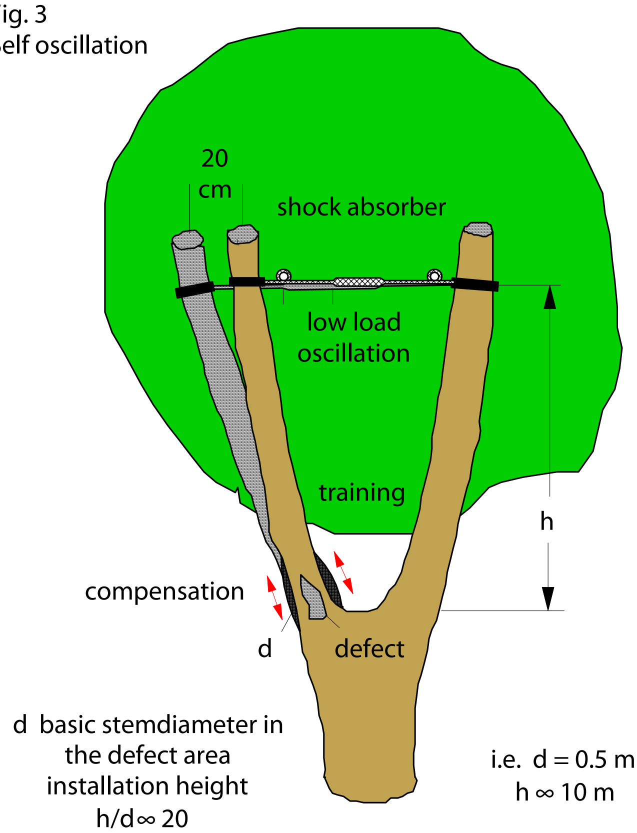
In a scientific dissertation at the University of Weihenstephan,SPIESS had examined the long-time effects of cobra on the girdling area of the tree after 5 years operation. It had been proved by LESNINO in the lab of the Biological Timber Institute of the University Munich that even after this operation period there had been absolutely no change of the cambium in the girdling area of the wood. The inspected trees were smooth barked lime trees, maples, and ashes. That means that the elongation of cobra by expansion insert is enough to avoid injuries of the cambium in the girdling sector.

When removing used crown cabling systems it had been observed yet several times, that the cobra friction sleeve gives shelter to a number of beneficial animals. Besides the cavity, the black textile hollow girth-web, heated by the winter sun, might welcome a lot of insects.

Training program for the cabled tree part

The shock absorber had been taken from another sector, which used ropes for anchoring. To avoid shocks when mooring boats in stormy water, although most ropes already have a high elasticity, special shock absorbers mostly made of flat spiral springs, are used. Schröder intended it for the system Osnabrück, but when changing steel cables against hollow braid ropes, surprisingly, he dropped it.

Fig. 3
Self oscillation



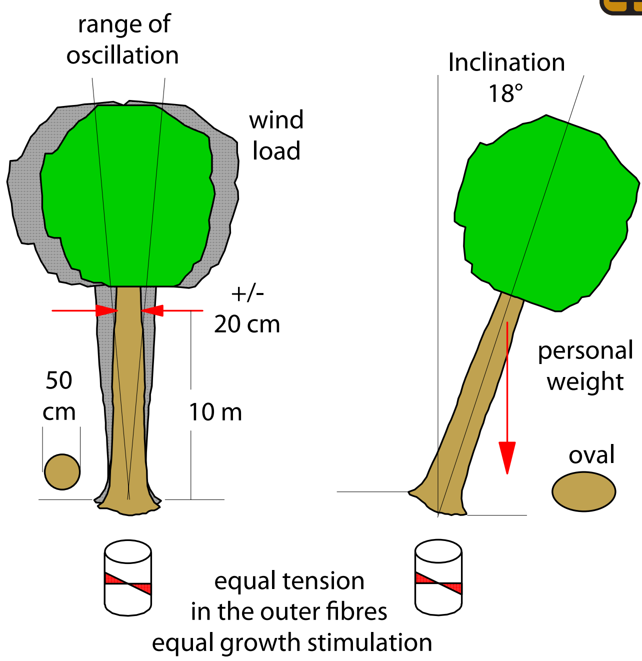


Fig.4.
Personal weight at an inclination of 18° and deviation of 20 cm at self oscillation effect the same tension at a tree of 50 cm width

The cobra hollow braid offered the possibility to use a shock absorber, which could be inserted in the inner rope like the expansion insert. It was not necessary to establish 2 extra connections. A special weather resistant rubber (EPDM) had been used as absorbing material. Its shape is simple and can be compared to a long cigar. Diameter and sturdiness are exactly adjusted to the specially manufactured cobra hollow braid rope. The rope is contracted by expansion in the section of the absorber. This contraction is released by a corresponding short jerk. The consequence is that the cabled tree part can move at this light low load oscillation, without feeling the cable. (Every support felt by the tree is integrated in its static system and reduces its own abilities). Eventually, the tree can oscillate freely during its growth period at light winds, grow in a natural way or feel a weak link to compensate it. As for a healthy tree, a successful compensation makes the cabling after approximately 15 years superfluous. Without this low load oscillation, every smooth synthetic rope prevents the tree from a slow motion by the cabled branches. For example: a simple piece of string can hinder a child on a swing from swinging.

The shock absorbers of the dynamic cobra bracing system allow an almost free motion of 20 cm (low load oscillation), as the path is independent from the distance of the anchoring points. This is not only done by a soft rope: the longer the rope is, the greater the expansion. This means that narrow-standi ng stems have extreme small slack for sympathetic vibration, but distant-anchored ones maintain enough slack, which increases proportionally to the rope allow different motion possibilities. But that is the way it is without shock absorber, unless the slack is calculated for each single anchoring distance which corresponds to a way of 20 cm motion freedom. This process is quite complicated. However, it is simple with a shock absorber. It treats the stems independent from their mutual distance fairly equal.

Since long-term inspections were not possible until now, the efficiency of this 20 cm low load oscillation (a sort of body building for the tree) can be proved by the following simple thought: through its own weight and its own bending momentum a leaning tree creates a permanent mechanical tension. The low load oscillation enables together with low winds a certain stimulation. The calculated comparison of the tension recorded at a stem of 50 cm width that the installed connection with shock absorber (in correct relation of the installation height to a stem diameter of 20:1) corresponds to a permanent inclination of this stem at an angle of 18 degree. It's a known fact that the tree reacts by creating compensation wood and forms an oval stem. This proves the efficiency of the low load oscillation of the cobra shock absorber.

The purpose of the low load oscillation is to make the weak tree part independent from the bracing. Like a crutch that is put away after successful rehabilitat ion, the bracing system will be superfluous after a successful compensation. However, this compensation takes time. A healthy tree accomplishes it successfully only after 15 – 20 years, as demonstrated by the plane tree alley in Tübingen.

Long-time rupture strength of the synthetic rope

S CHRÖDER's presentat ion of the results on the long-time rupture strength of double rope system Osnabrück has caused a lot of concern. SCHRÖDER discovered reductions in sturdiness on the polyester rope up to 48 %, although the ropes had not been exposed to long-time stress as it can be seen on the figures of the slacking ropes in the plane tree. This does not explain a loss of performance. This means that the polyester multiple threaded filament braiding is able to carry only half the weight after 5 years operation as demonstrated in his examination. The impending question is if this is a half-life value or if the carrying capacity will have completely disappeared after another 5 years operation. It this is the case, even an increase of the final carrying capacity would not change much as proposed by SCHRÖDER. Eventually, each increase stiffens the rope. Its absorbing properties are reduced, the pressure on the tree and on the rope is increased while absorbing its self oscillation. There is a great demand on research for the PES-multiple threaded filament user in the methods of bracing trees.

Superficially, SCHRÖDER's results are surprising, as it is the common opinion, that polyester (PES) is more stable on UV than polypropylene (PP). Considering acid stability, it is vice versa. But the material itself is only half the rent; it is also a question of shape, respectively of surface. The polyester multiple threaded filament rope has (because of its filament diameter of approx. 1/1000 mm) compared to the polypropylene monofilament rope at diameter of 3/10 a surface at least 100 times higher which could be attacked by the sun or by acids. This means, even if polyester were to be 100 times more resistant against UV, it had only reached the same qualities than polypropylene. However, as polypropylene is absolutely resistant against acids, the results of the polyester multiple threaded filaments might be even worse. A further clue comes from the long-time rupture strength of the polyester double belts which are not multiple threaded material and are not blackened against UV as recommended by DIN. They are more stable than the ropes, but indicate (as mentioned by SCHRÖDER) a loss in the carrying capacity up to almost 29% after a 5 years period. There are a many indications that there are certain implications besides the missing blackening and the low acid resistance of PES compared to aerosols.

23 samples of the cobra polypropylene rope taken from several locations had been examined under the same conditions at lab 22 at German Lloyd like the PES ones after a 5 years operation in ashes, maples and lime tree. When these two types of rope are compared, an influence of the testing apparatus can be definitely excluded. The supposed strength was only between 5,5 and 8,6% and corresponds to a reduced carrying capacity between 1,1 and 1,72% per year.
Mostly, this can be avoided and compensated by a corresponding higher installation than 20:1. Thus, an excellent long-time rupture strength was proved for the cobra polypropylene ropes blackened as per DIN 83305. So, there is no need to oversize them. Ropes at 2 to are sufficient for a base diameter of approx. 50 cm of the stem at installation height / diameter relation of at least 20:1. When the diameter of a stem is up to 70 cm, 4 t. ropes are used by the same level of installation height. Further on, an examination on the dynamic strength of the cobra hollow braid rope at a weight of 2 t. effected by the DMT (Company of Development and Inspection) Bochum had shown an dynamic strength approx. 10 % higher than the static strength.

Sample	Number	Species	Installation	Average loss of carrying capacity	Carrying capacity per year
1	6	Maple	93/8	-8,6 %	-1,72 %
2	10	Ash	93/8	-8,3 %	-1,66 %
3	2	Maple	93/8	-7,7 %	-1,54 %
4	4	Maple	93/9	-5,5 %	-1,1 %
5	1	Lime tree	93/4	-5,9 %	-1,1 %

Results of lab. NO 22 at Germany Lloyd of Sept. 98 on used undamaged cobra monofilament polypropylene hollow braids at a weight of 2 tons blackened against UV as per DIN 83305.

Summary

Parallel to the research on tree diagnosis, a method for cabling trees had been developed (once again in Germany) that respects the natural needs of the tree, doesn't injure it and do not initiate it to form deformations. On the contrary, modern methods of bracing trees support the compensation growth of the trees at weak links by creating of a low load oscillation for self motion at light winds during its period of growth. After more than 5 years operation of the systems – more than 60.000 cobras had been installed worldwide – here are the first examinations on the long-time rupture strength which can be compared to SCHRÖDER's examinations on polyester ropes. The different results are significant and did surprise in that extent. The polyester multiple threaded hollow braid (which is used for the system OSNABRÜCK) demonstrated a loss in strength up to 48% within 5 years. The monofilament hollow braid rope blackened as per DIN 83305, part of the cobra system, had demonstrated during the same period only moderate strength reductions between 5,5 and 8,6%, which can be compensated in most cases easily by an installation higher than 20:1. Further on, the bodybuilding of the tree part might effect an increase of the carrying capacity, so that the consequences of the cabling method seem to be positive in regarding the installation period. Examinations of the cambium in the girdling sector of the tree proved that even after 5 years no negative effects or modifications could be recognized on the tree.

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