

# TREE CROWN STABILIZATION WITH THE DOUBLE-BELT SYSTEM OSNABRÜCK

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**Abstract.** Breaking-off of crown parts and large branches is a common type of tree failure and can result in substantial damage to objects and persons. The trees are often irreversibly damaged as well. Reasons for this type of failure are usually included bark in forks and decay or cracks in branches. As an alternative to topping or felling hazard trees, a tree crown stabilization system was developed for the protection of crowns endangered by possible failure. The System Osnabrück consists of at least two double belts, each strapped around the stem or branch and connected by wire cables. Wood-biological investigations on beech trees with six-year-old double-belt systems showed that neither discoloration nor fungal attack occurred in the wood and bark under the belts. The cambium beneath the belts apparently was not impaired either. The double-belt system makes it possible to maintain old trees with severe defects in urban areas by safeguarding their natural crown architecture as well as providing maximum safety to the public.

**Key Words.** Included bark; branch failure; tree care; crown stabilization; System Osnabrück; hazard trees; public safety; CrownTex®.

Breaking-off of crown parts and large branches is a common type of failure with city trees. This failure may cause substantial damage to objects and persons, and subsequently the trees concerned are often damaged irreversibly. The reason for failure is that the force (i.e., weight and wind) on the branch exceeds the strength of the wood, which is strongly influenced by such weaknesses as included bark between stem and branch, split forks, fractures in branches (hazard beams), or rot in branches (Matheny and Clark 1994; Mattheck and Breloer 1994).

The breaking-off of parts of trees can be prevented by various methods. Instead of severely reducing the crown, so-called crown anchorages or cables have been used for many years, whereby the tree's sections to be protected are connected with steel cables anchored with rods or bolts in the branch or trunk (Figure 1).

Investigations of tree sections with rods and bolts from old crown anchorages showed that the perforation leads to injury of the initially healthy wood and results in discoloration and decay within the area of the crown anchorages, which is narrowly compart-

mentalized on cross-section (Shigo and Felix 1980) but vast in longitudinal direction (Dujesiefken et al. 1989; Dujesiefken and Liese 1990) (Figure 2). This is damage to the tree but normally does not predispose the system to failure.

The general efforts to base tree care methods on biological results include the avoidance of unnecessary injury. Therefore, crown-securing systems that avoid such injury were developed for the protection of crotches that are at a high risk of failure (Sinn 1989;



Figure 1. The crown anchor is mechanically well done, but is it really the best solution for the tree?

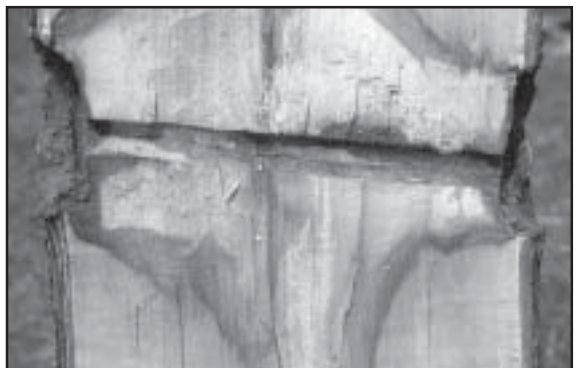


Figure 2. Some years after installation of a crown anchor: The bolt with a diameter of 18 mm (0.7 in.) led to discoloration and white rot above and below the drill hole.

Schröder 1993). These methods were integrated into the German rules and regulations for tree care methods for the first time in 1993 (ZTV-Baumpflege 1993), with the note that long-term experiences and secured results were not available at that time. With the objective to contribute to these experiences, the following wood-biological investigation was made to determine potential subsequent effects on the tree by this type of crown-stabilization system.

#### MATERIAL AND METHODS

In December 1991, securing systems using belts were installed on ten beech trees (*Fagus sylvatica* L.) with crowns with a high risk of failure because of included bark in compression forks. The trees were in an urban forest near Osnabrück, Germany, and were approximately 60 to 80 years of age. Beech trees have a thin bark even at the age of about 80 years and thus react sensitively to such attachments. The double-belt System Osnabrück was a forerunner of the today's CrownTex® belts (Figure 3). The clamps to close the belts were not yet padded, and the system was not equipped with an elastic element within the fastening belts to keep them in place and which surround the stem or branch. Instead of the hollow polyester ropes used today, wire cables were used to link these belts to each other.

In October 1997, ten stems were examined to determine the effects of this system on the trees (Schröder et al. 1998). For wood-biological investigations, five

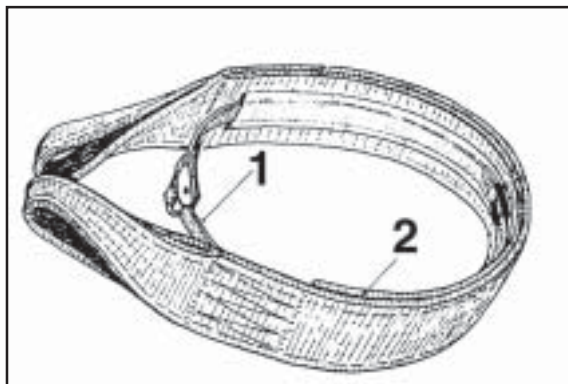


Figure 3. The double-belt System Osnabrück. It consists of a fastening belt to fix the system at the stem (1) and a superimposed, strong retaining belt that carries the load (2).

30-cm-long (12-in.) wood samples were taken from the area where the belts were installed. These samples were split radially and the condition of the wood in the area of the belts was examined.

For light-microscopic observations, 1 cm<sup>3</sup> (0.06 in<sup>3</sup>) wood samples were taken from the area under the belt; Twenty- $\mu$ m cross sections were prepared and stained with safranin and astra blue to differentiate between distinct cell structures. The results were photographically documented.

#### RESULTS

Six years after installation, the diameter of the investigated stems increased 1 cm (0.4 in.), resulting from an annual increment of nearly 1 to 2 mm (0.04 to 0.08 in.), which is typical for older trees in urban areas. The wire cables used for the crown protection had sagged slightly and appeared to be in a good condition. In general, the belts were exactly in the place of installation; only one had slipped down after installation. Visually, both holding and fastening belts were in good condition, except for normal algae growth and some slightly abraded parts in the areas around the connection to the wire cables (Figure 4). The clamping locks in the fastening belts could be opened without problem and were entirely functional.

The bark beneath the belts showed only partially visible deformation—a 1- to 2-mm-thick fold on the bark in the area of the strap and the clamping lock (Figure 5). This fold was restricted exclusively to bark tissue.



Figure 4. A double belt at a secured stem six years after installation. Tree and crown protection system are in a good condition.



Figure 5. On four stems, a 1- to 2-mm-thick (0.04- to 0.08-in.) fold on the bark was visible (arrow); it was found in the area of the strap and the clamping lock

In the wood, neither discoloration nor fungal attack occurred (Figure 6). The cambium did not seem to have been impaired by the belts concerning wood formation.

The microscopic investigation of the woody tissue formed before and after the installation of the double belts did not result in altered cell structures (Figure 7); therefore, the disturbances of the cambium activity due to the attachment of the belt to the stem can be excluded.

#### DISCUSSION

According to German rules and regulations for tree care methods (ZTV-Baumpflege 1993) crown-securing systems using belts must be inspected close-up in the crown every second year. On the basis of the findings at hand, an inspection interval of five years ap-



Figure 6. No changes of the wood are visible in the area where belt and tree were in contact.

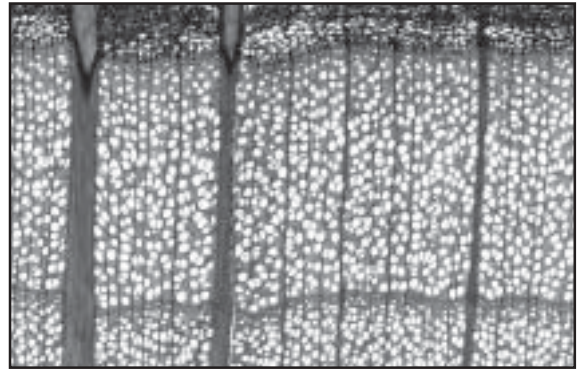


Figure 7. The light-microscopic study shows no changes in wood structure and normal increment. Bark at the top; late wood of the 1996 growth ring at the bottom (40 $\times$ ).

pears feasible for the System Osnabrück, if it is dimensioned and installed correctly. This interval corresponds to the inspection interval for conventional crown anchorages. For fast-growing trees (e.g., *Populus*), the inspection interval of the double-belt system should be reduced to allow the functioning of the system to be maintained.

It can be stated that even after six years, no damage to the trees resulted from the installation of the crown-securing systems. In some cases, marks on the bark were observed in the area of the strap and the clamping lock. Bark deformation can be avoided by installing the CrownTex<sup>®</sup> belt system, which has a flexible element in the fastening belt and padded clamping lock.

Even if the tree compartmentalizes wounds (Shigo and Felix 1980) from crown anchorages using threaded rods or bolts, discoloration and decay occurs in the wounded tissue, especially in the longitudinal direction (Dujesiefken et al. 1989; Dujesiefken and Liese 1990). These wounds can be avoided using systems consisting of belts strapped around the stems.

A professional installation of crown-securing systems with regular inspections of the straps every two to five years causes no impairments for the tree. Safeguarding methods, such as the double-belt System Osnabrück and other products in normal commercial usage, such as the Cobra System (Lesnino et al. 2000), can be recommended without reservation based on our observations of ten trees over several years. These systems are harmless to slow-growing trees and are easy to tend.

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Zusammenfassung. Das Brechen von Kronenteilen und großen Ästen ist ein häufiges Baumversagen, welches zu enormem Schaden an Personen und Objekten führen kann. Oft sind die Bäume dabei unwiederbringlich geschädigt. Die Gründe für diese Art von Versagen sind oft eingewachsene Rinde in Astgabeln und Fäulnis oder Risse in Ästen. Anstatt diese Bäume zu köpfen oder zu fällen, wurde ein neues Stabilisierungssystem entwickelt, um Kronen zu schützen. Dieses System besteht aus mindestens zwei Doppelgurten, von den jeder um den Stamm oder Ast befestigt ist und die mit Stahlkabeln verbunden sind. Waldbiologische Untersuchungen an Buchen mit einem sechsjährigen Doppelgurtsystem zeigten, daß weder Verfärbungen noch Pilzinfektionen an dem Holz und der Borke unter dem Gurt auftraten. Das Kambiumwachstum unterhalb der Gurte war nicht beeinträchtigt. Das Doppelgurtsystem "System Osnabrück" liefert Möglichkeiten zur Erhaltung alter Bäume mit schweren Defekten in Stadtbereichen, indem die natürliche Kronenarchitektur erhalten und gleichzeitig die Öffentlichkeit geschützt wird.

Résumé, Le bris de portions de la cime et de grosses branches est une source fréquente de chutes chez les arbres qui résultent en des dommages substantiels pour les biens

et les gens. Souvent, les arbres sont endommagés de manière irréversible. Les causes de ce type de bris sont souvent la présence d'écorce incluse et de carie dans les fourches ou de fissures dans les branches. Au lieu d'écimer ou même d'abattre les arbres dangereux, un nouveau système de stabilisation de la cime a été développé pour la protection des cimes. Ce système consiste à employer au moins deux ceintures doubles, chacune entourant la branche, et reliées ensemble par des câbles d'acier. Des analyses biologiques du bois sur des hêtres attachés depuis six ans de cette manière ont conclu qu'aucune décoloration ou attaque de champignon ne s'était produite dans le bois et sur l'écorce sous le système de ceintures. Le cambium qui a crû sous les ceintures n'a pas été affecté apparemment. La double ceinture de type *System Osnabrück* offre la possibilité de conserver des arbres âgés en milieu urbain avec des problèmes structuraux importants tout en maintenant de façon sécuritaire leur architecture naturelle de cime et ainsi qu'en assurant la sécurité du public.

Resumen. La rotura de grandes ramas y partes de la copa es una falla frecuente de los árboles que resulta en

daños substanciales a objetos y personas. Con frecuencia los árboles son irreversiblemente dañados. Las razones para este tipo de falla son con frecuencia corteza incluida en hendiduras y descomposición o agrietamientos en las ramas. En lugar de desmochar, o peor aun, derribar los árboles de riesgo, un nuevo sistema de estabilización de la copa del árbol fue desarrollado para la protección de las copas. Este sistema consiste de al menos dos cinturones dobles, cada uno de los cuales es sujetado alrededor del tronco o rama y conectados por cables de acero. Las investigaciones en biología de la madera con hayas, con sistemas de doble cinturón de seis años de antigüedad, han mostrado que ni decoloración ni ataque de hongos han ocurrido en la madera y la corteza bajo los cinturones. El crecimiento del cambium bajo los cinturones aparentemente no fue afectado. El "Sistema Osnabrück" de doble cinturón da la posibilidad de mantenimiento en áreas urbanas de árboles viejos con defectos severos, para la salvaguarda de la arquitectura de su copa natural como también para dar seguridad al público.