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5 pages from Mario Lanthier

TREE RISK ASSESSMENT AND BIOMECHANICS SYMPOSIUM

Tree Risk Assessment
The Biomechanics of Stability, Strength, and Structure
September 24-25, 2012

The event was held September 24 and 25 at Lisle Illinois (near Chicago).

It was organized by the Morton Arboretum *"to share solutions to biomechanics questions that may make tree care safer and more efficient"*.

It was attended by 160 persons, a mixture of researchers from USA and Europe and tree care companies from Eastern USA.

Fifty years of research in tree biomechanics

By Alexia Stoke, INRA-UMR, France (http://amap.cirad.fr/fr/index.php)

Biomechanics is the study of how trees stand and why they fail. It leads to the ability to predict failure but it also help tolerate risk and not remove sound trees.

Biomechanics is to understand why trees behave the way they do and describe it in a quantitative way. The mathematics are complex and require specialists.

But tree behaviour is intuitive and not always meant for numbers. If we take a tree out of its natural habitat and plant it elsewhere, will it behave the same?

The first biomechanics paper was published in 1962 "Soil & Roots as Factors in Tree Stability". It described a fundamental principle of soil mechanics: an increase in soil moisture leads to a decrease in soil strength. A 2012 follow-up study showed that adding water inside the root plate leads to more anchorage (higher weight of root plate), but adding water under the root plate leads to less anchorage (slippage on wet soil).

RISK ASSESMENT BMP AND QUALIFICATION

by Tom Smiley, Bartlett Tree Research Laboratories, North Carolina

ANSI Standard A300 part 9 Tree Risk Assessment (published 2011)

ANSI is the American National Standards Institute.

The Standard is "to assess structural integrity and other factors that affect the level of risk to people or property and to provide information for mitigating risk".

There are 3 levels of tree risk assessment.

- Level 1: Walk-by or drive-by visual survey to identify obvious defects.
- Level 2: A 360-degreee ground-based visual inspection of the tree and the site.
- Level 3: Employing advanced methodologies to determine extent of defect.

Methods used include binoculars, mallet, probing, sounding, aerial inspection, drilling, increment boring, as well as pull test, resistance drill and sonic assessment.

ISA (International Society of Arboriculture) Best Management Practices (2011)

BMPs are "to aid in the interpretation of professional standards". They are consensus documents (approved by the largest majority while considering all disagreements).

It is impossible to maintain trees free of risk, some level of risk must be accepted.

The *"risk assessment"* will determine the *"hazard assessment"* (the tree is likely to fail and cause an unacceptable degree of damage).

The arborist must determine the likelihood of failure and its impact on a target.

Tree failure	Likelihood of impacting target			
(in 1 to 3 years)	Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

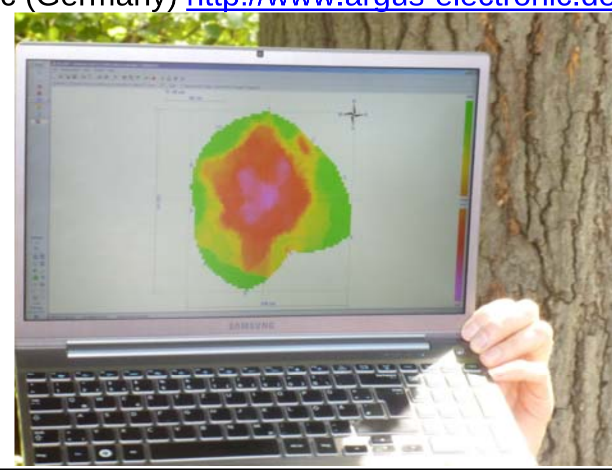
The result is placed in a second matrix to determine a level of risk.

Failure + Impact	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low risk	Moderate risk	High risk	Extreme risk
Likely	Low risk	Moderate risk	High risk	High risk
Somewhat likely	Low risk	Low risk	Moderate risk	Moderate risk
Unlikely	Low risk	Low risk	Low risk	Low risk

TOOLS FOR ADVANCED ASSESSMENT # 1

Above: Participants during the field activities.
Stations were set-up to demonstrate tools for advanced tree assessments.
Each tool was described by a specialist then explained in an indoor lecture.
All tools are expensive and likely best operated by properly trained technicians.

Sonic Tomography and Electric Resistance Tomography. Cost Euros 10,000 to 14,000.
Demonstrated by L. Göcke, Argus Electronic (Germany) http://www.argus-electronic.de/



Left: Sensors are attached around the trunk and send signals to each other.
Right: The information is read by a computer to create a cross-section view of the trunk.
Red indicates void (decay or crack), green indicates sound wood.

Time of travel from one sensor to the next is determined by wood strength.
Where there is a cavity, travel time is slower, which allows the mapping of the cavity.
The same tree can be scanned at intervals over time to verify progression of the decay.

TOOLS FOR ADVANCED ASSESSMENT # 2

Resistance drilling. Cost of equipment is Euros 8,000.
Demonstrated by Frank Rinn of Rinntech company (Germany) http://www.rinntech.com/

Left: A small-size drill is entered into the tree equipped with a high resolution sensor.
Right: The sensor transfers data as a continuous line on a paper roll.

It provides information on transition between intact and decayed parts inside the tree.
Studies show strong relationship with actual wood density (r^2=0.94)
How hollow can a tree become before removing? There is no clear answer at this time.

Stress wave tomography (sonic tomography). Cost of equipment is Euros 12,000.
Demonstrated by Frank Rinn of Rinntech company (Germany) http://www.rinntech.com/

Left: Sensors attached around the trunk send signals to each other.
Right: The information relayed to a computer creates a cross-section view of the trunk.

The technique shows the remaining load-carrying part of the cross section.
Studies show strong relationship with actual wood density (r^2=0.99).
Combining the Resistograph with Tomography generates a complete picture of decay.
The presenter says location of tree decay is more important than size of decay.

TOOLS FOR ADVANCED ASSESSMENT # 3

Static load test. Cost of equipment is Euros 9,000. One test is CDN $1200 to $1500.
Demonstrated by A. Detter, Brudi & Partner (Germany) http://www.tree-consult.org/
This is a non-destructive pulling test. Measures are made of one rope pulling one point.

Left: A rope is exerting a controlled force on the tree by means of a mechanical winch.
Right: Blue parts on the trunk are high sensitivity sensors that monitor tree movement.
Data is extrapolated to deduct how well the tree is bearing a load such as gust of wind.
How much strength does the wood have? How strong should the tree be?
There is currently no method to calculate. The answer has a factor of safety of 1.5.

Dynamic root plate measure. Cost of test is Euros 500 + each report Euros 500.
Demonstrated by Ken James, ENSPEC (Australia)
This is a non-destructive pulling test. Measures are made of wind impact on the tree.

Left: Participants pull on a rope to mimic canopy movement in a wind storm.
Right: Tilt sensors attached to the trunk measure the tilt to 0.01^o.
The sensors operate continuously, making 20 readings per second for 20 days.
Information is sent to the manufacturer, where it is reviewed in preparation of a report.
The equipment is brand new in North America.