

Modelling stem resistance to breakage

Montpellier, October
2009



Calculating stem resistance to breakage in ForestGales

$$M_{\text{crit}} = (\pi/32) f_{\text{knot}} \times \text{MOR} \times \text{dbh}^3$$

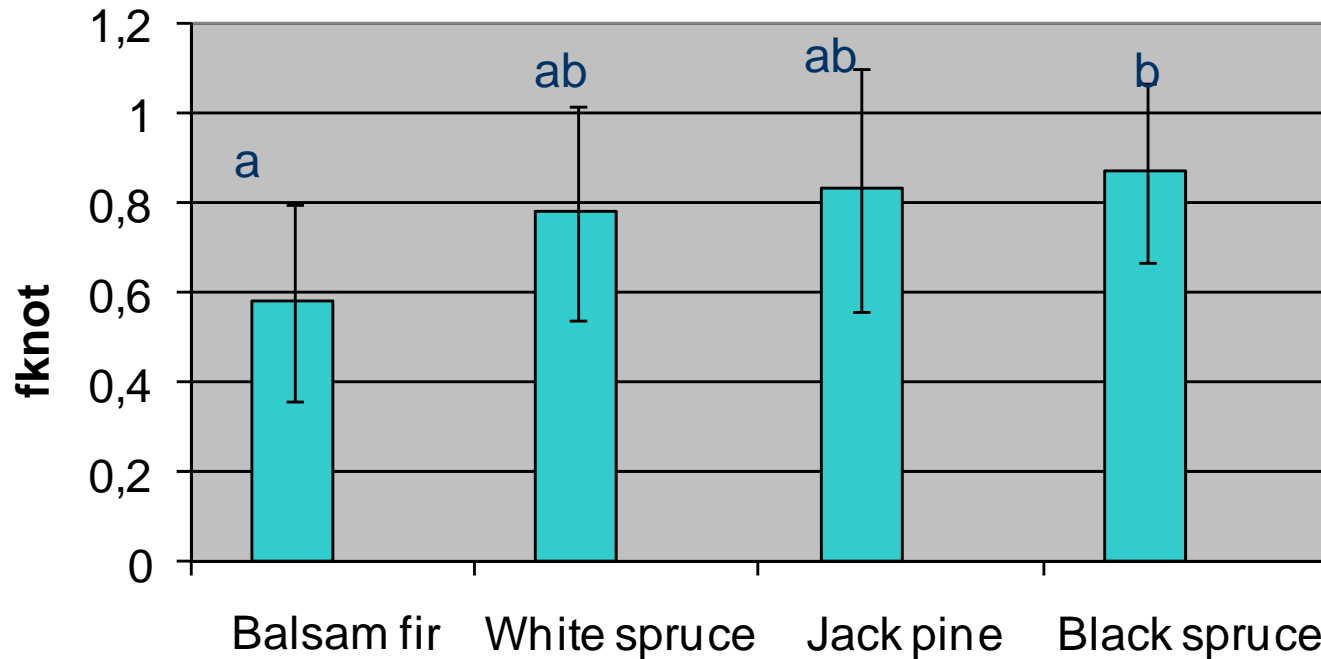
- M_{crit} : Critical moment for stem breakage
- F_{knot} : correction factor for MOR to account for defects (knots)
- Previously used values: 0.7-1

Determining f_{knot} from tree-pulling tests

- Data available for a number of species: balsam fir, white spruce, black spruce, jack pine
- Broken stems: representative of the whole population?



Fknot, tree pulling tests, sound stems without external defect



Sample size: balsam fir: 12; white spruce: 5; black spruce: 12; jack pine: 4

Determining f_{knot} : three-point bending tests



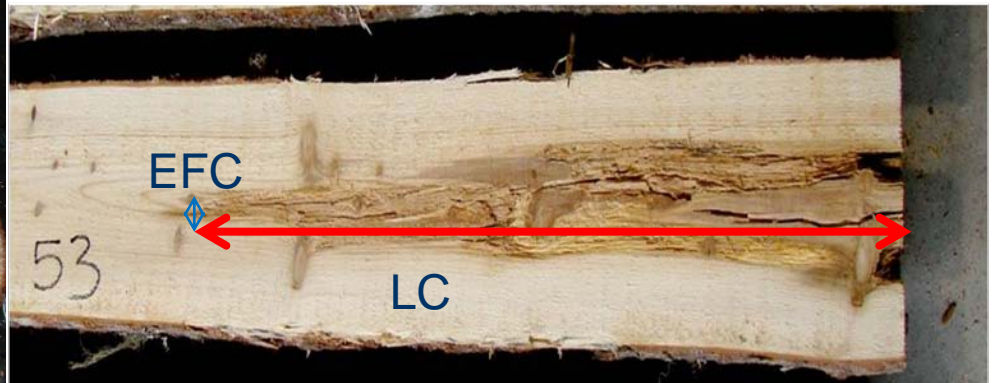
F_{knot} :

$MOR_{test} / MOR_{tables}$

Sample:

- 48 logs (8 feet)
- Diameter at middle of log: 11-22 cm
- Percent decay (% diameter) at the middle of the log: 0-76%

Measuring decay



Testing indices of mechanical strength loss at the middle of the log

- $d/D \times 100$
- $d^2/D^2 \times 100$
- Wagener index(1963):
 - $d^3/D^3 \times 100$
- Coder index(1989):
 - $d^4/D^4 \times 100$
- Mattheck et al (1992) index :
 - t/R

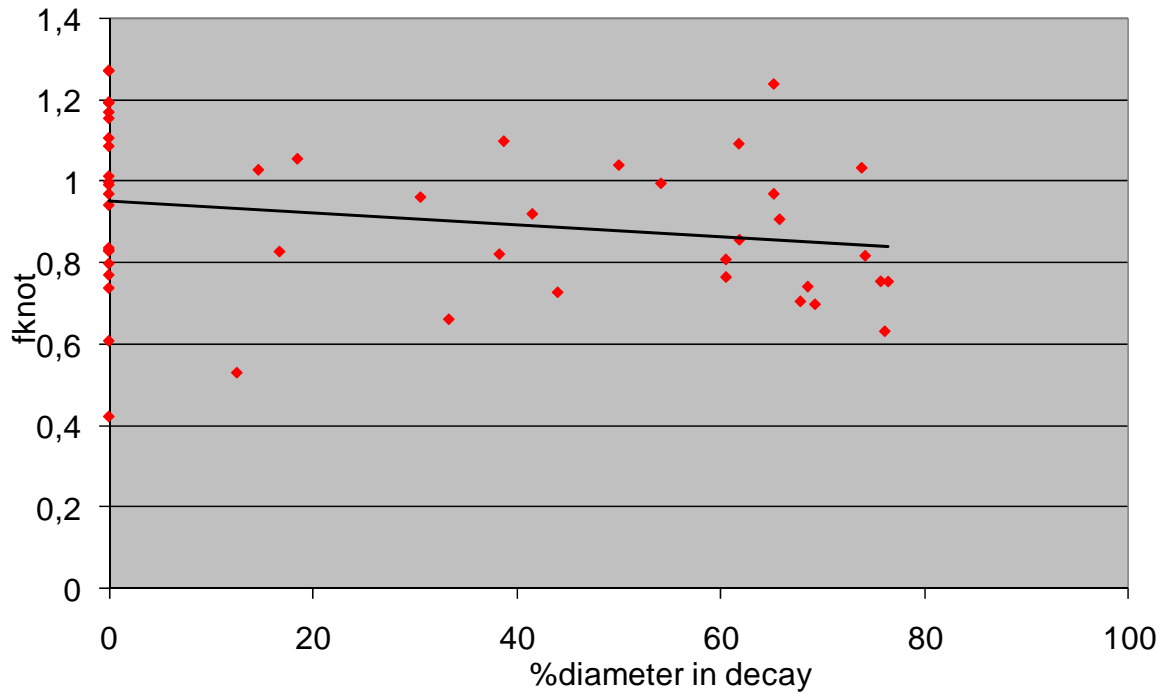
Where d =diameter of decay

D =diameter of section

t =thickness of sound wood

R =radius of section

Results: percent diameter in decay

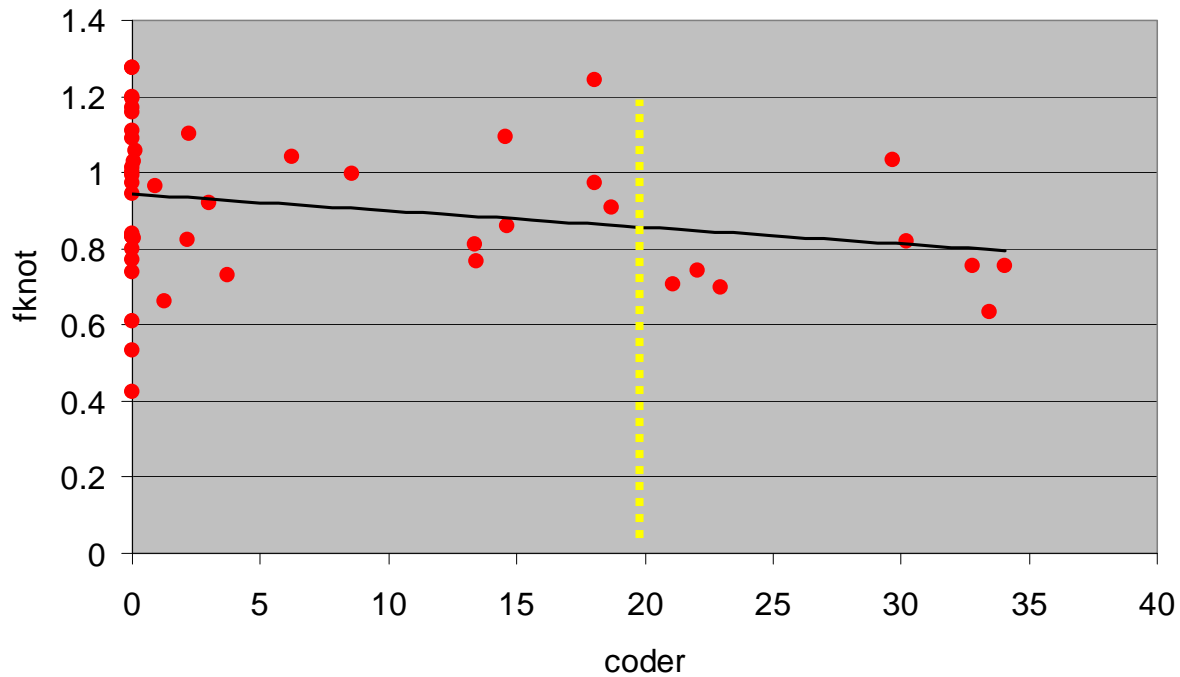


Corr fknot vs
index:

$R=-0.23$

$P=0.12$

Résultats indice Coder



Corr fknot vs
indice:

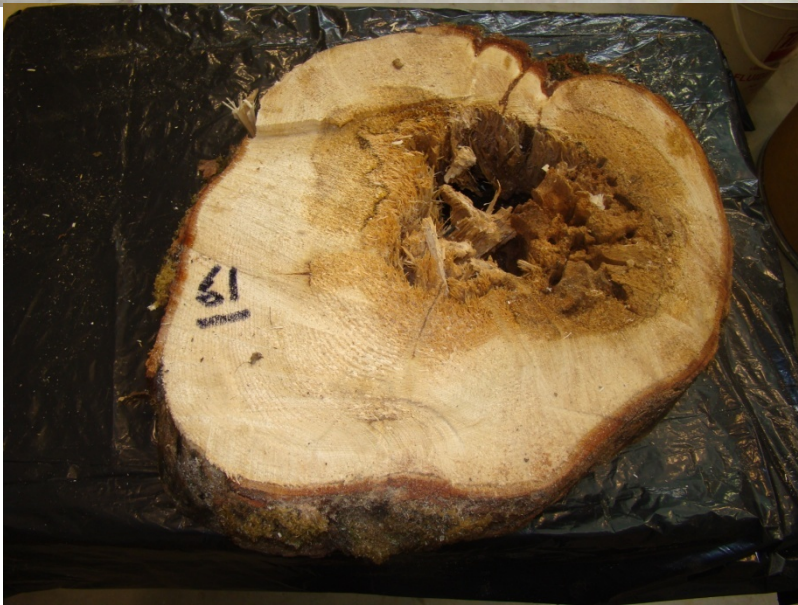
$R=-0.24$

$P=0.10$

Stepwise regression

- Independent variables:
 - Number knots, %decay vol, %decay basal area, coder, wagner, matheck
- Nothing significant at $\alpha=0.05$

Potential explanations



Comparing fknot between tree pulling and three-point bending tests, sound stems



Sample size: tree pulling: 12; bending tests: 32