









stress Stress distribution along the lever arm<sub>BAUMPFLEG</sub>

30,000 28,285

26,570

21,424. 19,709.

17,994. 16,279.

14,564. 12,849.

11,133.

9,418.

7,703.

5,988.

4,273. 2,558. AUMPFLEGE Fig.11 Cantilever beam: von Mises stress contours in kPa, prior to failure George Markou Manolis Papadrakakis , (2015), "A simplified and efficient hybrid finite element model (HYMOD) for nonlinear 3D simulation of RC structures", Engineering Computations, Vol. 32 Iss 5 AU pp.1477 G 1524













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## Material properties BAUMPFLEGE

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- Why are they important?
- What different material properties do we know?
- BAWhat-characteristics of woodbatemPFLEGE important to us?
- What do these properties depend on?
- What might be different in a dead tree, a sunburnt tree or in a tree with a fungus infection?











	/		AA		DUUFIXXXX	-/	
Nummer	Querichnittsform	Fläche F	Größter Abítand e	Trägheitsmoment J	Widerftandsmoment $W = \frac{J}{e}$		MAU
13		$2 r^2 \sqrt{2} = 2,8284 r^2$	$\frac{r}{2}\sqrt{2+\sqrt{2}}=0,9239r$	$\frac{1+2\sqrt{2}}{6}r^4 = 0,63807 r^4$	$\frac{1+2\sqrt{2}}{\sqrt{2+\sqrt{2}}}\frac{r^3}{3} = 0,69071 r^3$		BAUMPFLE
14		$\pi r^2$	r	π <b>r</b> <sup>4</sup> 4	$\frac{\pi r^3}{4}$		
15		$=$ $=$ $=$ $(r^2 - r_1^2)$	•	$\pi \frac{r^4 - r_1^4}{4}$	$\pi \frac{r^4 - r_1^4}{4r}$		$\rightarrow$
16		π a b	а	$\frac{\pi}{4} b a^3$	$\frac{\pi}{4} b a^2$		
17	<u></u>	$\frac{\pi}{2}r^2$	$\left(1-\frac{4}{3.7}\right)r=0,5756r$	$\left(\frac{\pi}{8}-\frac{8}{9\pi}\right)r^4=0,10976r^4$	$\frac{9\pi^2 - 64}{3\pi - 4} \frac{r^3}{24} = 0,19065 r^3$		MAU
18	÷ (a)	$\frac{\pi}{2}ab$	$\left(1-\frac{4}{3\pi}\right)a=0,5756a$	$\left(\frac{\pi}{8} - \frac{8}{9\pi}\right)ba^3 = 0,10976ba^3$	$ \frac{9\pi^2 - 64}{3\pi - 4} \frac{ba^2}{24} = 0,19065 \ ba^2 $		BAUMPFLE
19	$\hat{e}$ $\hat{b}$	•	b	$\frac{\pi}{8} a b^3$	$\frac{\pi}{8} a b^2$	/	
20	e $a$ $**$	$\frac{2}{3}ab$	$\frac{3}{5}a$	$\frac{8}{175}$ b $a^{3}$	$\frac{8}{105} b a^2$		1
21	e e e e e b		$\frac{b}{2}$	$\frac{a b^3}{30}$	$\frac{a b^2}{15}$	//	
22	$ \begin{array}{c}                                     $	α a + β b	$\frac{a}{2}$	$\frac{a^3+b\beta^3}{12}$	$\frac{a a^3 + b\beta^3}{6 a}$		MAU
23	e	N		Ф Я	•		BAUMPFLE
24		$(2a-\delta)\delta$	$\frac{a}{2}$	$[a^3 + (a-\delta)\delta^2]\frac{\delta}{12}$	$[a^3+(a-\delta)\delta^2]\frac{\delta}{6a}$		
	* Halbellipfe. *	* Parabelfegme	ent.		WWWWW	1	



www.meuz-beu	Material properties: Fa	agus sylvatica		www.aneurz-beur				
apflege.de	BAUMPFLEGE	MoR [N/mm <sup>2</sup> ] Bending strength	MOE [N/mm <sup>2</sup> ] Elasticity	σ <sub>c,II</sub> [N/mm <sup>2</sup> ] Compressive strength	T <sub>c,II</sub> [N/mm <sup>2</sup> ] Shear strength	<b>GE</b> <b>O</b> <sub>T,II</sub> [N/mm <sup>2</sup> ] Fagus grandifolia [Kretschmann*] Tensile strength	BAUMPFLEG	
boumpflage.de	Green (alive) LEGE (88 % moisture content)	65 B	AUMPFLEGE 9800	27,6	BAUMPF 9,4	_EGE 86,2	BAUMPFLEG	
WWWWWWWWWWW	Dry (dead) (12 % moisture content)	118	12600	56,3	15,9	58,6 =0,68* σ <sub>τ,ιι</sub>		
	"The strength properties of Timber" by Gwendoline M I (Third Edition, Revised by G Building Research Establish 1983	Lavers B L Moore) ment Report ci/Sfl	AUMPFLEGE B i(J3)	* Wood Properti David E. General 1999	* Wood Handbook, Chapter 5: Mechanical Properties of Wood FLEGE David E. Kretschmann General Technical Report FPL–GTR–190 1999			
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## BAUMPFLEGE What we did so far

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- forces, loads, load transfer, load distribution
- stability, force flow, static systems, supports
- Different types of loads: compression, bending
- Stresses: compressive and bending stresses
- Resistance EGE

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- geometric resistance,
- material properties
- Elasticity







## Excercise BAUMPFLEGE

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- Where are load entry points?
- What types of loads are created?
- What static systems do you see?
- Which are the active lever arm
   lengths?
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   BAUMPFLEGE
- Where do these loads show effect?
   Where are maxima/minima
- Where are the locations of maximum stress?

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•BAWhere could the tree fail? BAUMPFLEGE











































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## summary practical approach MAUZ BAUMPFLEGE BAUMPFLEGE

- Where do I have to move in the tree?
- What are suitable anchor or redirect points?
- Where are weak spots in the structure? BAUMPFLEGE
- How can I **align my rope** to create compression?
- Can I connect branches in my load direction for better stability?
- BHOW care Goistribute my load? AUMPFLEGE



