EU HARDWOODS

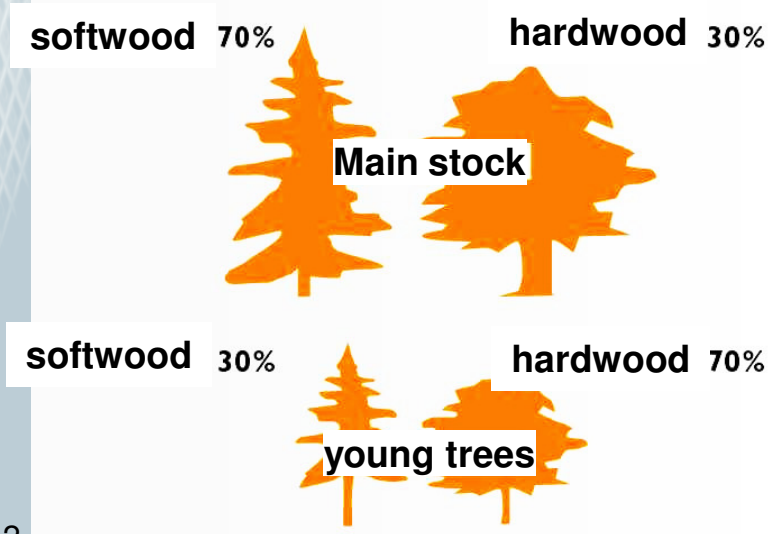
Gerhard Dill-Langer

EU Hardwoods: Situation today

architects love it…

.. engineers need it

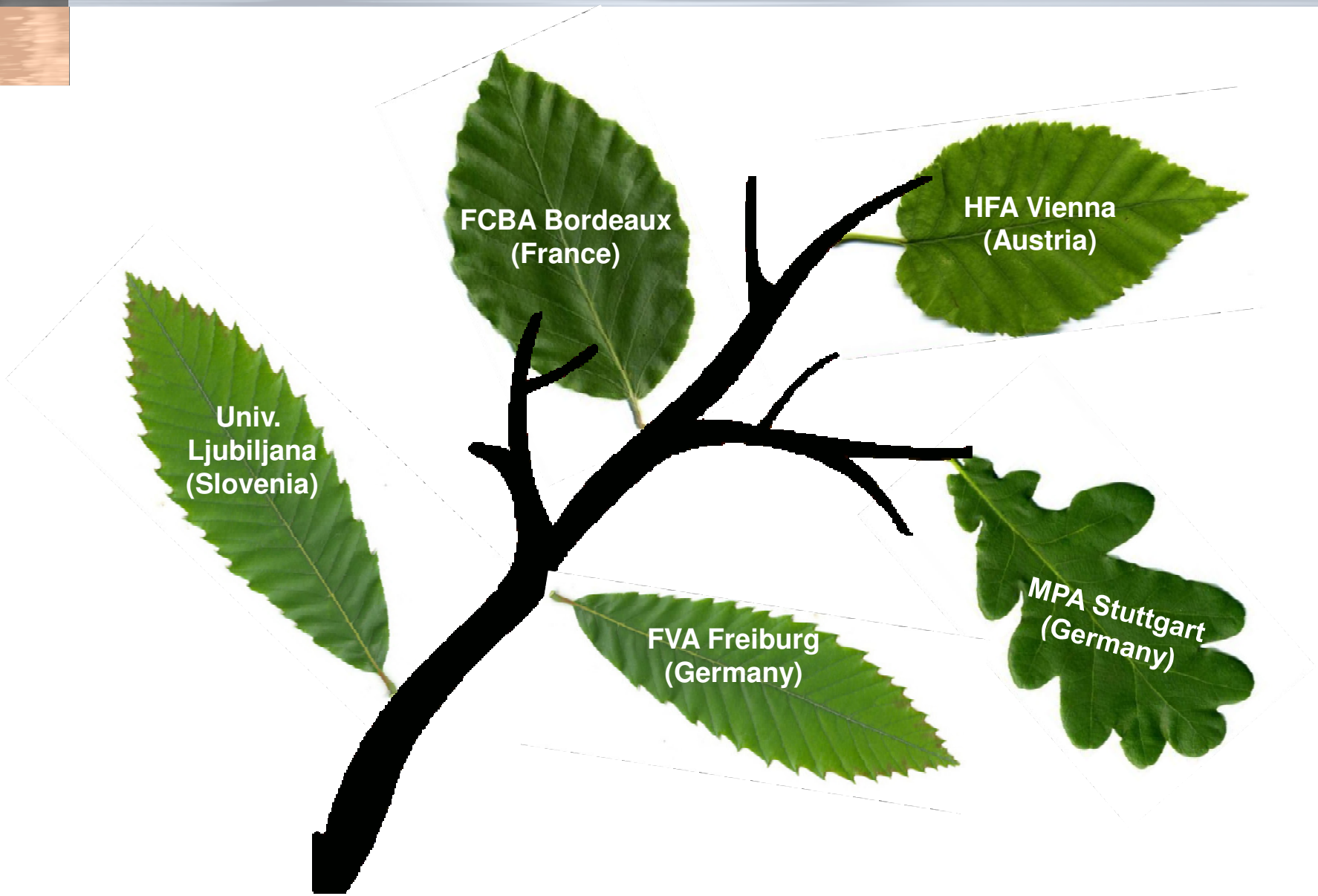
… forests provide it



Source: German association of saw milling industry

…but today hardwood is hardly used for structural applications !

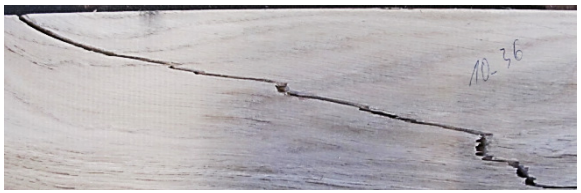
EU Hardwoods: Partners



HARDWOOD STRUCTURE: Problems

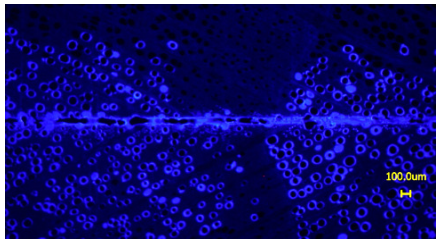
GRADING:

e.g. fiber deviation in oak

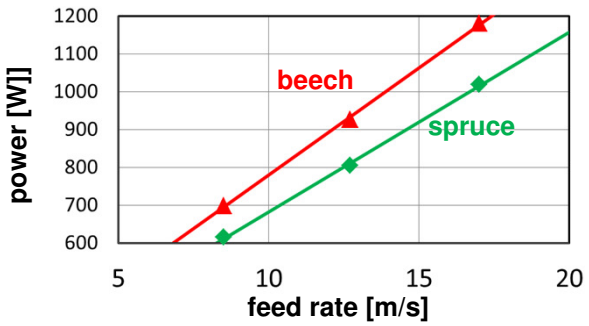


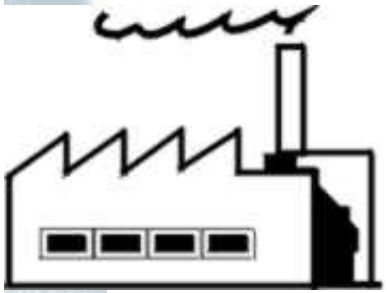
BONDING:

problems due to porosity (e.g.: beech)
and extractives (e.g. oak)

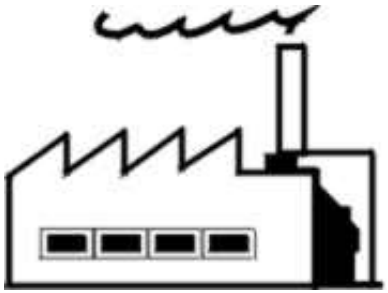


MACHINING:





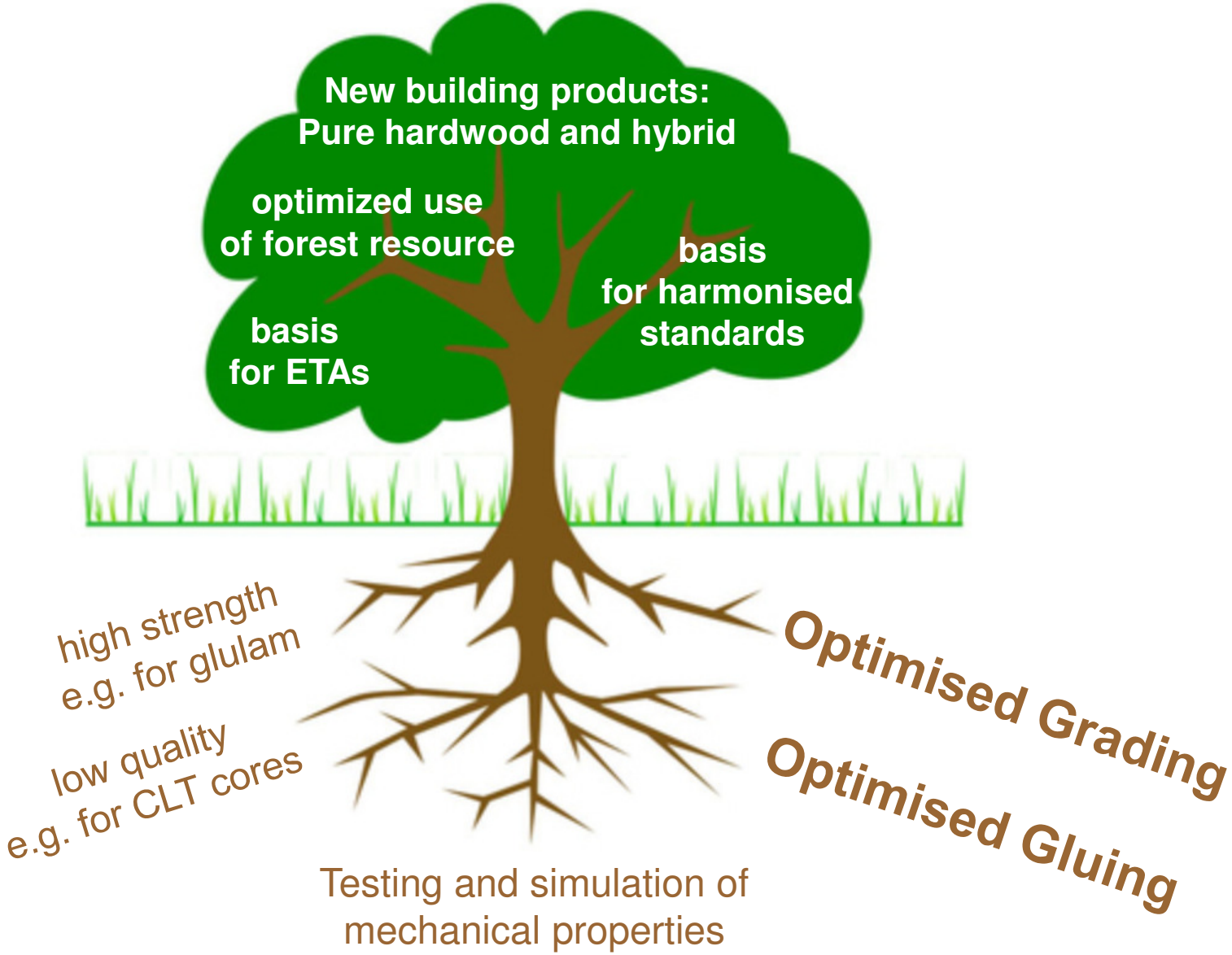
producer of structural products based on softwood



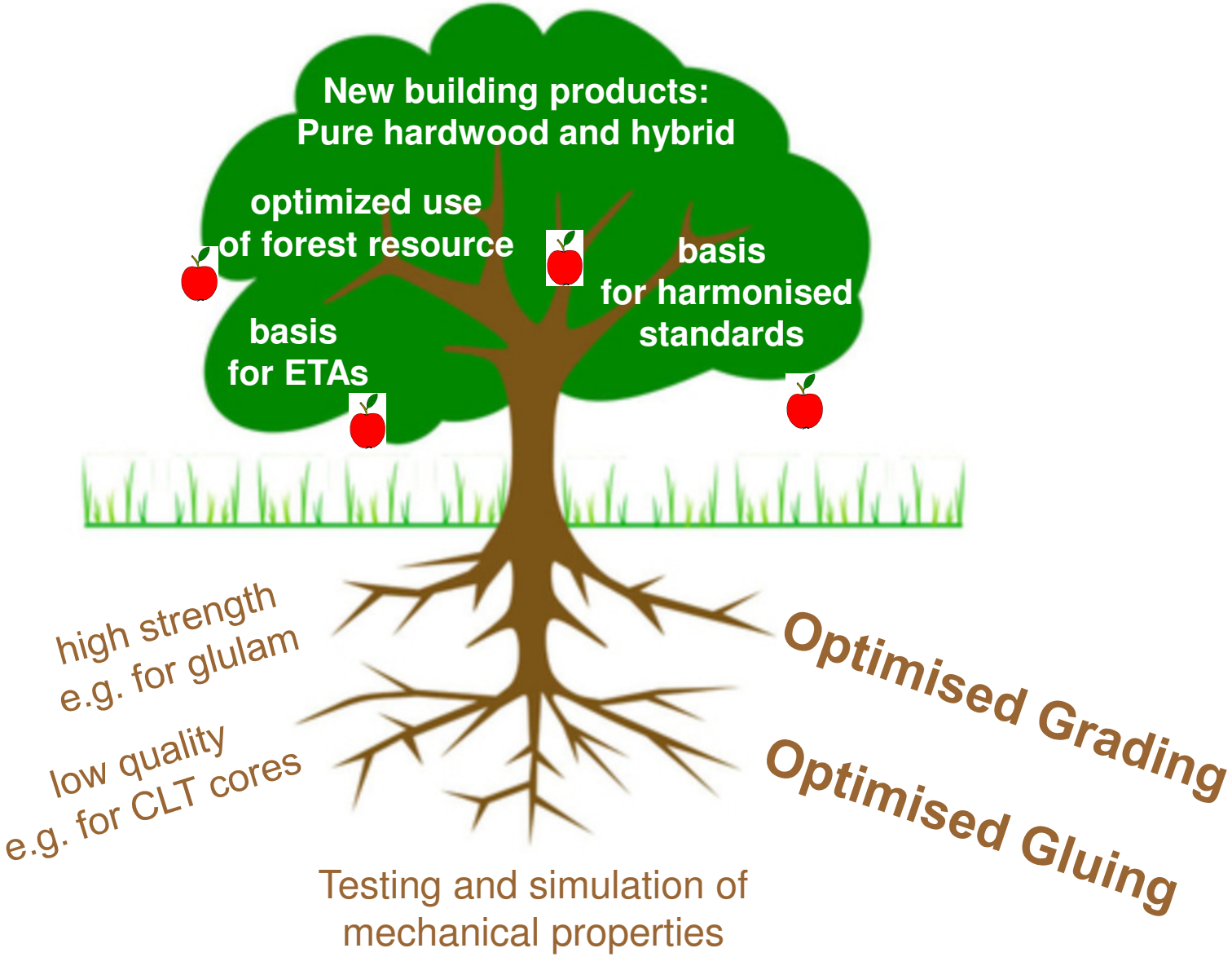
producer of structural products based on softwood and hardwood

Results of research project

HARDWOOD STRUCTURE: Project idea



HARDWOOD STRUCTURE: Some fruit already there!



Glulam made of hardwoods: German Approvals (valid today)

Deutsches Institut für Bautechnik

DIBt

Allgemeine bauaufsichtliche Zulassung

Beech:	Oak:	
Z -9.1-679	**Z -9.1-704**	**Z -9.1-821**
- GL28 – GL48	- GL33.5	- GL 31.5 / GL 59
- pure beech	- pure oak	(with / without finger joints)
- hybrid (spruce/beech)	- composite built-up	- pure oak
- h ≤ 600 / 900	- h ≤ 400	- h ≤ 280
- b ≤ 150	- b ≤ 160	- b ≤ 70
- min. 3 lam.	- min. 4 lam.	- min. 4 lam.
- lam. thickness: 42	- lam. thickness: 20	- lam. thickness: 23
- adhesives: two melamine adh.	- adhesives: one melamine adh.	- adhesives: one melamine adh.

Examples: CUAP for glulam made of hardwood

CUAP 03.04/29-1

Common Understanding of Assessment Procedure

April 2013

For a European Technical Approval according to Article 9.2 of the Construction Products Directive

GLUE LAMINATED TIMBER MADE OF HARDWOOD

BEECH, CHESTNUT AND OAK

Wood species	Oak *Quercus robur, Quercus petraea*	Chestnut *Castanea sativa*	Beech *Fagus sylvatica*
Min. and max. dimensions	mm	mm	mm
Max. width of lamellae	160	200	160
Max. thickness of lamellae	20	30	30
Max. depth of GLT	400	900	900
Min. width of GLT	50	50	50
Max. width of GLT	160	200	160
Max. length of GLT	12 000	18 000	18 000
Service class	1 and 2	1 and 2	1
Moisture content	8 – 12 %	8 – 12 %	8 – 12 %
Min. number of lamellae	4	4	4

ETAs (valid today)

Authorised and notified according to Article 10 of the Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products

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Schenkenstrasse 4 | 1010 Vienna | Austria
T +43 1 533 65 50 | F +43 1 533 64 23
mail@oib.or.at | www.oib.or.at

Member of EOTA

CUAP 03.04/29-1

Common Understanding of Assessment Procedure

April 2013

For a European Technical Approval according to Article 9.2 of the Construction Products Directive

GLUE LAMINATED TIMBER MADE OF HARDWOOD

BEECH, CHESTNUT AND OAK

to be transfered to EAD

European technical approval **ETA-13/0642**

English translation, the original version is in German

Handelsbezeichnung *Trade name*	**VIGAM Brettschichtholz aus Eiche** *VIGAM - Glued laminated timber of oak*
Zulassungsinhaber *Holder of approval*	**Elaborados y Fabricados Gámiz, S.A.** **Ctra. Vitoria-Estrella, № 2** **01110 Sta. Cruz de Campezo (Àlava)** **Spanien**
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	**Brettschichtholz (BSH) aus Laubholz** *Glue Laminated Timber (GLT) made of hardwood*
Geltungsdauer vom *Validity from* bis zum *to*	**28.06.2013** **27.06.2018**
Herstellwerk *Manufacturing plant*	**Elaborados y Fabricados Gámiz, S.A.** **Ctra. Vitoria-Estrella, № 2** **01110 Sta. Cruz de Campezo (Àlava)** **Spanien**

Oak

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tria

Member of EOTA

European technical approval **ETA-13/0646**

English translation, the original version is in German

Handelsbezeichnung *Trade name*	**SIEROLAM Brettschichtholz aus Kastanie** *SIEROLAM - Glued laminated timber of chestnut*
Zulassungsinhaber *Holder of approval*	**SIEROLAM SA.** **Los Cuetos s/n, Argüelles** **Siero 33188 Asturias** **Spanien**
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	**Brettschichtholz (BSH) aus Laubholz** *Glue Laminated Timber (GLT) made of hardwood*
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Chestnut

Characteristic values of hardwood glulam

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Chestnut

		Test results	Derived individual strength profile	Comparison prEN 14080, GL 30c
Bending strength [N/mm²]	$f_{m,g,k}$	30,4[1)]	30,0	30,0
Tensile strength [N/mm²]	$f_{t,0,g,k}$	20,0[1)]	20,0	20,0
	$f_{t,90,g,k}$	0,73	0,70	0,50
Compression strength [N/mm²]	$f_{c,0,g,k}$	**47,1**	**40,0[2)]**	**25,0**
	$f_{c,90,g,k}$	**5,5**	**5,5**	**2,5**
Shear strength [N/mm²]	$f_{v,g,k}$	**5,2[3)]**	**5,0**	**3,5**
(shear and torsion)				
Rolling shear strength [N/mm²]	$f_{r,g,k}$	—[4)]	1,2	1,2
Modulus of elasticity [N/mm²]	$E_{0,g,mean}$	13000	13000	12500
	$E_{90,g,mean}$	1450	1400	300
Shear modulus [N/mm²]#	$G_{g,mean}$	—[4)]	650	650
Rolling shear modulus [N/mm²]	$G_{r,g,mean}$	—[4)]	65	65
Density [kg/m³]	$\rho_{g,k}$	524	520	390
	$\rho_{g,mean}$	547	540	420

Characteristic values of hardwood glulam

Oak

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OiB Member of EOT

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Festigkeitskennwerte (N/mm²)	
$f_{m,k}$ [a]	33,5
$f_{t,0,k}$	23
$f_{t,90,k}$	0,6
$f_{c,0,k}$ [b]	45
$f_{c,90,k}$	8,0
$f_{v,k}$	4,0
Steifigkeitskennwerte (N/mm²)	
$E_{0,mean}$	14400
$E_{0,05}$	12000
$E_{90,mean}$	800
$E_{90,05}$	660
G_{mean}	850
$G_{0,05}$	700
Rohdichtekennwert (kg/m³)	
ρ_k	690

Glued structural hardwood products: I-Beams

Allgemeine bauaufsichtliche Zulassung

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffent

Mitglied der EOTA, der UEAtc und der W

Datum: 02.09.2011

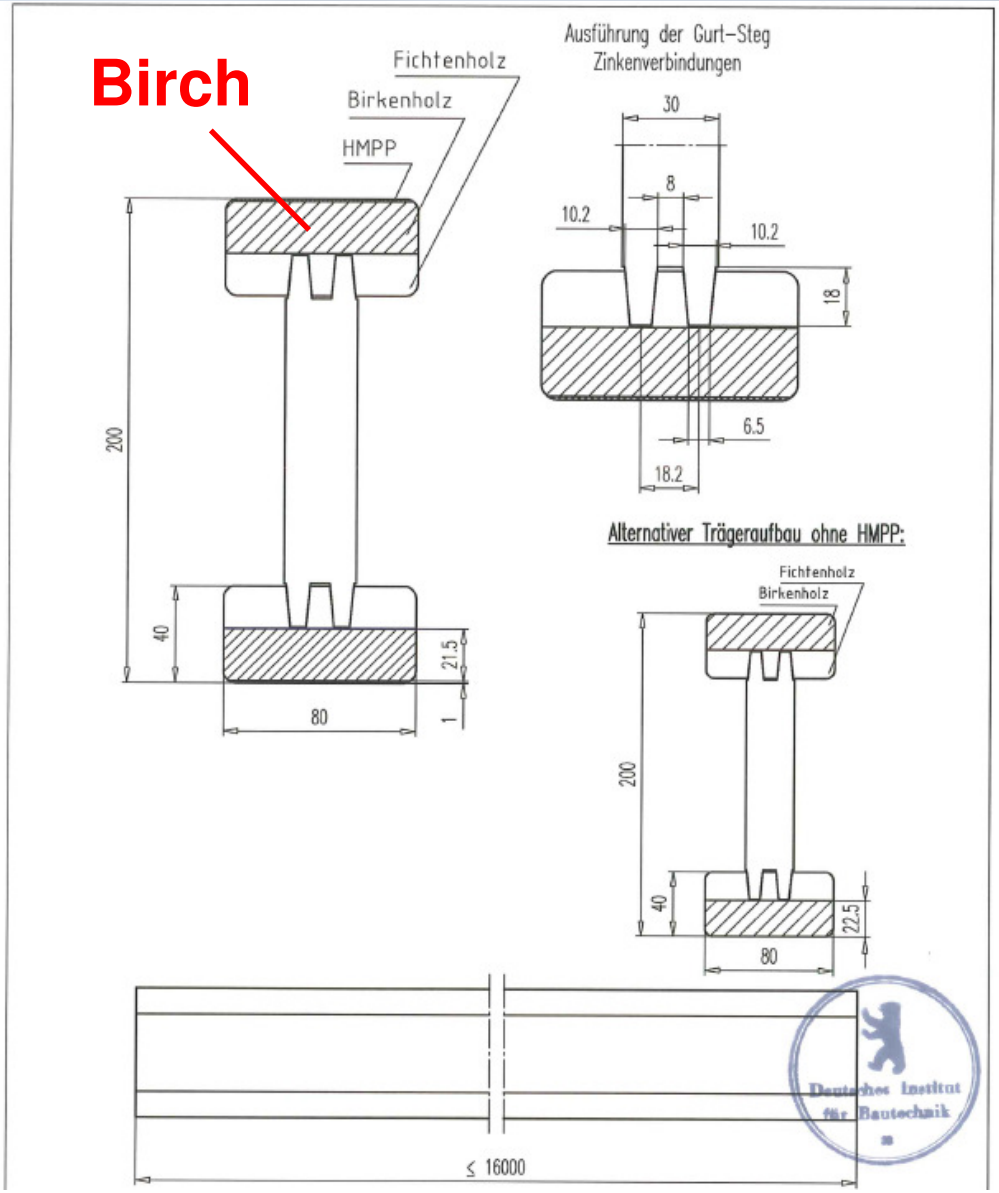
Geschäftszeichen: I 52-1.9.1-773/10

Zulassungsnummer:
Z-9.1-773

Antragsteller:
Doka Industrie GmbH
Josef Umdasch Platz 1
3300 AMSTETTEN
ÖSTERREICH

Geltungsdauer
vom: **2. September 2011**
bis: **24. Februar 2016**

Zulassungsgegenstand:
Holzschalungsträger DOKA-Träger I tec 20



Nearly double resistance (moment and shear capacity) compared to spruce I-beams

Are there tested and approved adhesives?

Allgemeine bauaufsichtliche Zulassung

Zulassungsstelle für Bauprodukte und Bauarten

Bautechnisches Prüfamt

Eine vom Bund und den Ländern
gemeinsam getragene Anstalt des öffentlichen Rechts

Mitglied der EOTA, der UEAtc und der WFTAO

Datum: 18.06.2012

Geschäftszeichen: I 52-1.9.1-838/11

Zulassungsnummer:
Z-9.1-807

Geltungsdauer
vom: **18. Juni 2012**
bis: **18. Juni 2017**

Antragsteller:
Casco Adhesives AB
PO Box 115 38
100 61 STOCKHOLM
SCHWEDEN

Oak, Beech, Birch, Chestnut

Zulassungsgegenstand:
Melamin-Harnstoffharz-Klebstoff GripPro™ Design für die Verklebung tragender Holzbauteile aus Nadelholz sowie aus den Laubhölzern Eiche, Buche, Birke und Kastanie

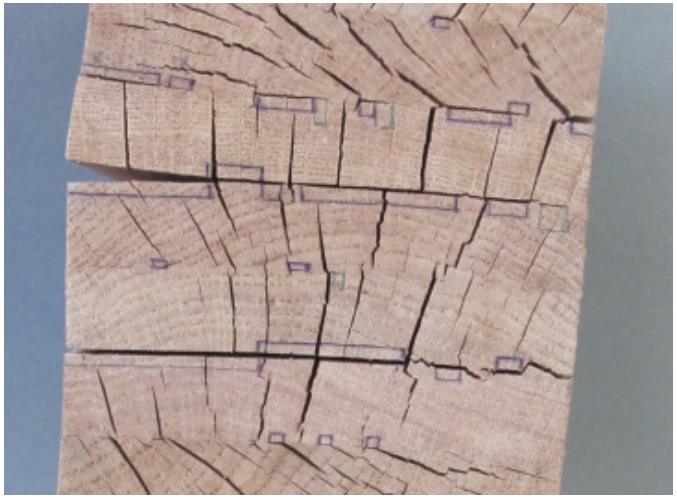
Are there any problems to solve?

We do not have:

- enough knowledge about availability of hardwoods of certain „quality“
- a direct link between „quality“ and strength classes
- strength models for e.g. glulam (comparable to „Karlsruhe model“)
- enough positively tested adhesive systems (e.g. no Formaldehyde-free system…)
- clear and transparent criteria for the test of adhesives and glued products
- clear rules for quality control systems
- Proofs for the lay-out and design for hybrid glulam and cross-lam structural members

WP3: Adhesives for structural hardwood bonding

3.1 Principal tests and face gluing



- short term strength properties according to EN 302-1

  and adaption of the strength requirements of EN 301;

- testing of separate application of hardener and resin by means of delamination tests according to EN 302-2;

- working properties, minimum press time acc. to EN 302-6 and EN 15416-5;

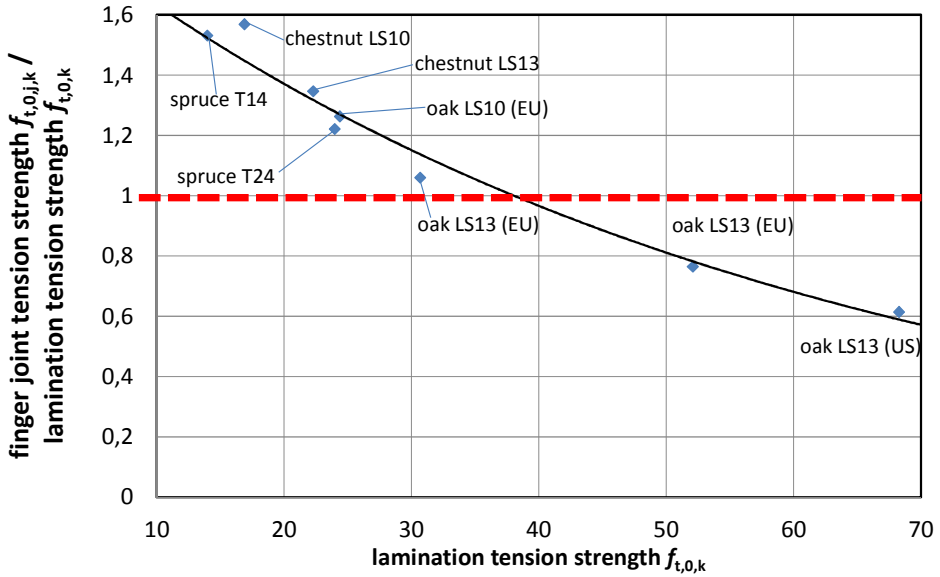
- testing of the effects of wood shrinkage on the shear strength similar to EN 302-4 with hybrid hard- and softwood bonds (necessary to evaluate shrinkage capacity of the bonds in hybrid cross-lam);

- durability tests by means of tension perpendicular to the grain according to EN 14080:2005, Annex C and by means of shear parallel to the grain according to EN 15416-2;

- derivation of quality procedures adapted to hardwoods.

WP3: Adhesives for structural hardwood bonding

3.2 Bonding of finger joints

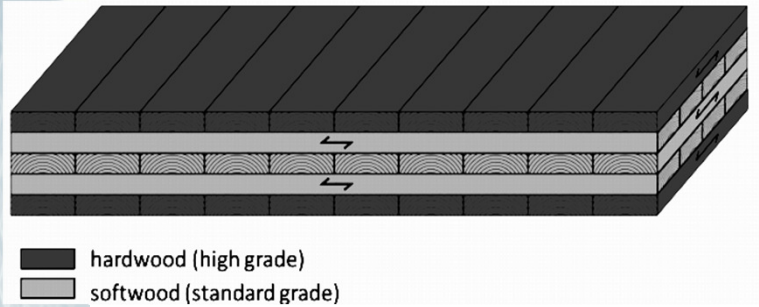


- consolidate finger-joint data in solid wood and lamellas form all partner
- investigate influence of size and finger-joint type for the different species with accomplishing tests if necessary (finger-joint tensile tests according to EN 408 or finger-joint bending tests according to EN 408)
- bonding of finger joints and finger joint adhesives under consideration of density and dynamic moduli of elasticity as well as moisture content

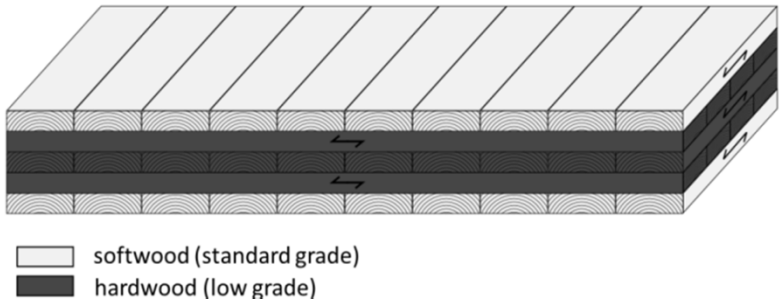
WP5: Hybrid cross-laminated timber

5.1 X-lam loaded out-of-plane (e.g. floors)

enhanced moment capacity



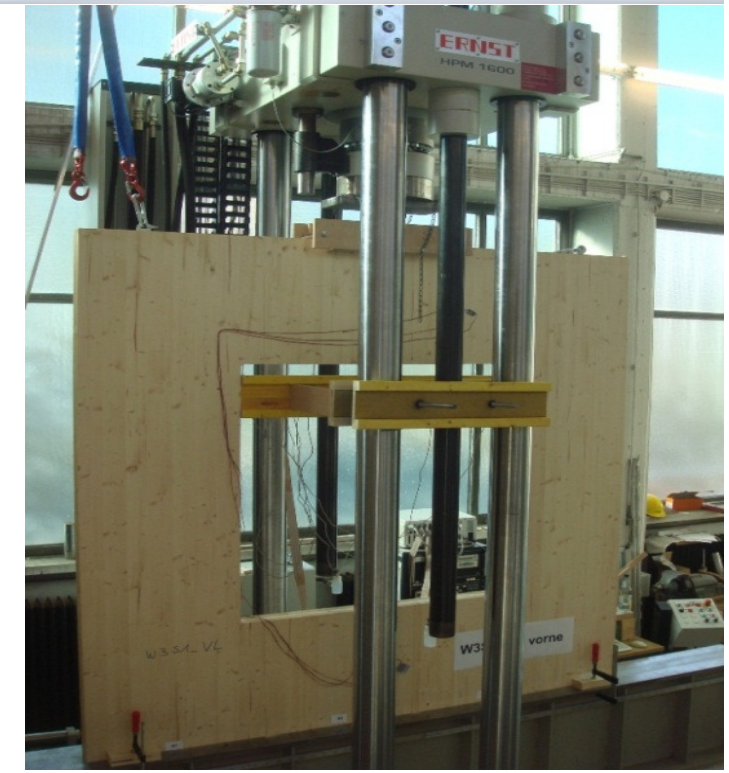
enhanced shear capacity



- Finite-Element-analysis and -optimisation of tailor-made hybrid cross-sections for out-of-plane loading conditions. Based on the results of visual and mechanical strength grading of beech laminations in WP2, the bending and shear strength capacities will be predicted by the simulation models.
- Structural cross-lam plates with hybrid cross-sectional build-ups (see e.g. Figure below with examples for 5layer plates) will be produced by industrial partners.
- The model will subsequently be validated with bending and shear tests of the produced hybrid cross-lam plates in structural dimensions.

WP5: Hybrid cross-laminated timber

5.2 X-lam loaded in-plane (e.g. for walls)



- Finite-Element-analysis and -optimisation of tailor-made hybrid elements with and without openings cross-sections for in-plane loading conditions including point load simulation of elements with openings.

- Production of structural elements for empiric validation of the calculation model. The hybrid build-ups will be chosen according to the numerical predictions.

- Compression tests with small sections of structural members comprising a combination of softwoods in the parallel layers and hardwoods in the cross-layers will be performed. A significantly more isotropic behaviour and thereby an increased point load capacity is anticipated.

- Tests of whole wall elements with and without openings loaded by vertical loads (stability behaviour) and horizontal loads (shear wall resistance) will be conducted to verify the model predictions. A small series comprising wall elements with opening will also be performed, in order to derive some elements of tailored design rules for hybrid wall elements.