Use- and wood product-orientated investigations on *Abies grandis* from sustainable managed beech-mixed forest stands

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Outline of presentation

Project objectives

Investigation material

Part of investigation results

Solid wood products

Possible uses

Transfer services

Project objectives

- Selection of the investigation material
- Heartwood discolouration and wetcore analysis
- Investigation of wood- and wood processing properties
- Investigation of the wood properties after modification due to thermal treatment
- Cooperation with industry partners and wood products
- Dissemination of the investigation results

Origin of the sample trees

A total of:

- 6 forest sites, 42 sample trees, 5 mixed stands and 1 pure forest stand,
- Tree age 40 – 64 years

- ***Municipal forest:*** **Meschede, Höxter, Schmallenberg (North-Rhine-Westphalia)**
- ***State forest:*** **Forest district Grünenplan (Lower Saxony)**

Heartwood discolouration and wetcore

Wetcore analysis - Results

- Results ot the cellular UV-spectroscopic analysis within the „heartwood“-area from 5 sample trees containing wetcore:
  - No transformation of the lignin structure of the cellwall layers
  - No mircobial degradation of the cell wall
  - Therewith no deterioration of the elasto-machanical wood properties

Results - Wood density

- Significant differences among the site-collectives
- Sicnificant increase within the trees from pith to cambium
- Trend to decrease (lengthwise) longitudinal from the bottom to the top end of the trees; MC at 12 %

Site	n	$\overline{X}$ (g/cm³)	s (g/cm³)
Schmallenberg	272	**0,438**	0,050
Meschede	389	**0,390**	0,053
Höxter	301	**0,364**	0,035
Total	962	0,396	0,055

Sawn timber drying

- Square timber dimensions
  - 40 mm * 80 mm * 2350 mm
  - 80 mm * 160 mm * 2350 mm

- Drying processes
  - Air seasoning
  - Convection drying
  - Hot steam drying

Drying quality

- Air seasoning
  - Timber yard
  - Application of well-proven stacking methods
  - 1500 square timbers
  - Quick and steady drying (good results)
  - MC between 12 % and 15 %

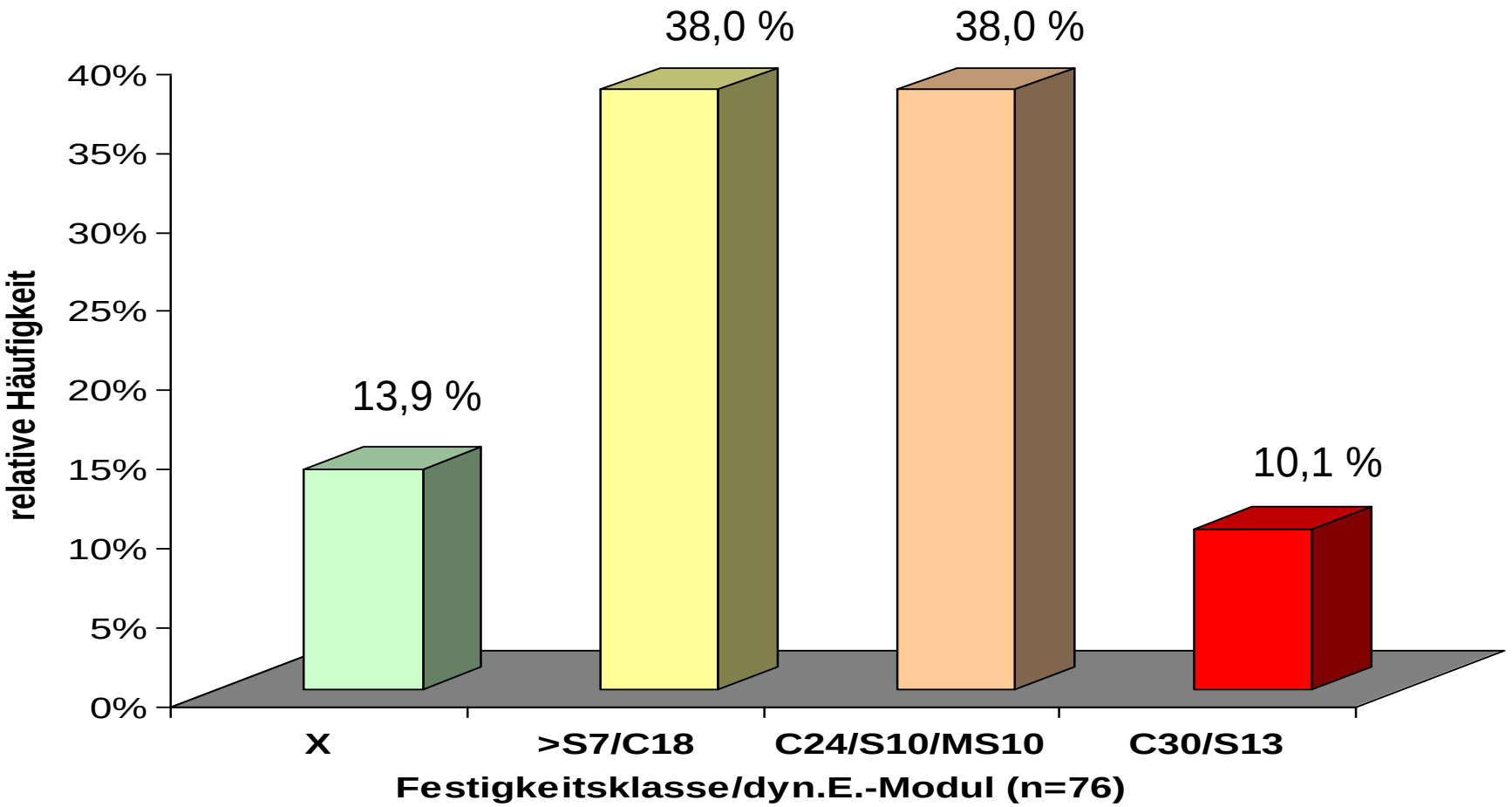
Drying quality

- Convection drying
  - Kiln temperature
    > 50 °C
  - 8 different processes
  - 550 sqaure timbers
  - Final MC-average 10 %
  - Well and quick drying possible

Stress-grading of sawn-timber

- **Objectives:**
  - Testing MOE and strength properties of full size-timber
  - Applicability of verification of the DIN 4074 standard
  - Assessment of potential sawn-timber uses

Stress-grading using „Timber-grader“ according EN 338 (Schmallenberg 80 mm x 160 mm)



Stress-graded timber according EN 338 (n = 76)

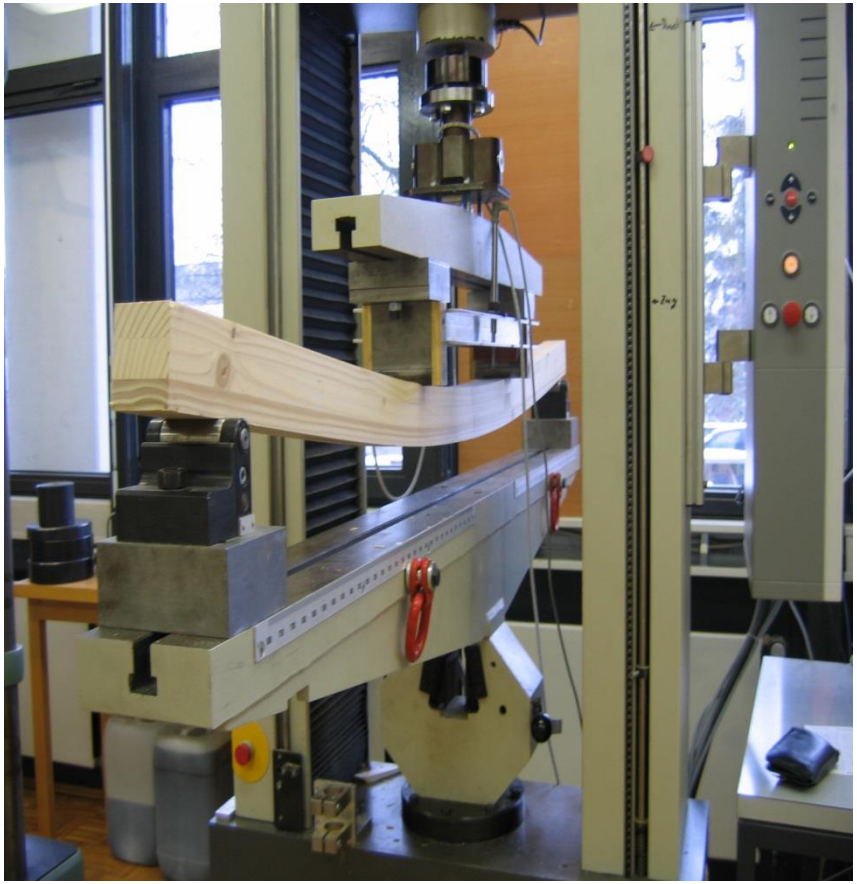
Sawn-timber grading

- **Conclusions:**
  - **Visual grading according DIN 4074 heavily underestimates the strength potential of the sawn-timber (95 % rejected, Site-Höxter)**
  - **Stress-grading using MOE dyn. yielded 70 % in class S7 or higher**
  - **Grading by machine can detect strength reserves**
  - **The use of Grand-fir timber for constructive applications requires a machine based grading**

Gluing investigations

- Five glue-type systems based on **phenol-resorcinol, melamine-urea, urea-formaldehyde** and **polyurethane** were tested
- Tests according DIN 68141 and DIN EN 302:
  - Tensile stress test perpendicular to the grain
  - Tensile shear strength test parallel to the grain (EN 204/205)
  - Delamination tests
- All tested glue-types can be used without restrictions for *Abies grandis* timber products

4 point-bending test according to EN 408 Glued-laminated timber (Site-Höxter)



Dimensions: 60 mm x 70 mm x 2350 mm

Thermal treatment

- **Objectives:**
  - To distinguish the modification of wood product properties
  - To assume the application area of thermally treated wood products
  - The thermal treatment of wood products was carried out over 180°C using BICOS-process

Results - Thermo-Wood

- **Dimensional stability:**
  - Low water uptake
  - ASE about 20 % - 60 % higher
  - Max. volume swelling at 7.5 %

Results - Thermo-Wood

- Wood density and mechanical properties:
  - Little decrease in oven-dry density
  - Compressive strength parallel to the grain about 7 % higher
  - MOE_{static} slightly increased
  - Bending strength about 8 % decreased

Results - Thermo-Wood

- Durability and weathering
  - Biolocical resistance comes up to durability class 1 – 2 (EN 113 and EN 350-1)
  - Thermo-Wood becomes greyish after QUV; Colour conservation by means of pigmented glaze coating possible (need for research)

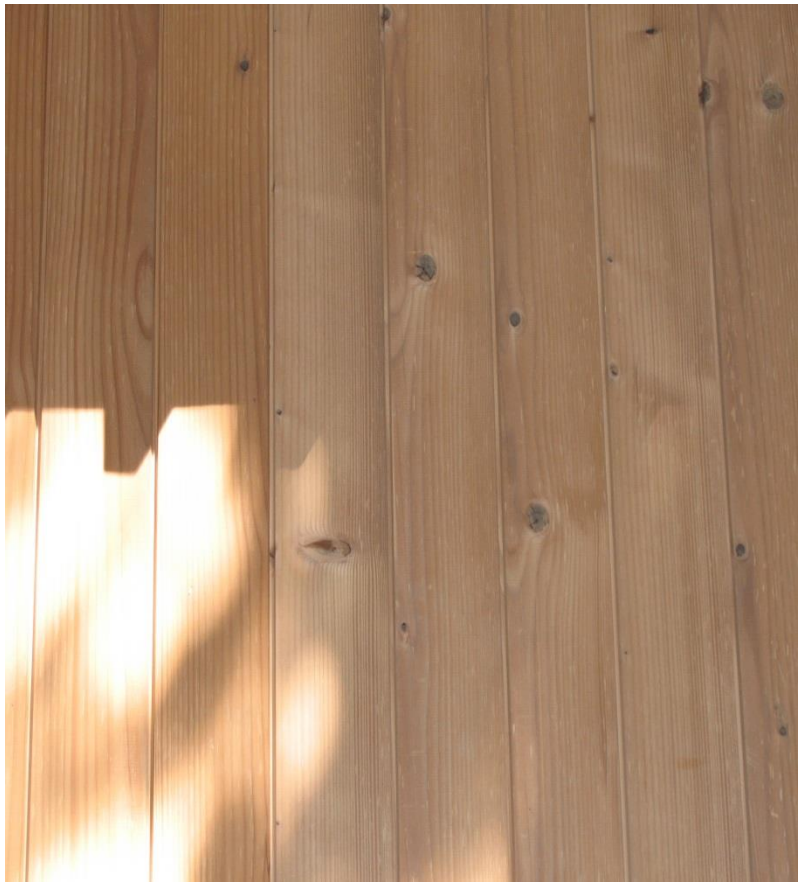
Thermo-Wood – *Abies grandis*

Dado and rabbet joint thermally treated

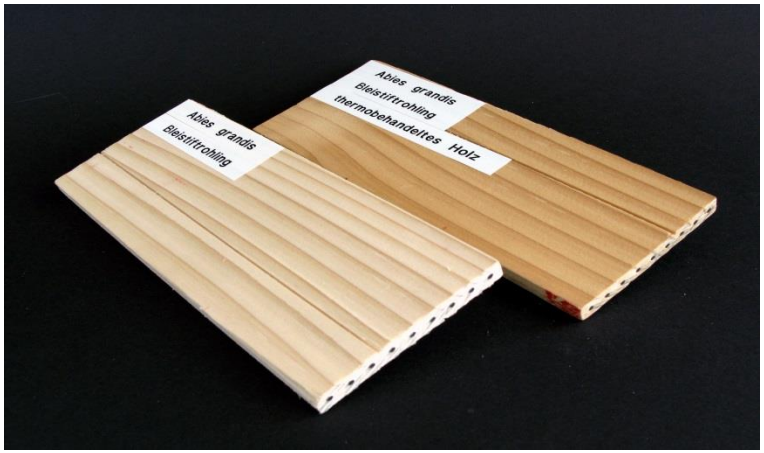
Terrace-floor panel thermally treated

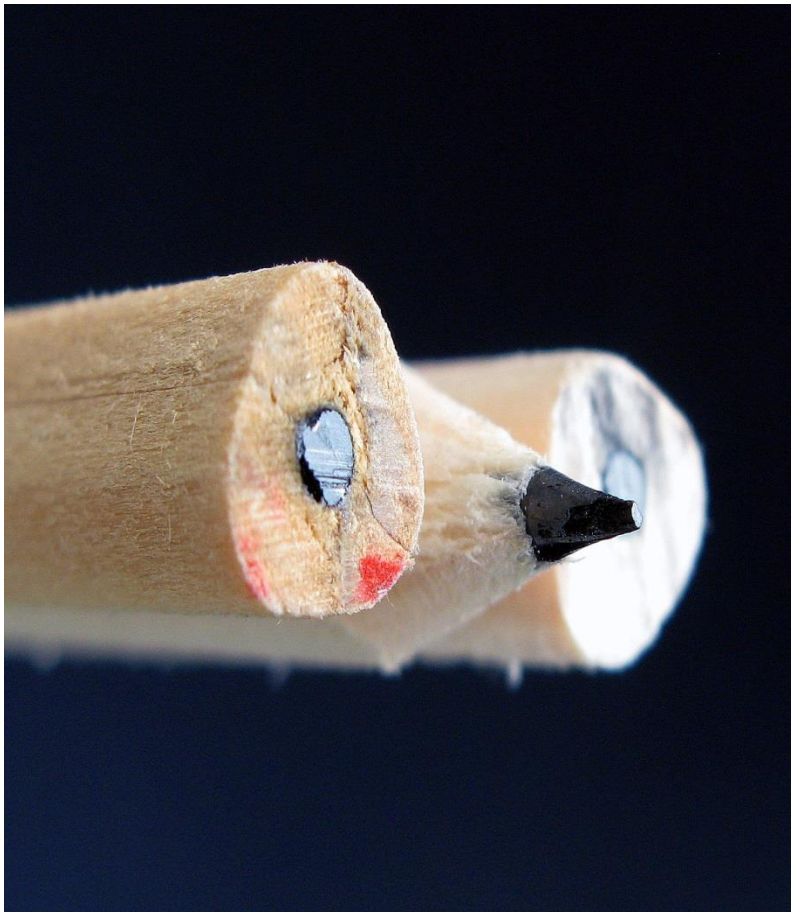
Thermo-Wood-Bench - *Abies grandis*

Thermo-Wood-Facade - *Abies grandis*



Pencil-Products - *Abies grandis*





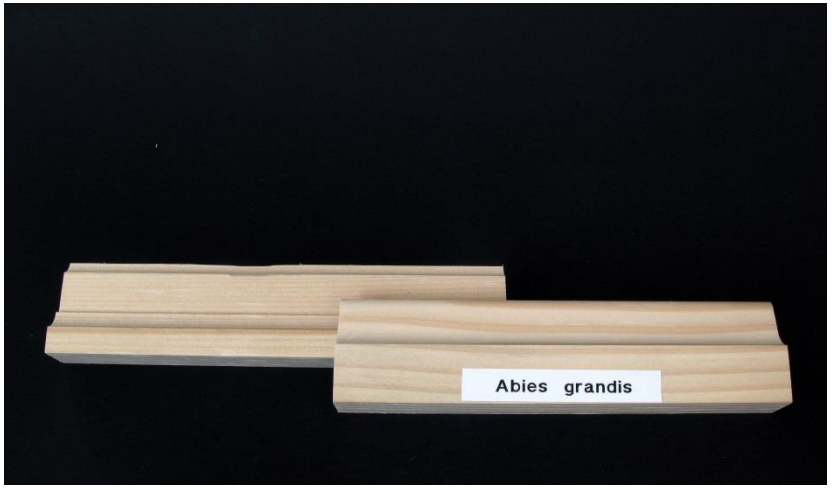
Pencils and blanks

Other wood products - *Abies grandis*

Door in Physics-Lab

Kitchen-cabinet door unit

Other wood products - *Abies grandis*

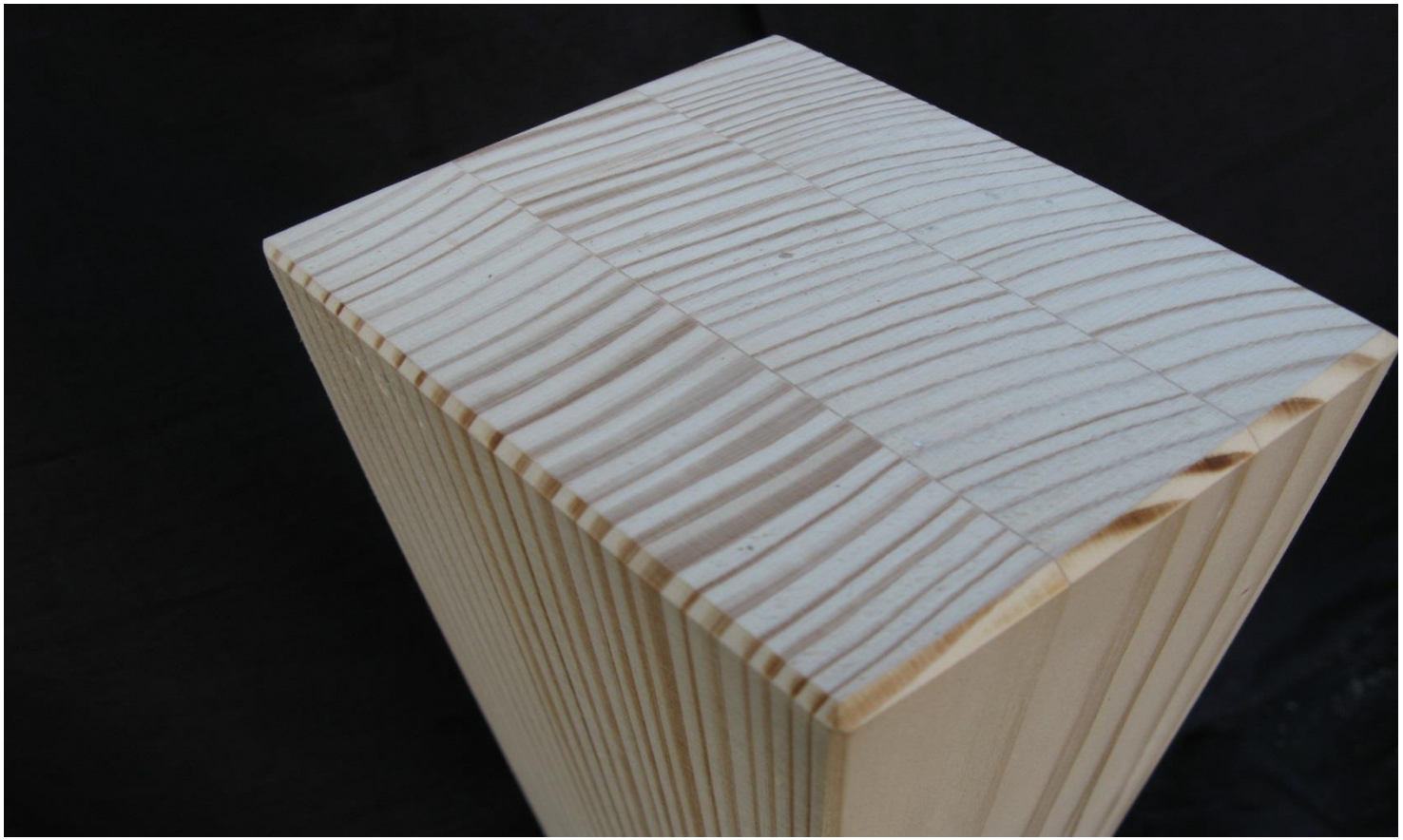


Profiled baseboards

Other wood products - *Abies grandis*

Sauna profile boards

Glued-laminated timber product - *Abies grandis*



Wood processing advantages – *Abies grandis*

- High yield of sawn-timber
- High grade of sawn-timber according EN 1611 (aesthetic point of view)
- Good results in air seasoning and convection drying (good dimensional stability)
- Sorption behaviour comparable or even favourable to spruce timber

Wood processing advantages – *Abies grandis*

- Mechanical properties come partly up to spruce-values (however specific silvicultural management of the mixed-stands is necessary)
- Good results in machining and glueing
- Ipregnation (moderate)

Utilization options for the sawn-timber in interior woodwork

- Benefical assesement of the aesthetical aspects (light-coloured wood, ageless design)
- Ceiling- and wall panelling
- Cabinet wood; furniture manifacture
- Solid-wood boards
- Sauna facilities (no resin canals)

Papers and proceedings

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Future Ecological Silviculture

Mixed-stands

Natural regeneration