

## hardwood\_joint

Innovative joints in hardwoods

Carmen Sandhaas, KIT



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773324



**10 project partners**

4 from research

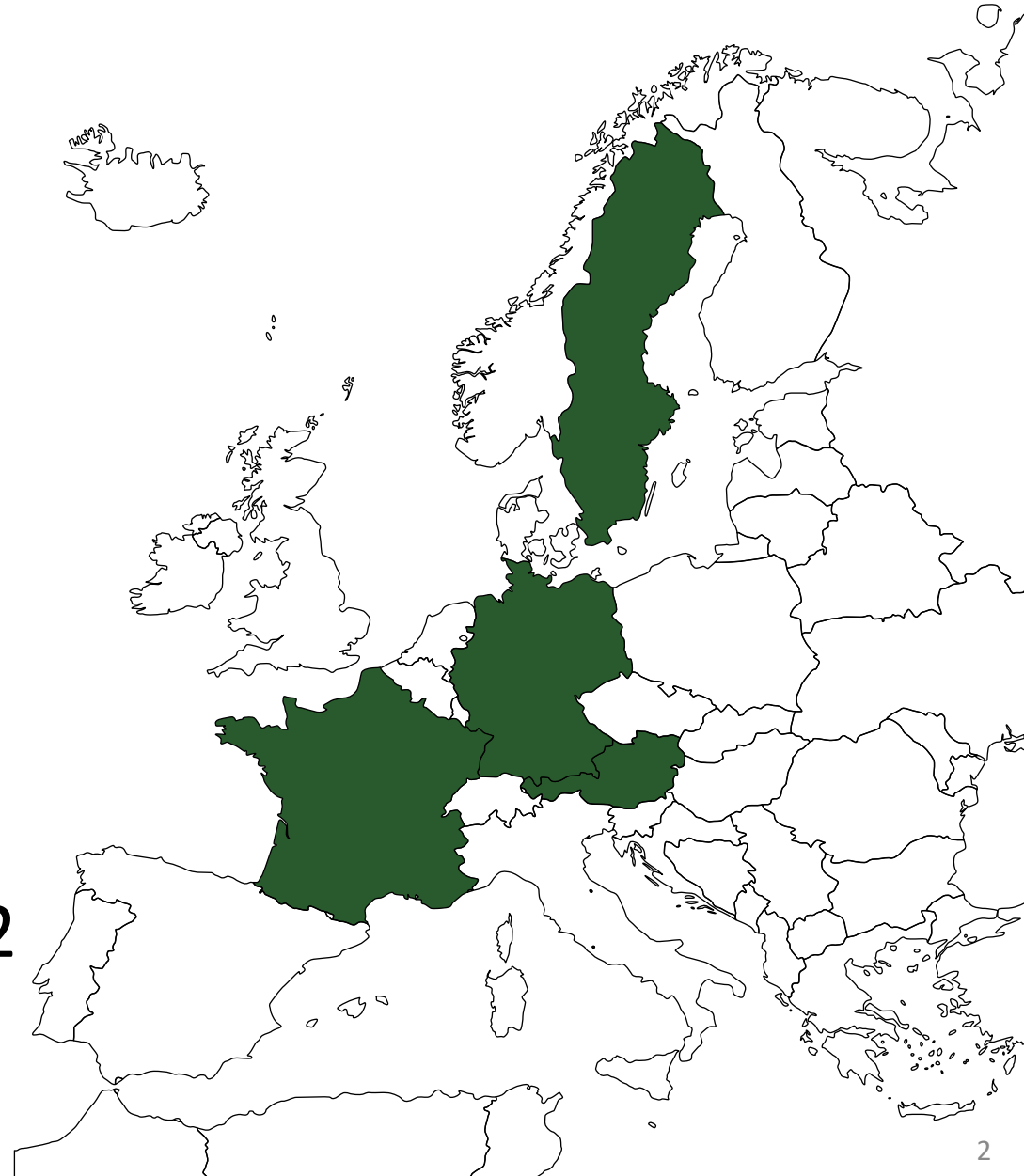
6 from industry

**Project budget**

€1.1m

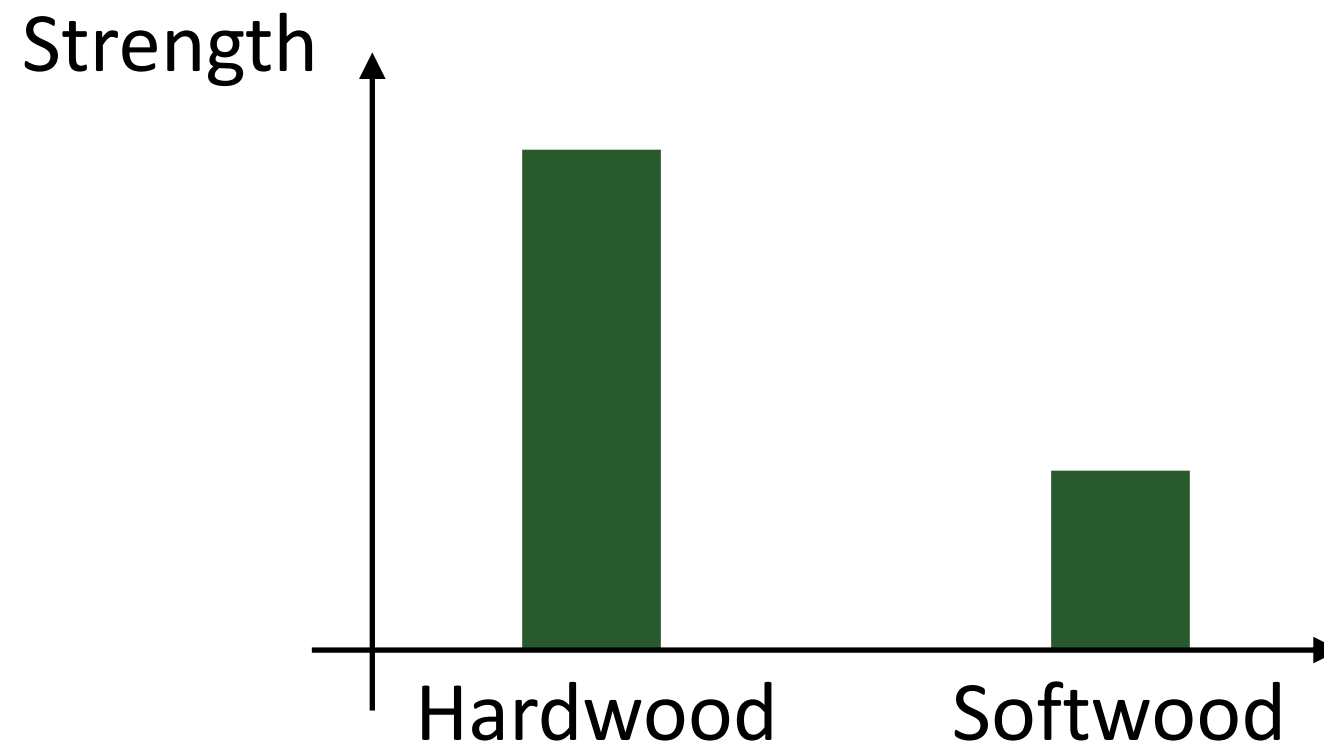
**Project duration**

01.02.2019 – 31.10.2022





## Using hardwoods to build

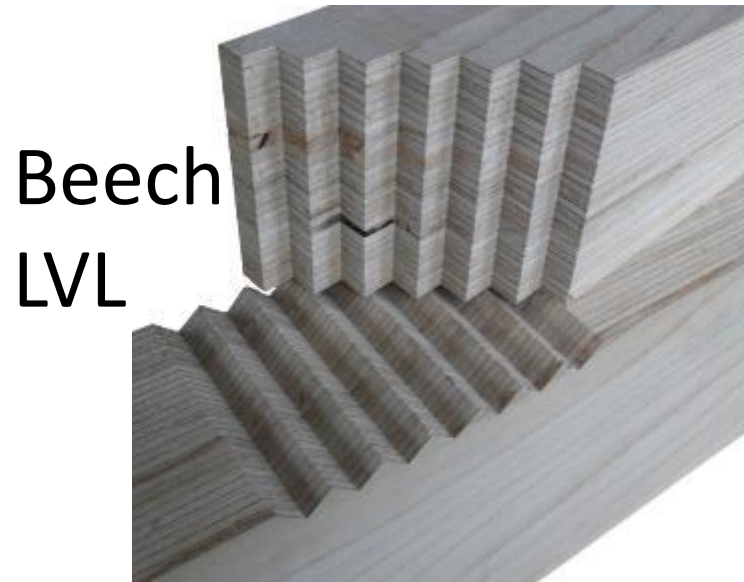




## Building materials



Beech  
glulam



Beech  
LVL



Birch  
CLT

Photo: HASSLACHER NORICA TIMBER



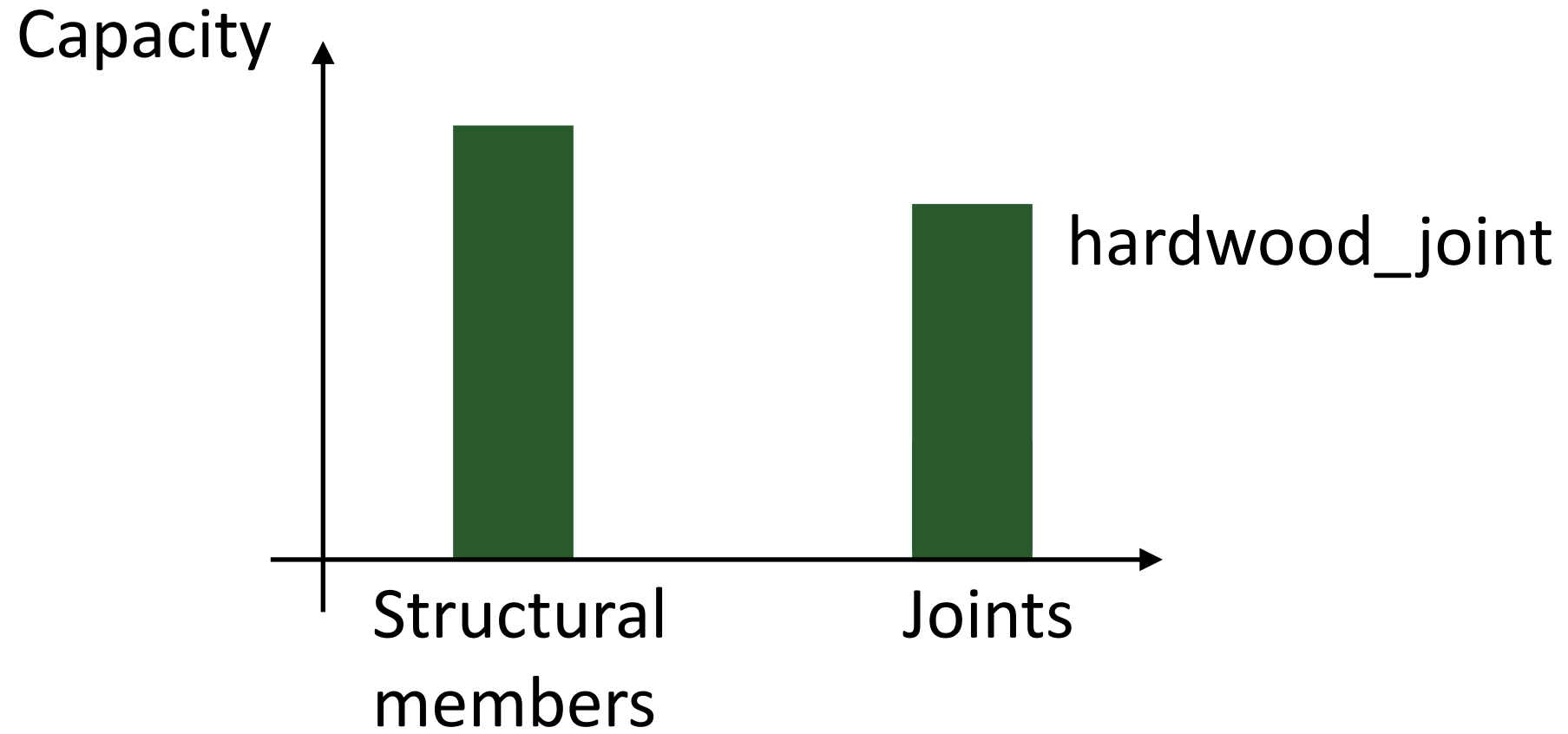
Birch  
glulam

Photo: HASSLACHER NORICA TIMBER





# Joints

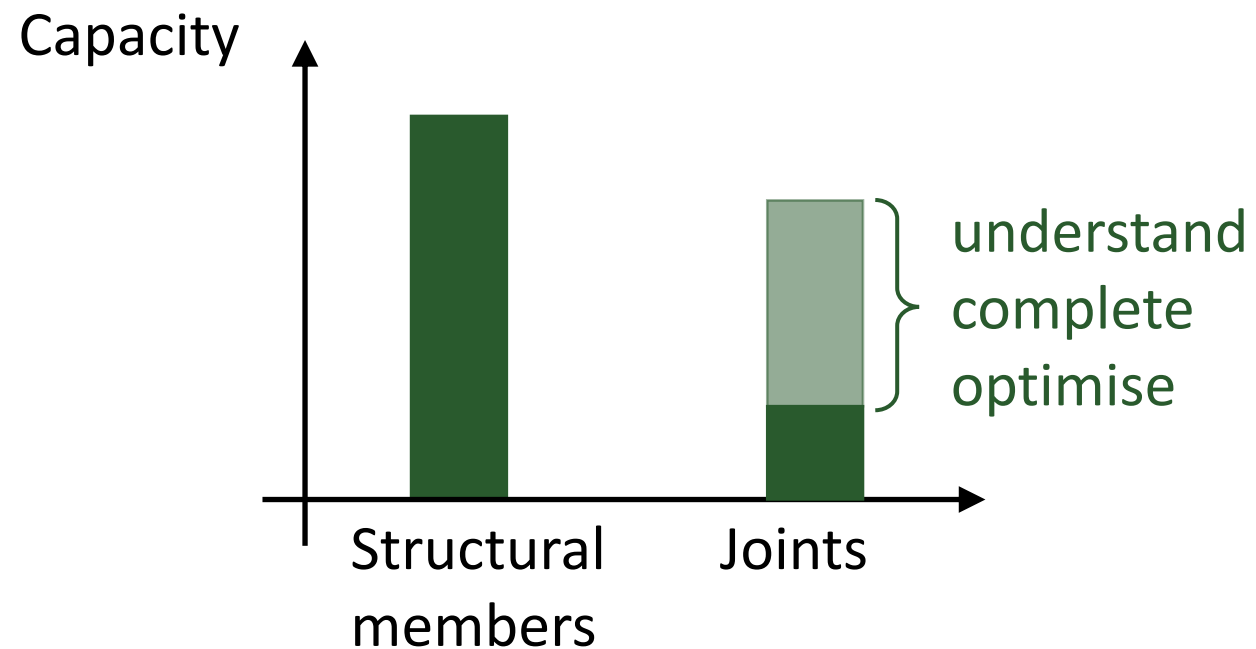




## HOW?

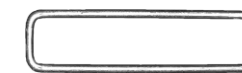
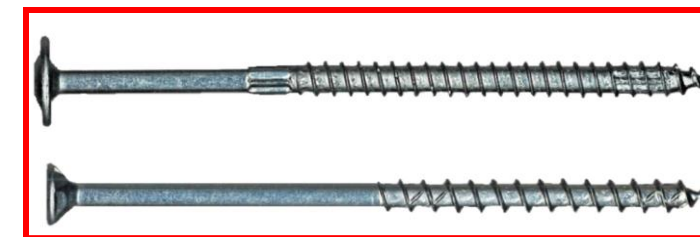
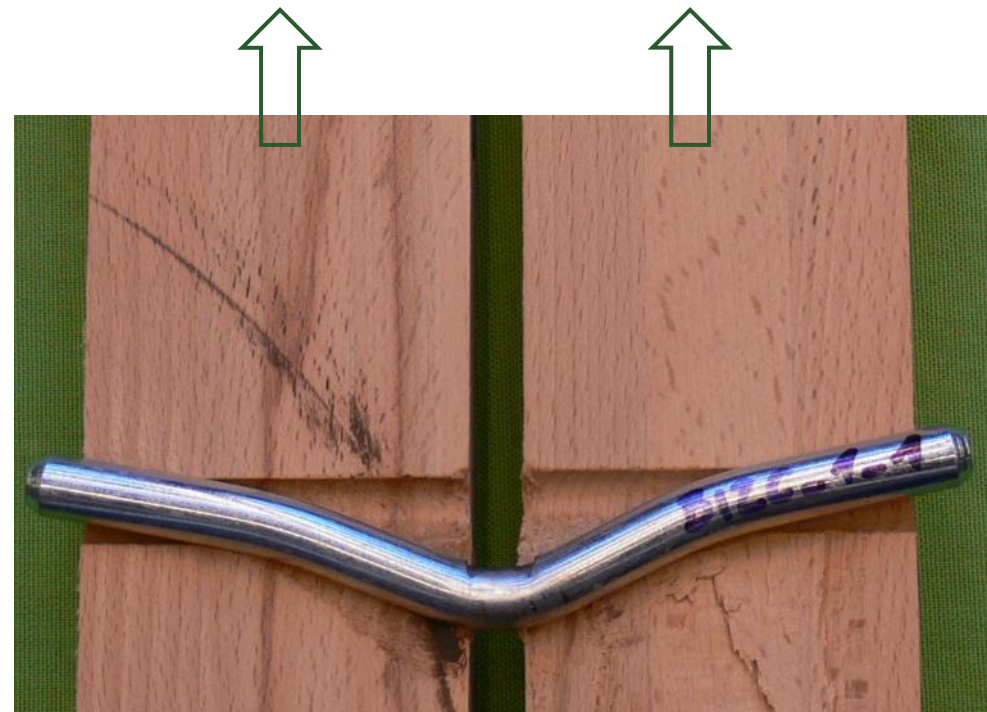
UNDERSTAND – COMPLETE – OPTIMISE – IMPLEMENT

APPROACH: EXPERIMENTAL+NUMERICAL → DESIGN MODELS





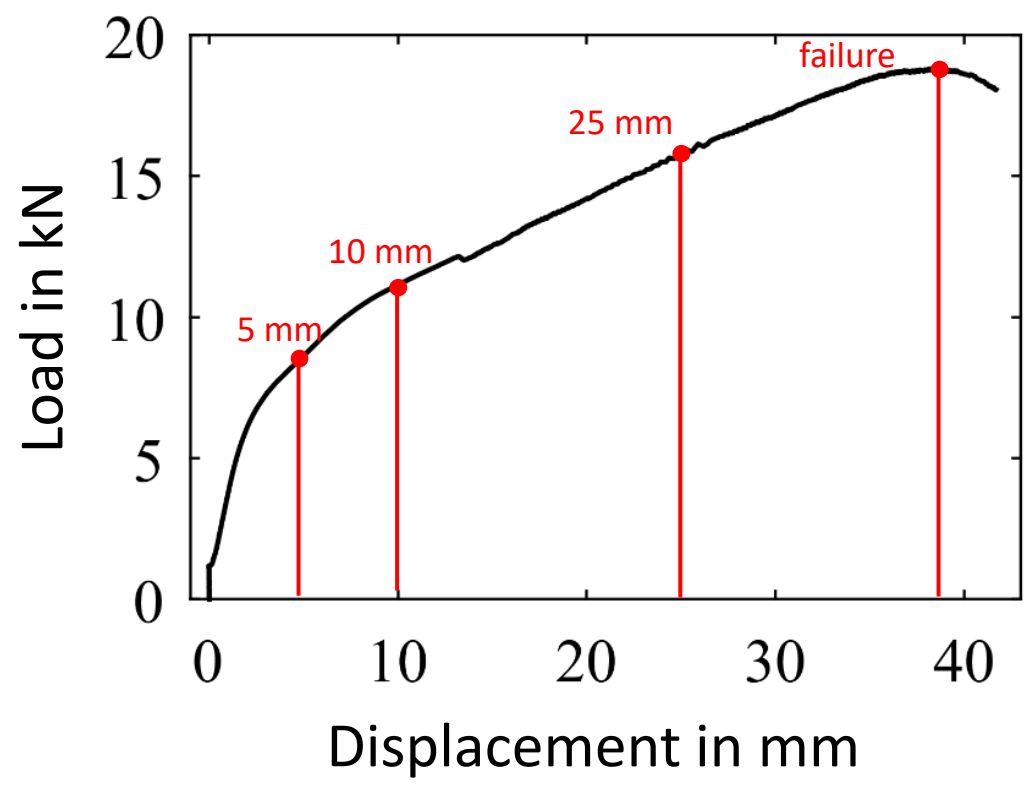
# UNDERSTAND – JOINTS WITH Laterally LOADED FASTENERS



**Same as softwoods?**



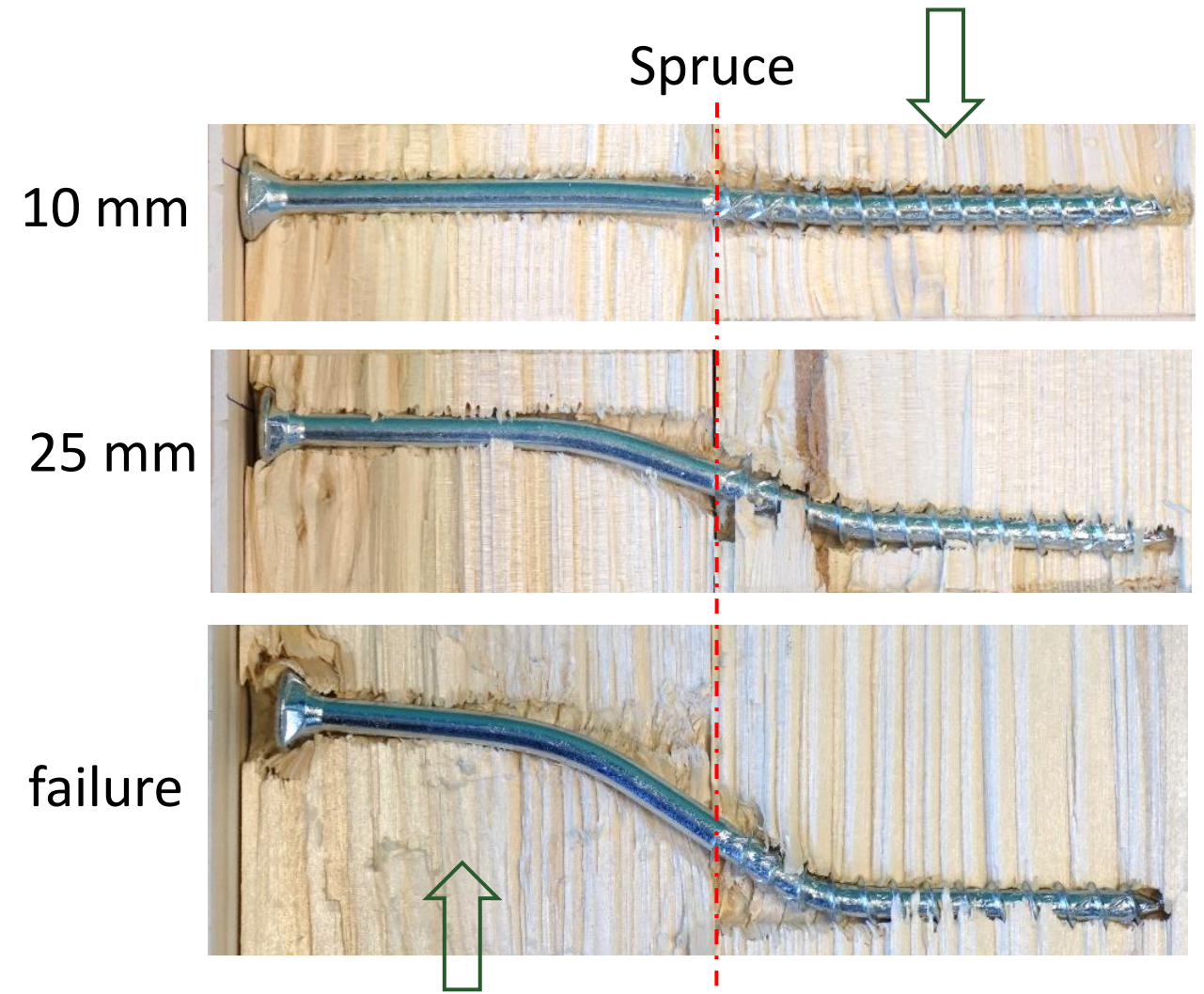
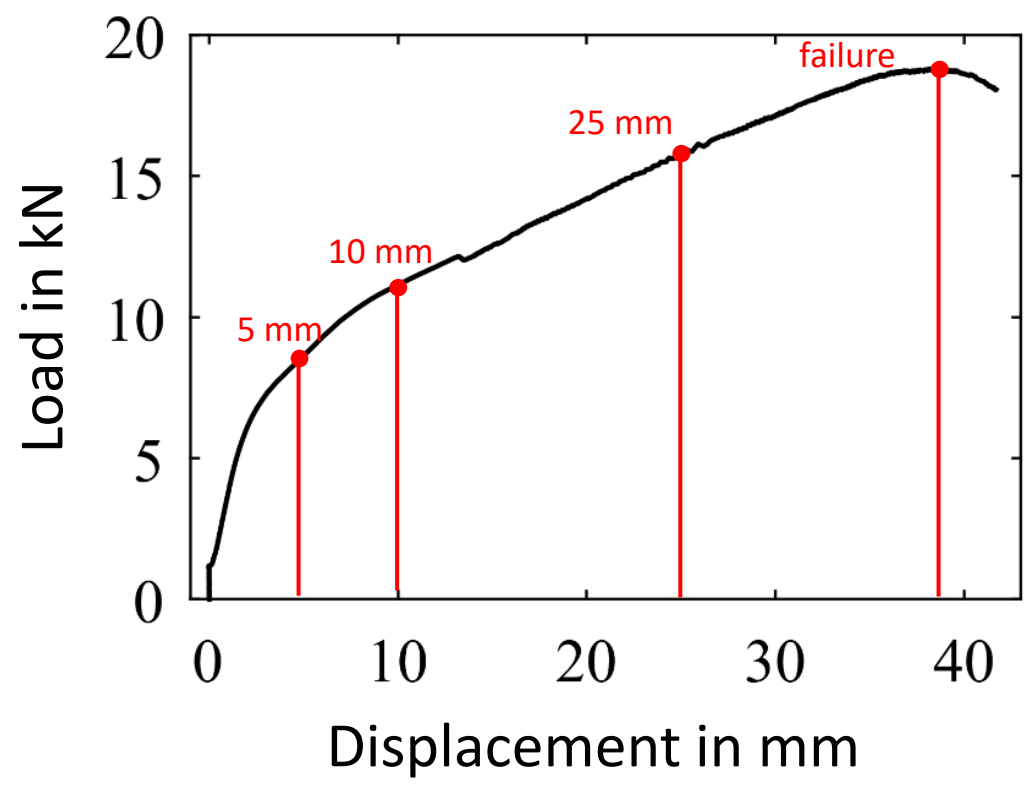
# UNDERSTAND – MULTI-STAGE TESTS







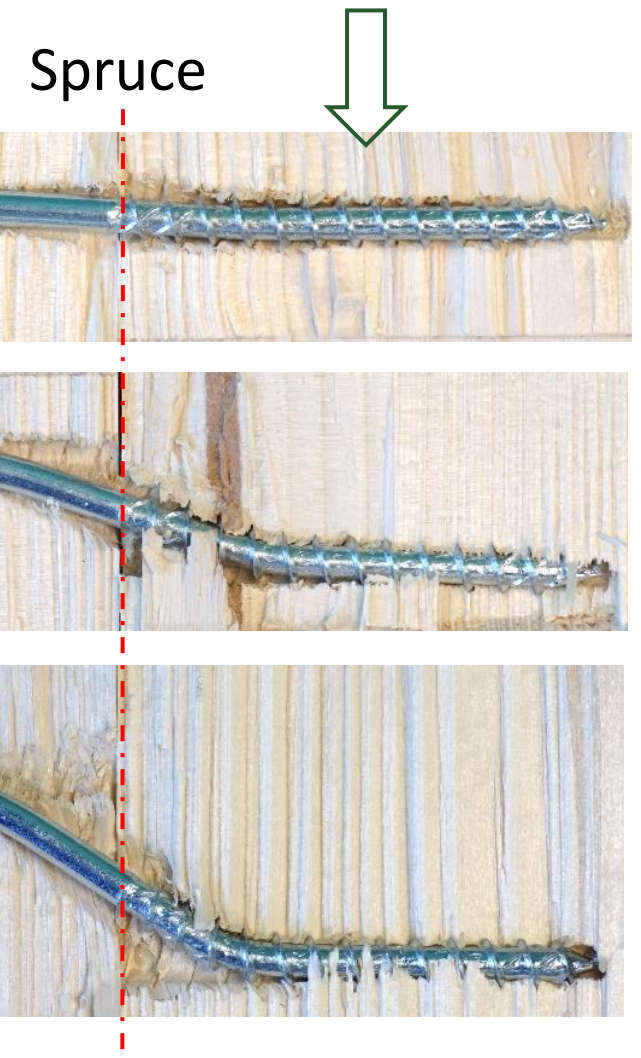
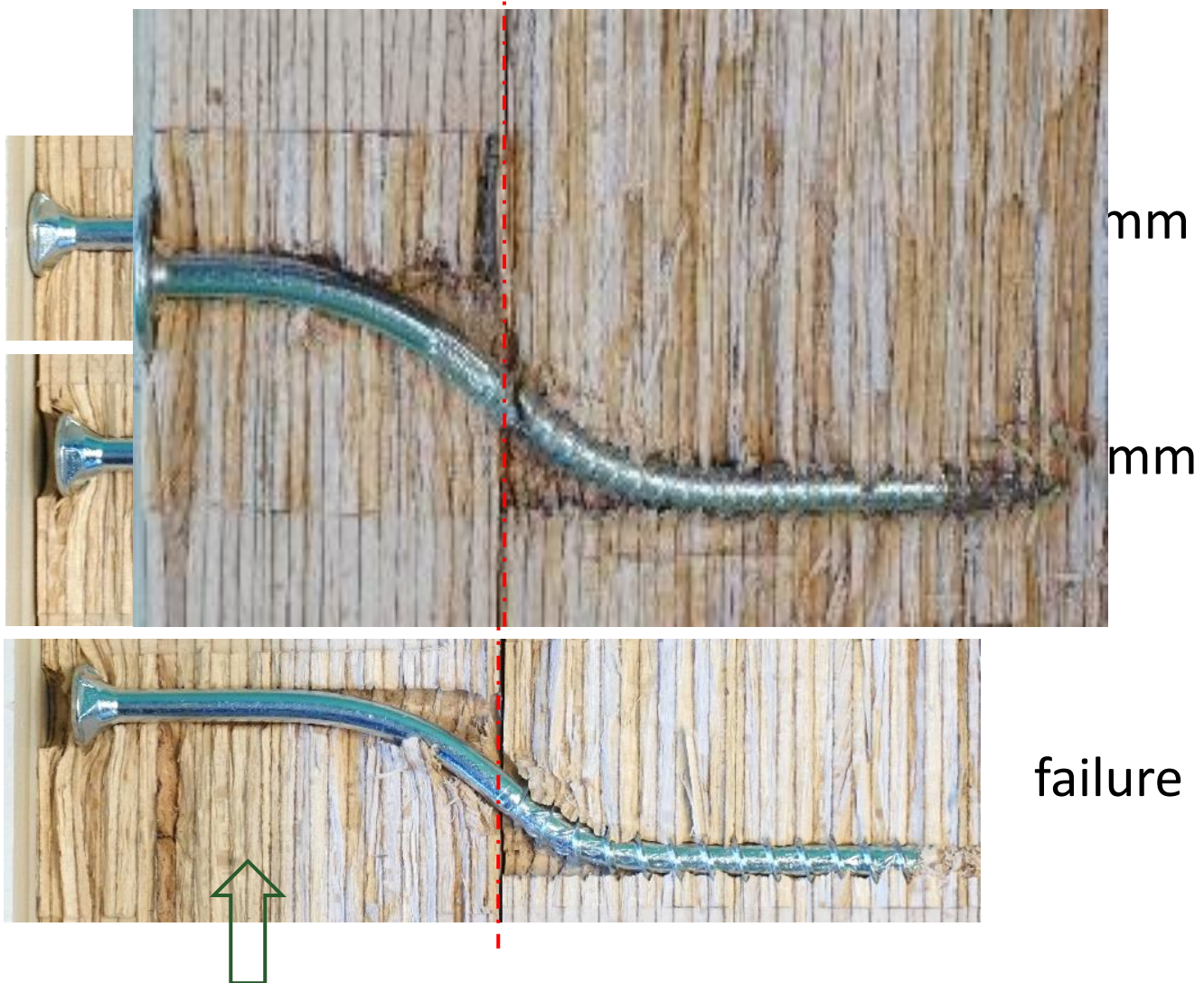
# UNDERSTAND – SOFTWOOD VERSUS HARDWOOD







# UNDERSTAND – SOFTWOOD VERSUS HARDWOOD



## Outcomes - Impact

Is the current design suitable for hardwood joints with laterally loaded fasteners?



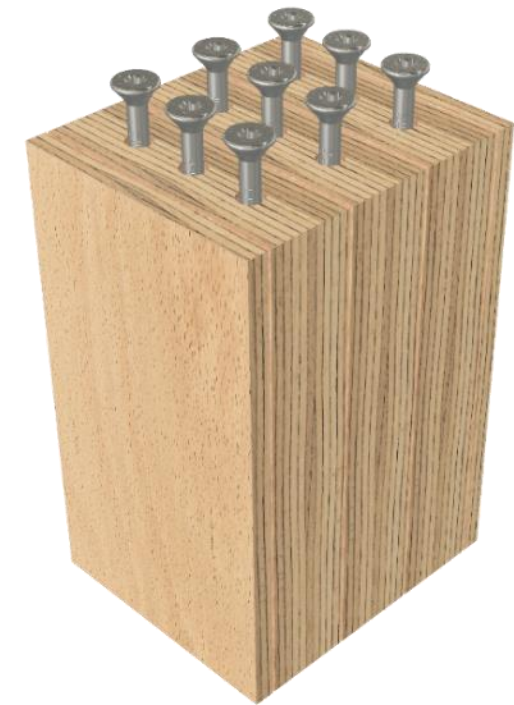
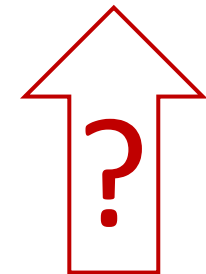
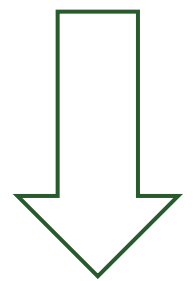
Yes, in general. Fastener failures must be accounted for. **Execution rules** depend on the combination of wood species and type of fastener.





# ForestValue

## COMPLETE







## COMPLETE – JOINTS WITH AXIALLY LOADED SCREWS

experimental campaign (short term)



$$\alpha = 90^\circ$$



$$\alpha \leq 45^\circ$$



$$\alpha = 0^\circ$$

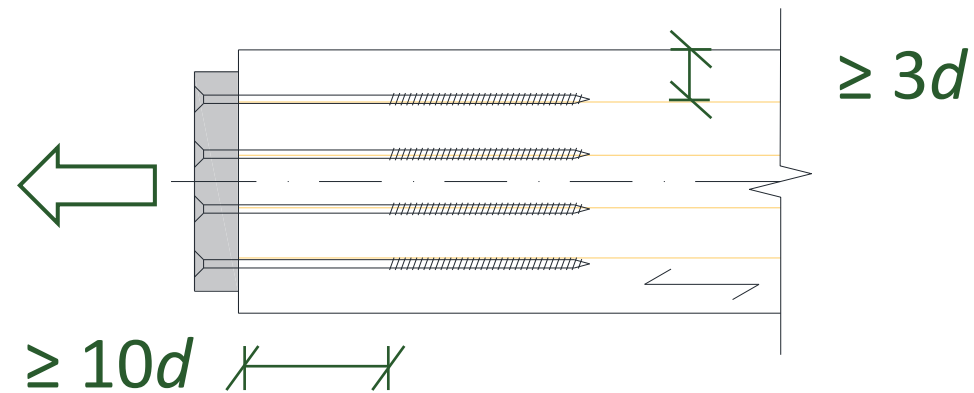
experimental campaign (long term)





## COMPLETE – EXECUTION RULES

### Example for end-grain joints



Predrilling required

## Outcomes - Impact

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Are design rules available for hardwood joints with axially loaded screws?



Yes, if **minimum geometric conditions and further execution rules** are respected.



## OPTIMISE



Laterally loaded fasteners



Axially loaded screws



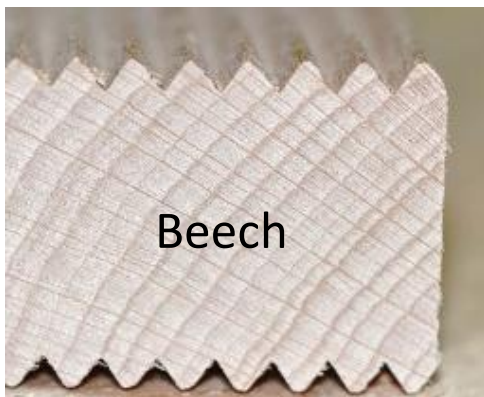
Increase stiffness and capacity





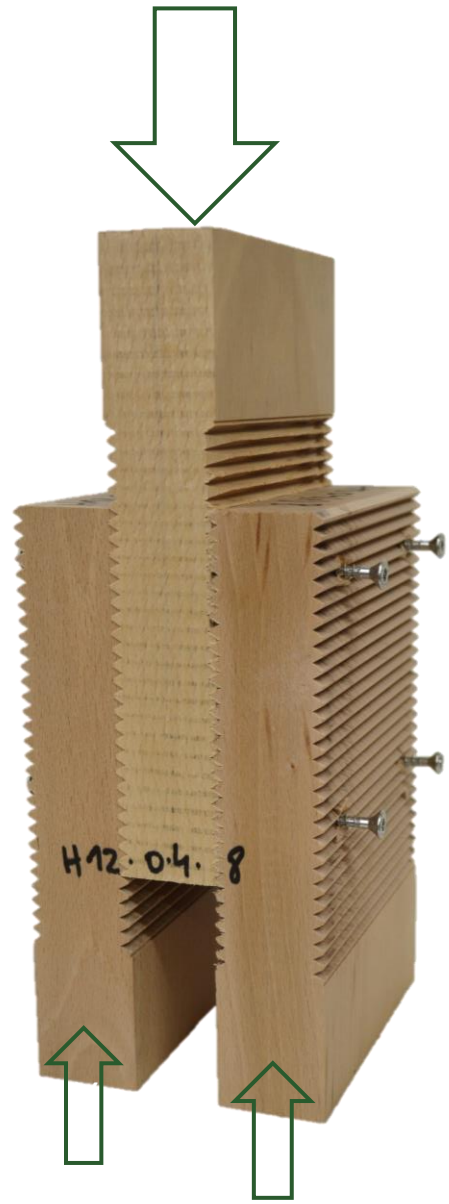
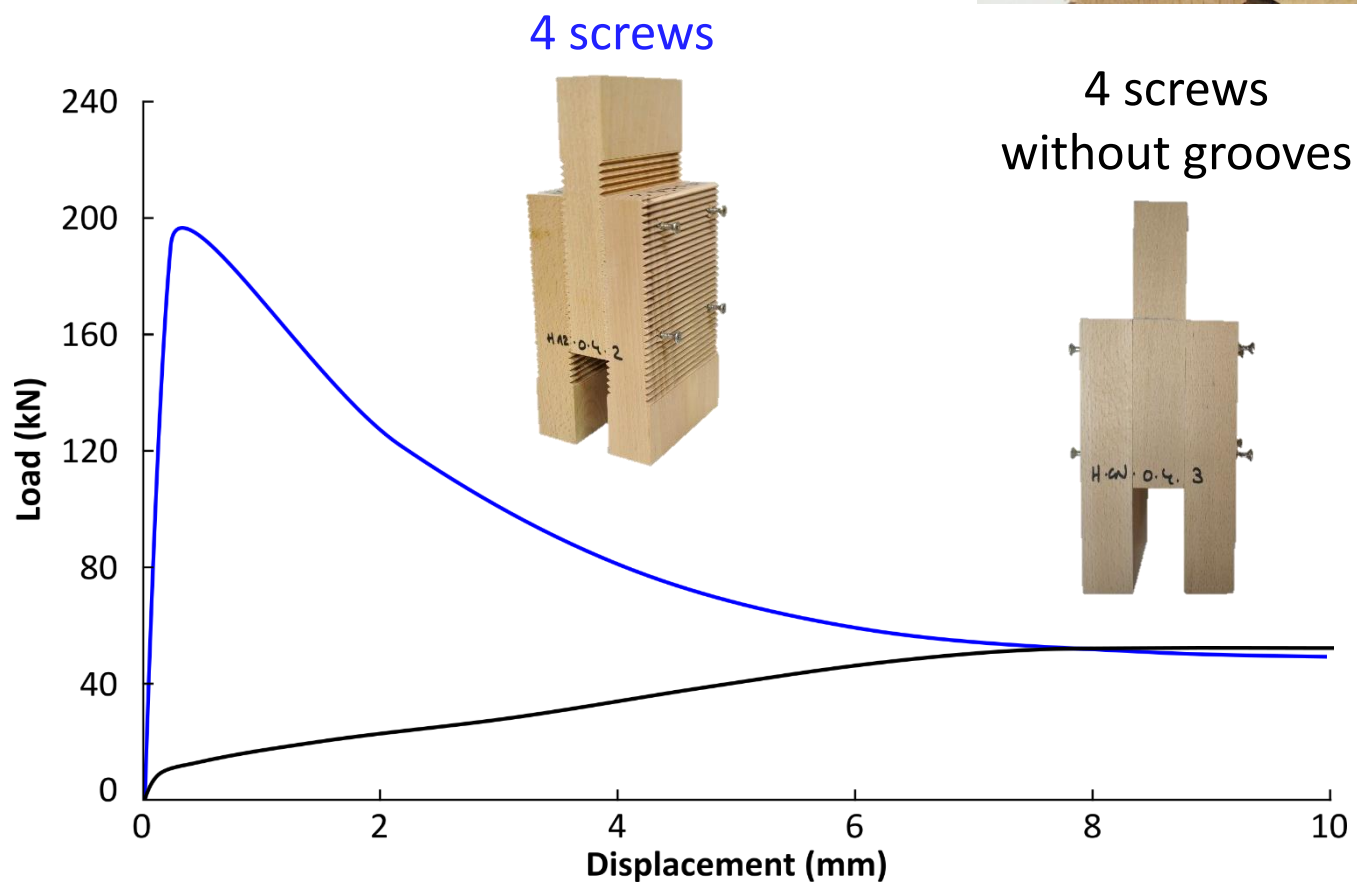
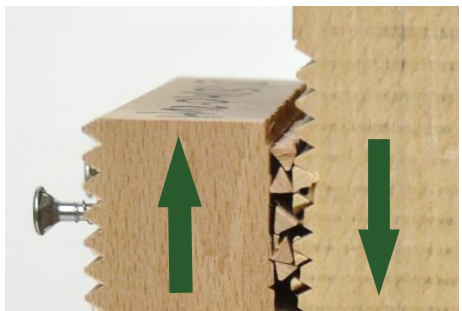


# OPTIMISE – ROUGH SURFACES





OPTIMISE – ROUGH SURFACES



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Are design rules available for hardwood joints with axially loaded screws?



Yes, if **minimum geometric conditions and further execution rules** are respected.

Can hardwood joints be optimised in terms of stiffness and capacity?



Yes. Further influences such as **changes of moisture content** need to be considered.





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...hardwood joints are more than only design models...





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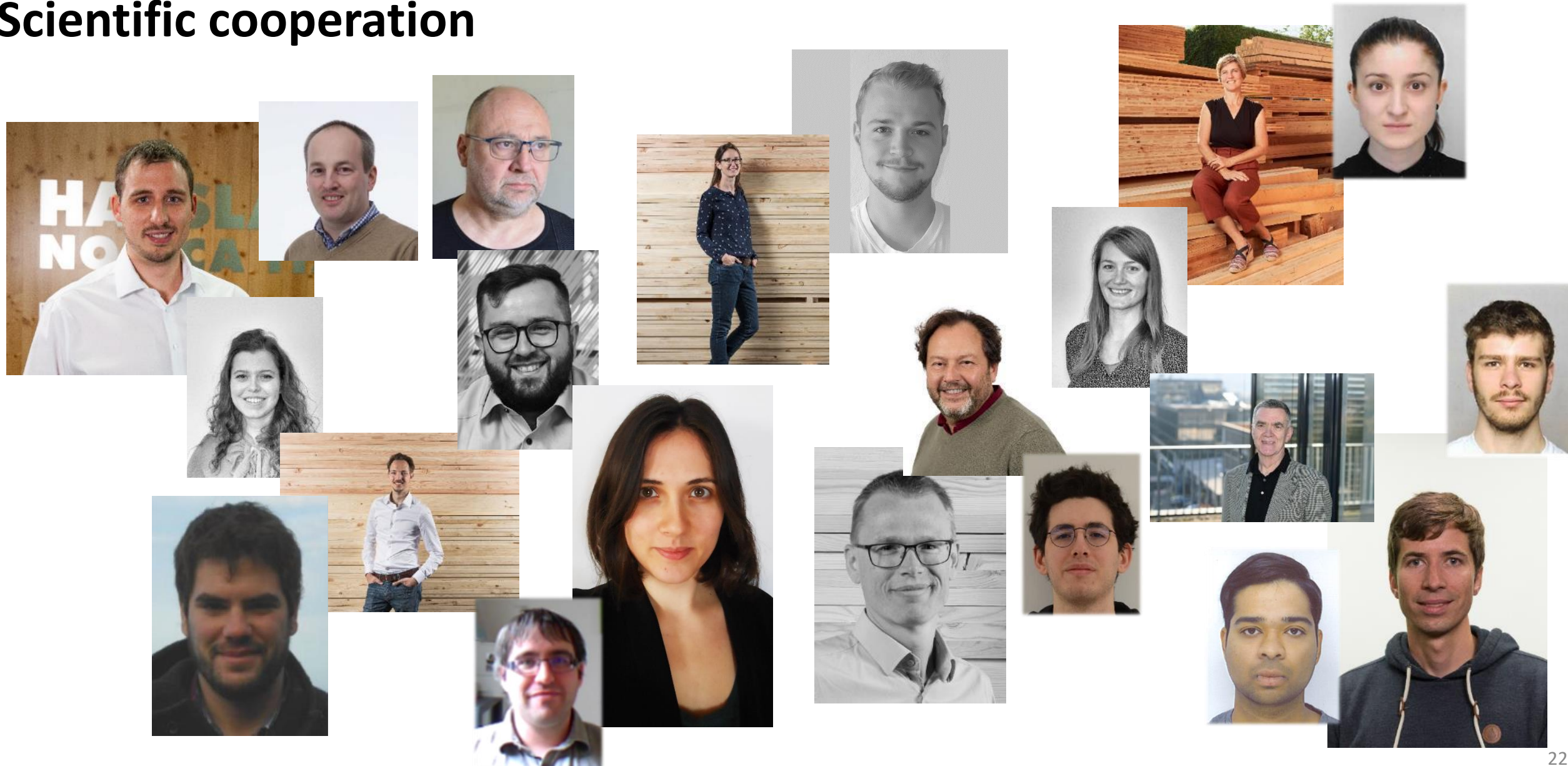


Yes. Further influences such as changes of moisture content need to be considered.

More diversity in timber building sector



## Scientific cooperation



**Thank you!**

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**ForestValue**

Website: <https://forestvalue.org/>

Twitter: <https://twitter.com/ForestValue2017>

LinkedIn: <https://www.linkedin.com/groups/12110816/>