Dowel type joints –

Influence of moisture changes and dowel surface smoothness

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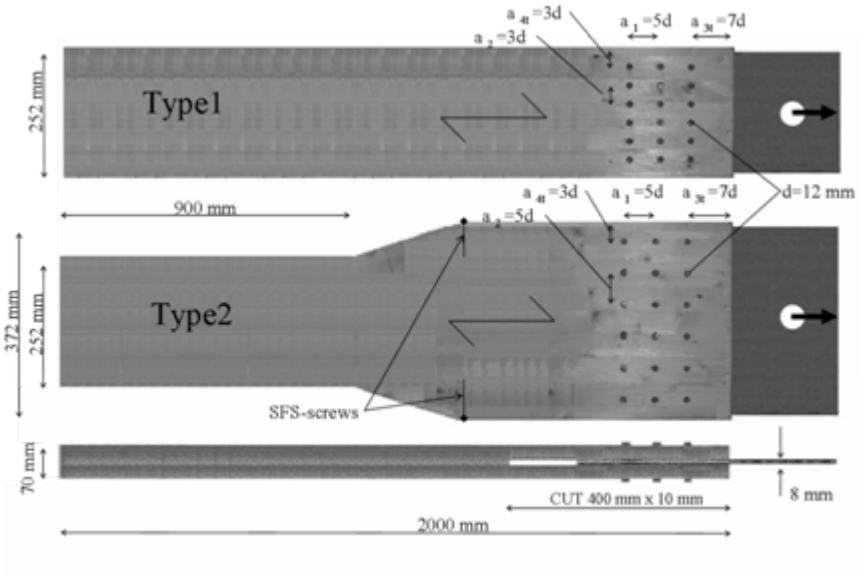
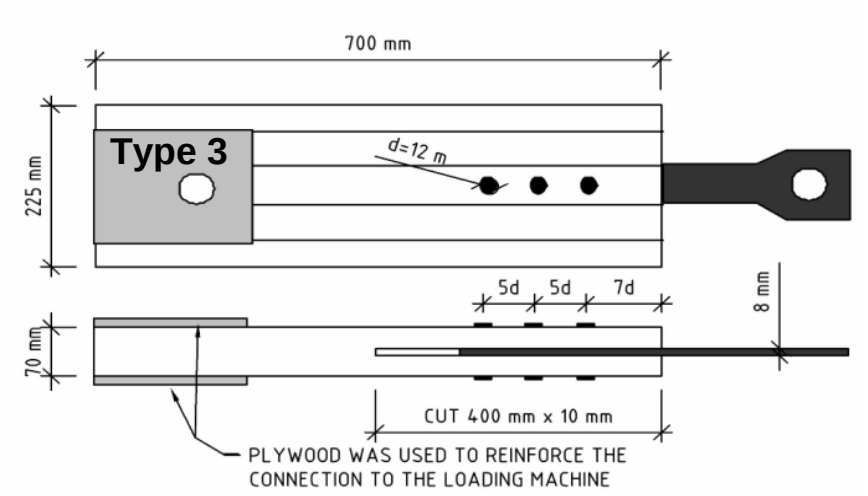
Outline

- Recent research – On the influence of moisture variations
- Digital image correlation – Measuring strain distributions
- Very recent research – Influence of dowel-wood friction
- Relation to COST E55 MoU
- Conclusions

Influence of moisture variations





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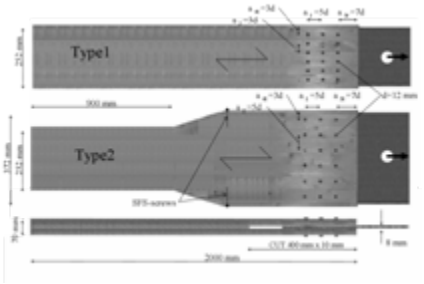
Climates

- **A:** the steel plate and the steel dowels fitted at 12% equilibrium moisture content (20ºC, 65%)

- **B:** After equilibrium moisture content of 12 %:
  - (20ºC/30% RH – 110 days) Type 1 and 2
  - (20ºC/20% RH – 3, 7, 14 or 60 days). Type 3
  - After drying, plates and dowels were fitted

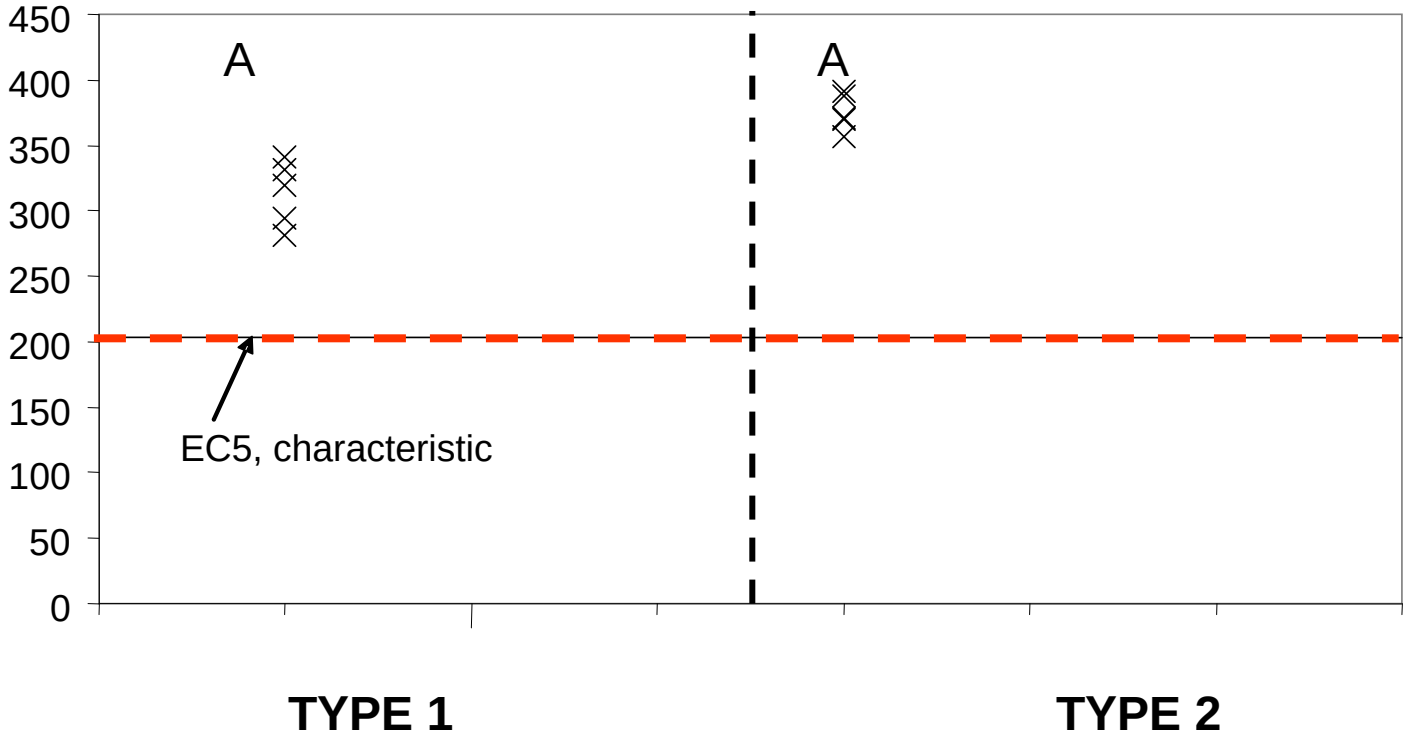
Climates

- **C:** Steel plate and the steel dowels were fitted at 12% EMC. The climate was then changed to one of 20ºC, 30% RH – 110 days



Type 1 and 2 joints

Load-bearing capacity, [kN]



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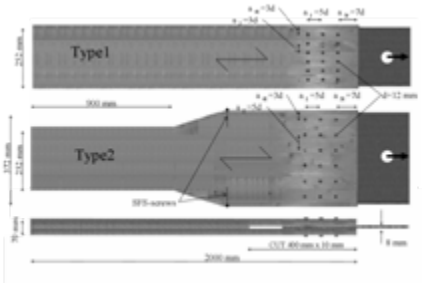
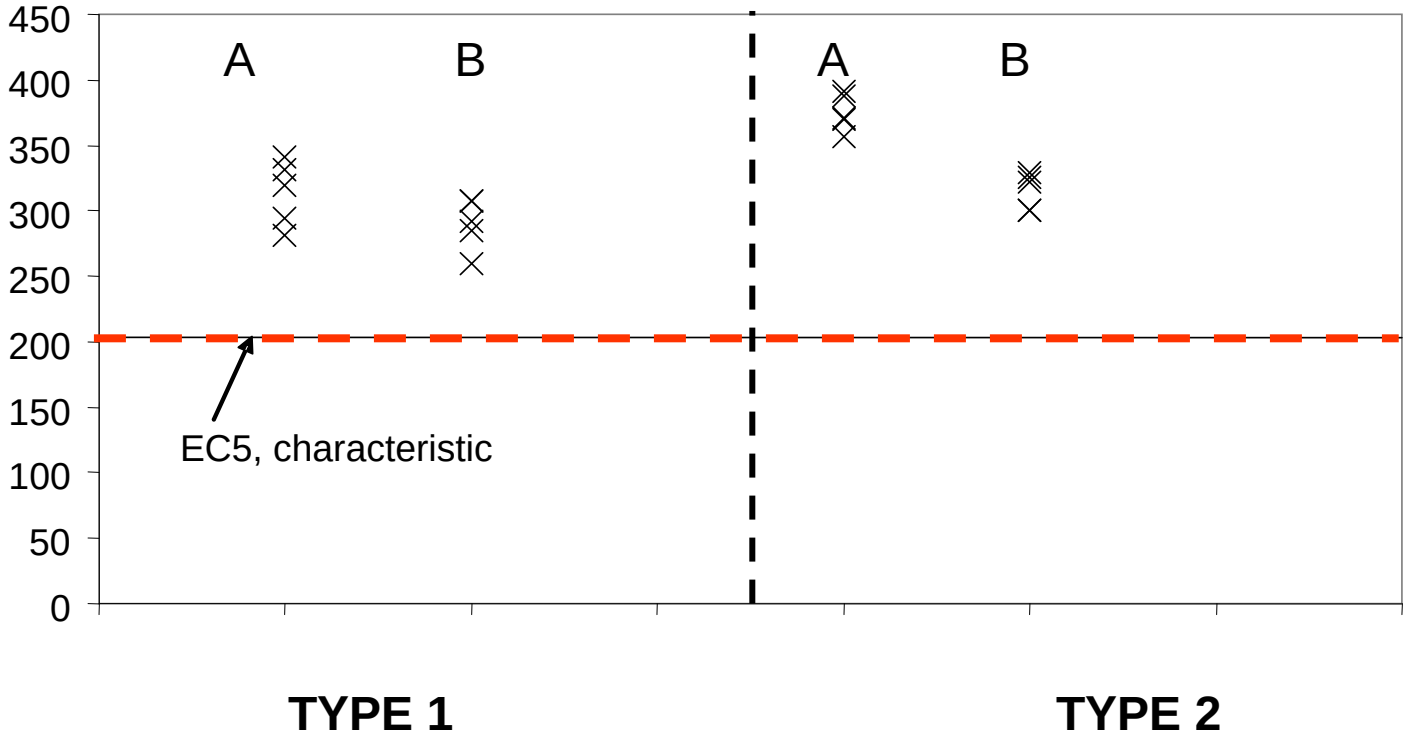


Type 1 and 2 joints

Load-bearing capacity, [kN]



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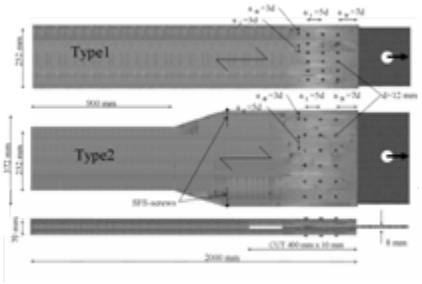
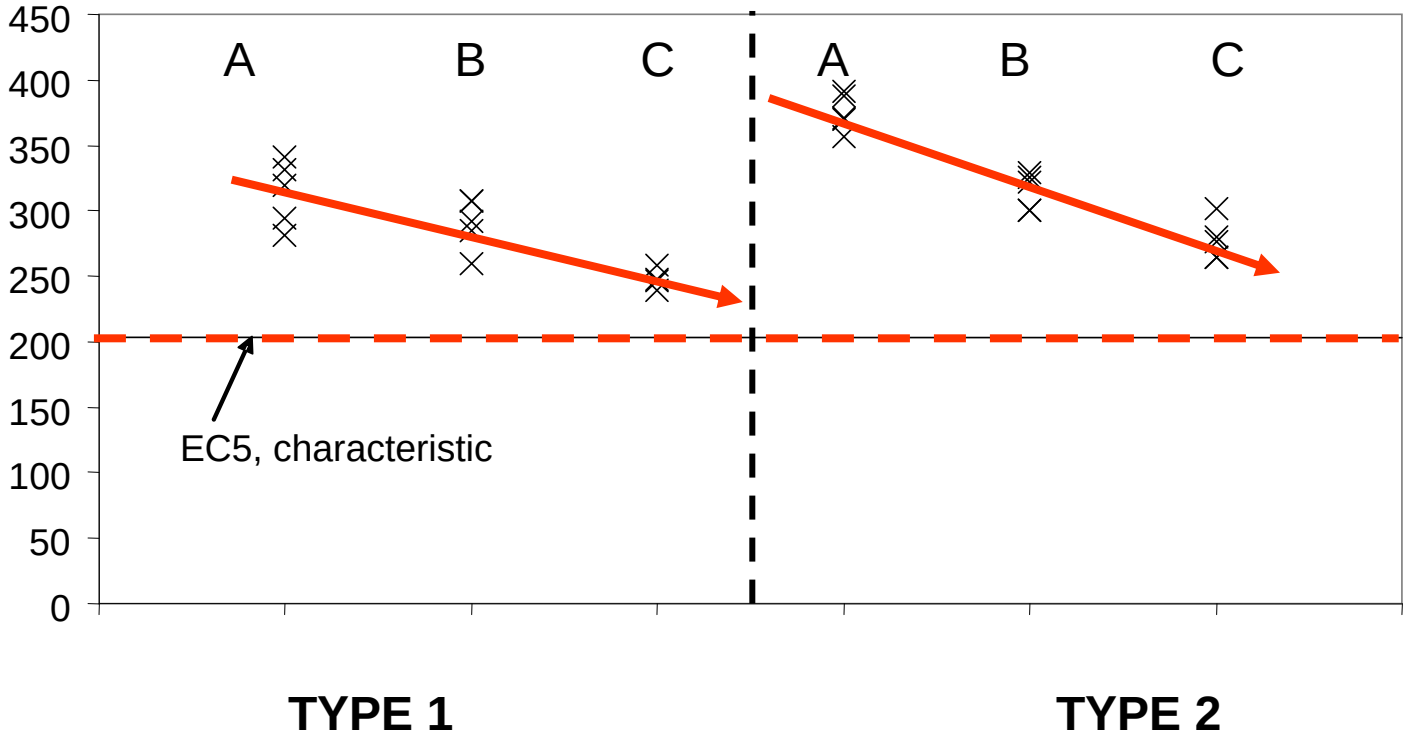


Type 1 and 2 joints

Load-bearing capacity, [kN]



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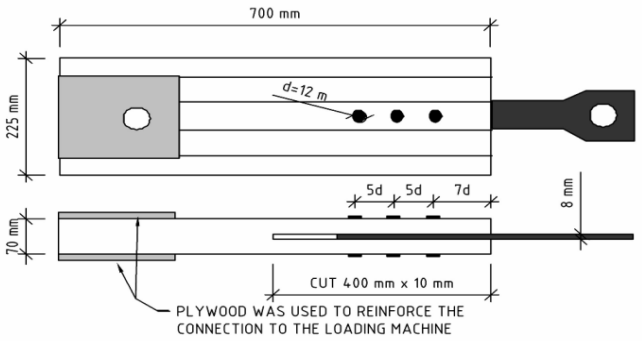
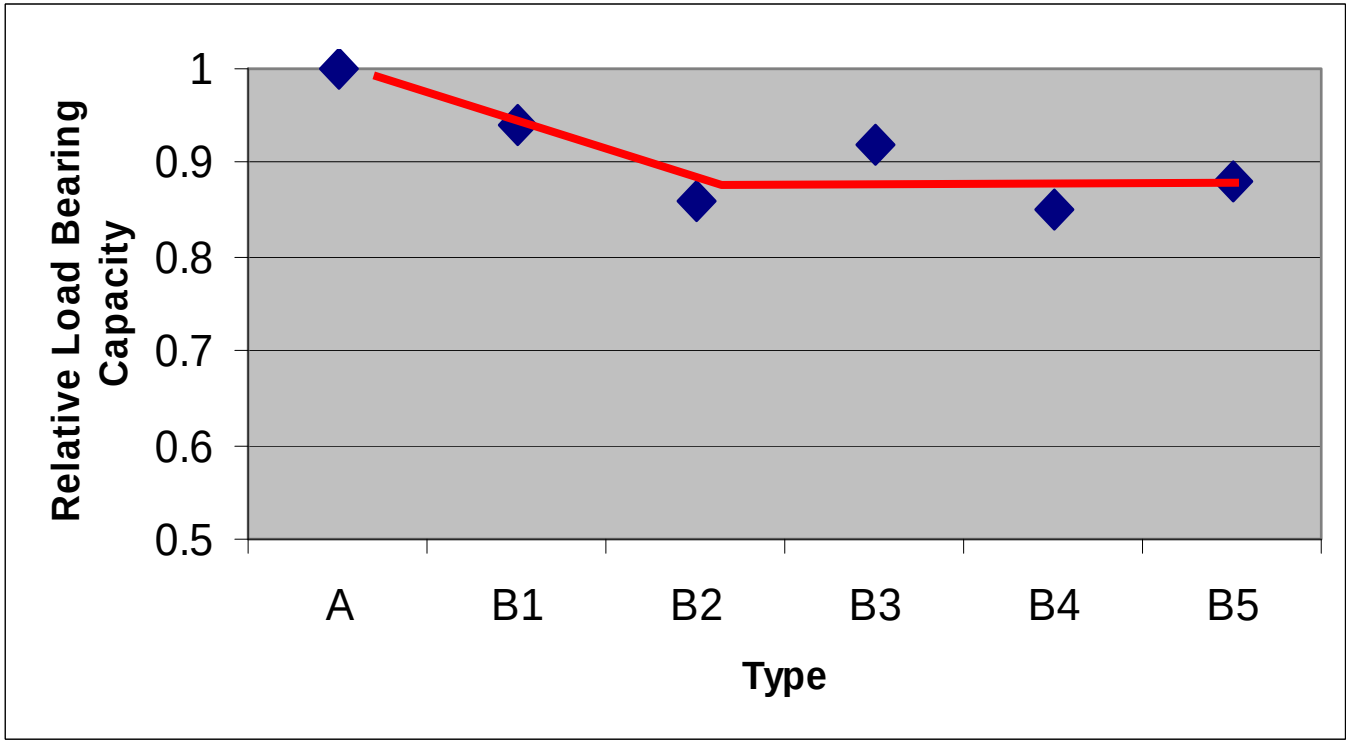


Type 3



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Contact free deformation measurements

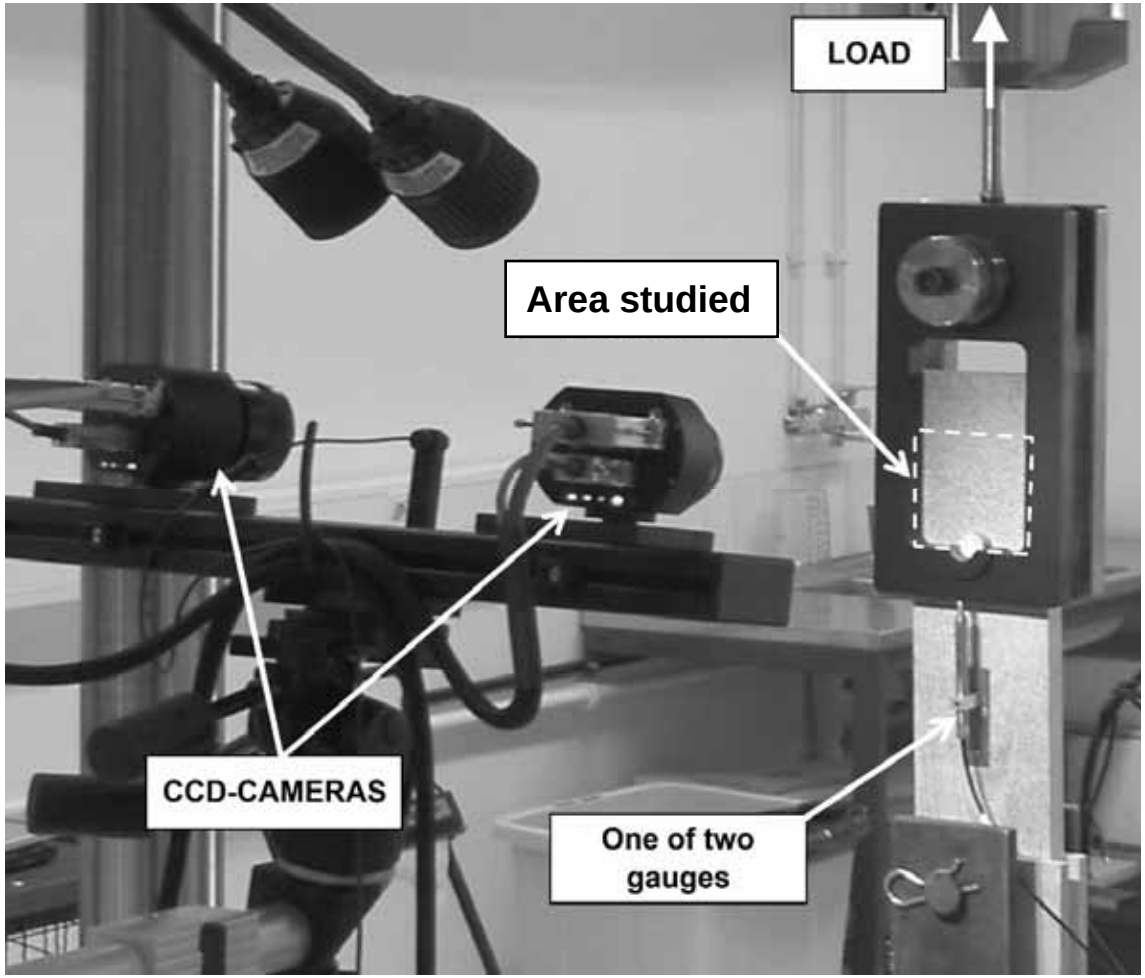
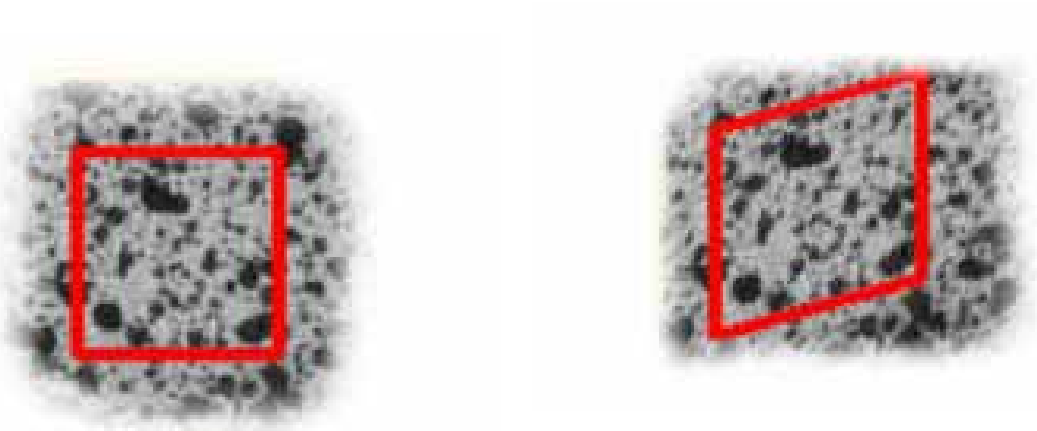
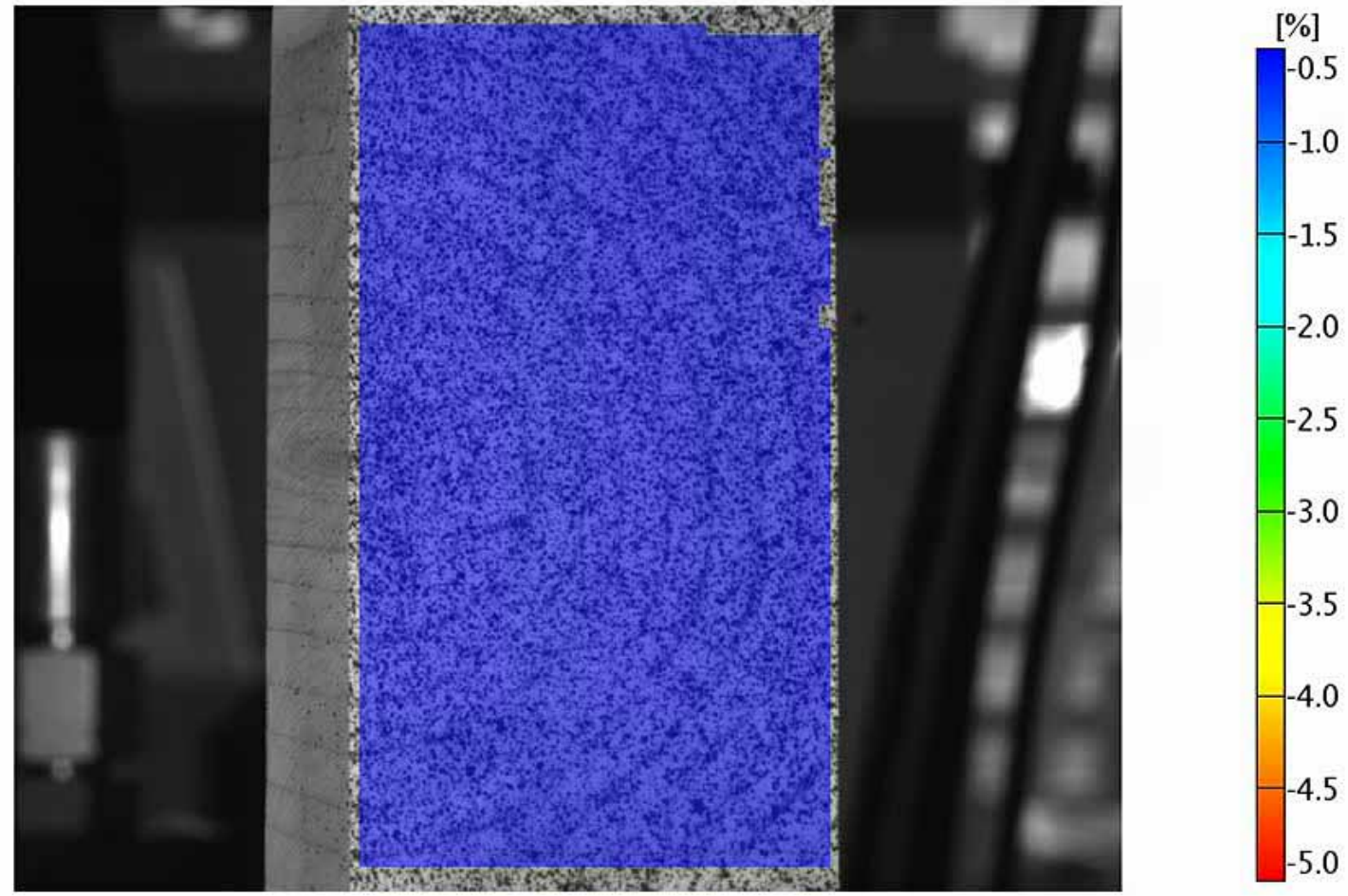


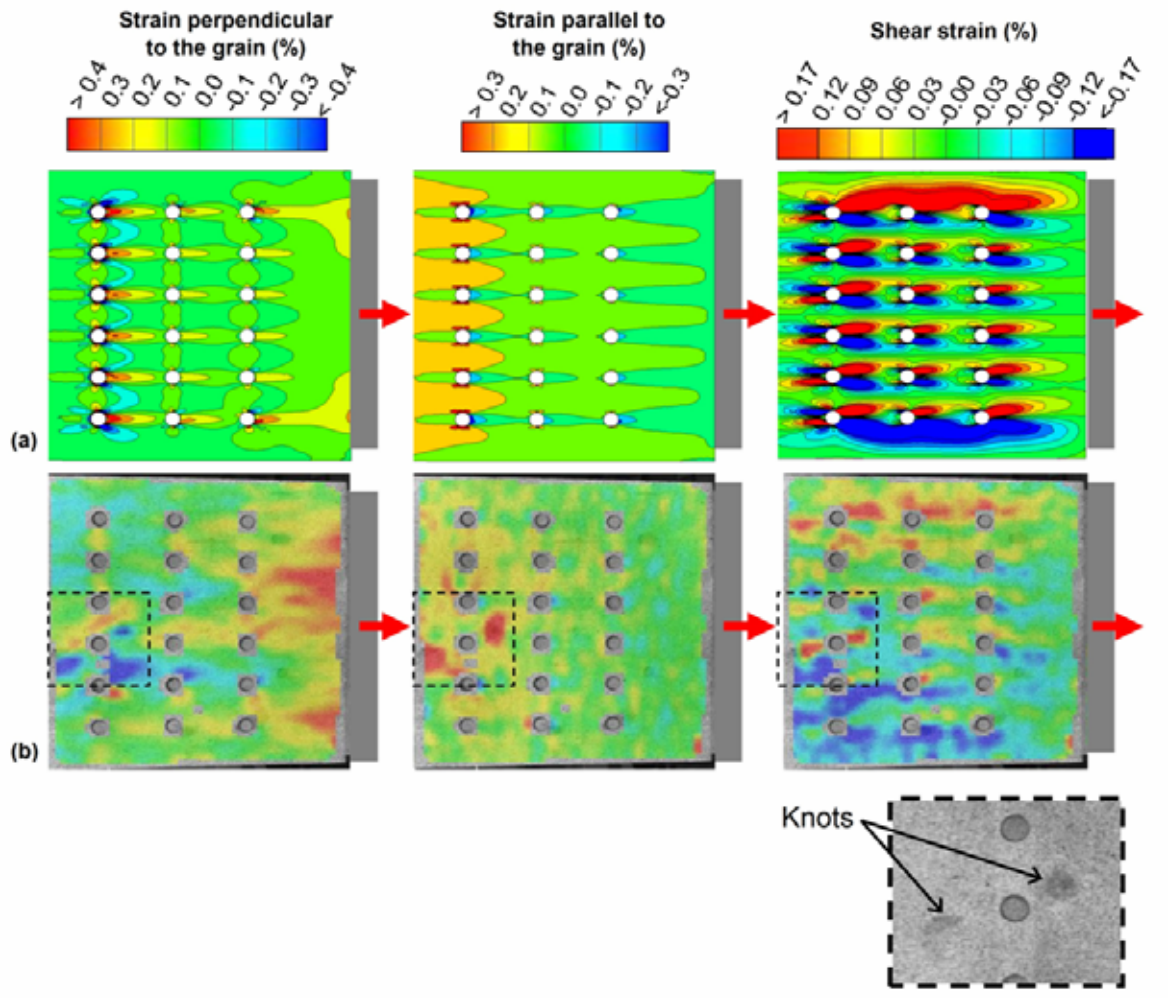
Image correlation

- Sub picture facets are tracked throughout the loading sequence
- Location and shape of facets can be determined (sub-pixel accuracy)




es01
Nominell spänning: 0.000000 MPa
Epsilon Y
[%]
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0

Strain analysis and measurements



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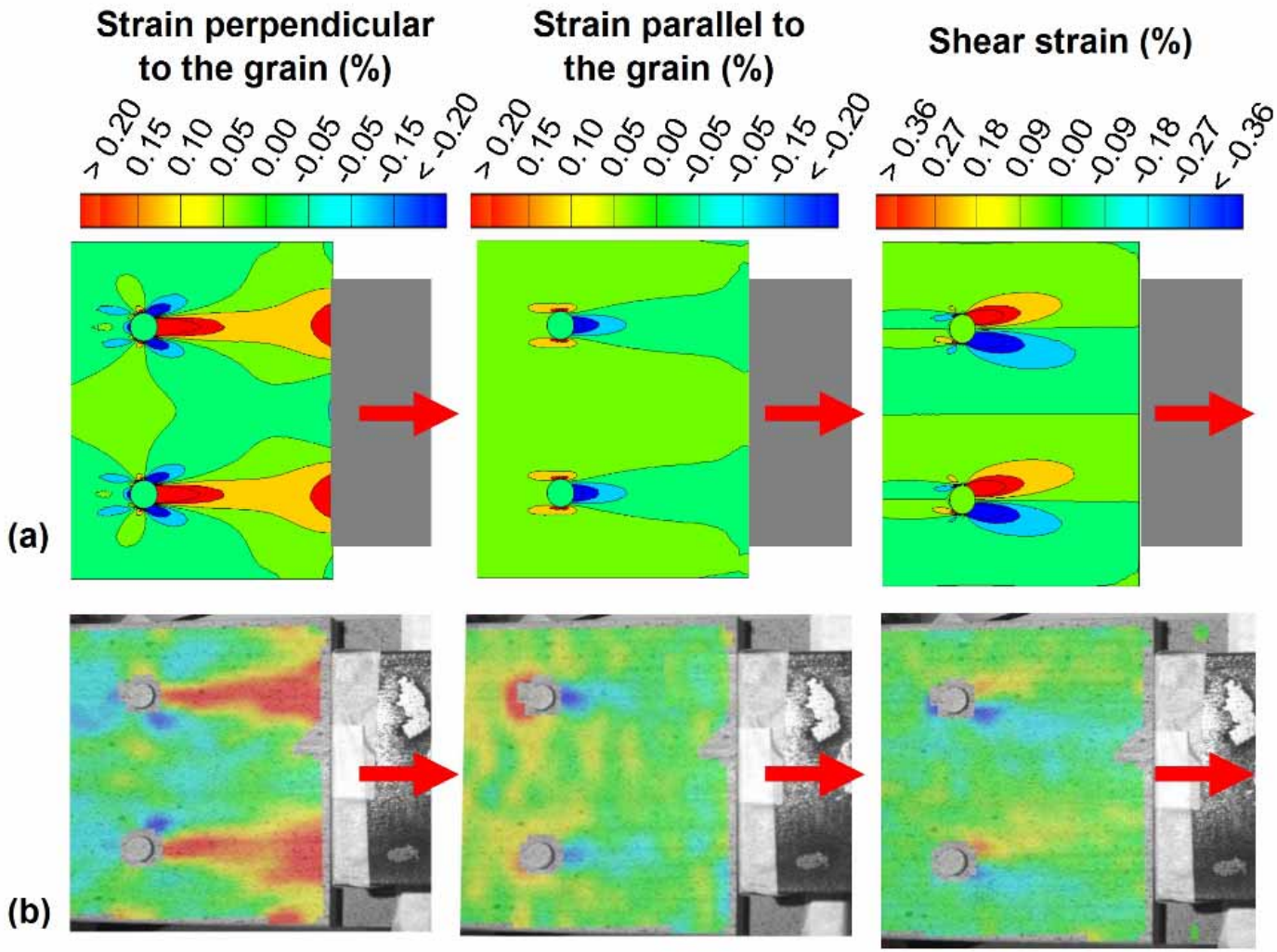
Strain analysis and measurements



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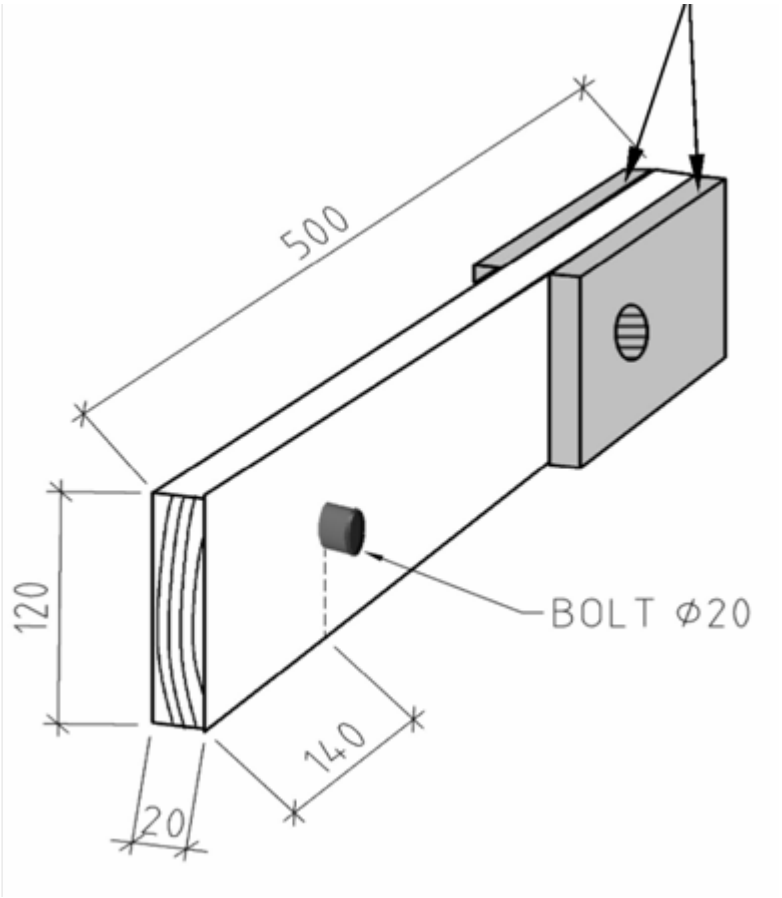
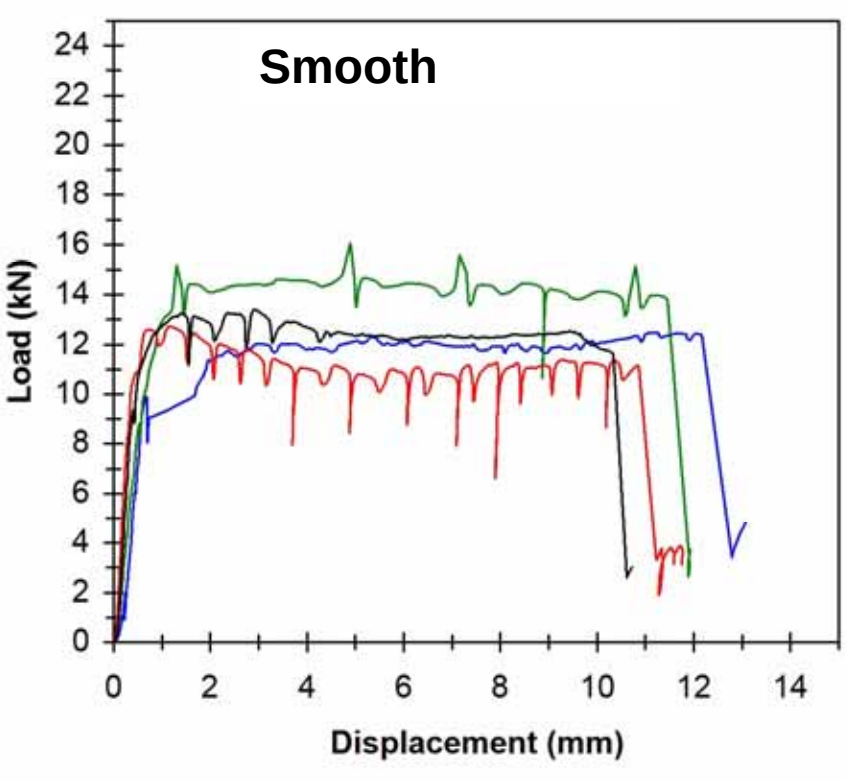
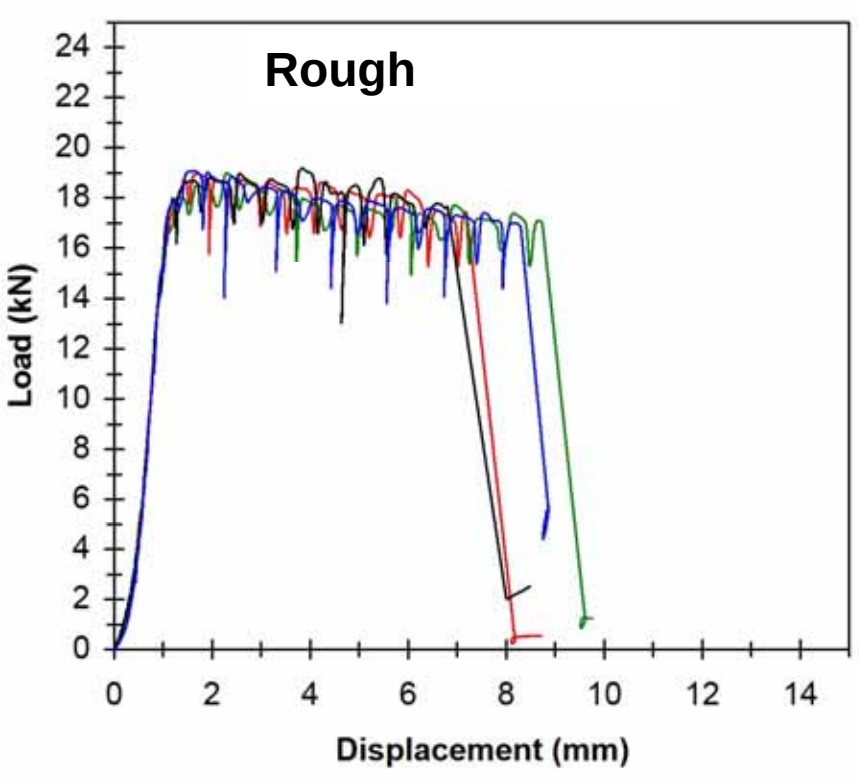
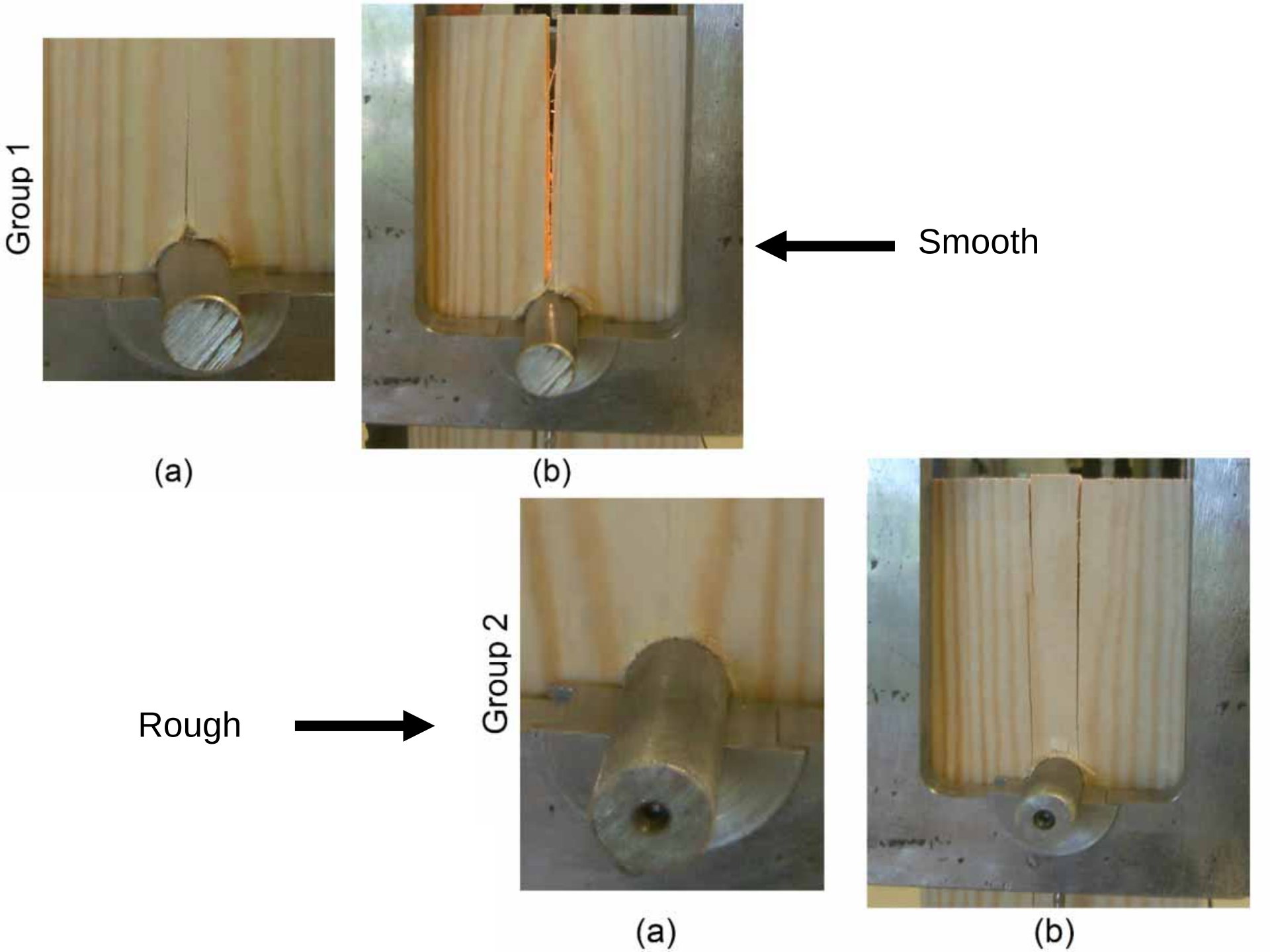
Influence of friction



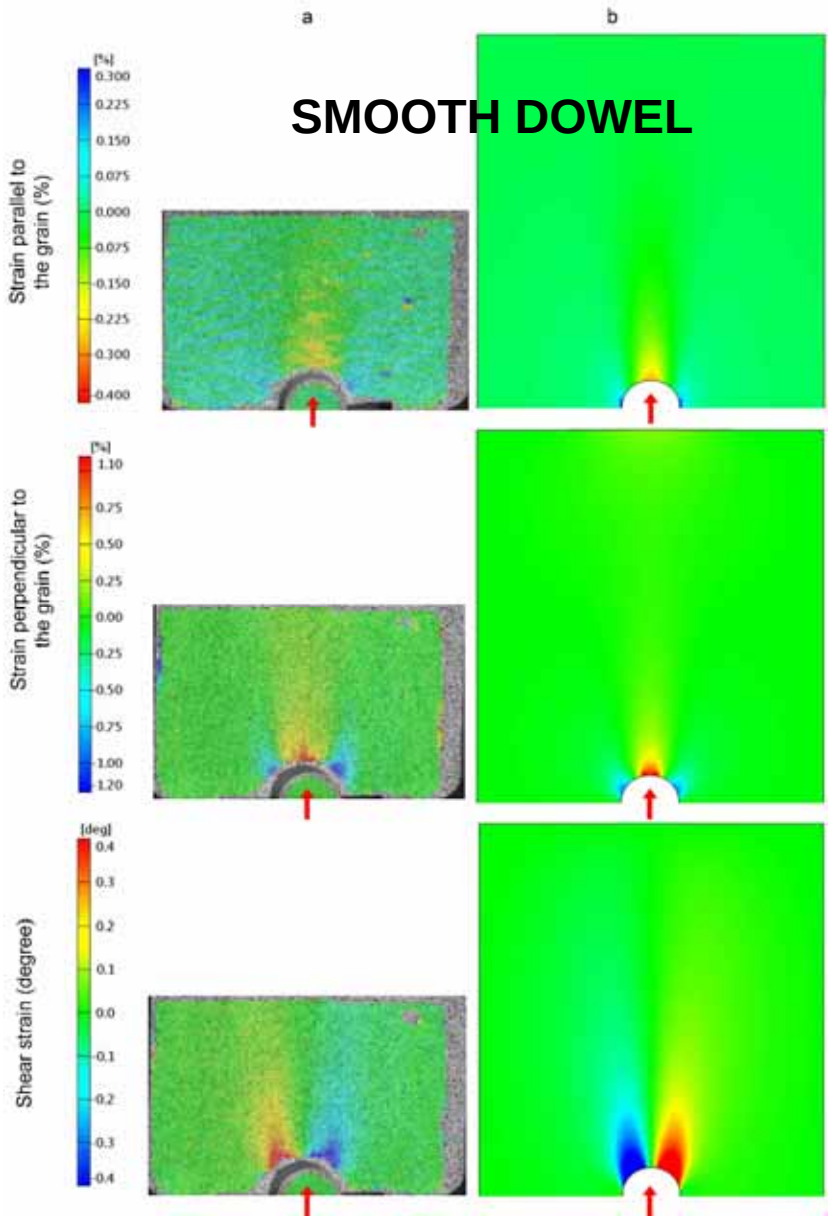
Results

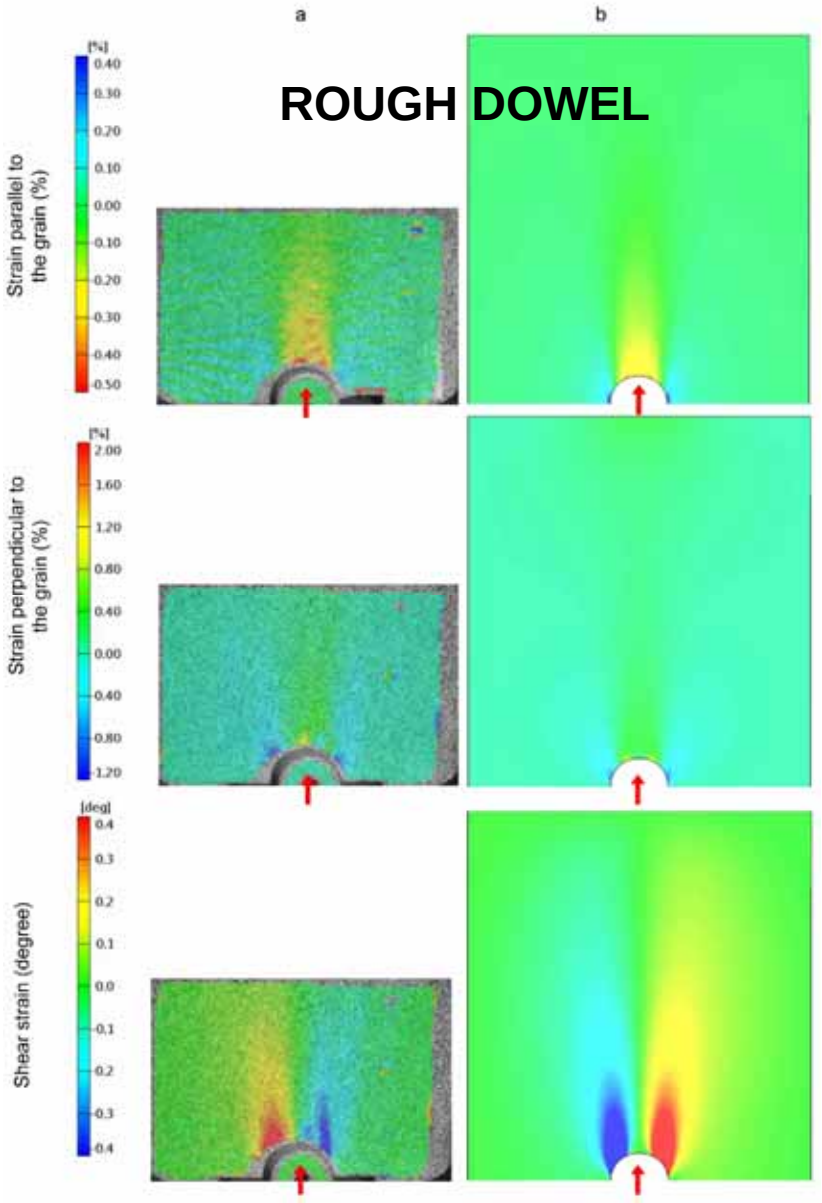

Smooth
Load (kN)
Displacement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24


Rough
Load (kN)
Displacement (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24

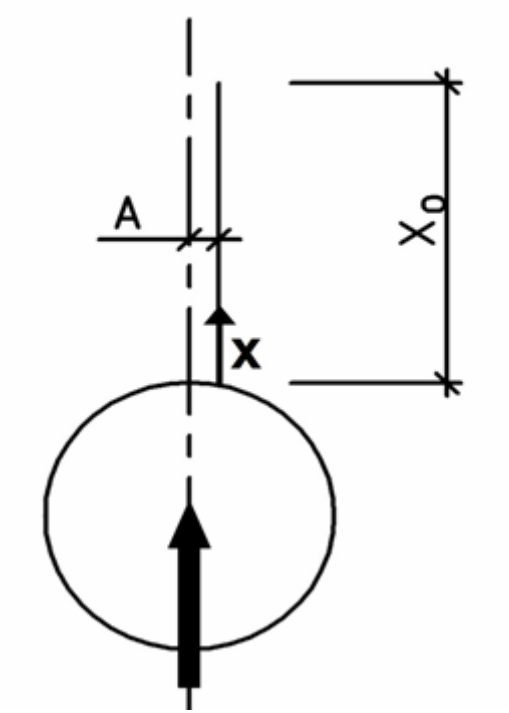

Group 1
Smooth
(a)
(b)
Rough
Group 2
(a)
(b)

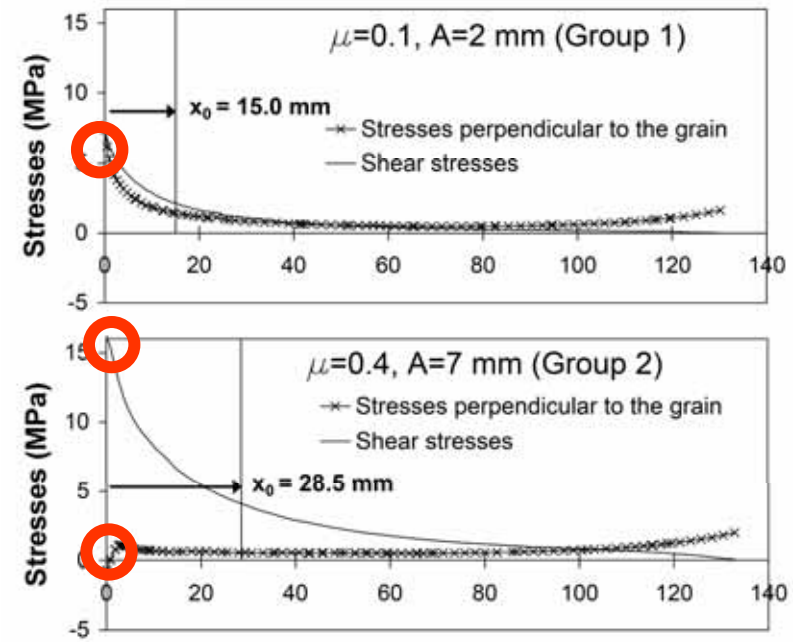
FEA vs. Measurements





Calculation of load bearing capacity





Shear strength 15 MPa – OK!

Tensile strength perp. Approx 9 MPa – Not OK!!!

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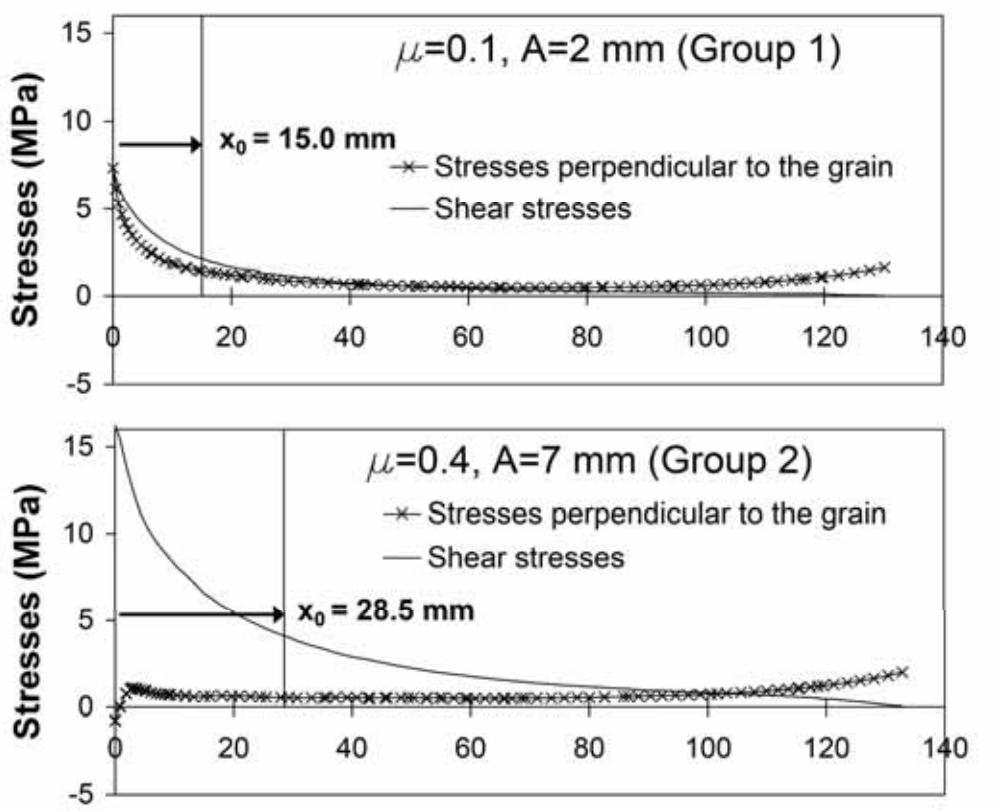
Mean stress criterion



- Calculate mean stress along line X_0
- X_0 calculated from: stiffness, strength, fracture energy

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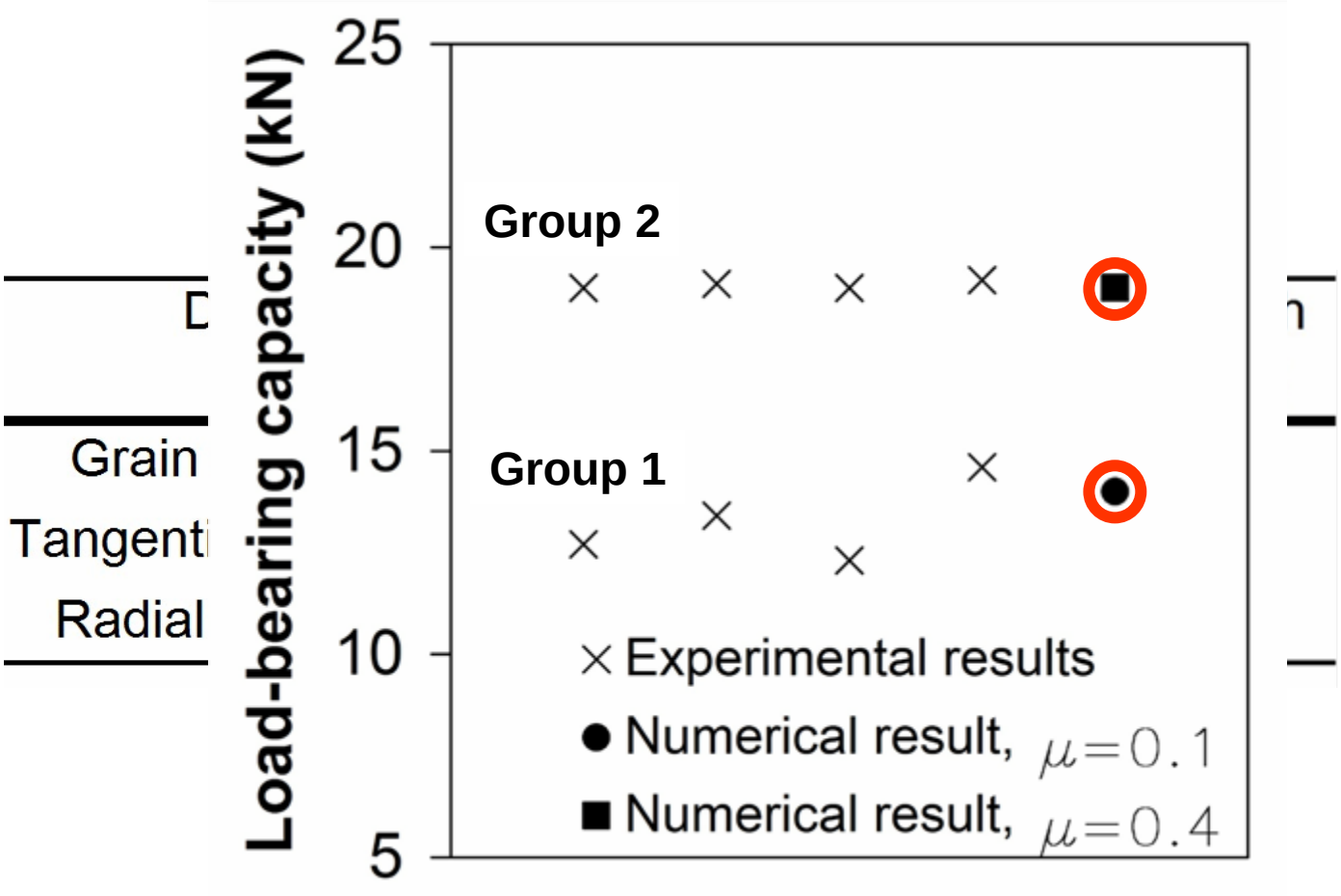
Using fracture mechanics



Conclusions

- Parameters to be included
  - Moisture variations
  - Friction
- Calculation models
  - Include moisture variations as eq. load?
  - Explicitly include surface roughness
  - Fracture mechanics...

Relation to MOU

- to improve the understanding about typical design and assessment situations as well as the circumstances, including exposure conditions leading to inadequate performance;

- to improve the fundamental understanding of timber material and engineered timber products, such as glued laminated timber, as well as the understanding of connections for efficient and reliable use in production and service;

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Relation to MOU

Long-term objectives; based on the theoretical and methodical achievements developed during the Action:

- to establish a rational basis for the design and assessment of timber structures ensuring that the full potential of the use of timber material as a sustainable construction material may be used for the benefit of the timber industry and society in general;
- to provide a basis for assessing the real need for targeted future research activities regarding the service-life aspects of high performance timber structures.

Conclusions

- Influence of moisture variations (drying from 20/65)
  - Plates/dowels prevent shrinkage
  - Moisture gradients in “free shrinkage”
- Discussion on relation to service classes
- Influence of dowel friction
- Digital image correlation – valuable
- Fracture mechanics could be useful