On the consideration of moisture induced stresses in timber structural design

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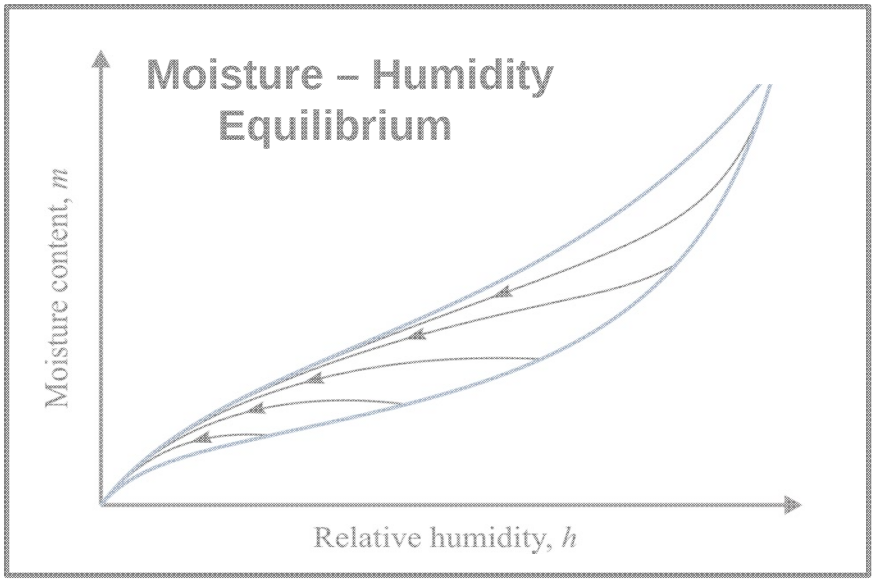
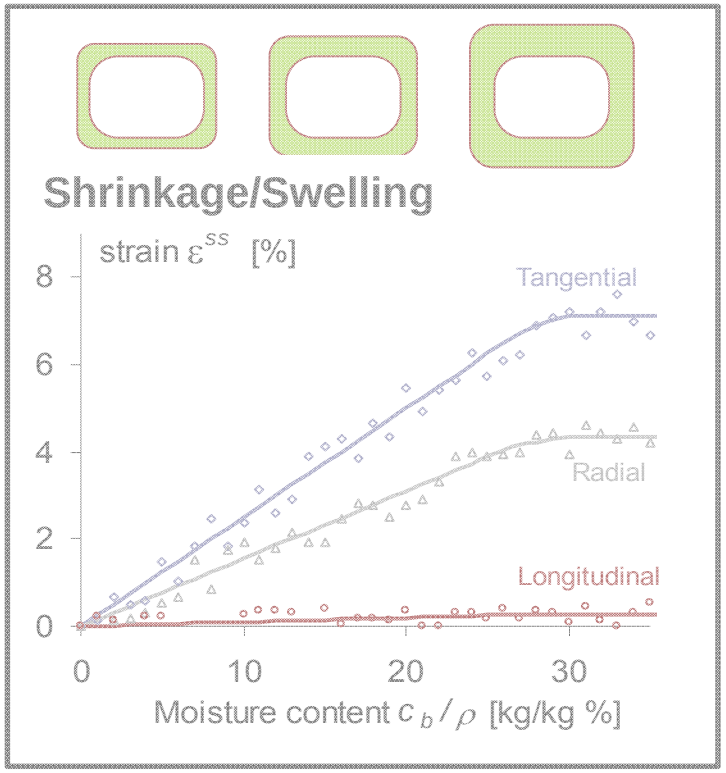
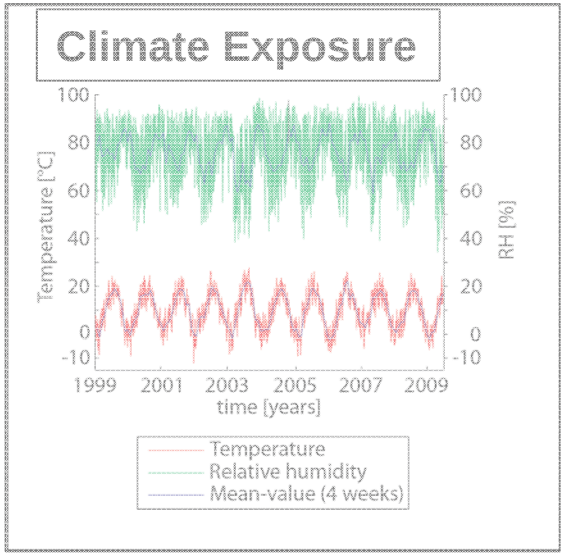
Overview

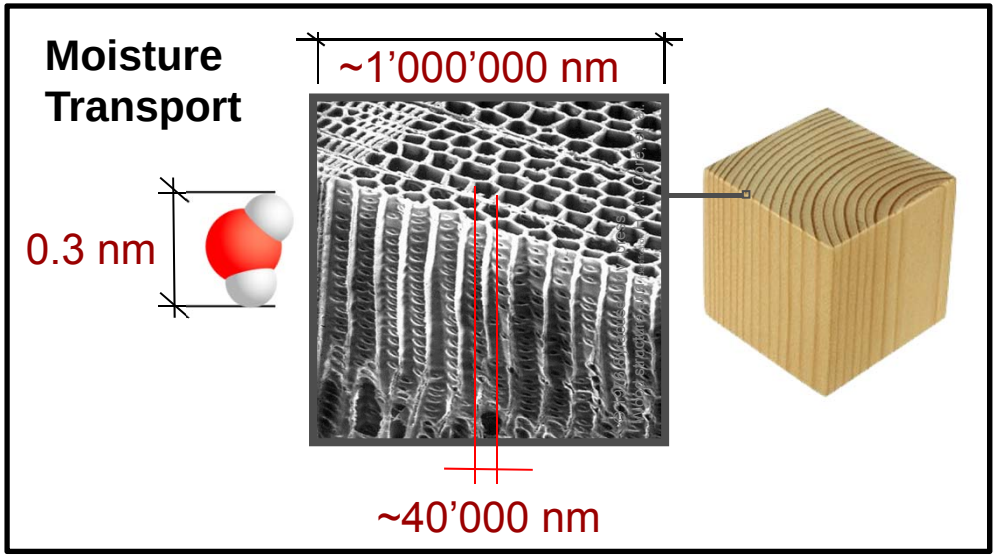
- Problem setting
- Design codes, present
- Analysis of failures and malfunctions
- Moisture induced stresses, explicit
- Implications and outlook

Problem setting









Design codes, present

e.g. EUROCODES BUILDING THE FUTURE

$$r_d = k_{\mathrm{mod}} \frac{r_k}{\gamma_m}$$

$k_{\mathrm{mod}} = 1$: Climate and loading conditions similar to standard test conditions

$k_{\mathrm{mod}} \neq 1$: Climate and loading conditions depart from standard test conditions

$\longrightarrow$ Choice depending on 3 x 3 climate and load classes.

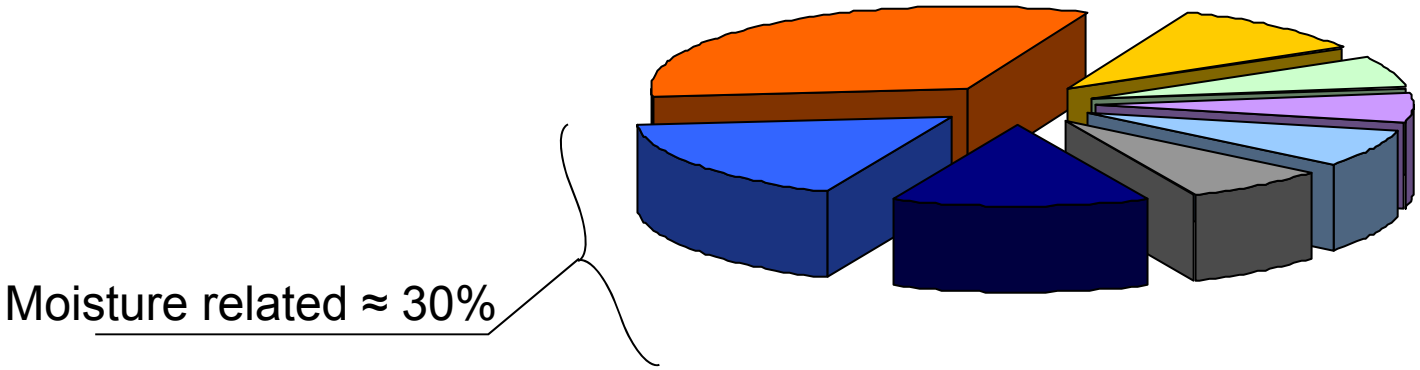
- Load duration classes, the 'shortest' in the combination is relevant
- Climate classes only with direct criteria for absolute surrounding RH

Analysis of failures and malfunctions

COST E55 WG 1:

Conclusion from national surveys* on timber structure failures:

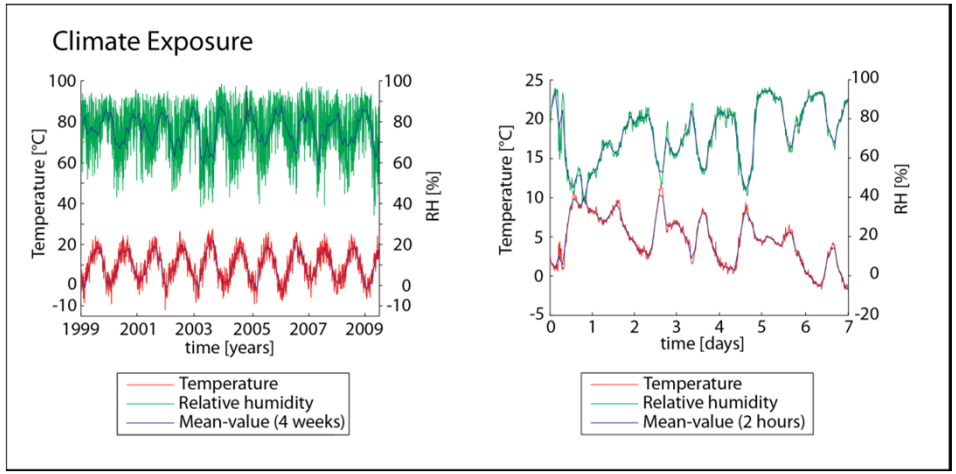
A significant part of the failures assessed were a (indirect) result of humidity and variation of humidity.

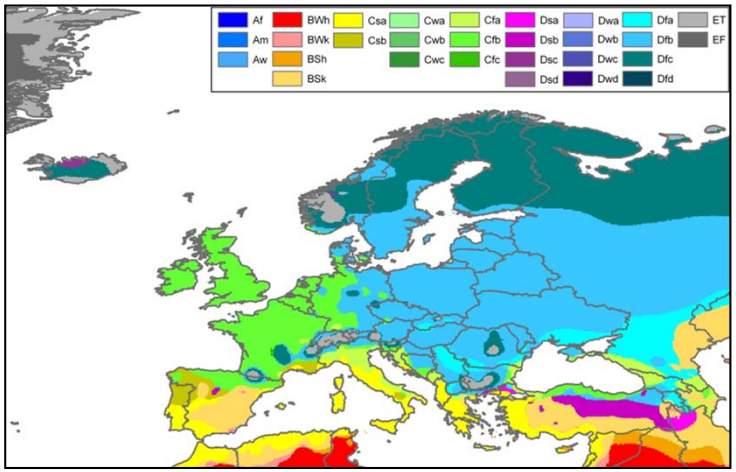


Finland, Germany, Slovenia & Sweden

Moisture induced stresses, explicit

1. Climate exposure:

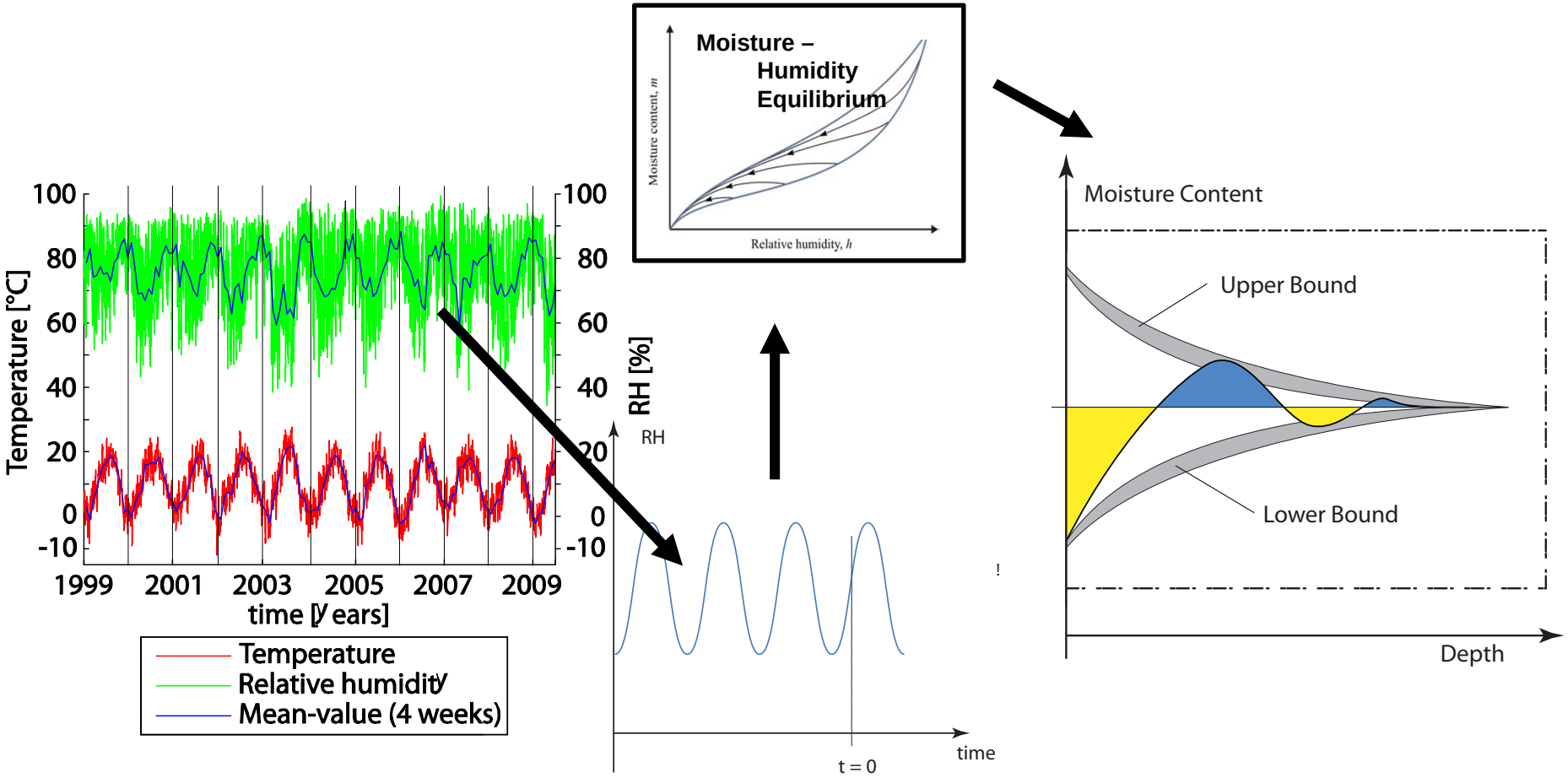




- Relevant period dependent on scale / treatment of components
- Extremes are relevant
- Combination with other external loads (correlation)

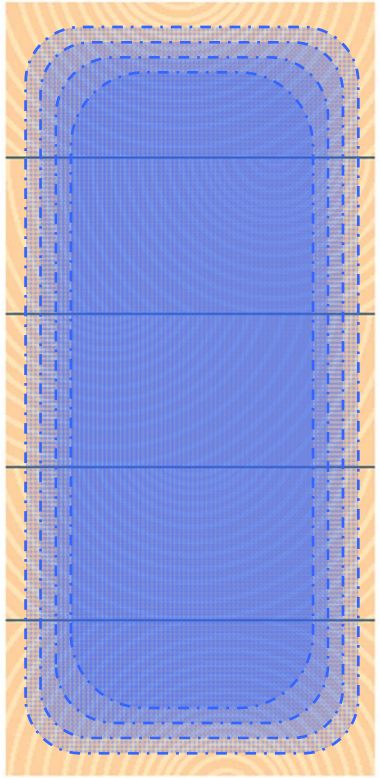
Moisture induced stresses, explicit

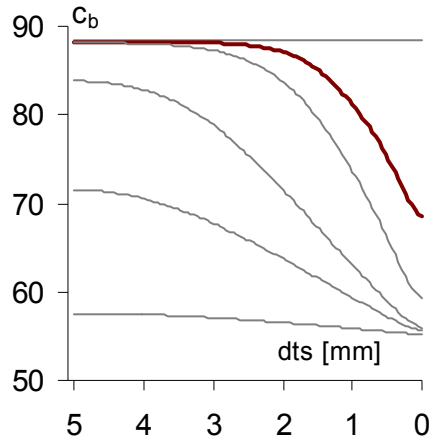
2. Moisture transport / sorption:

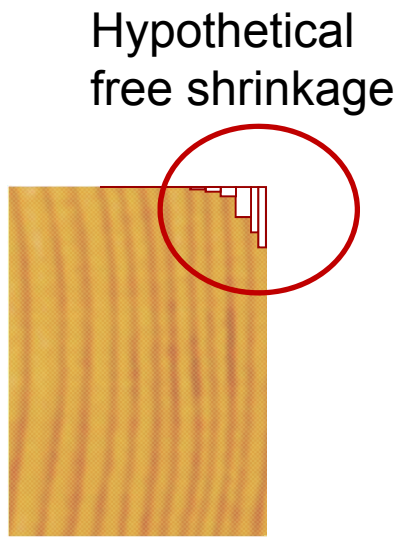


Moisture induced stresses, explicit

3. Constraint strain and stress:







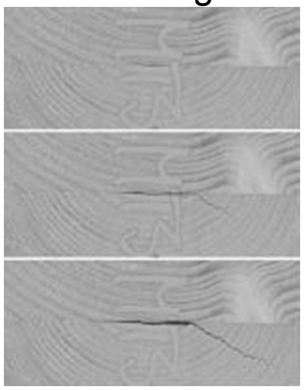
Moisture induced stresses, explicit

4. Localised fracture:

Drying

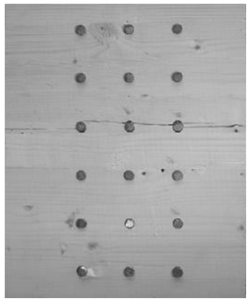
Toratti

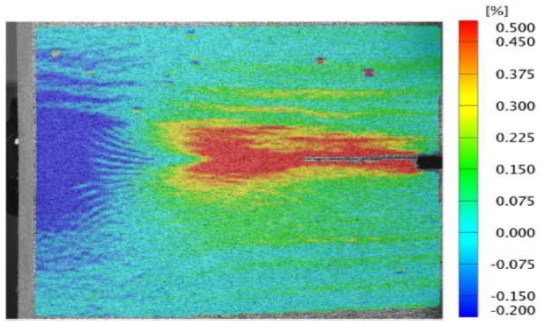
Wetting



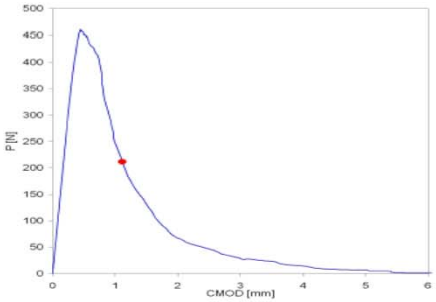
Jönsson & Thelandesson

Connections





(k) *Transverse strain,* ϵ_y



(l) *Load: 211N ; time: 254s*

Moisture induced stresses, explicit

5. Design situation and scale issue:

Design situation A:
No external load

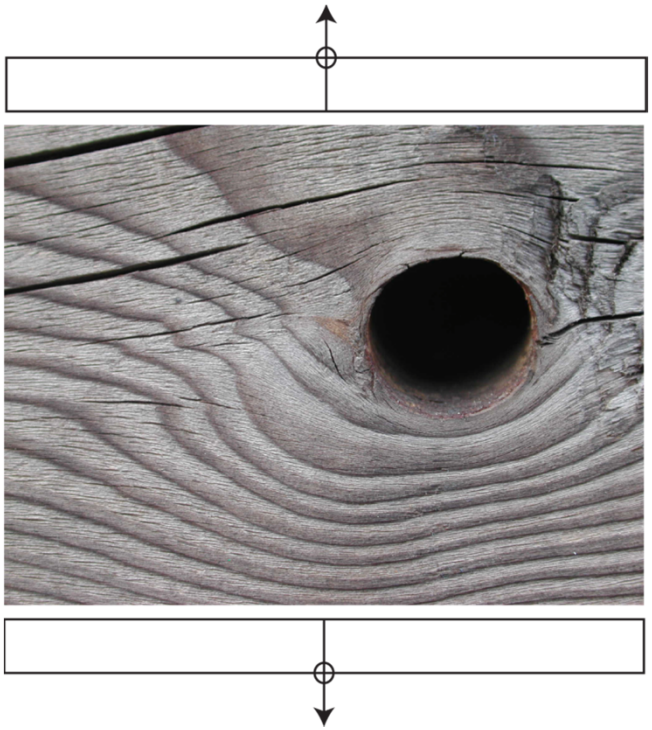
Criteria: no cracks,
serviceability

Moisture induced stresses, explicit

5. Design situation and scale issue:

Design situation B:
Load perp. to the main grain direction

Criteria: no failure, ultimate



Superposition of external load effects with estimations of MIS

Moisture induced stresses, explicit

5. Design situation and scale issue:

Design situation C:
Load effects in main grain direction

Criteria: no failure, ultimate

Superposition of external load effects with estimations of MIS not possible

Moisture induced stresses, explicit

5. Design situation and scale issue:

Design situation D:
Load effects in main grain direction

Criteria: no failure, ultimate

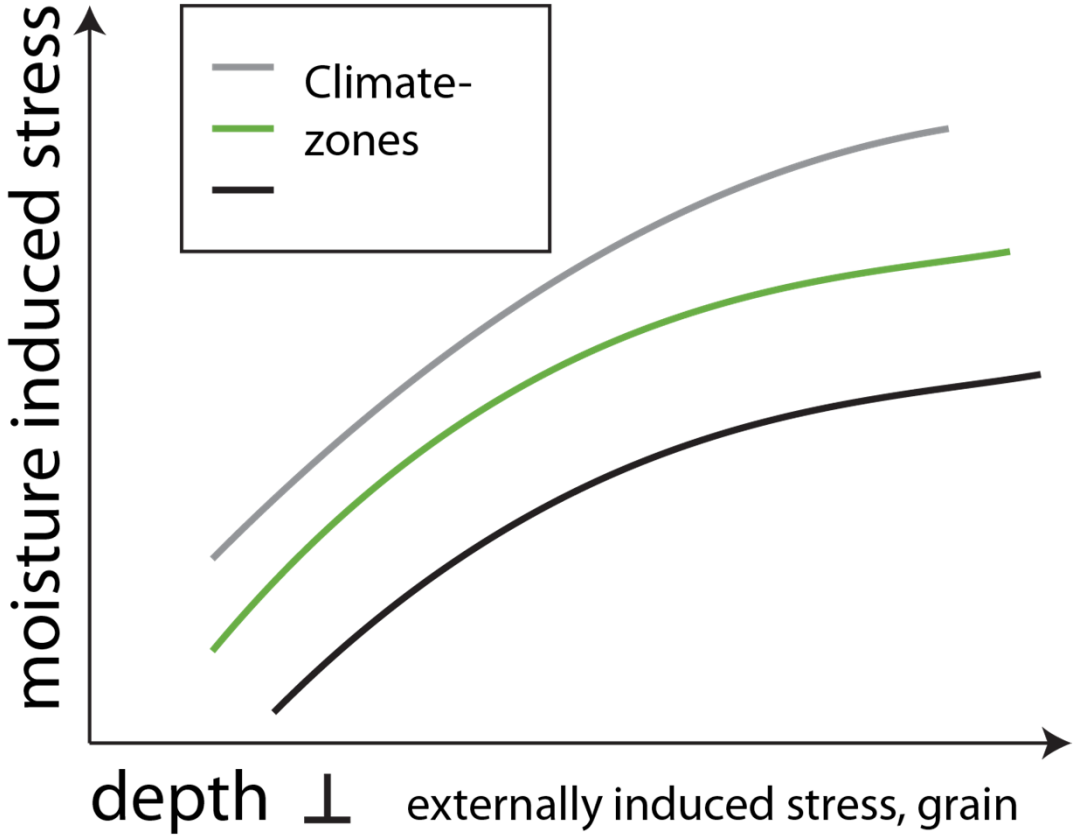
Superposition of external load effects with estimations of MIS not possible

Implications and outlook

When superposition is possible:

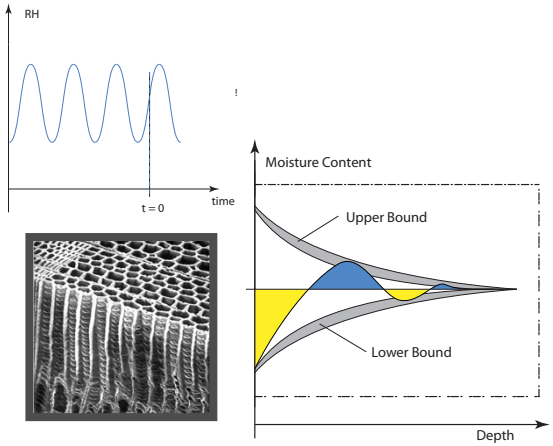
$$w_k \gamma_w \Psi$$

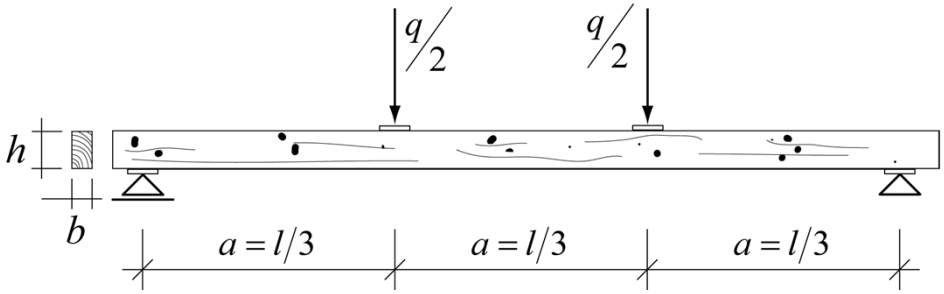
?



Implications and outlook

When superposition is not possible:





$$s = \frac{ql}{bh^2}$$

How do we come over the scale issue ?


After a tension test
Thank you
for your attantion !