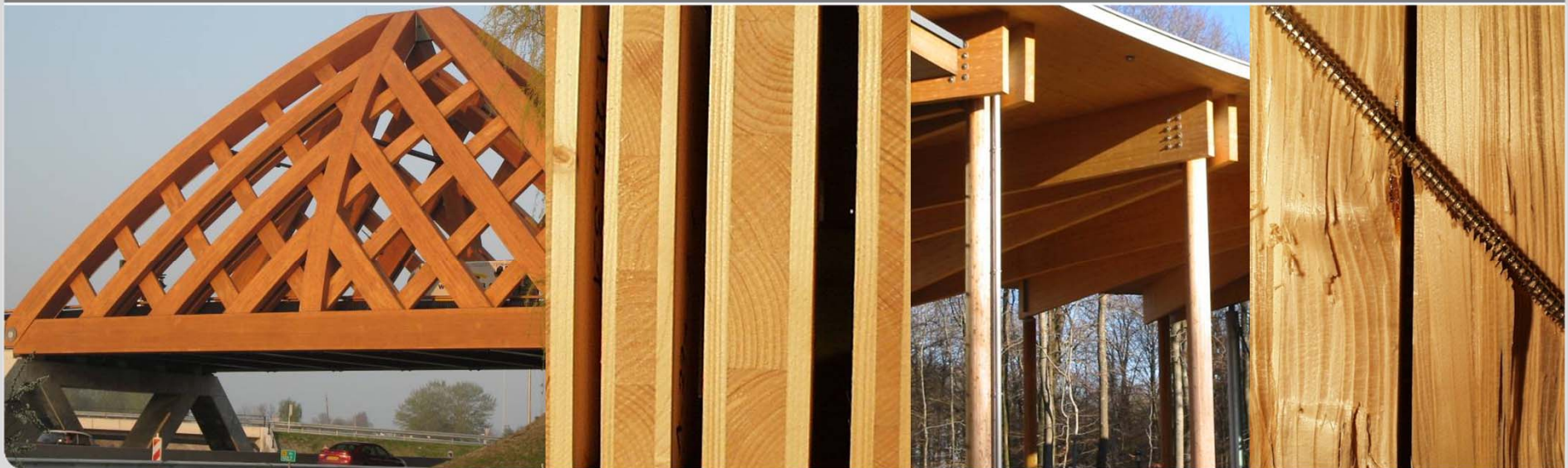


Ductility aspects of reinforced and non-reinforced timber joints

Hans J. Blass

HOLZBAU UND BAUKONSTRUKTIONEN

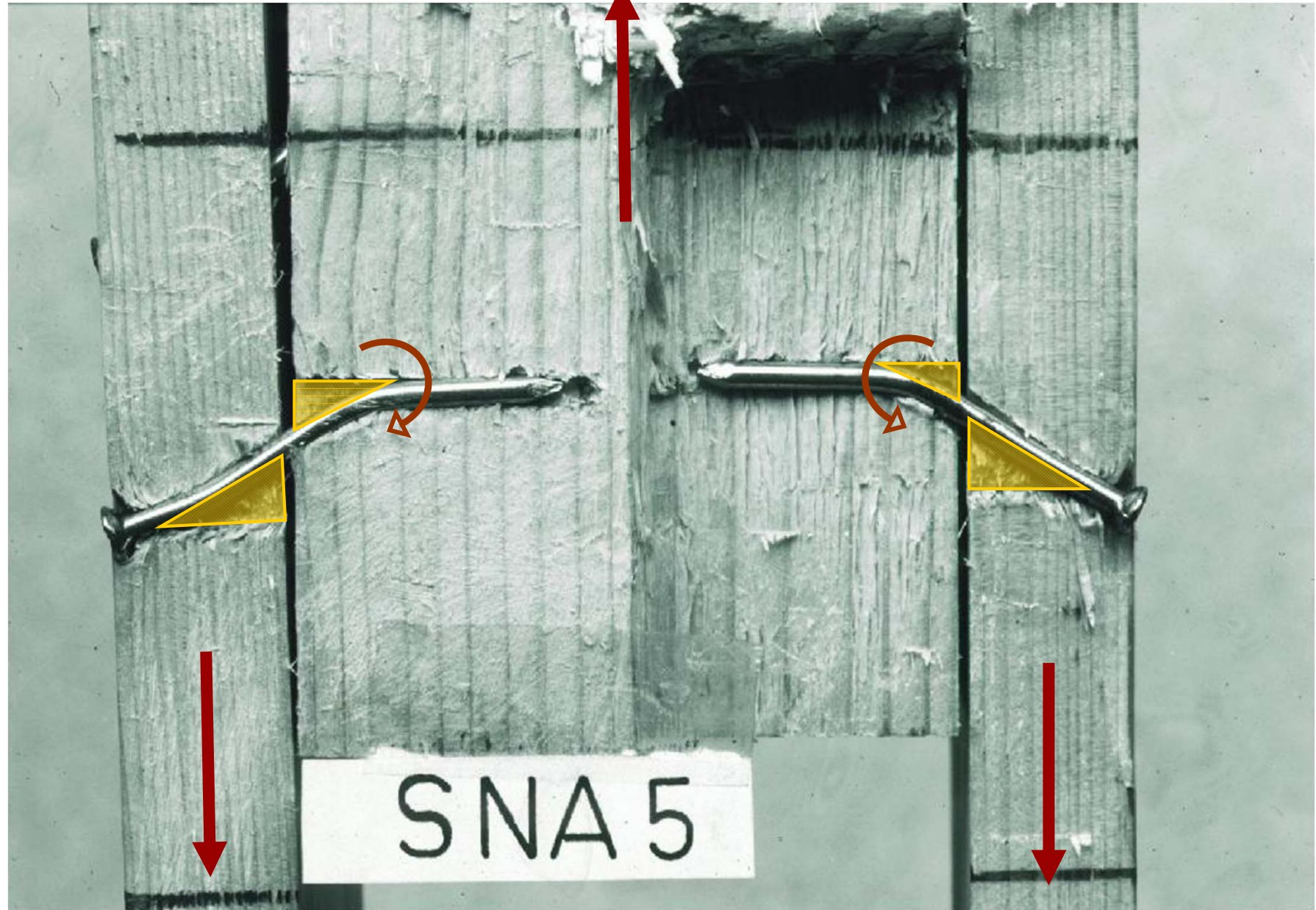


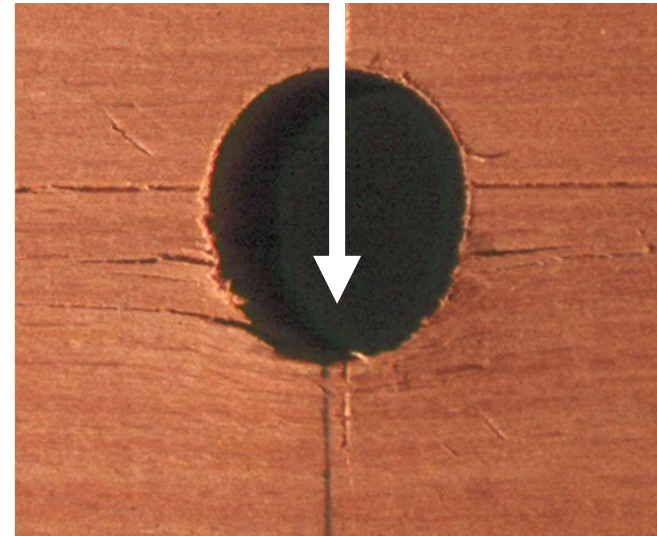
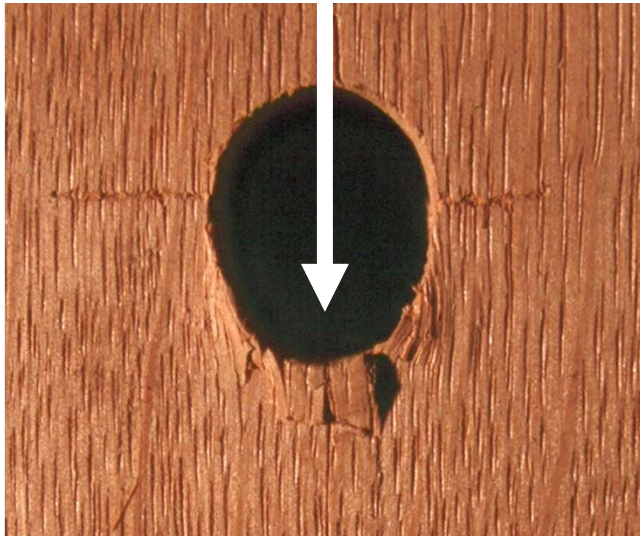
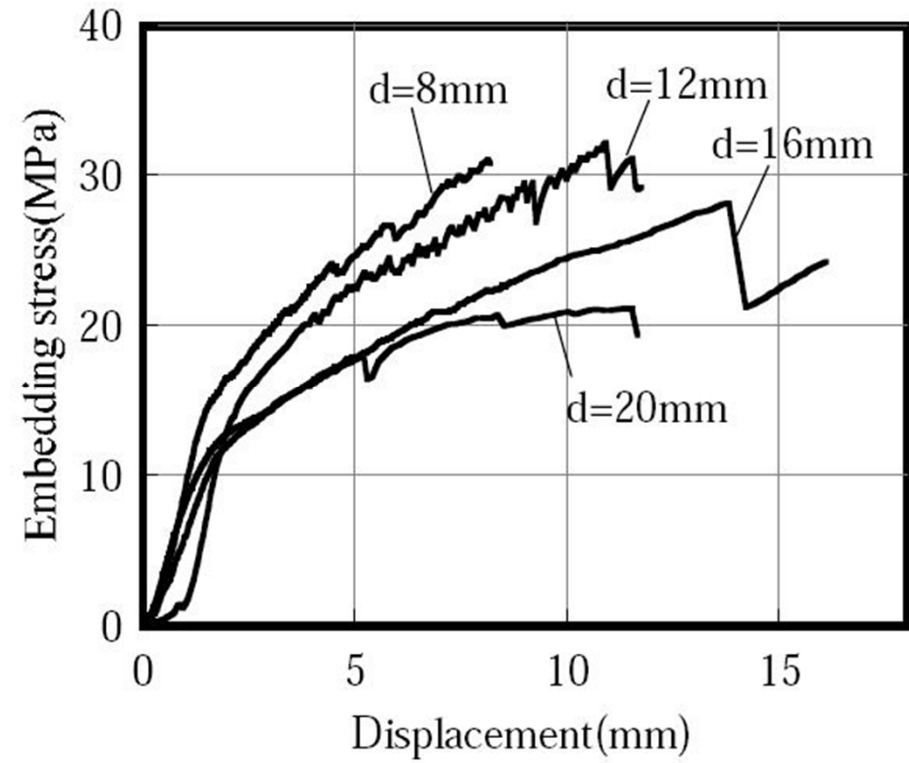
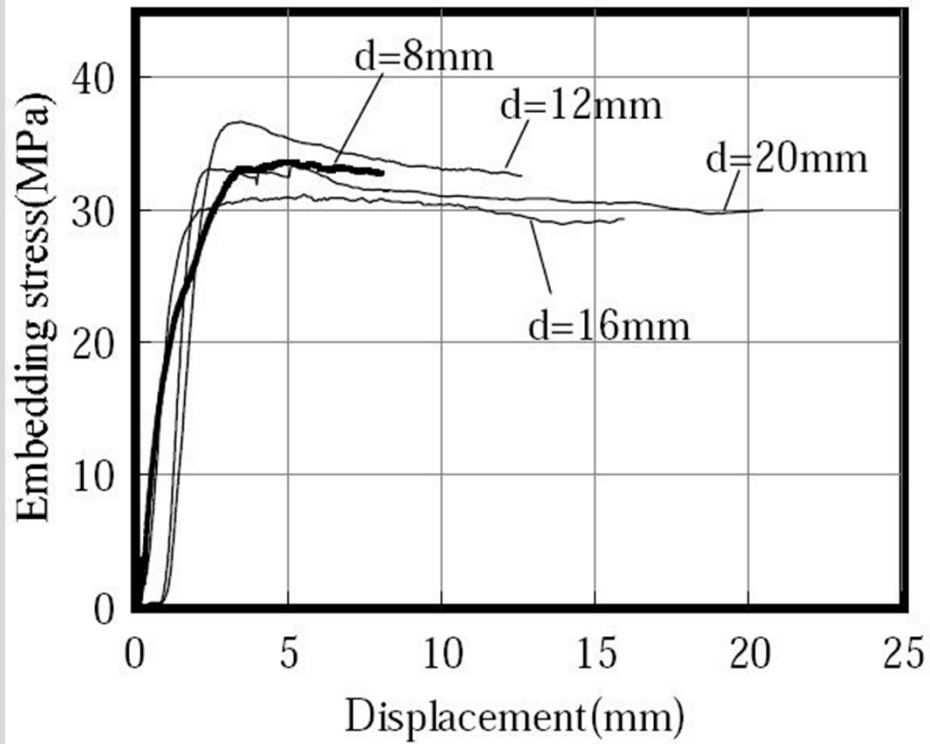
Timber joints

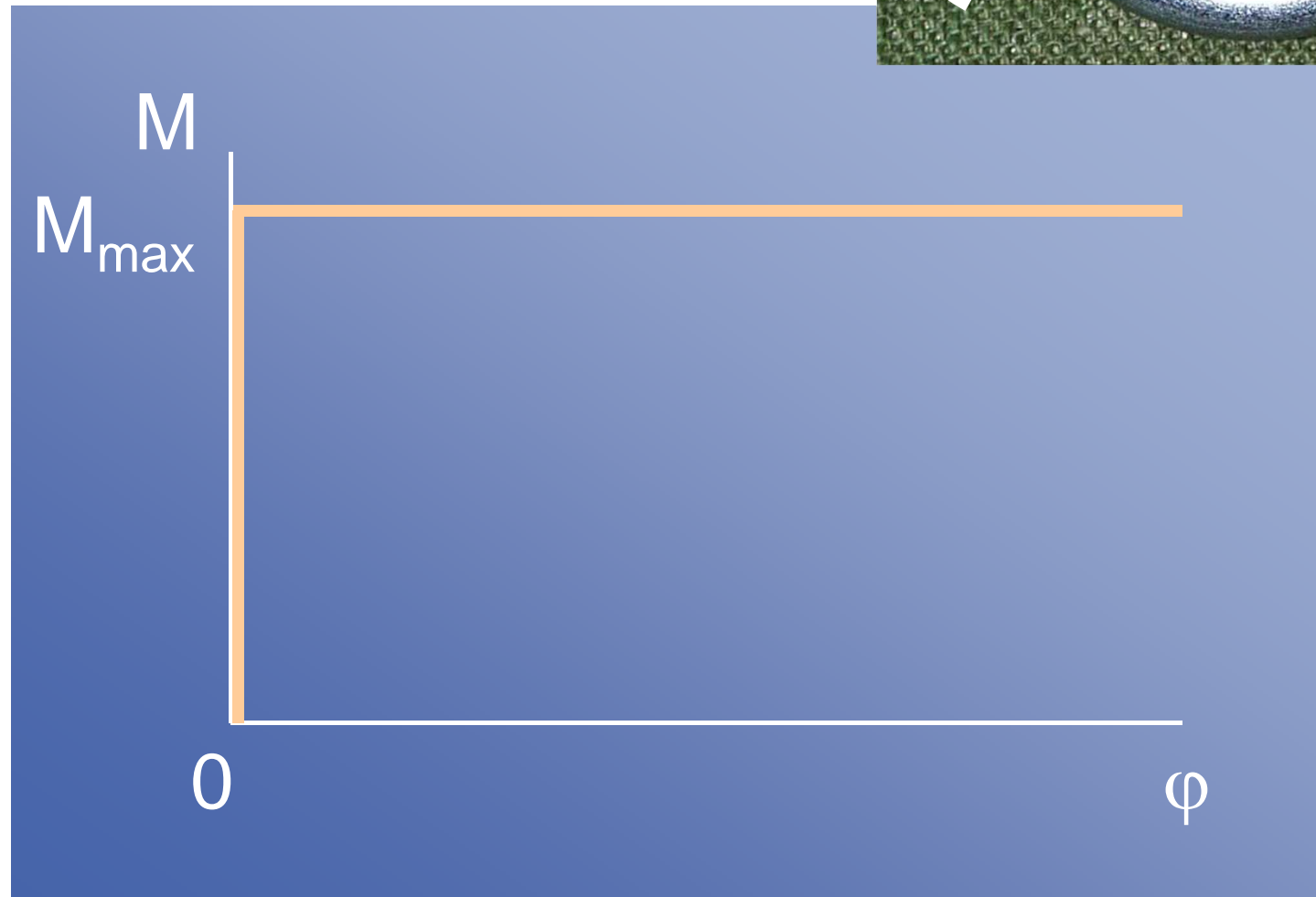
- Glued joints
- Joints with mechanical fasteners
- Carpenter joints

Joints with mechanical fasteners

- Dowel type timber joints
- Connector joints
- Truss plate joints



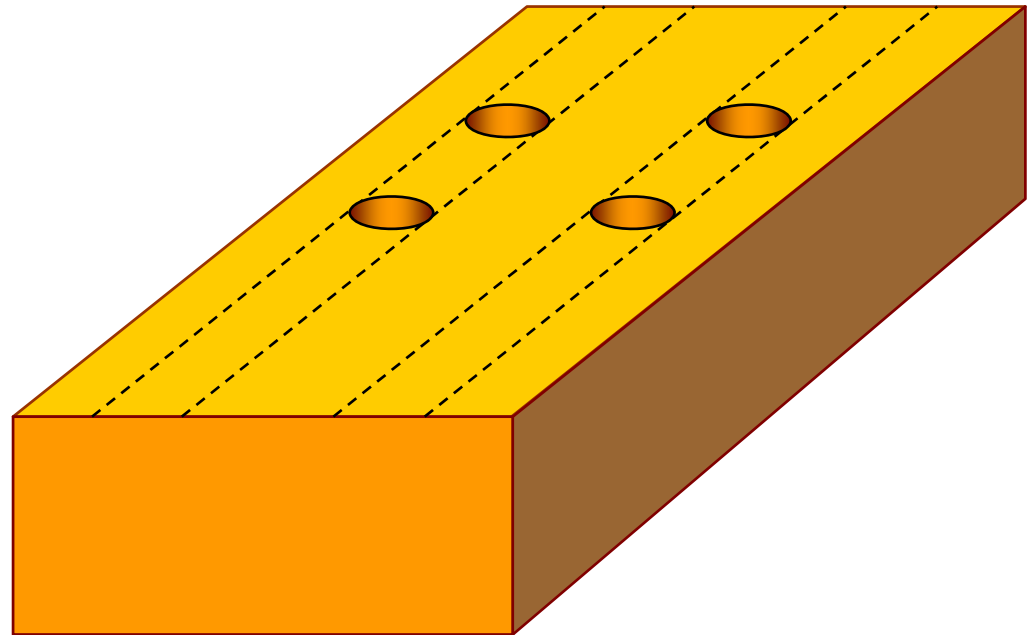




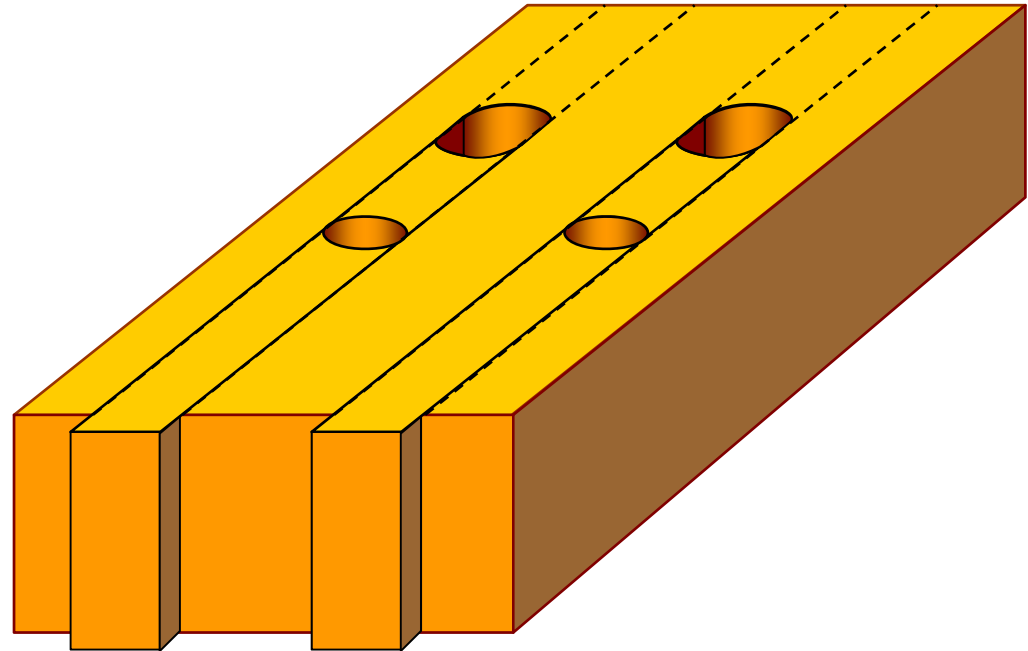
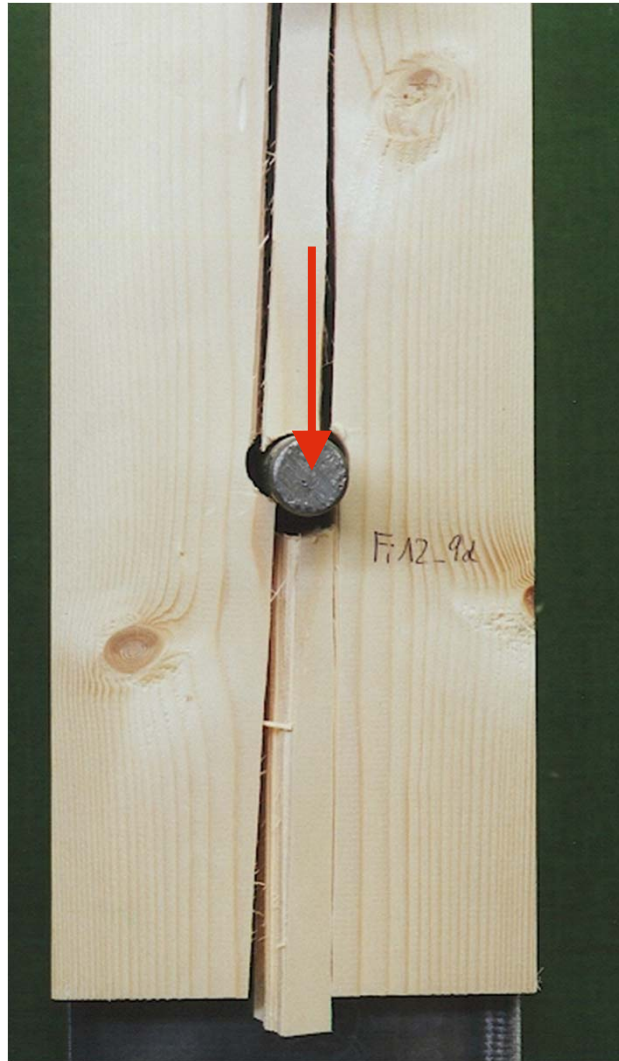
Brittle failure of dowel-type fasteners



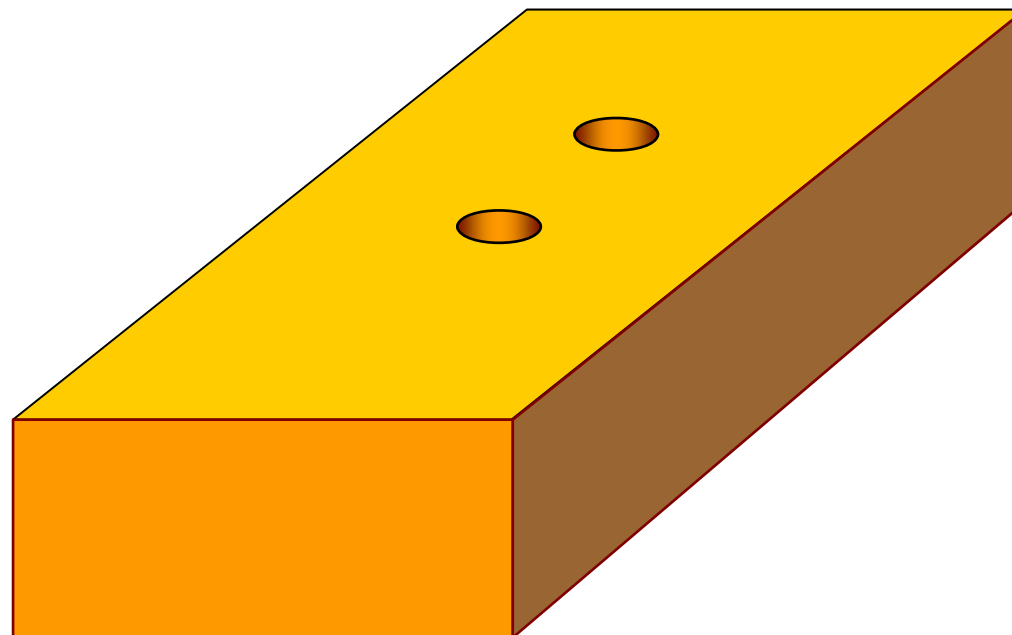
Brittle failure modes in joints



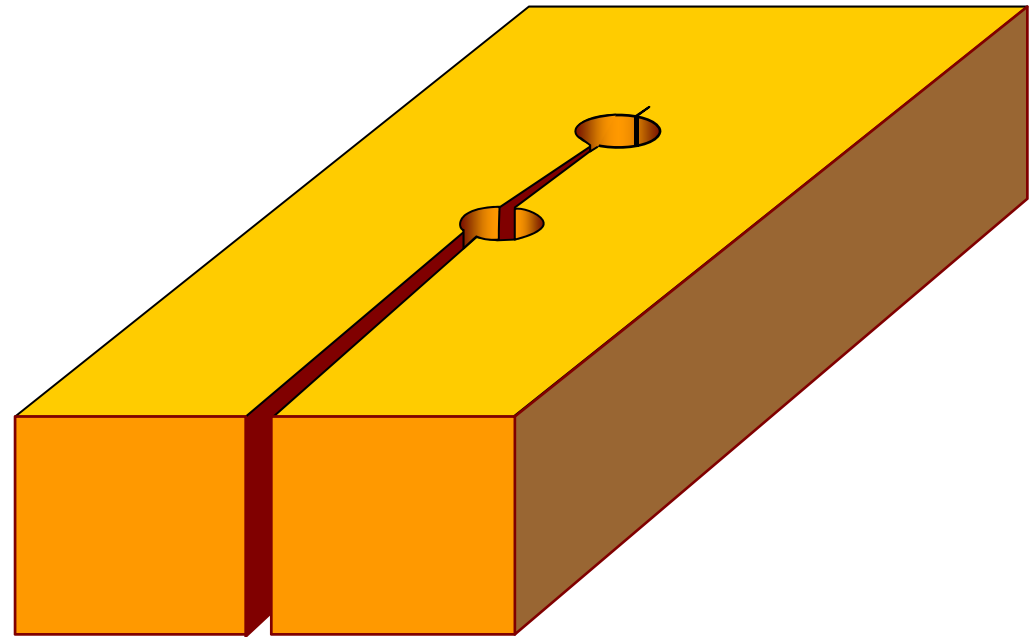
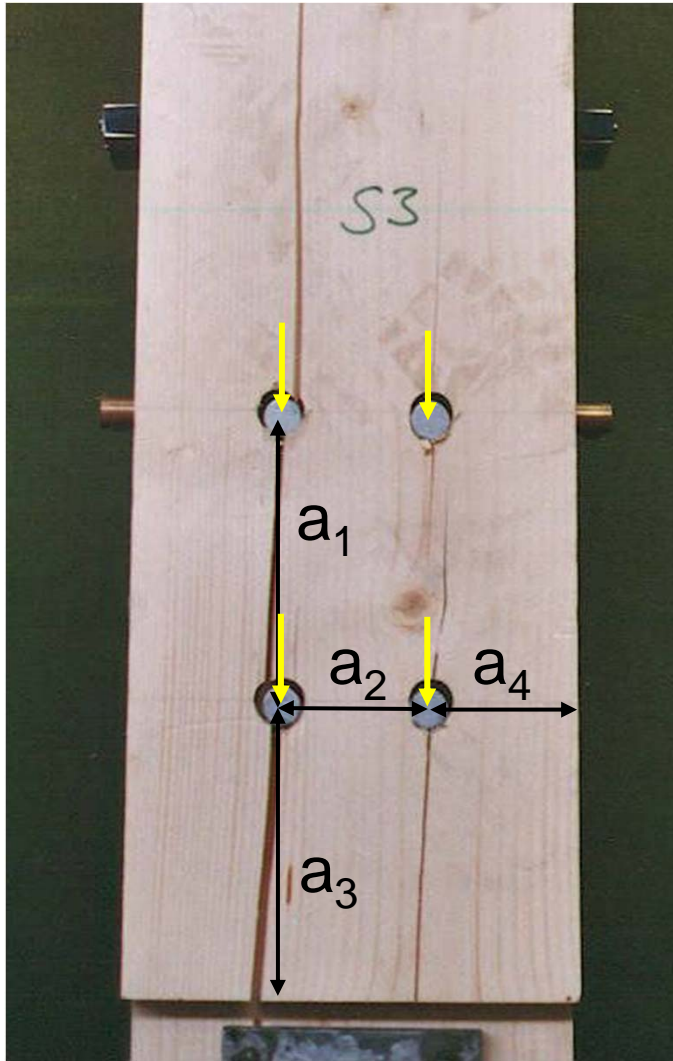
Row shear failure



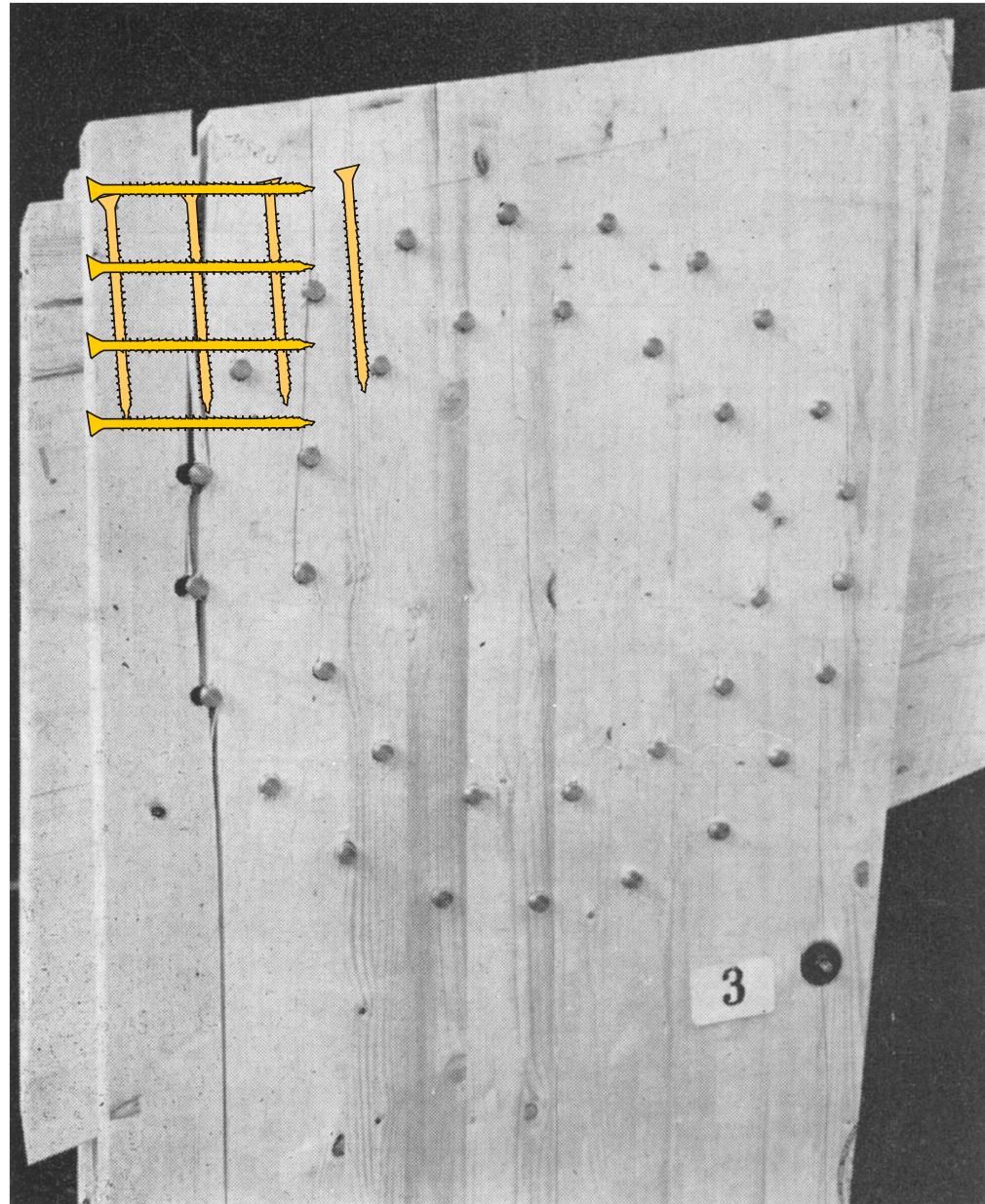
Brittle failure modes in joints

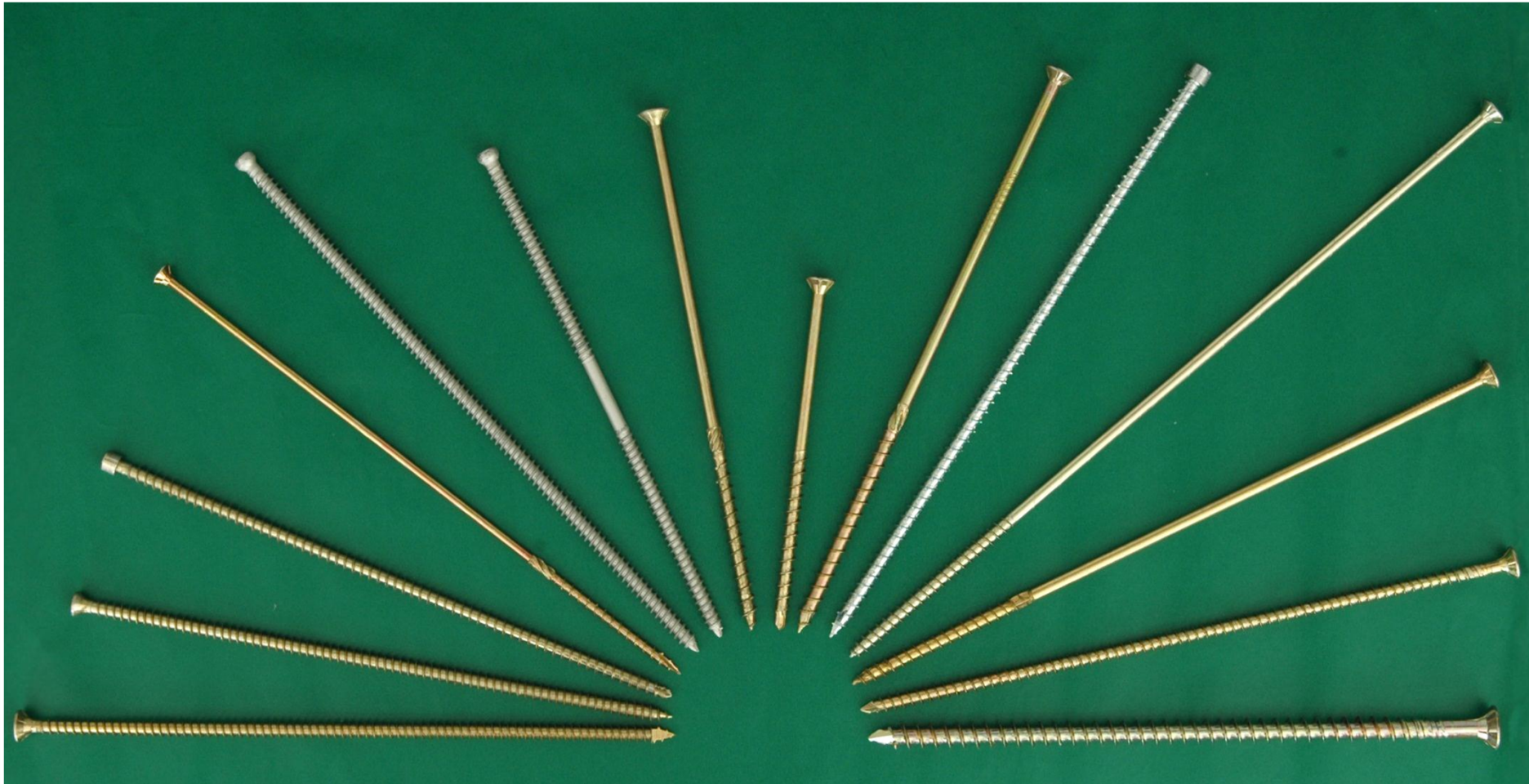


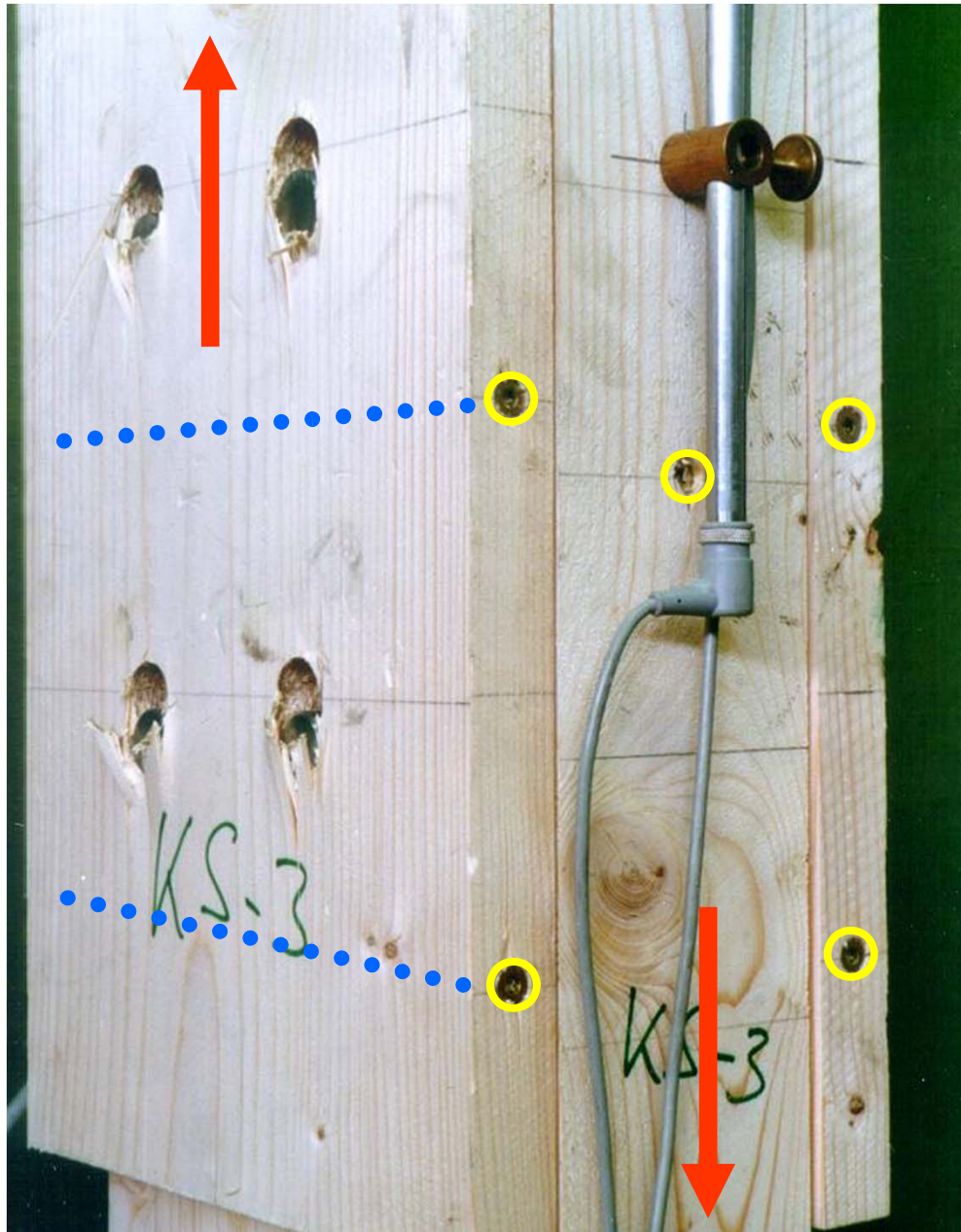
Splitting



Heimeshoff (1977):
Reinforcement in
frame corners by
using ringed shank
nails or screws



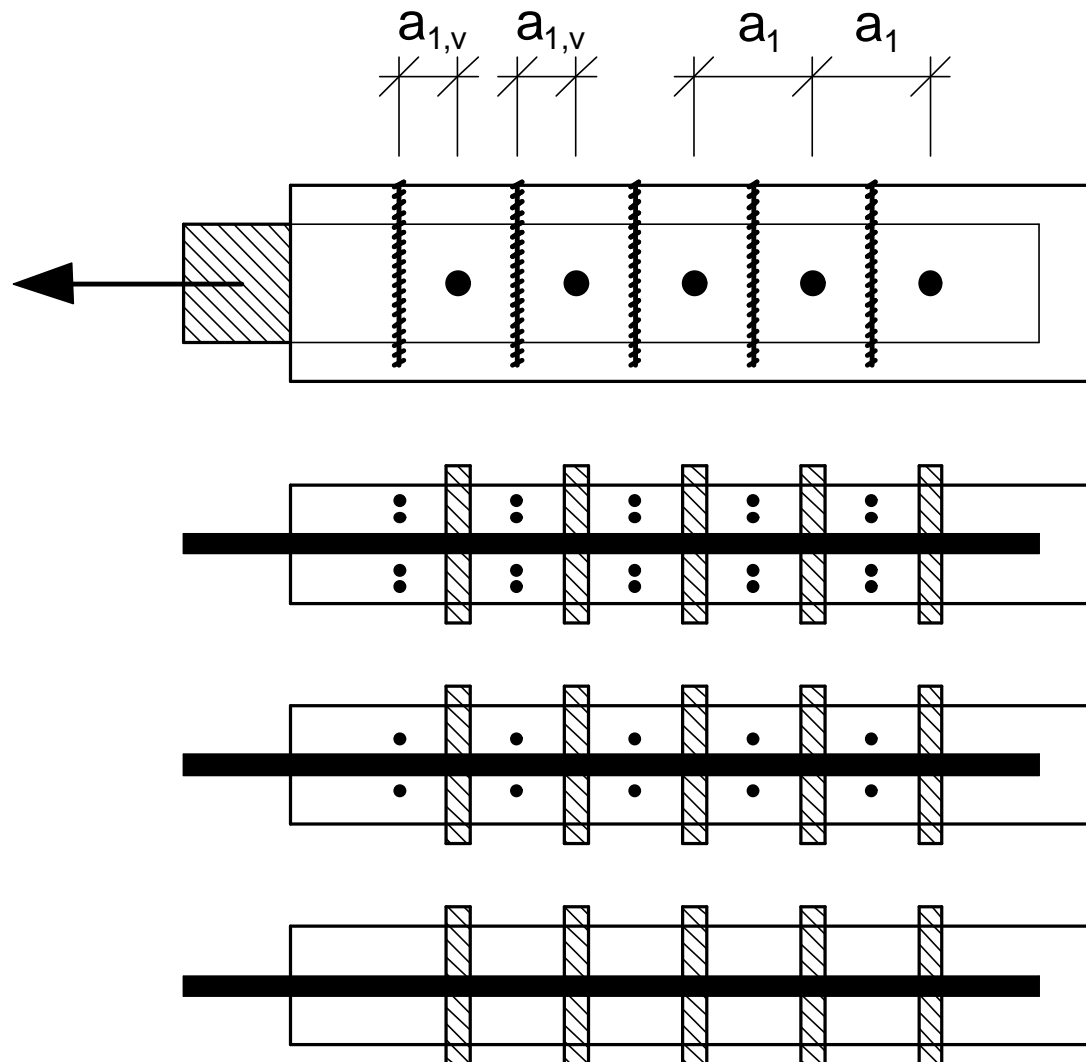




Reinforcement using self-drilling screws



**Crack growth is
stopped by the screws**

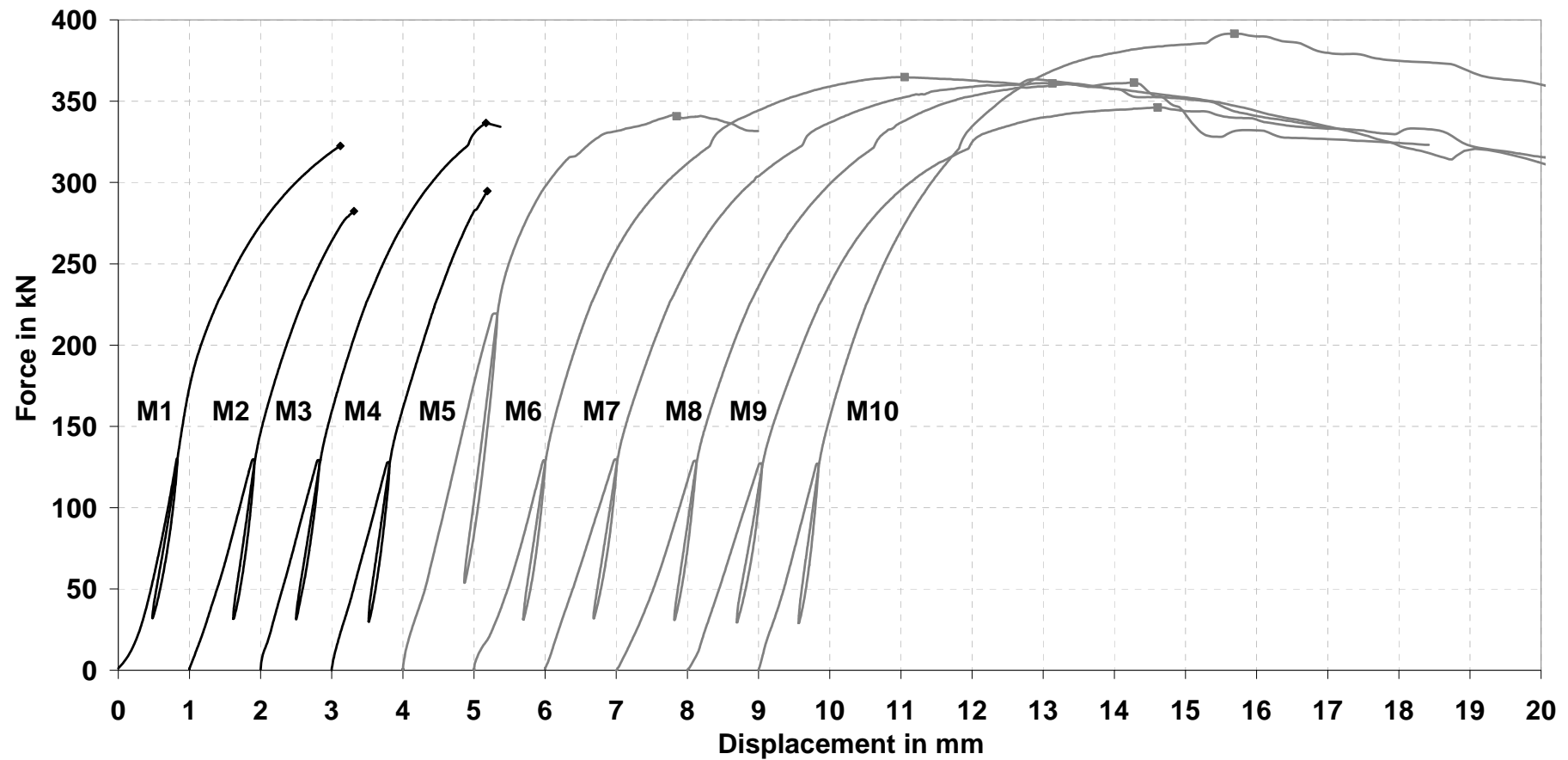


M1 to M4

$\mu_{\text{mean}} = 1,6$

M5 to M10

$\mu_{\text{mean}} = 5,3$



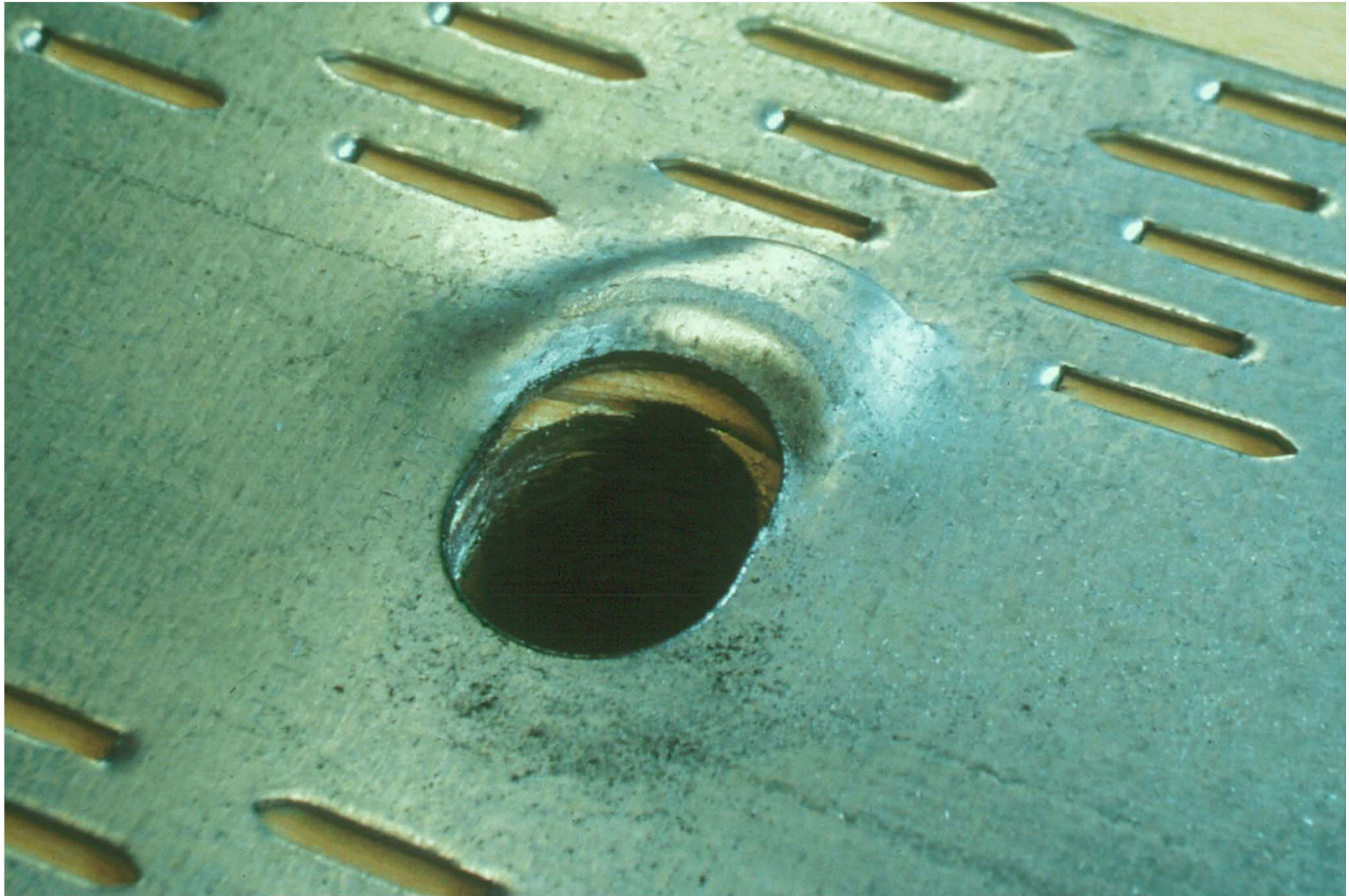
Reinforced joint: embedding failure

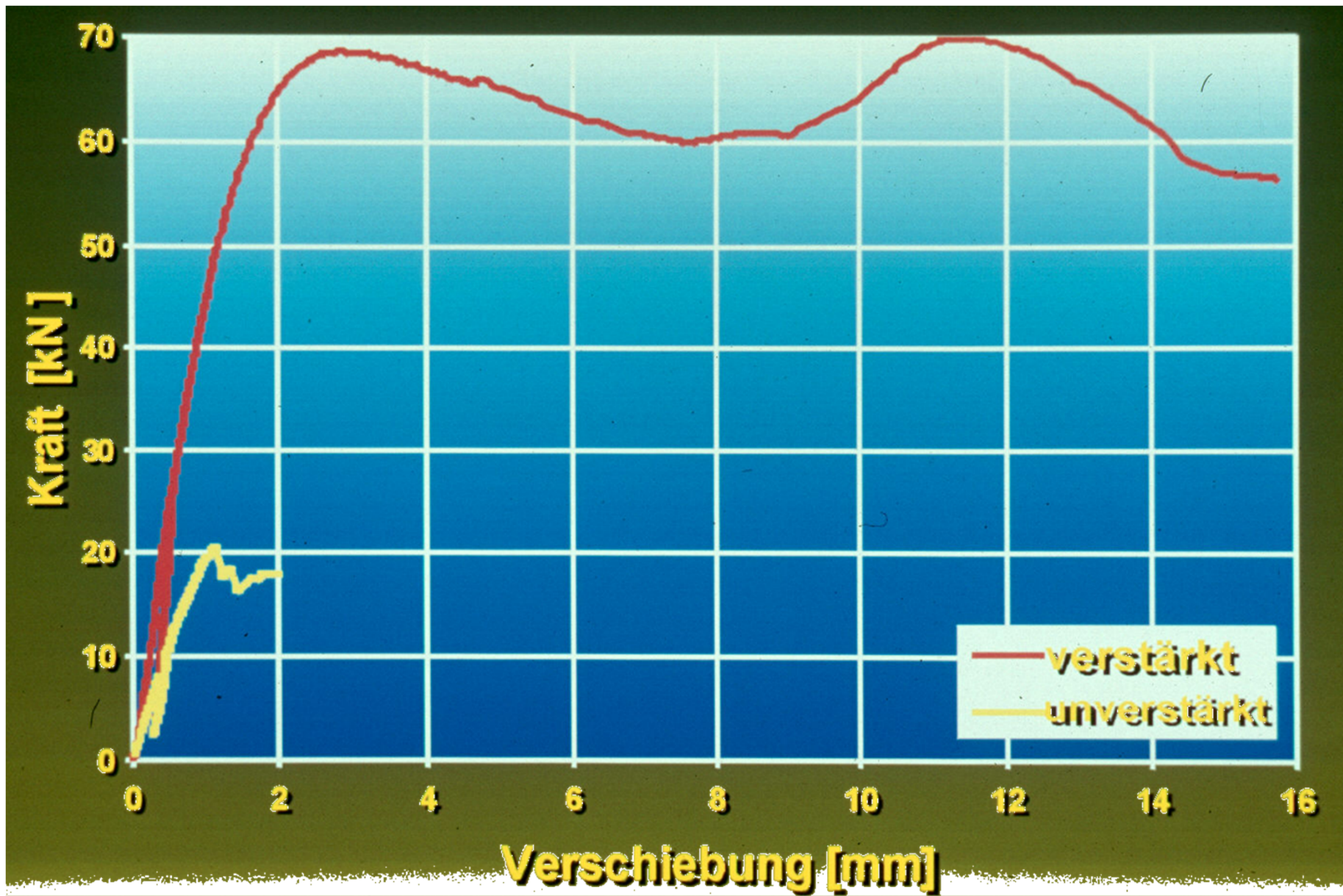


Skating arena Grefrath 1972



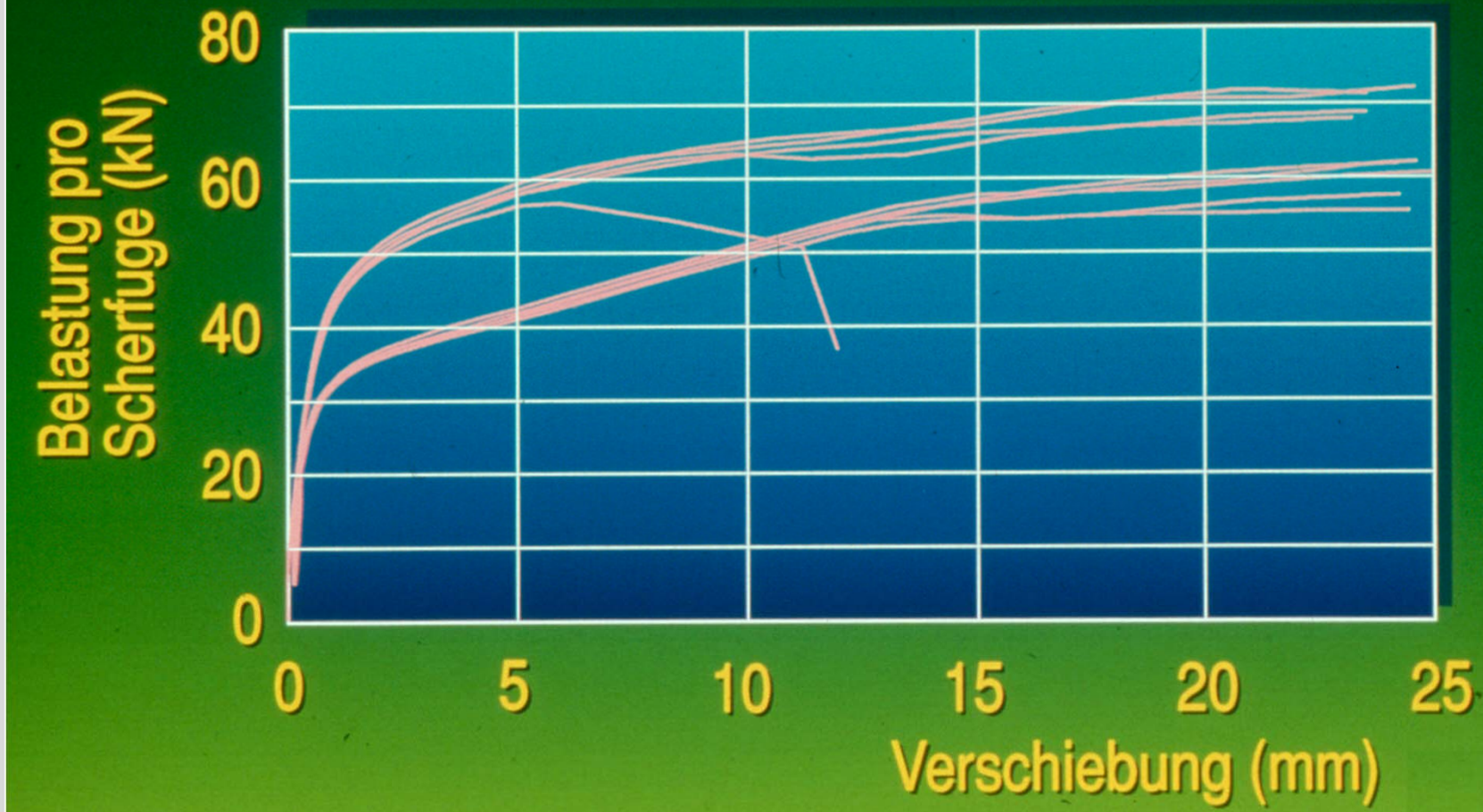












Cross Laminated Timber



Dowelled connection with CLT

■ Observations:

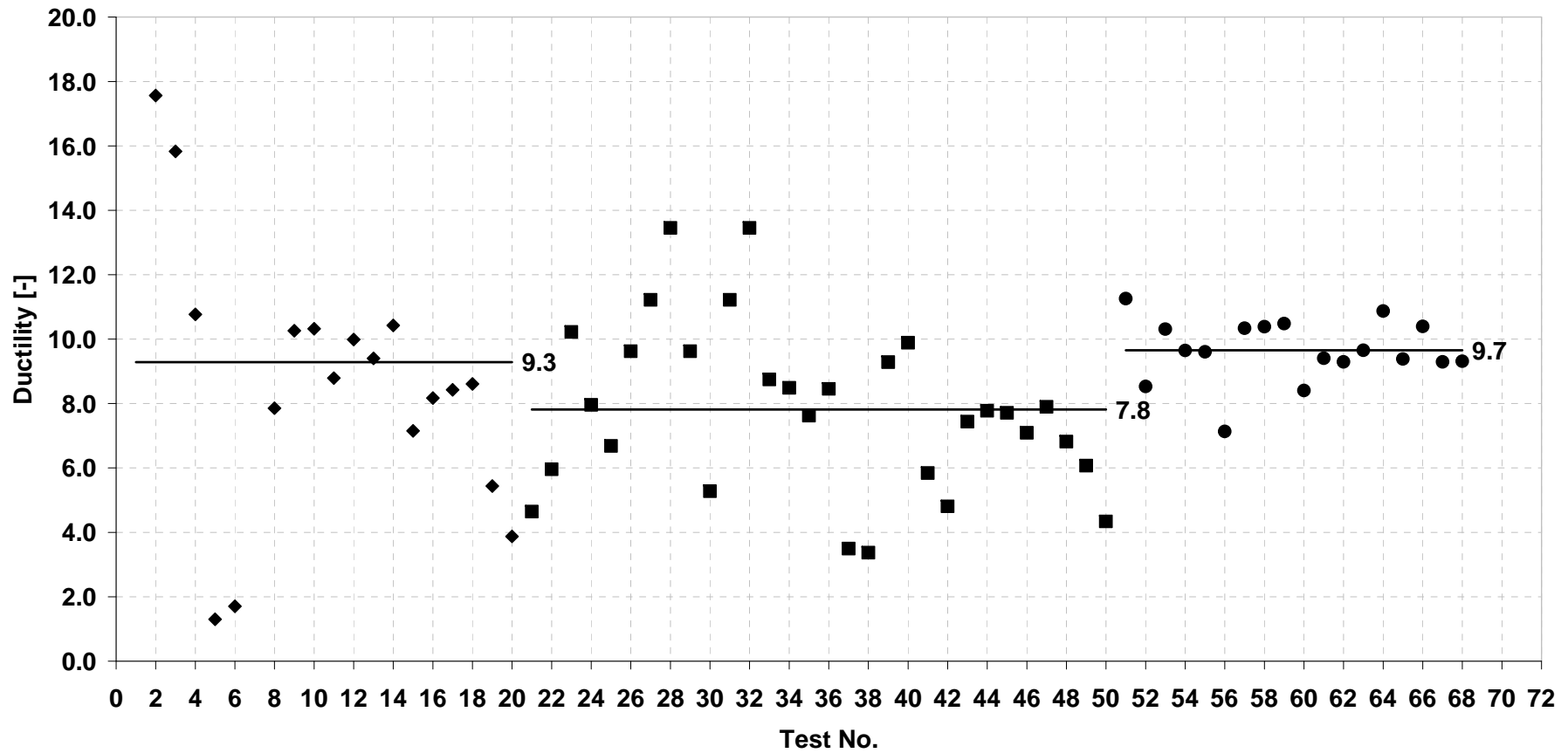


Cracks in outer layers

Block shear in outer layers

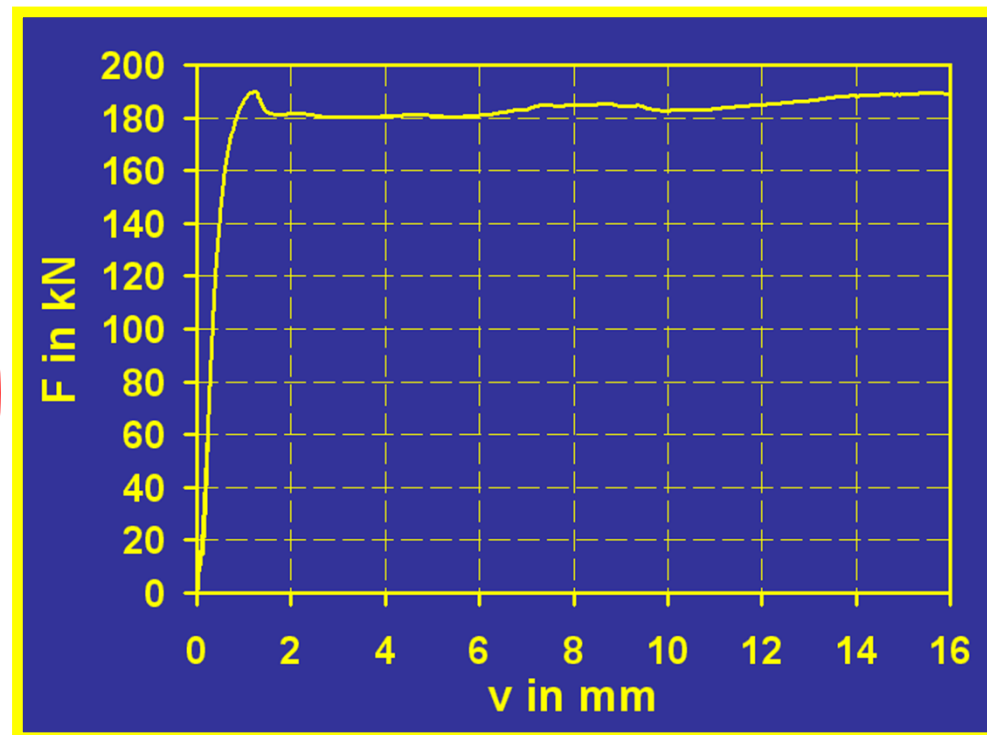
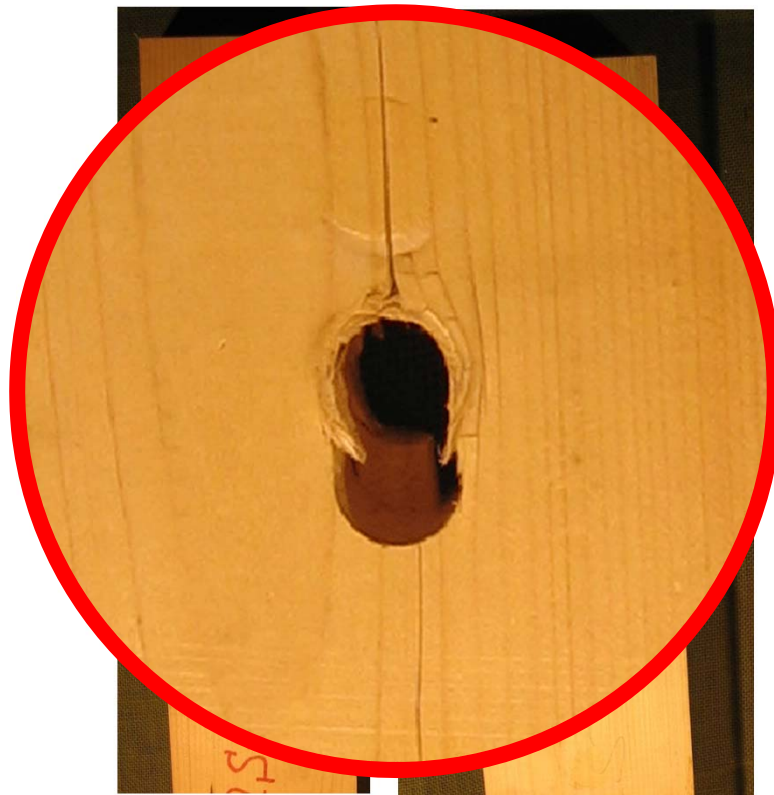
Embedding deformation

Steel-to-timber	Timber-to-timber	Timber-to-timber
Dowels	Dowels	Screws



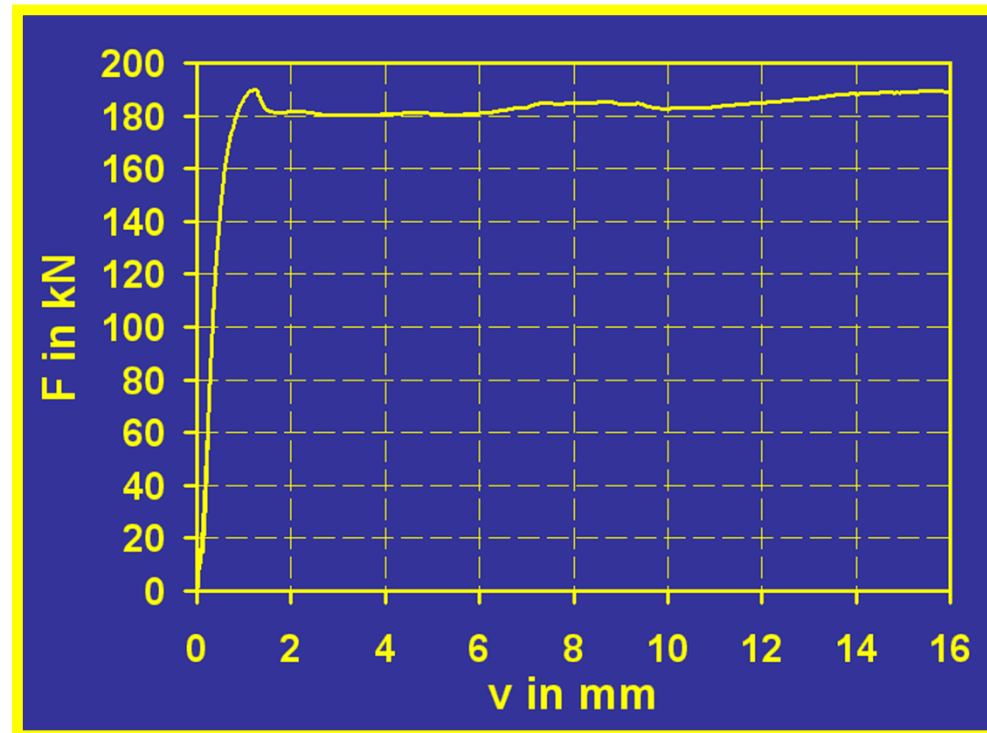
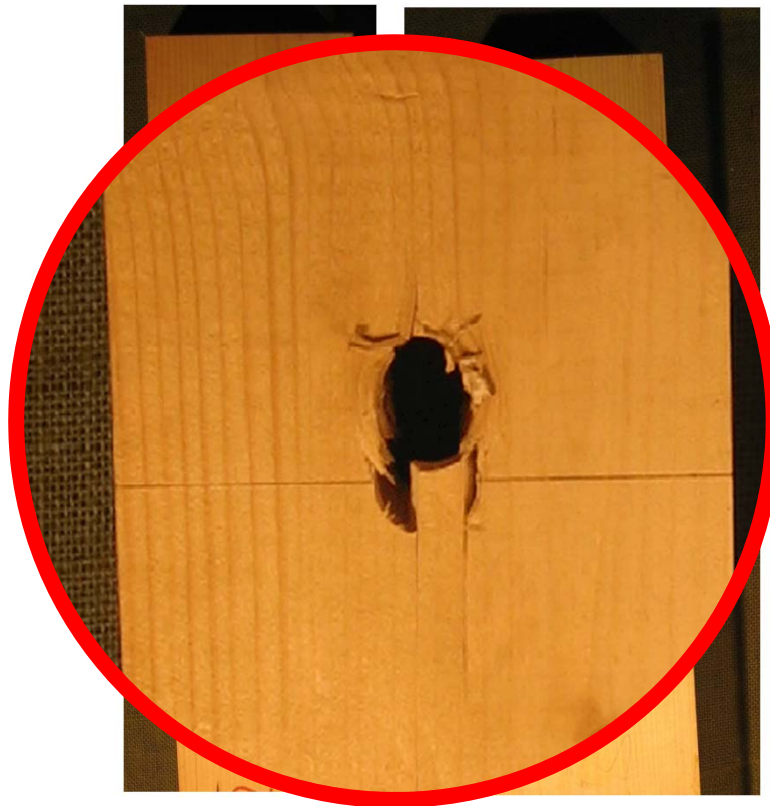
Dowelled connection with CLT

- Cracks in outer layer – Embedding deformation



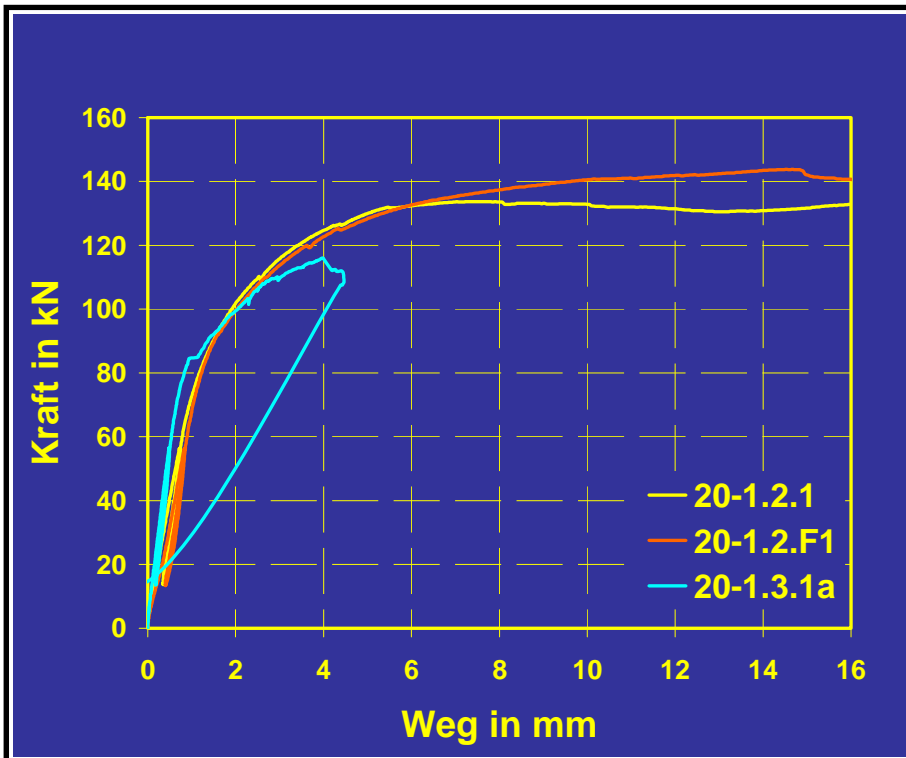
Dowelled connection with CLT

- Block shear in outer layer – Embedding deformation



Dowelled connection with CLT

Further reduced spacing \rightarrow brittle failure



ally loaded fasteners

Ductile behaviour in mild or stainless steel fasteners

Withdrawal or head pull-through must not be governing



Conclusions

- Ductile joint behaviour requires plastic deformation in fasteners and/or in timber
- Plastic fastener deformation in bending requires large embedding deformation without preliminary timber failure due to splitting or shear
- Plastic fastener deformation in tension requires mild or stainless steel fasteners with large withdrawal capacity

Conclusions

- Even mild steel fasteners may fail in a brittle manner due to fatigue loads
- Brittle timber failure due to splitting or shear may be prevented by reinforcement
- Reinforcements perpendicular to the grain may be glued-on or mechanical fasteners as self-drilling screws
- Connections between timber members made of CLT or plywood generally show ductile behaviour

