Connections for timber structures

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Timber bridge in Sneek, NL
Timber joints

Glued joints

Joints with mechanical fasteners

Carpenter joints
Joint with mechanical fasteners
Carpenter joint
Joints with mechanical fasteners

- Dowel type timber joints
- Connector joints
- Truss plate joints
Connector joint
Johansen‘s model
Plug shear
Splitting

\[ a_1 \]
\[ a_2 \]
\[ a_3 \]
\[ a_4 \]
Reinforcement using screws with continuous thread
Screws stop crack growth
Screws loaded in shear
Inclination of fastener axis
Truss action
Truss action

- $F_{c, 90}$
- $F_{\text{fr}}$
- $F_0$
- $F_{\text{ax}}$
Bolted steel connections in shear

Source: Project KI-Smile
Bolted steel connections in shear

Source: Project KI-Smile
Truss connection

Photo: Wiehag
Inclined screws in steel-to-timber joints
Inclined screws in steel-to-timber joints

Photo: Atlas Copco
Connection test Stuttgart University

- Ultimate load per shear plane:
  Test 1: $F_U = 6200$ kN
  Test 2: $F_U = 6600$ kN

Photo: Universität Stuttgart
Failure mode: screw tensile failure

Photo: Universität Stuttgart

Photo: Universität Stuttgart
Screws parallel to member axis
Threaded rods

Glulam

CLT
Screws parallel to member axis

B-B

A-A

CLT

glulam
Axially loaded screws

- Preliminary tests led to timber splitting or screw withdrawal after timber reinforcement
Timber is anisotropic

- Avoid perpendicular to the grain stresses
- Design for low strength and stiffness perpendicular to the grain
- Reinforcement
Shear failure parallel to grain
Shear reinforcement
Curved and pitched cambered beams
Tensile failure perp. to grain
Curved and pitched cambered beams
Notched beam supports
Reinforcement with screws

fully threaded screws
Compression perp. to grain

Photo: Kreuzinger
Compression perp. to grain

\[ \sigma_{c,90} = f_{c,90} \]
\( \sigma_{c,90} < f_{c,90} \)
\[ \sigma_{c,90} < f_{c,90} \]
Reinforcement using screws

Bottom view

8 x 400 mm
8 x 260 mm
7.5 x 180 mm
non-reinforced
Thank you very much for your attention!