COST Action FP1004

Final Meeting

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Stress-laminated-timber decks – state of the art and design based on Swedish practice

Crocetti, R.*, Ekholm, K. **, Kliger, R. **

*Division of Structural Engineering, Lund University, Sweden

**Division Structural Engineering, Chalmers University of Technology, Göteborg, Sweden

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- Evolution of stress laminated decks
- Stress laminated timber decks
- Butt joint
- Erection
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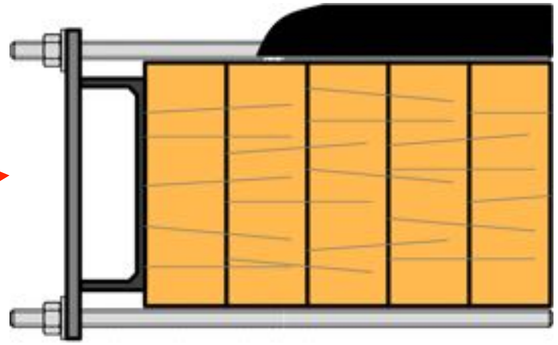
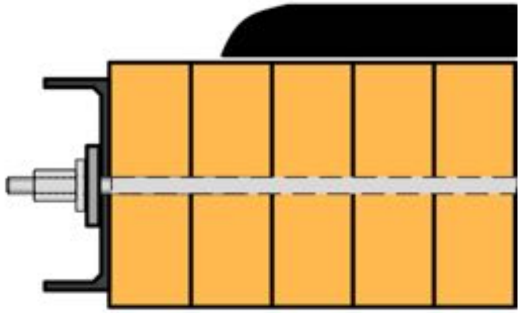
Evolution of stress laminated timber bridges

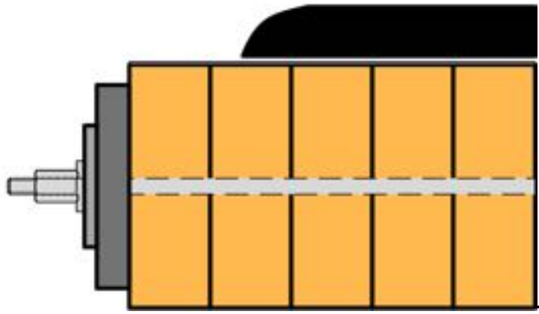
- Nail-laminated timber bridges (Unserviceable due to gaps)



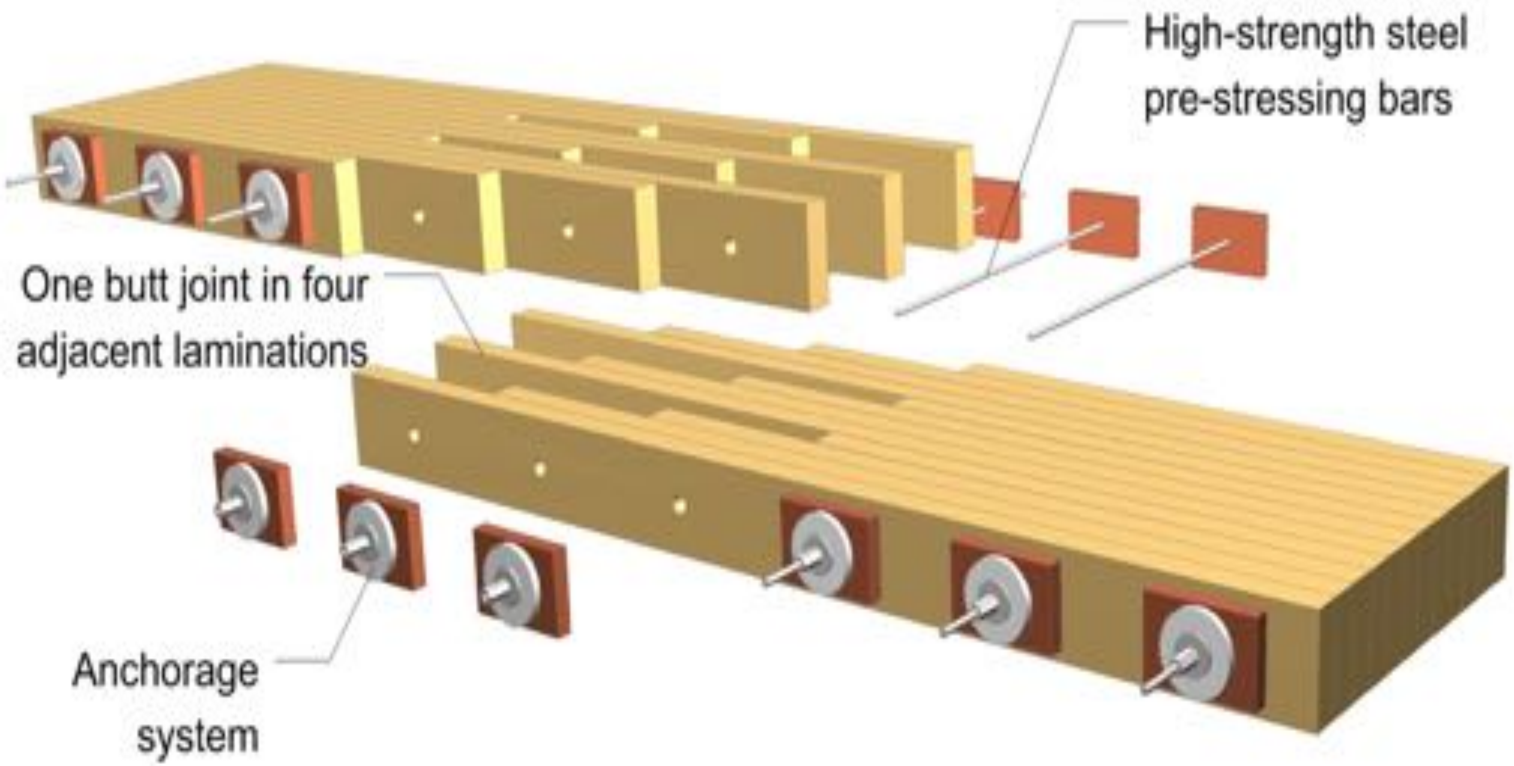
- Continuous steel profiles



- Patch anchoring with plates

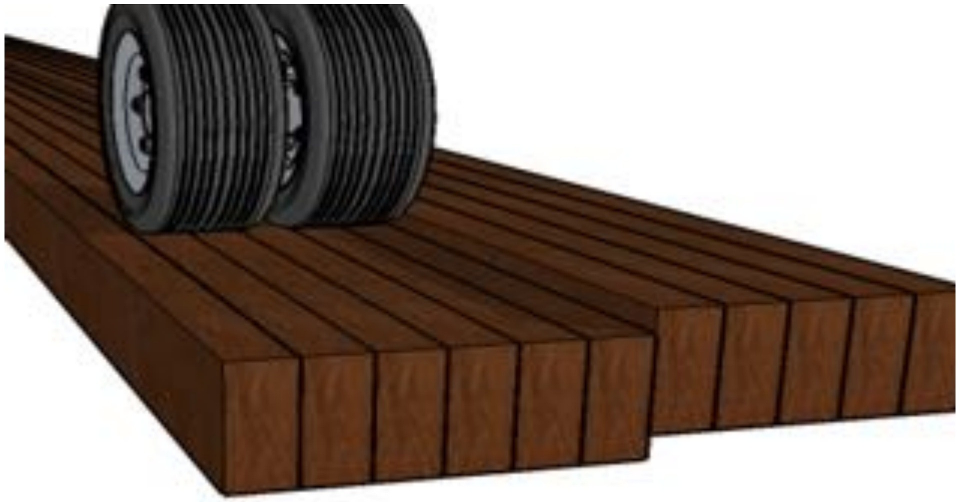


Stress laminated timber decks



Why do we need to prestress?

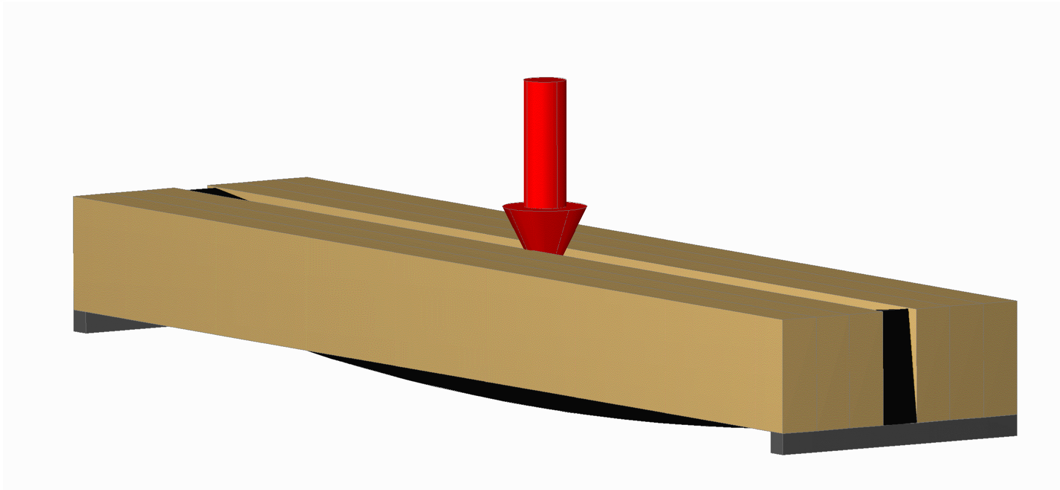
Transverse bending



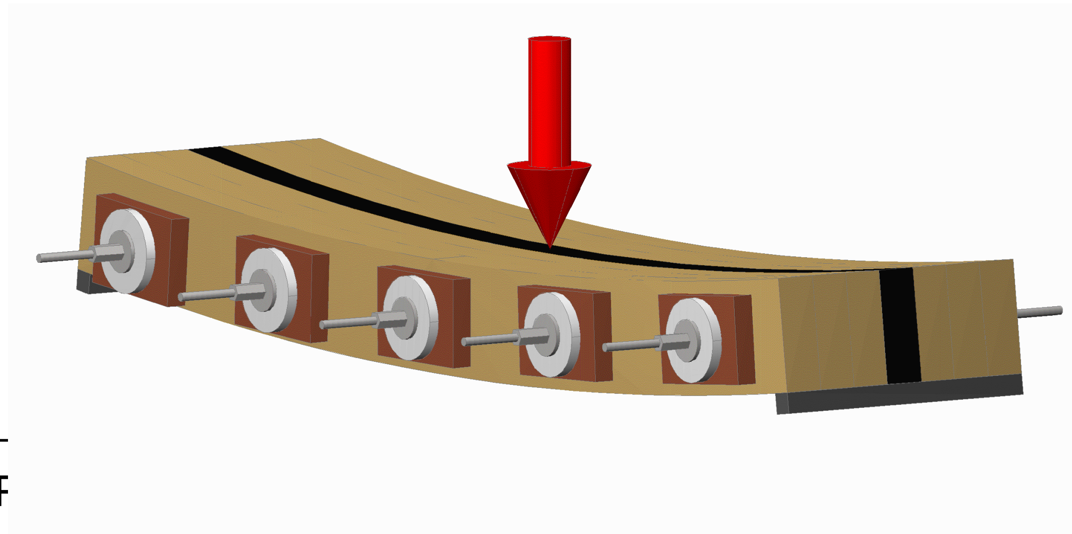
Transverse shear

Load distribution through friction

- Compressive stresses between laminations



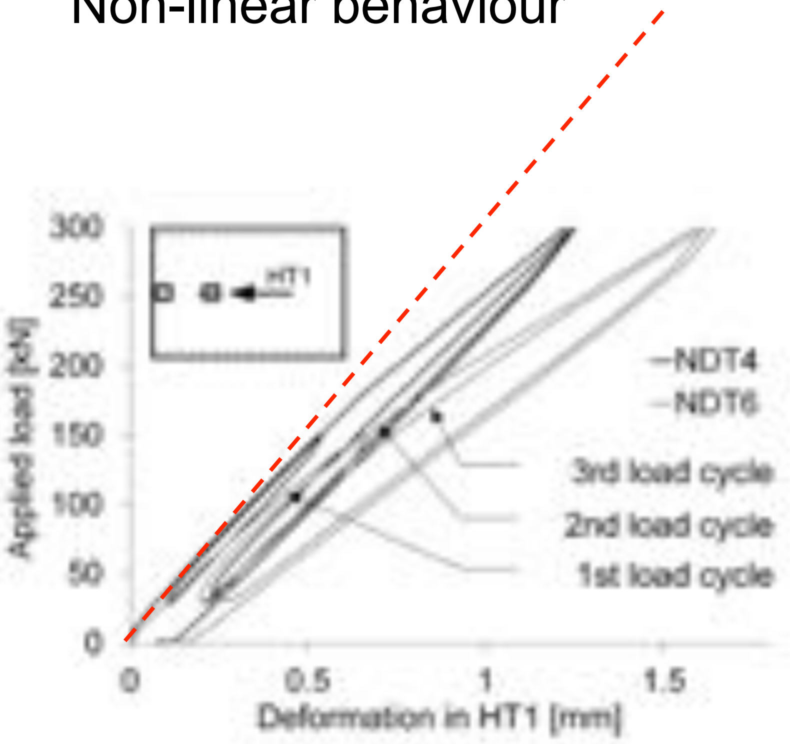
- Redistribution of concentrated loads



Other “movements” in the deck

Twist due to torsion in the deck

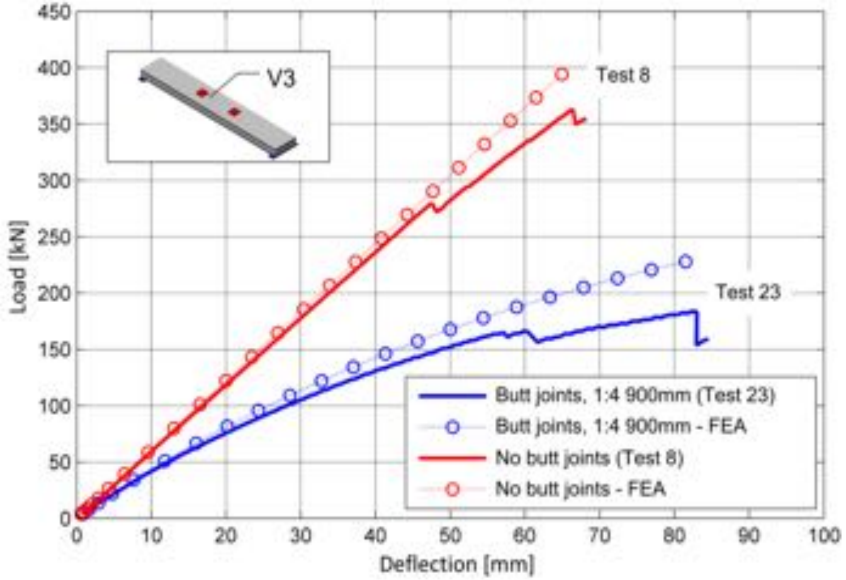
Non-linear behaviour



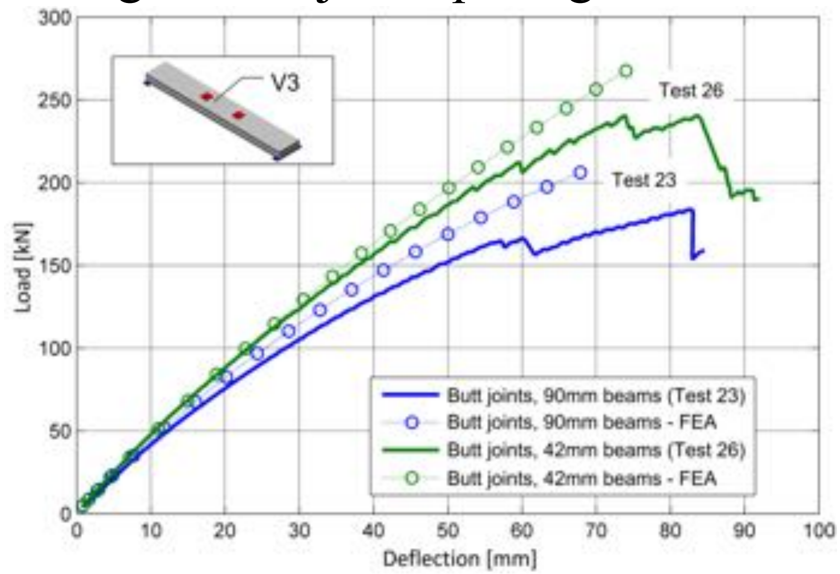
Butt Joints

Butt Joints

Comparison of specimens with and without butt joints



Comparison of 42 mm and 90 mm beam width for specimens with one-in-four spaced beams butt jointed with a longitudinal joint spacing of 900 mm

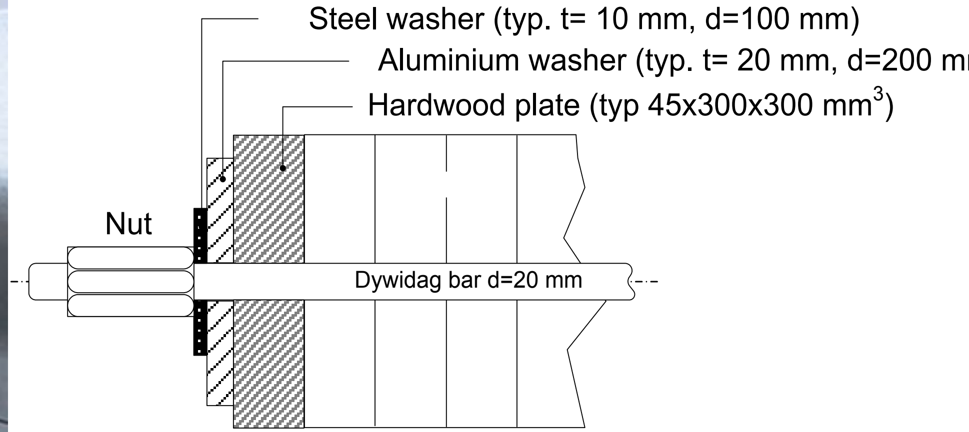


Erection

Pedestrian bridge, t=495mm,

B = 3m, L_{tot} ≈ 56m, s_{max} ≈ 17m

Erection



Initial compression stress between laminations: $\sigma_p \approx$ 0,8-1,0 MPa

Final compression stress between laminations: $\sigma_{p,t=\infty} \approx 0{,}4 \cdot \sigma_p$

Erection

Loss of pre-stress

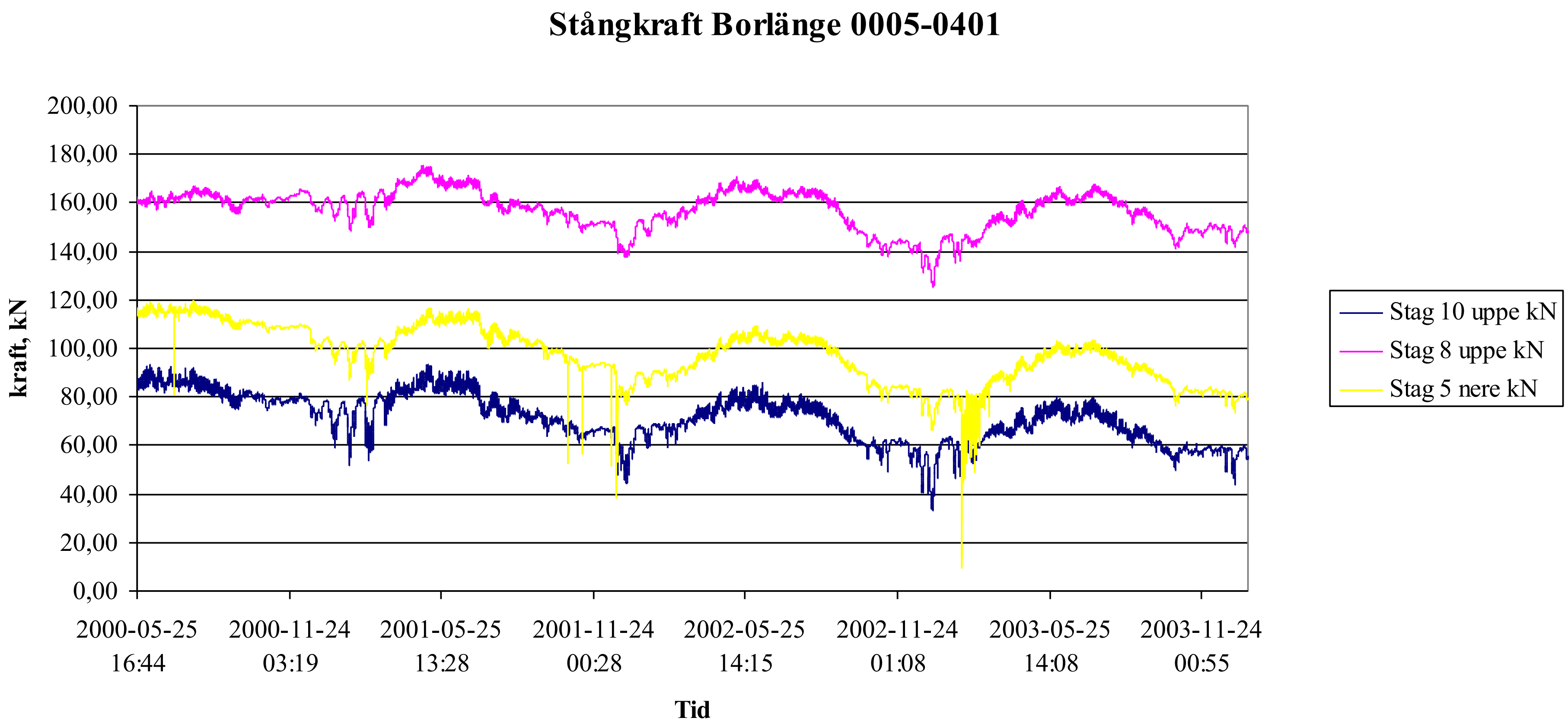
Building year: 1997

Inspection year: 2004

Lusbäckenbron, Borlänge –
Stress-laminated box-beam Bridge

Per-Anders Fjällström, SP-Trätek

Loss of pre-stress

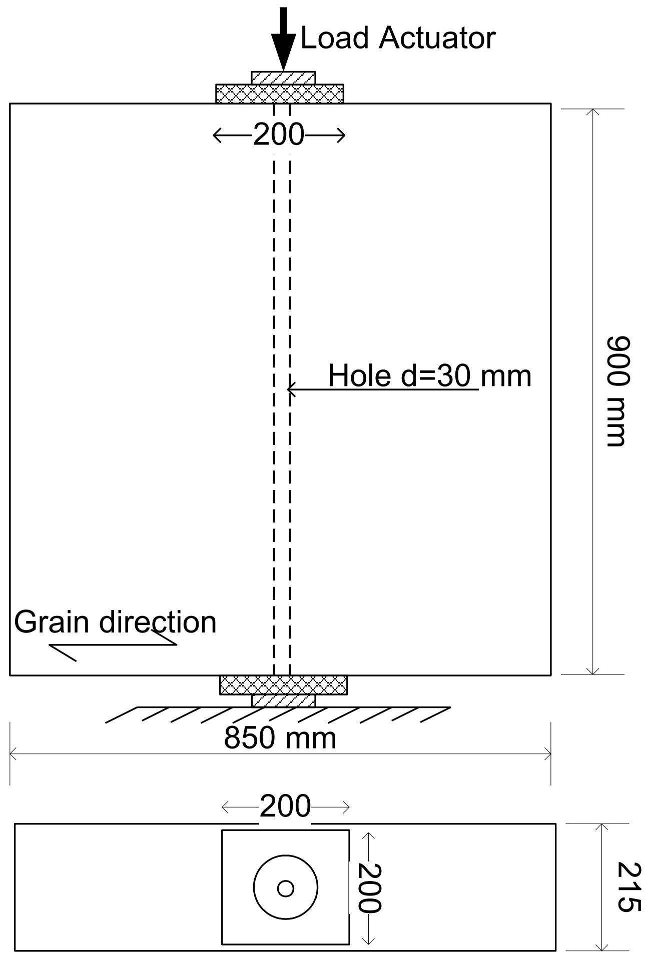


Lusbäckenbron, Borlänge –
Stress-laminated box-beam Bridge

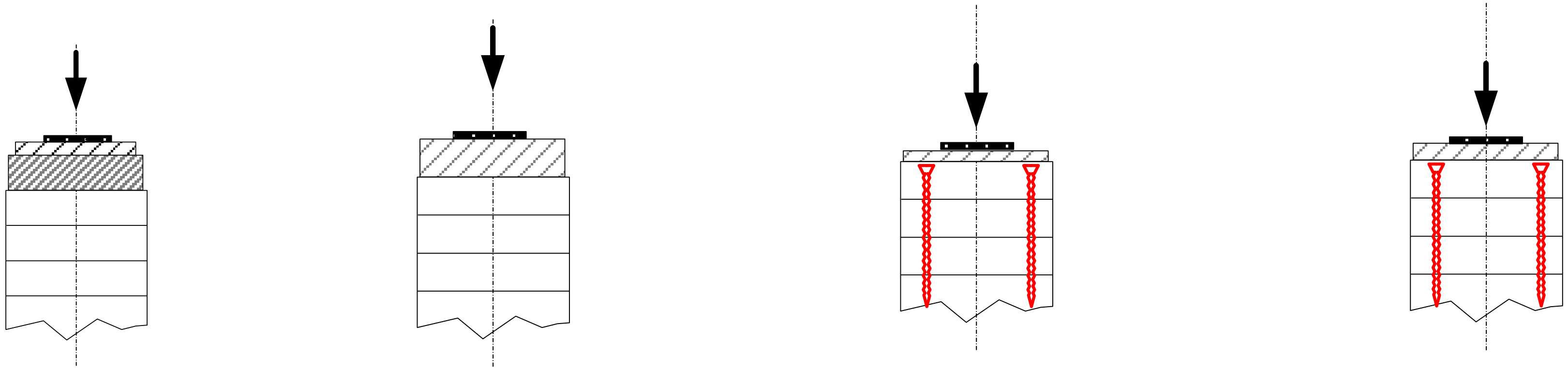
after Per-Anders Fjällström, SP-Trätek

Loss of pre-stress

Test series “a”: Ultimate Load Carrying Capacity



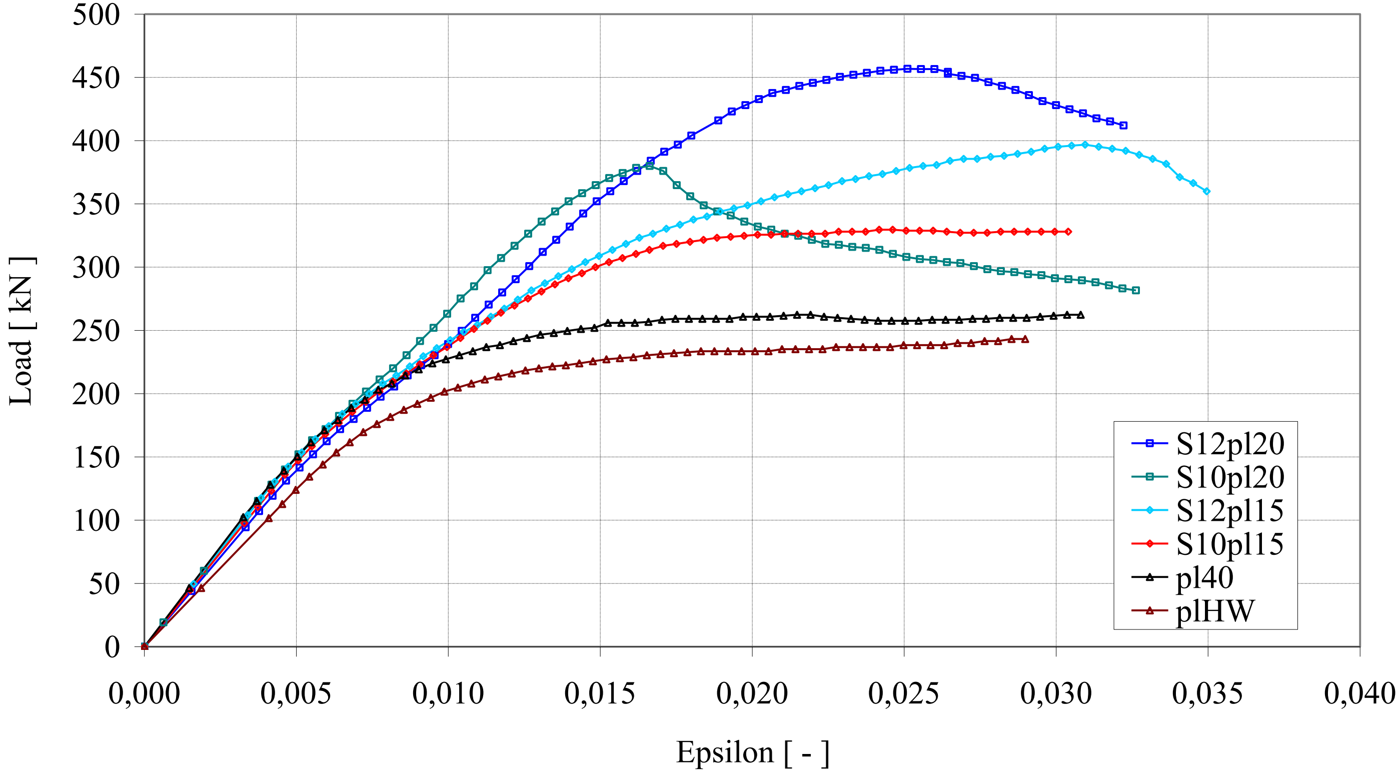
Test series “a”: Totally 6 specimens



Unrinforced 1 (plHW) | Unrinforced 2 (pl40) | Reinforced 1 & 2 (S10pl15) (S12pl15) | Reinforced 3 & 4 (S10pl20) (S12pl20)

- pl: Bearing plate
- HW: Hard Wood
- S: Screw

Test series “a”: Results

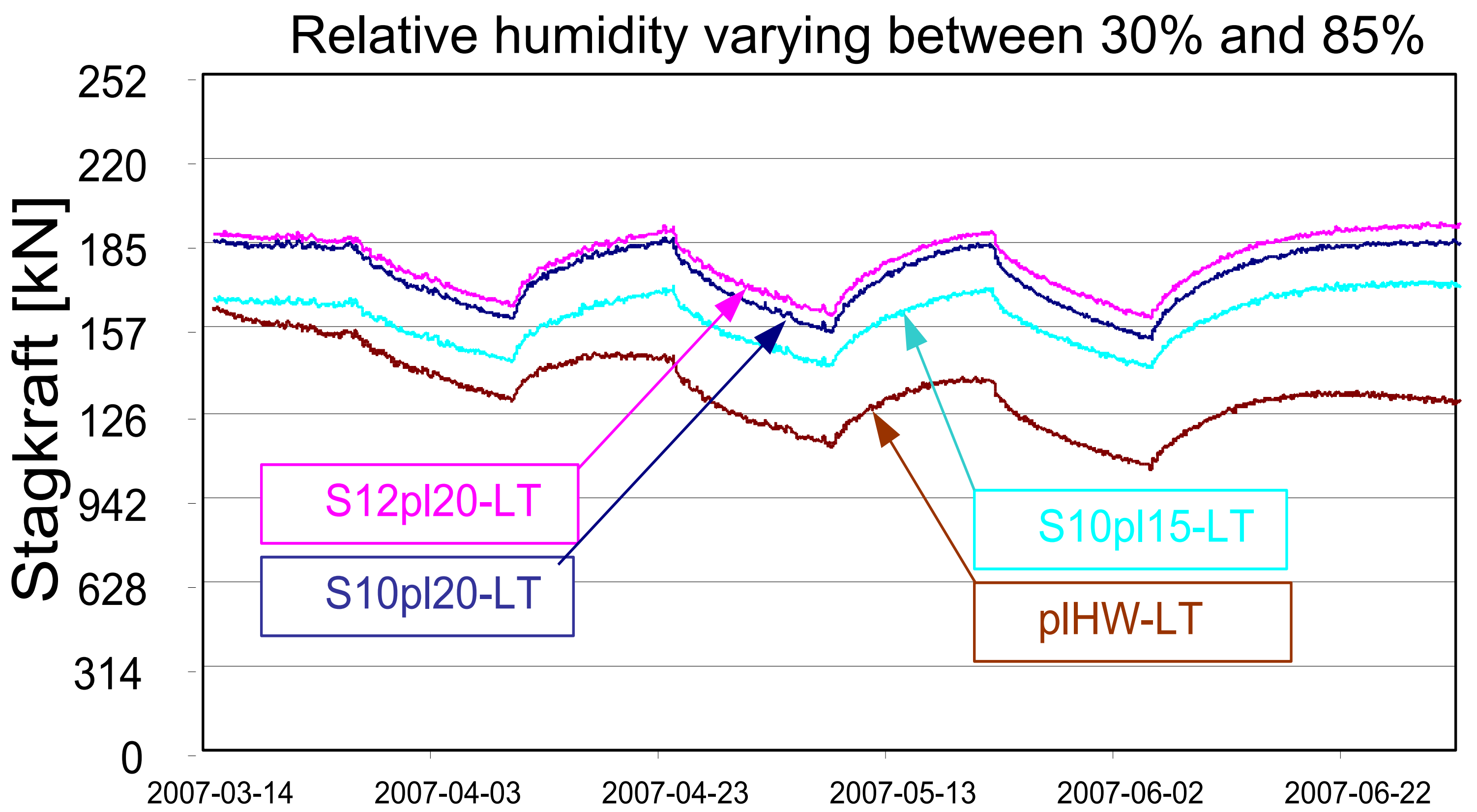


The screws increase the capacity of the anchorage system by:

- ~50% if d=10 mm; ~85% if d=12 mm.

Loss of pre-stress

Long term behaviour

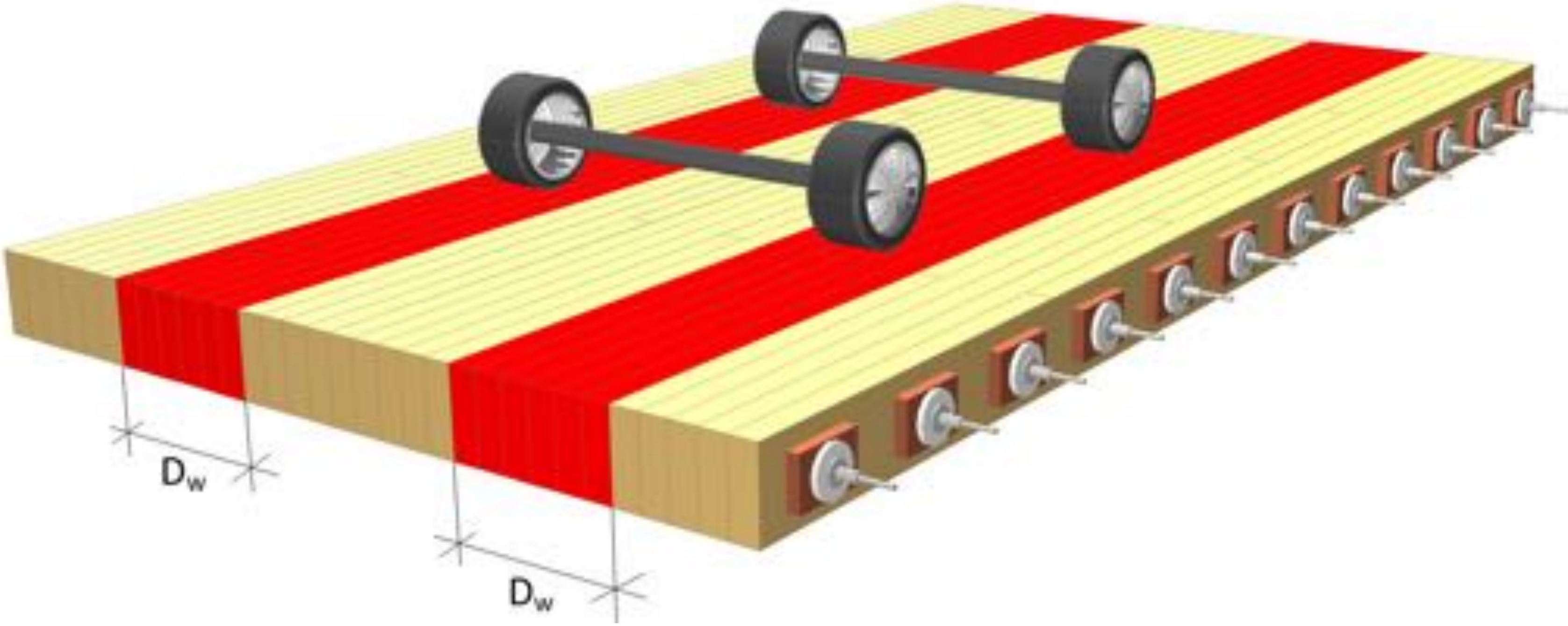


approx. 3 months

Design models

Equivalent beam theory

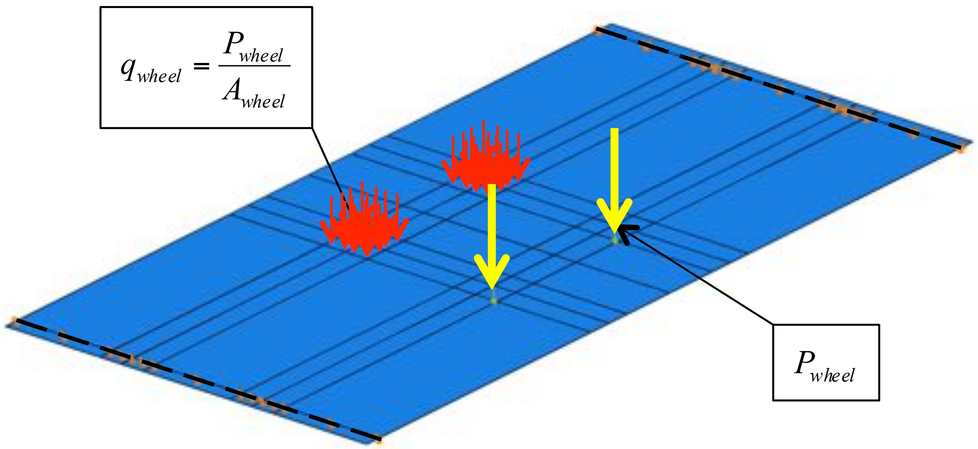
- Plate is substituted with beams in the wheel path, e.g. Ritter (1990), Crews (2001), EN 1995-2 (2004)



Design models

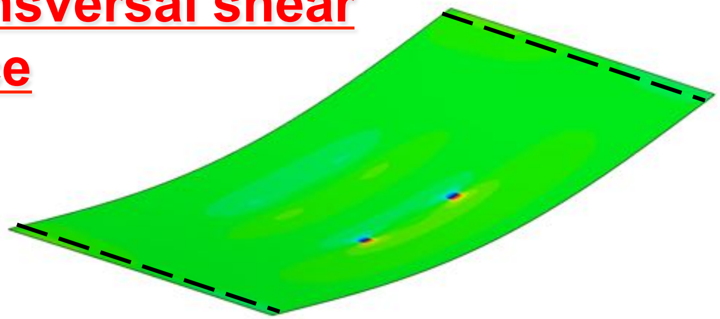
Orthotropic plate theory by means of the finite element method

Load and support configuration

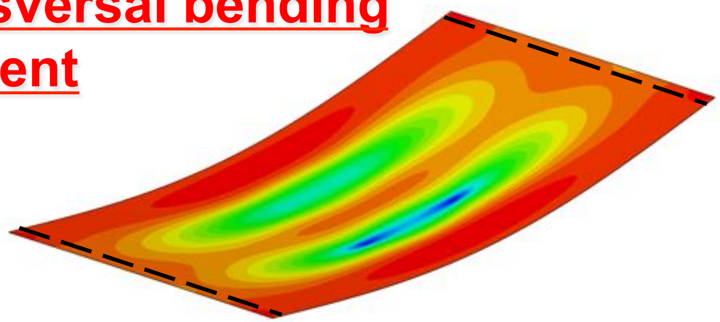


- Patch-loads instead of concentrated loads

Transversal shear force



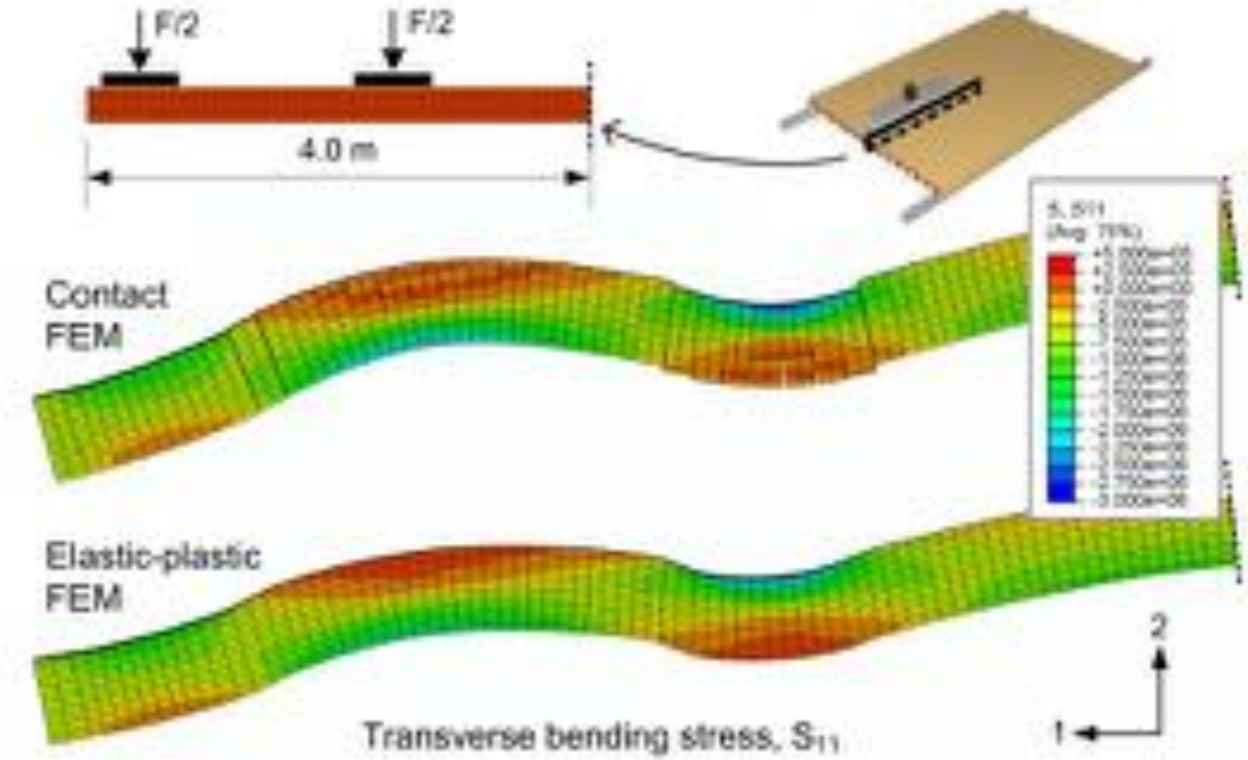
Transversal bending moment



Design models

Deck type	$E_{90,mean}$ / $E_{0,mean}$	$G_{0,mean}$ / $E_{0,mean}$	$G_{90,mean}$ / $G_{0,mean}$
Nail laminated	0	0.06	0.05
Stress laminated (sawn)	0.015	0.06	0.08
Stress laminated (planed)	0.02	0.06	0.10
Glue laminated	0.03	0.06	0.15

Modelling by means of solid finite elements



Railing system

Railing with balusters of steel and a top rail of wood

Railing with both balusters and top rail made of wood

Expansion joints

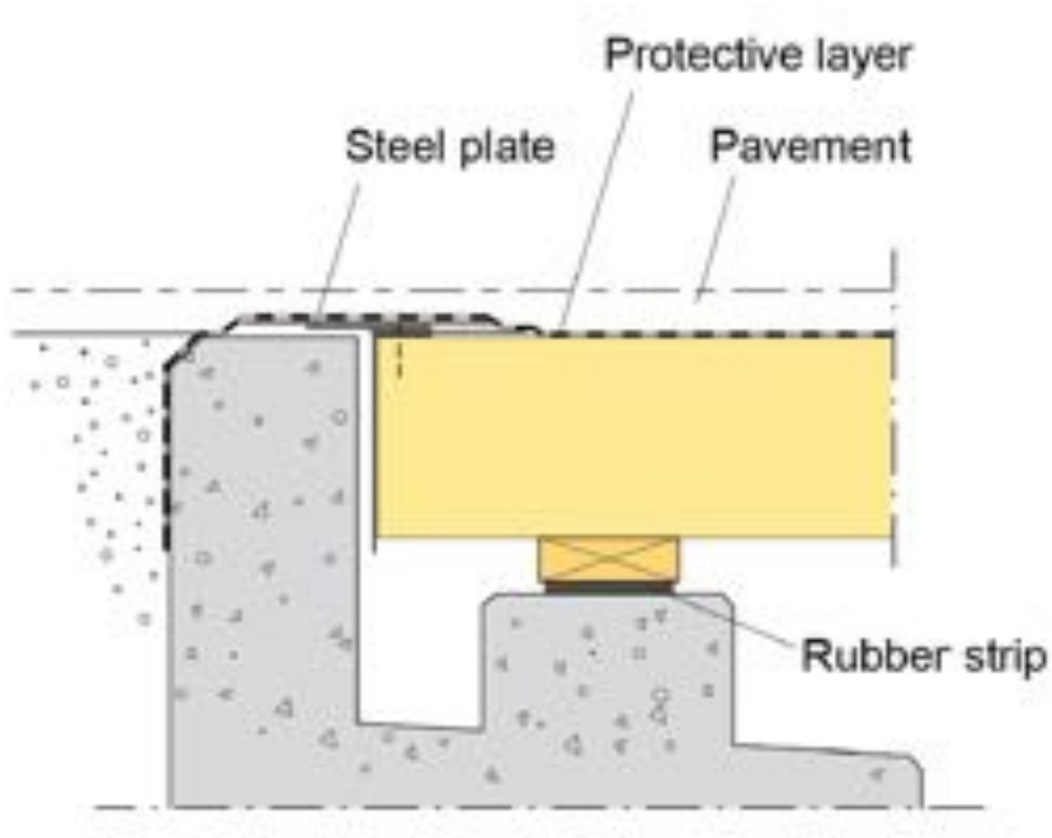
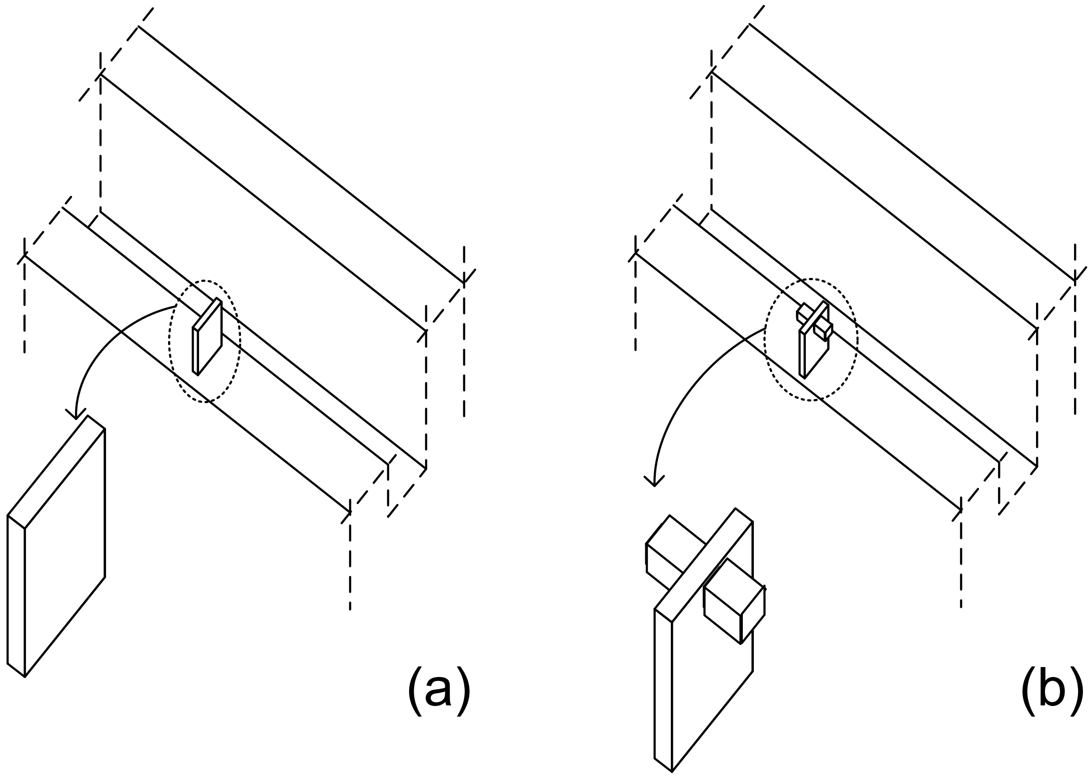


Figure: A. Pousette

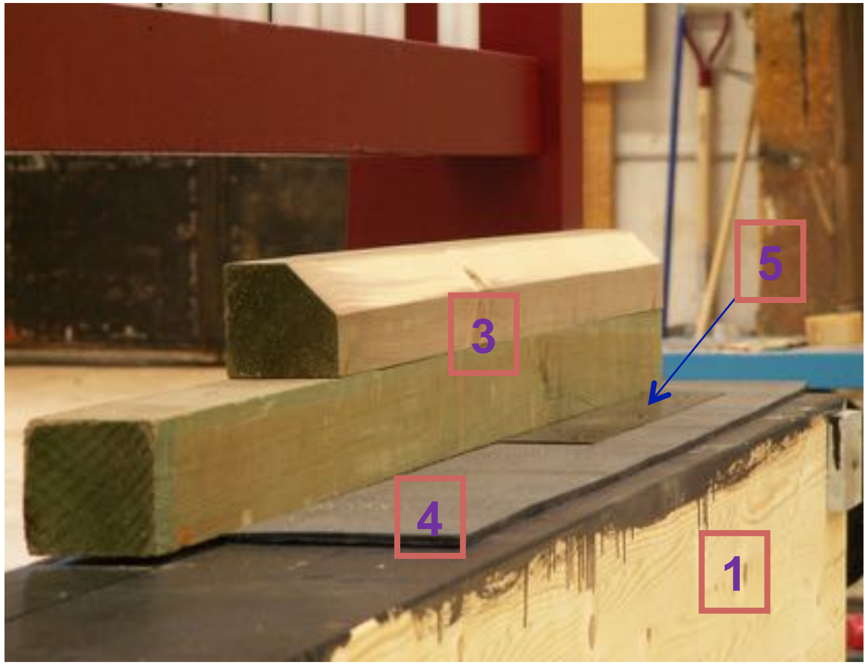
Bearing system

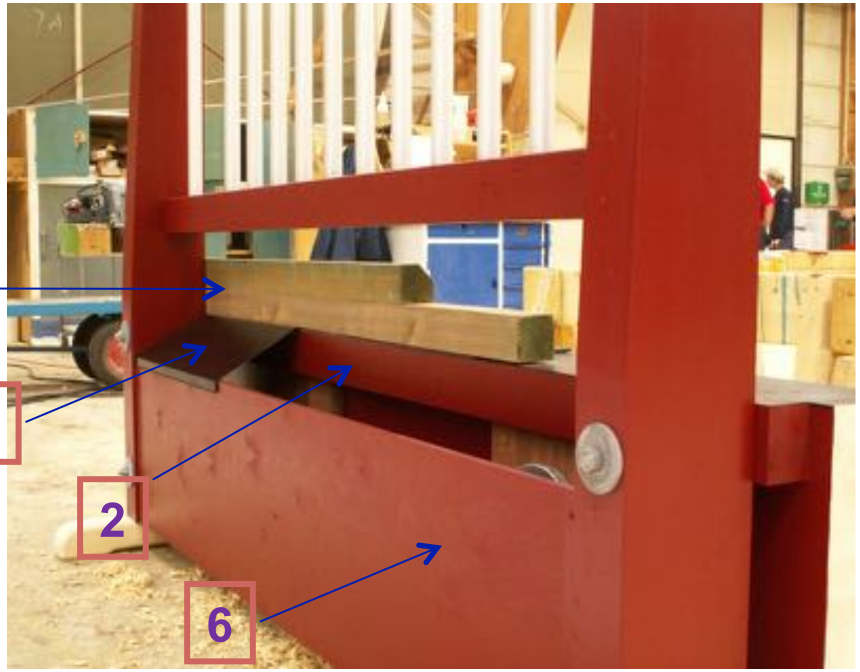


(a) Sliding support

(b) Fixed support

Durability





(1) Deck/beam

(2) Wooden strip – it is screwed to the side of the beam/deck

(3) Double wooden members – these are nailed to the wooden strip

(4) Rubber mat 5mm, b=250 mm

(5) Steel plate t=0,6 mm

(6) Wearing planks/ wearing timber plate

Durability

Conclusions

- Glulam beams which are pre-stressed with steel bars, create very efficient stress-laminated timber decks

- The main advantage of SLT decks used as a bridge are:
  - Simplicity
  - Possibility to shape – also curved geometries
  - Durability
  - Sustainability of the materials

- The recognised negative aspects of SLT decks are:
  - effect of butt joints on the stiffness
  - loss of pre-stress after assembly

Conclusions

- The design of SLT decks can be performed by e.g.
  - the theory of orthotropic plates using the finite element method,
  - simple calculation models, as shown in the Eurocode EN 1995-2

- Correct detailing is extremely important when it comes to deck durability