Applicability of Cross Laminated Timber in Bridges

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CLT as a construction material

- Buildings
  - Floors
  - Roofs
  - Walls
- Bridge
  - Decks

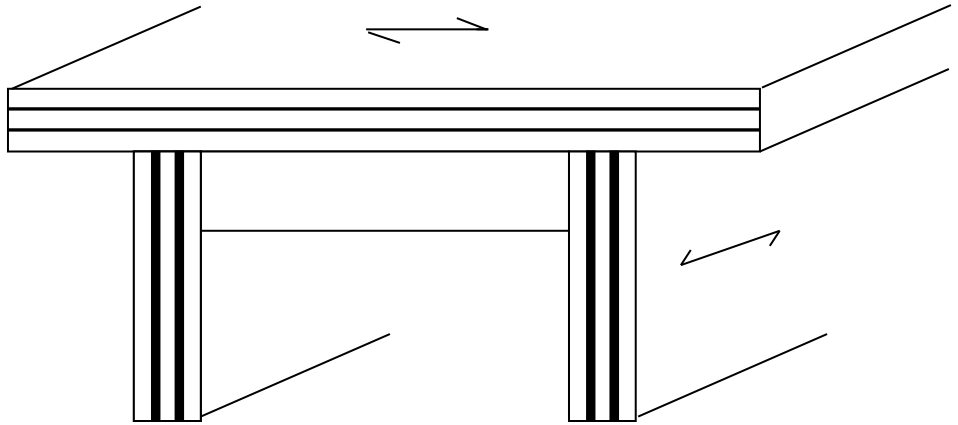

Finnish Nature Center Haltia, FInland


Klagenfurt, Austria

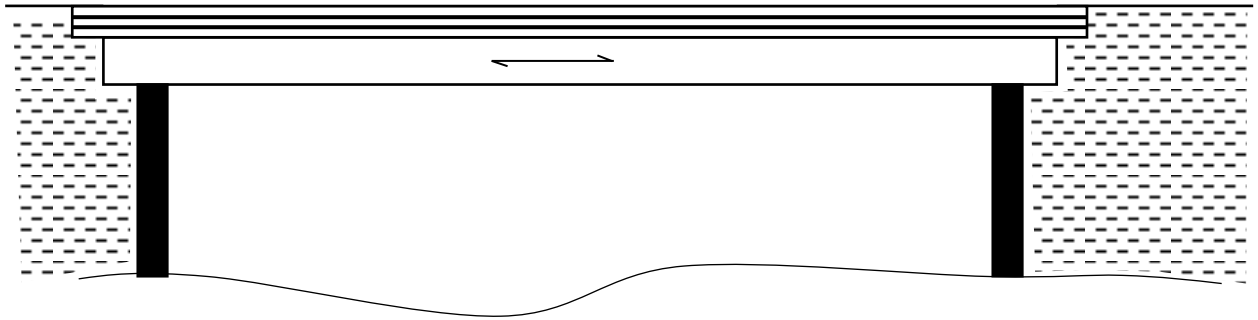

Hundorp Bridge, Norway

Applicability of CLT in bridges

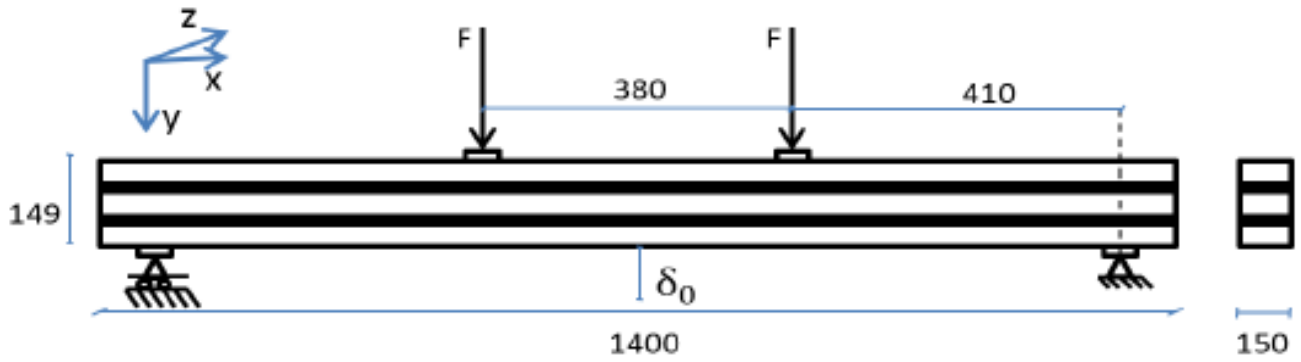
- Small span bridges
  - In theory all parts in CLT
  - Differently oriented



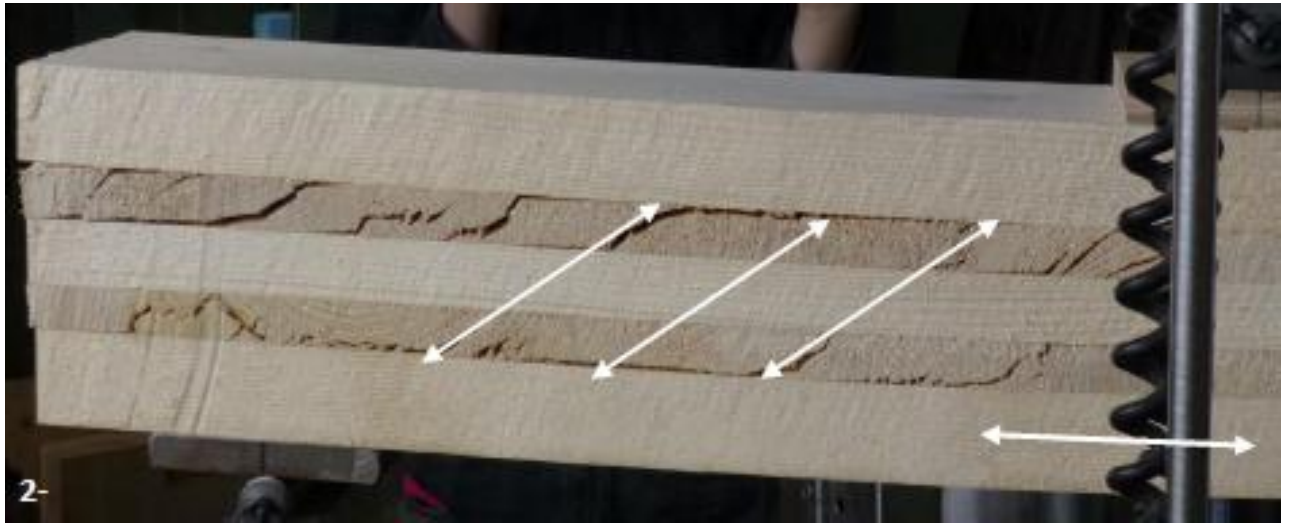
- Long span bridges
  - Deck
  - CLT long beams too weak against bending



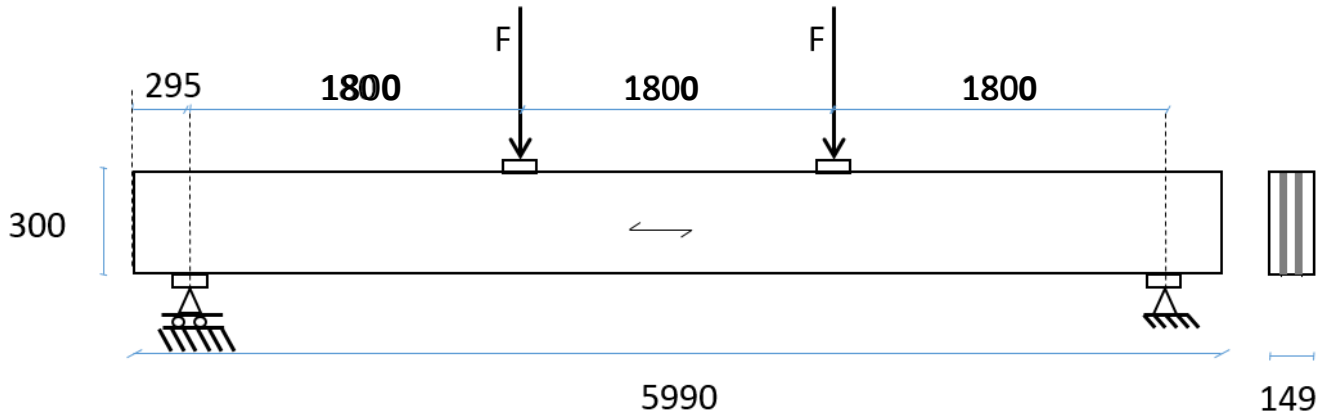
Experiments : Small scale test



- Deck representation
  - Rolling shear failure (50kN)



Experiments : Full scale CLT-beam test

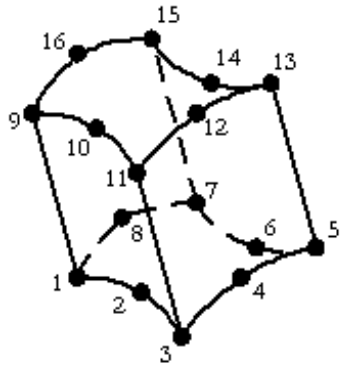


- Main girder representation
  - Bending failure (72kN)

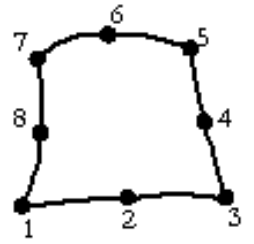
Numerical Analysis

- LUSAS finite element model
  - 3D Solid composite model
    - ➢ 16 noded solid elements (HX16L)
  - 2D Thick shell composite model
    - ➢ 8 noded thick shell elements (QTS8)

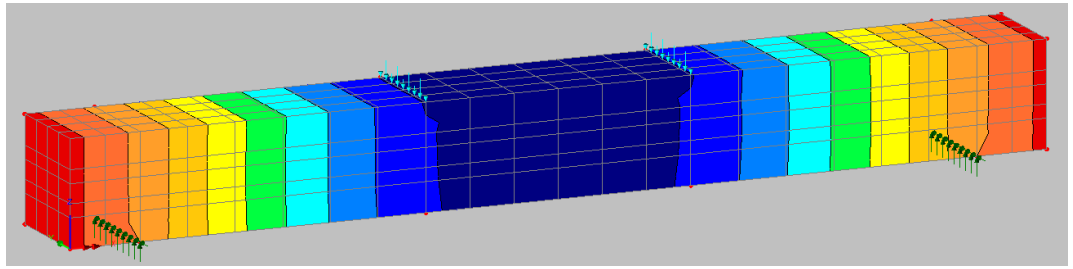
HX16L



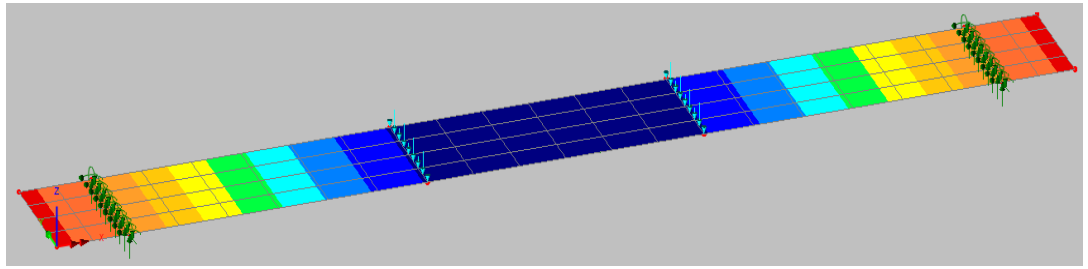
QTS8



Numerical Analysis : Small scale test



3D Solid composite model



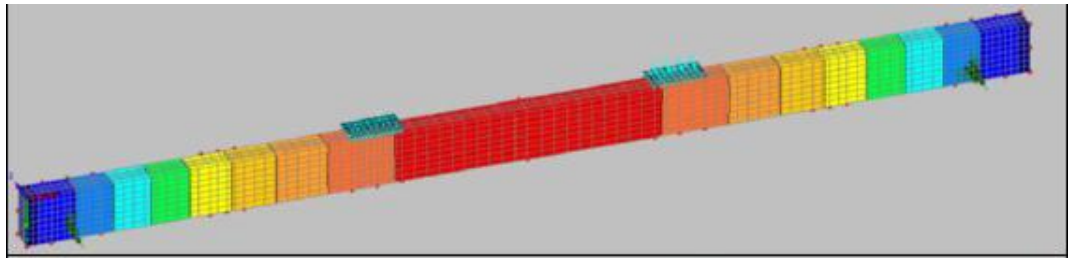
2D Thick shell composite model

Identical deflection

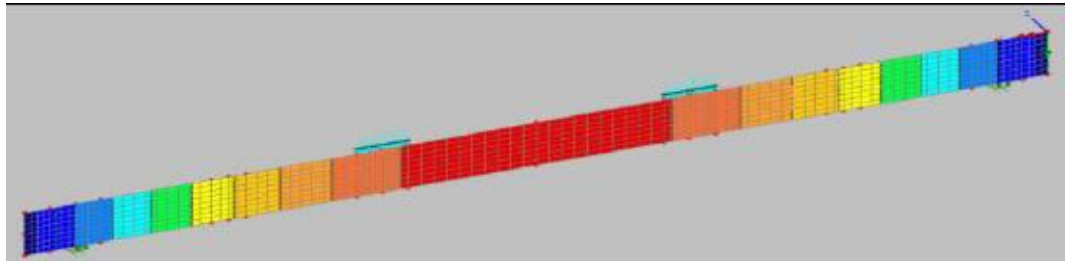
Load [kN]	Solid model	Thick shell	Experiment
20	3mm	5mm	3mm
35	5mm	9mm	5mm
50	7mm	13mm	7mm

3D model needed even for preliminary studies on CLT decks

Numerical Analysis : Full scale beam test



3D Solid composite model



2D Thick shell composite model

Identical deflection

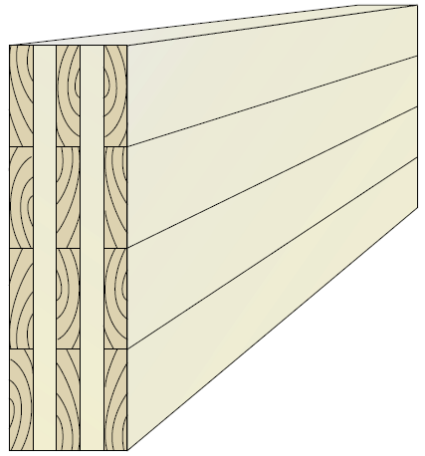
Load [kN]	Solid model	Thick shell	Experiment
20	17mm	17mm	19mm
35	42mm	42mm	46mm
50	59mm	59mm	65mm

Accuracy of 90%

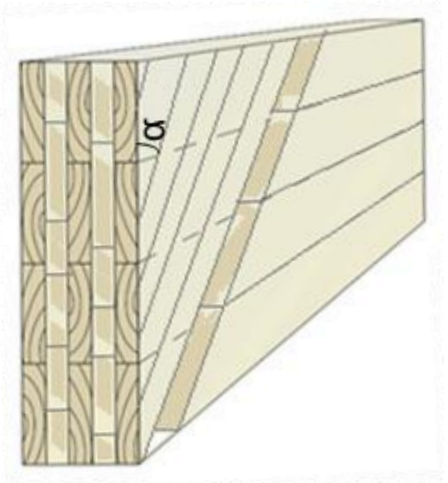
Simple 2D composite model seems accurate enough for preliminary studies on CLT beams

From CLT beams to DLT[1] beams

- Cross Laminated Timber beam
  - 90° angle orientation difference
  - Low bending stiffness if too long



- Diagonal Laminated Timber[1] beam
  - α angle orientation difference
  - Optimizable angle
    - ➢ Depending on the configuration of the bridge



[1] designation used in Bejtka I., *Cross (CLT) and diagonal (DLT) laminated timber as innovative material for beam elements*. KIT Scientific Publishing, Karlsruhe, Germany. 2011. 134 p.

Conclusion

- Cross Laminated Timber is being used for decks
- Small span all-CLT bridges possible

  Preliminary studies of CLT beams easily obtainable
- Longer span CLT bridges possible with Diagonal Laminated Timber beams
- DLT beams analysis and improvement needed

  Preliminary studies easily obtainable

Thanks for your attention!