Ductility aspects of connections perpendicular to the grain

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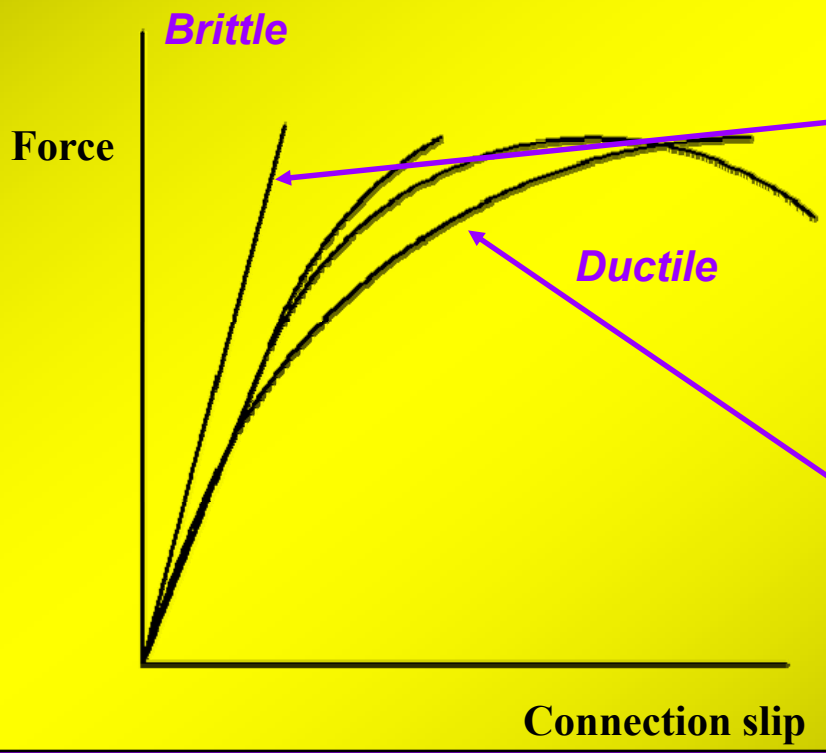
cost
Building European Science
Action E55:
Modelling of the Performance of Timber Structures

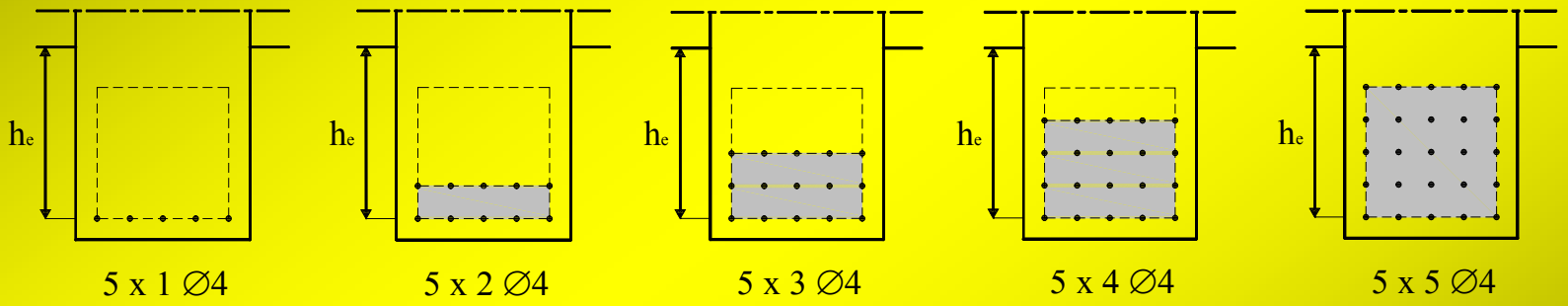
Joint Ductility

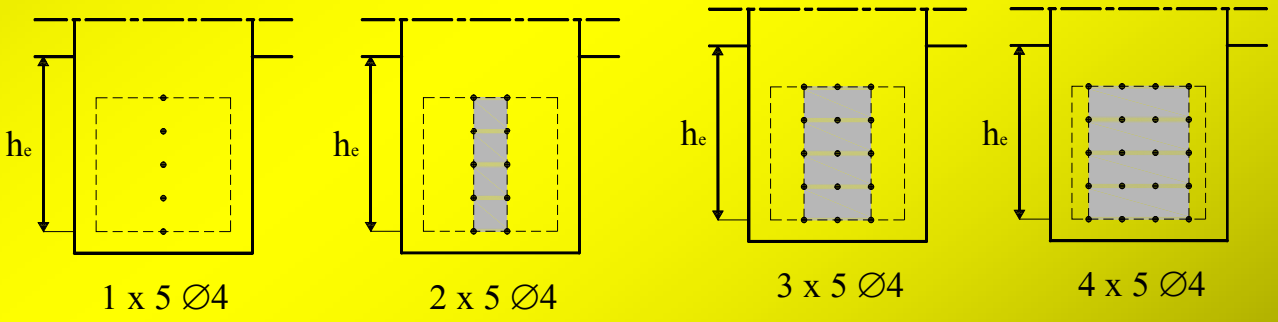
- Perpendicular-to-grain loading by mechanical connections
- Behaviour dependant of the number of fasteners



Joint Ductility ~ Number of fasteners

- Experiments with nails d=4 mm

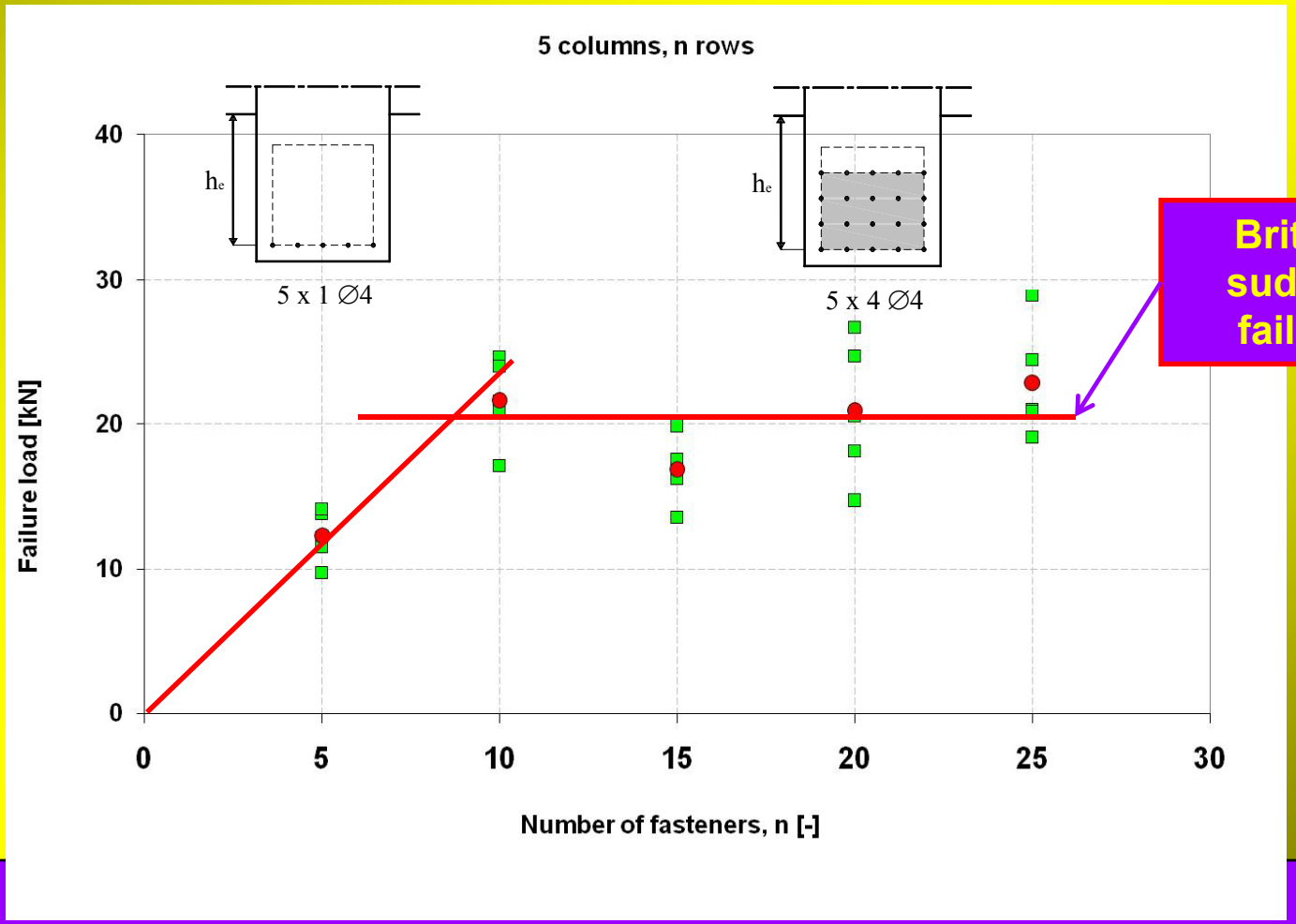




5 nails **10 nails** **15 nails** **20 nails** **25 nails**

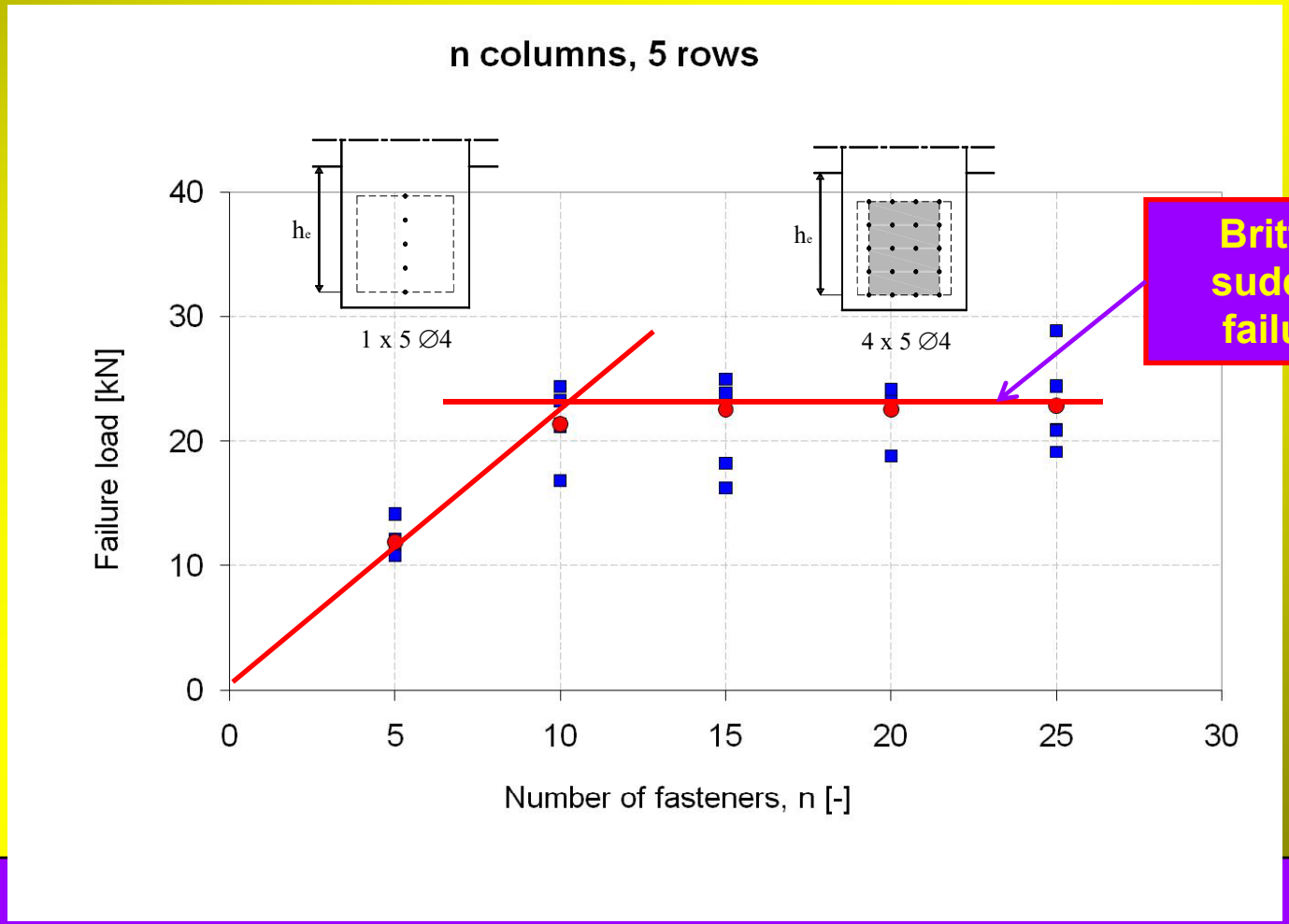
Joint Ductility ~ Number of fasteners

- Experiments, 5 columns, *i* rows

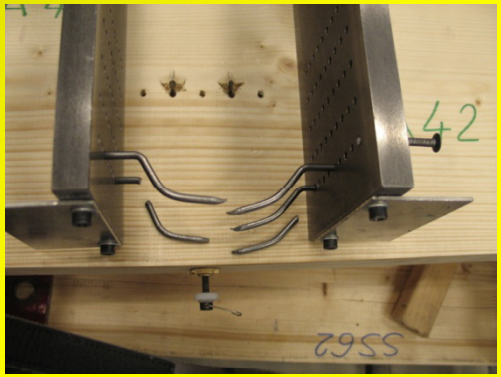


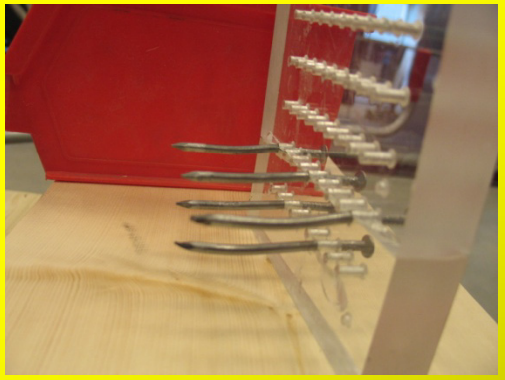
Joint Ductility ~ Number of fasteners

- Experiments, 5 rows, *j* columns



Joint Ductility ~ Number of fasteners





5 or 10 nails

5 rows

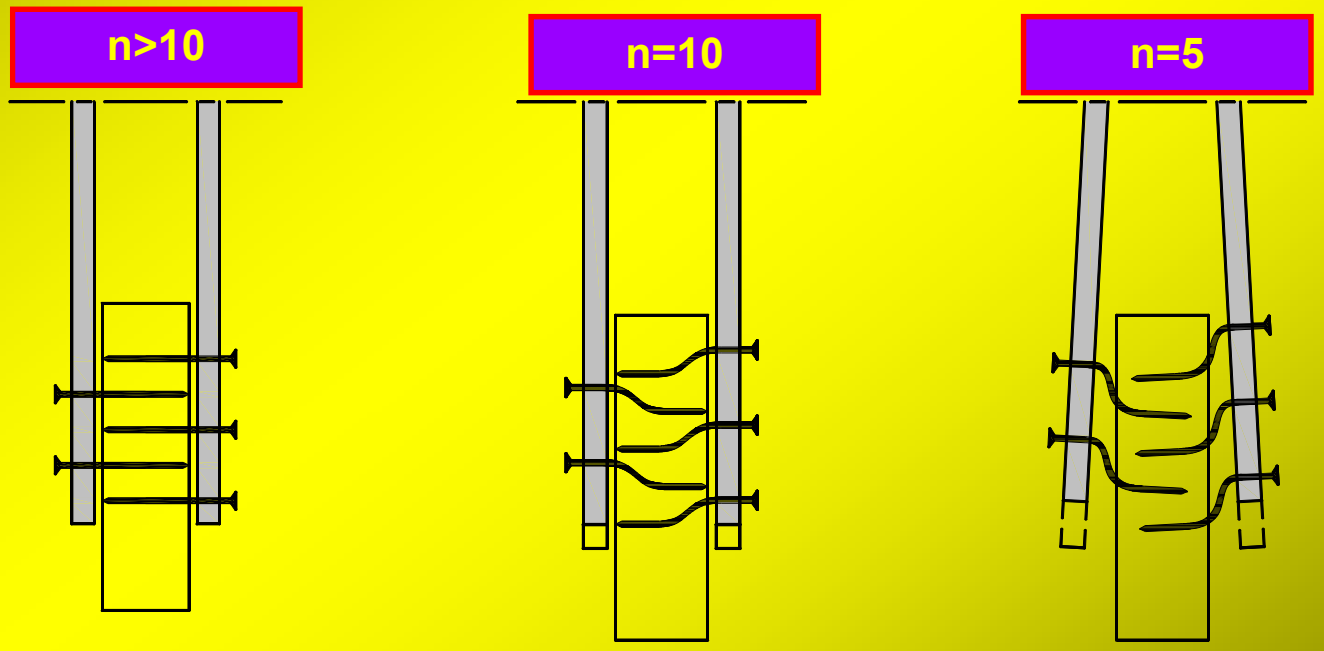
5 or 10 nails

5 columns

25 or 20 nails

Joint Ductility ~ Number of fasteners

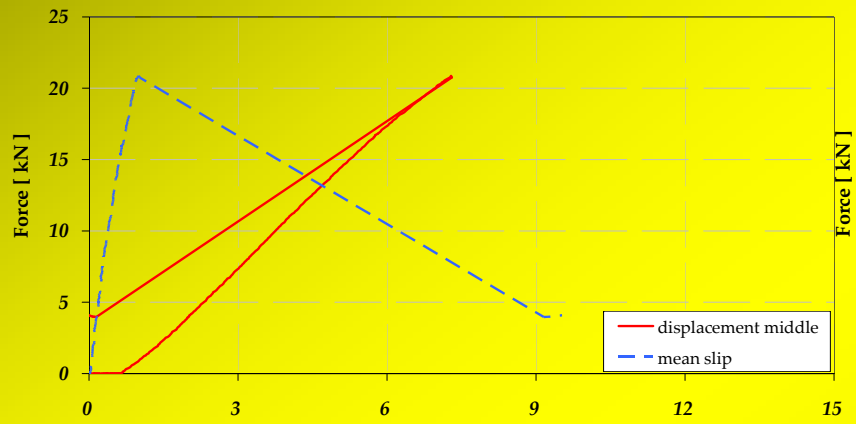
- Deformed shapes of fasteners, n dependant

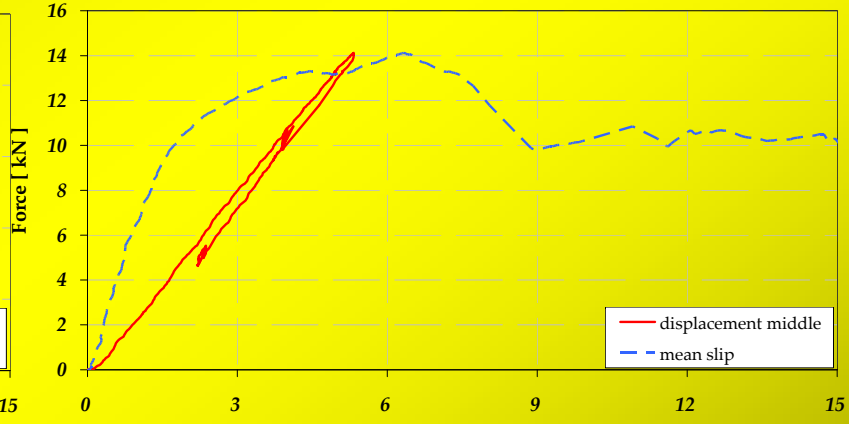


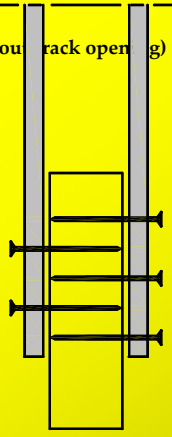
Rigid bearing, splitting governs	Plasticity in fasteners, splitting did occur	Plasticity in fasteners, withdrawal, splitting did not occur

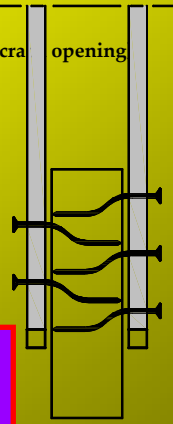
Joint Ductility ~ Number of fasteners

- Load-slip response, n dependant







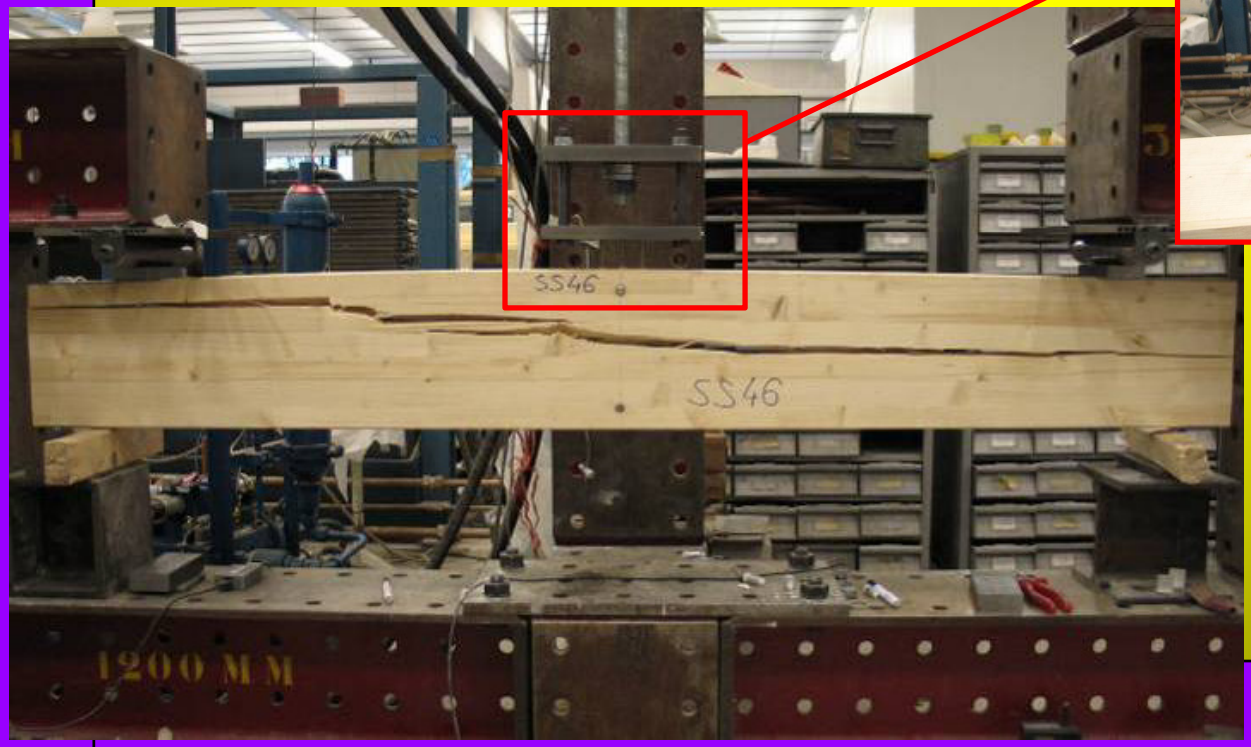


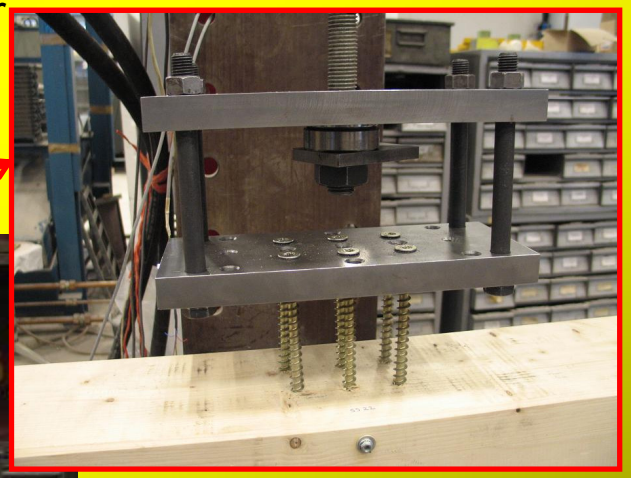
Large number of fasteners

Small number of fasteners

Joint Ductility ~ Self-tapping screws

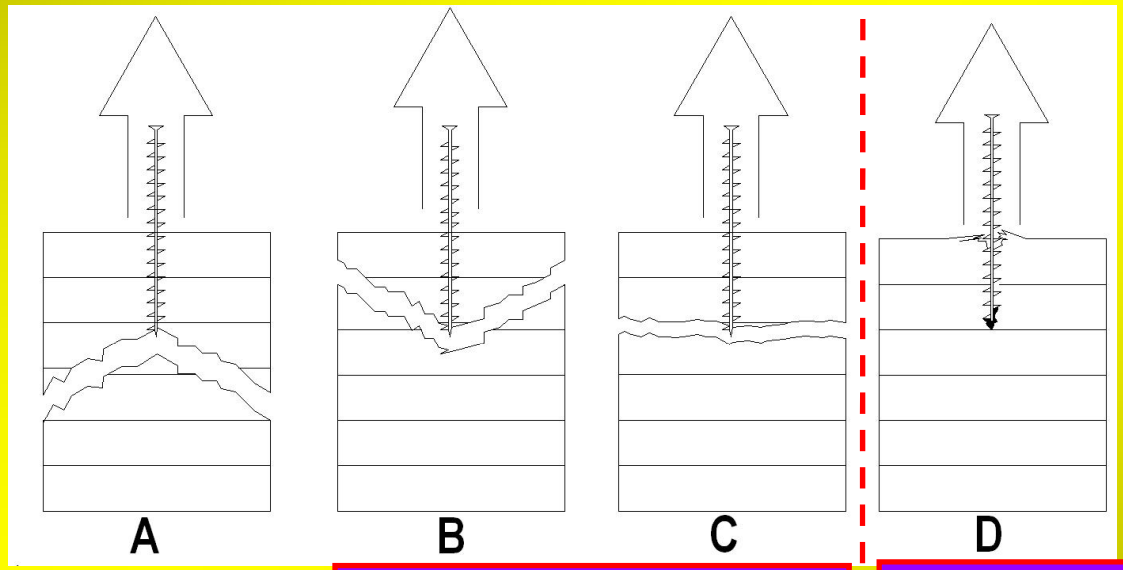
- Self-drilling screws, perpendicular-to-grain, axially loaded
- 3 or 6 screws of 8 mm or 12 mm diameter
- Anchorage length 30% or 50% of beam
- Spacing 4*d* or 8*d*





Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to-grain, axially loaded
- Again, different failure mechanisms occur, dependant of the number of screws, spacing (4*d* or 8*d*), and diameter

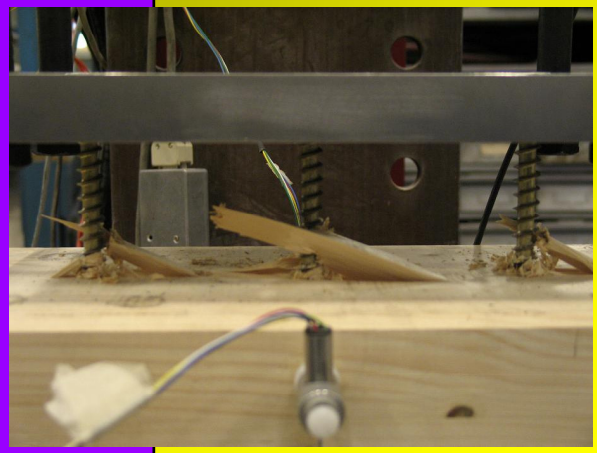


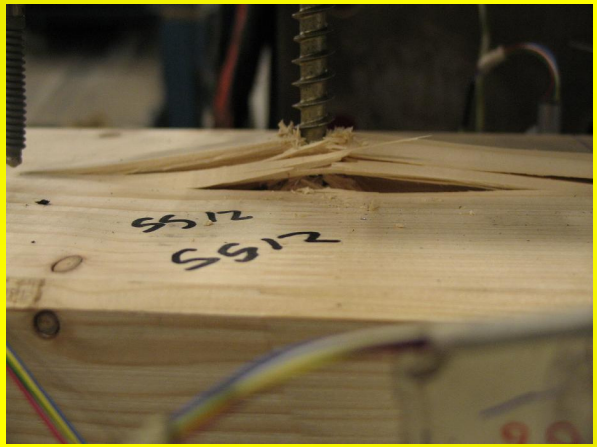
Splitting of the beam | **Withdrawal of the screws**

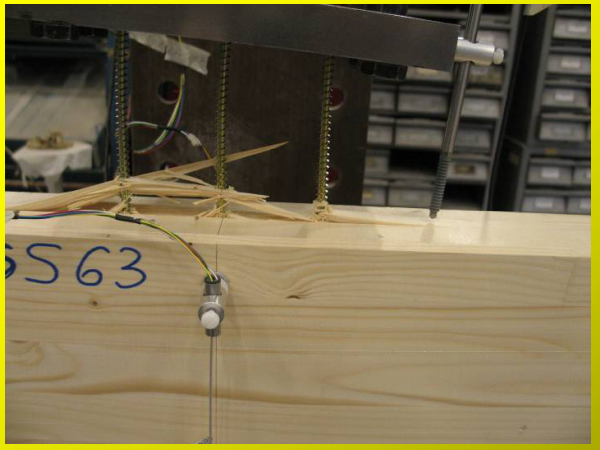
- Anchorage length doesn't affect the behaviour

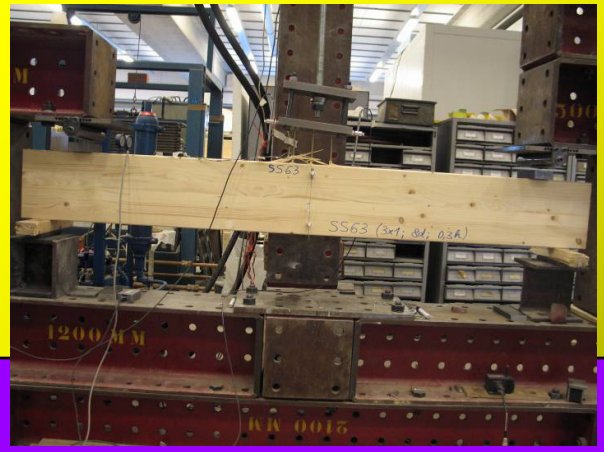
Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Withdrawal



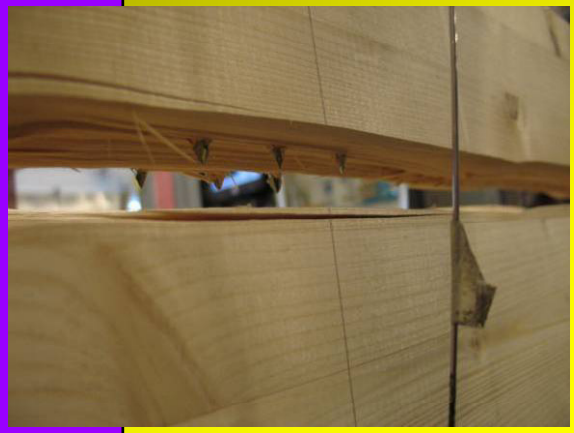


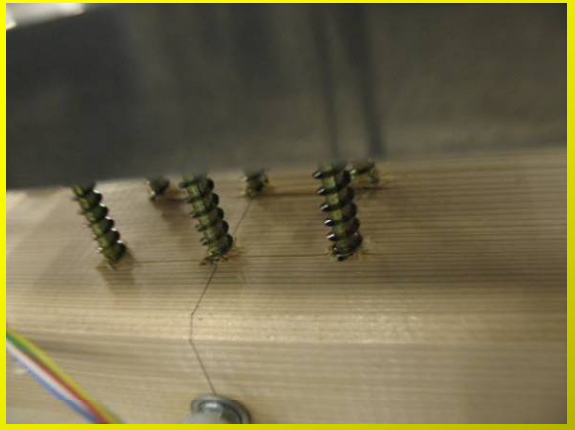


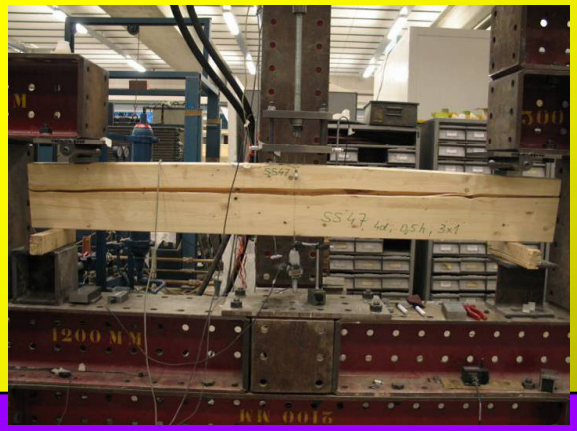


Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Splitting

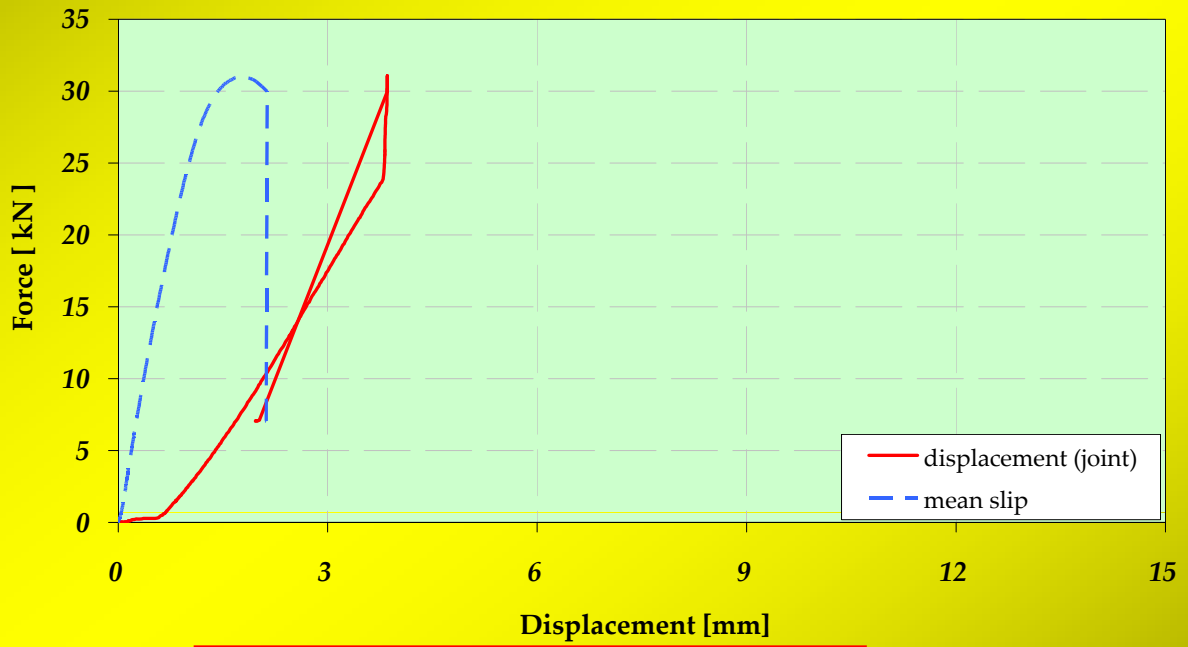


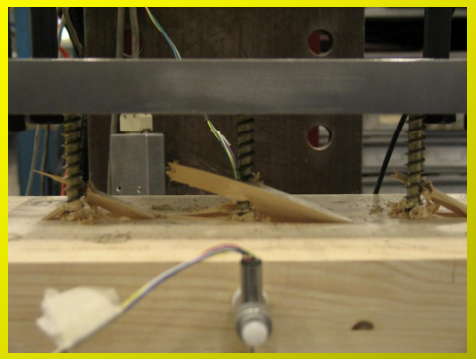




Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Withdrawal

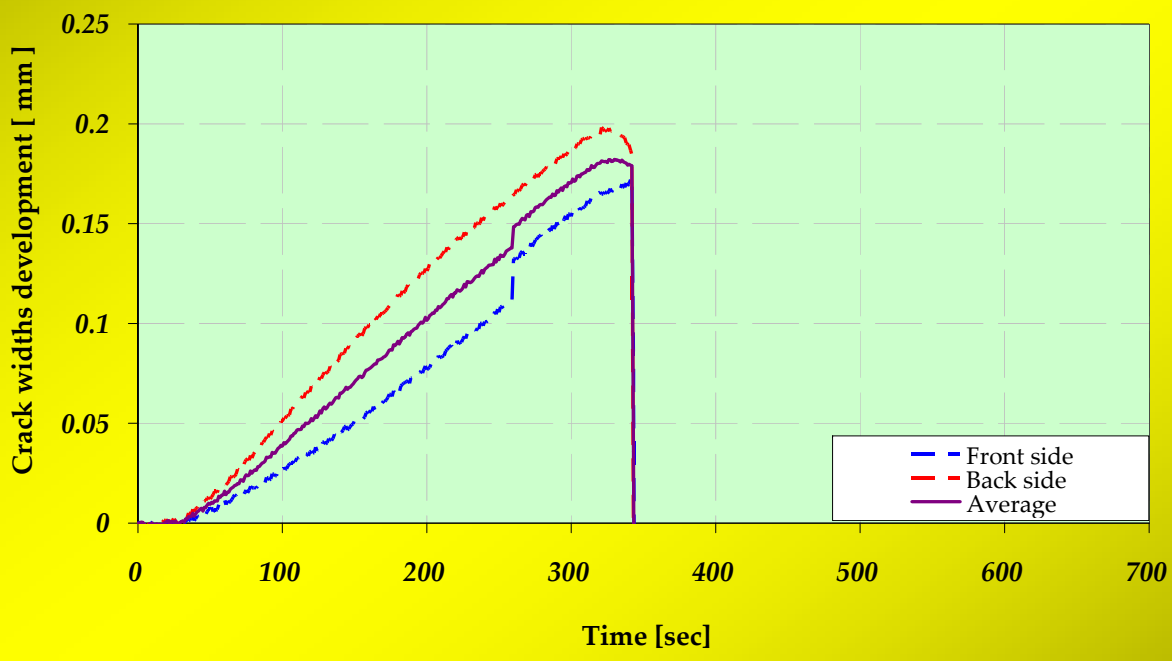


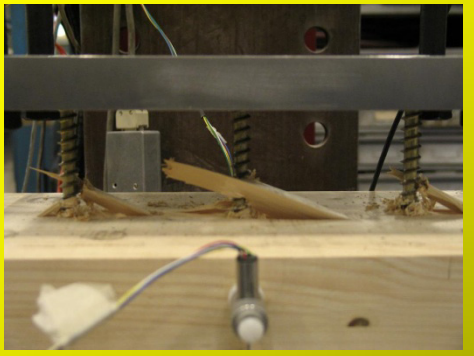


Load-slip response

Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Withdrawal





Time-Crack width (and elastic) response

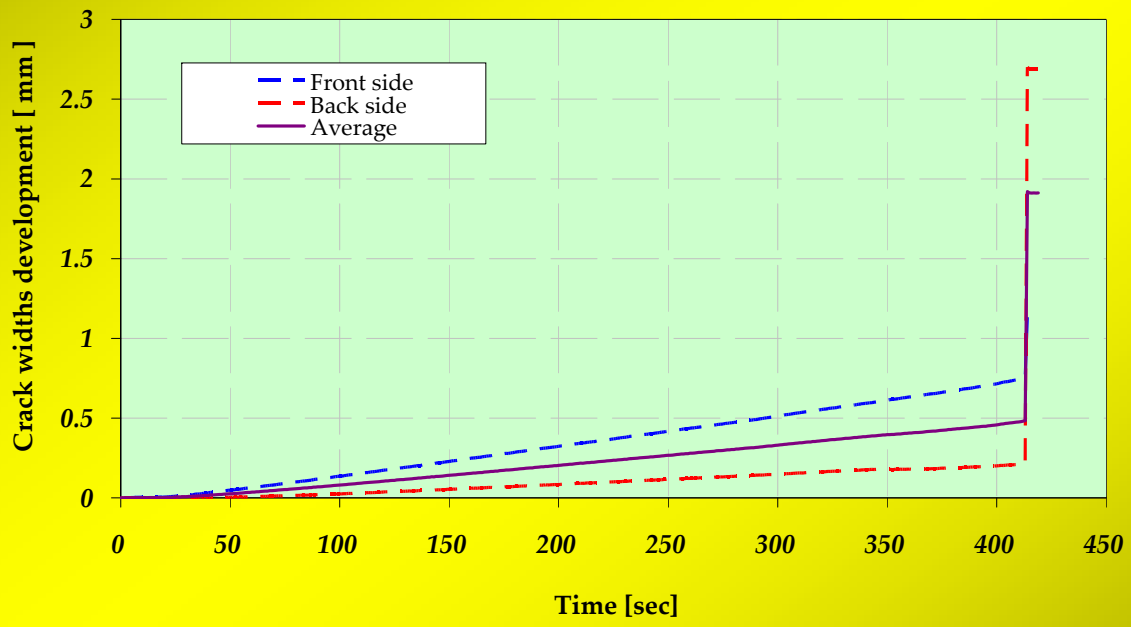
Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Splitting

Load-slip response

Joint Ductility ~ Self-tapping screws

- Self-drilling screws, perpendicular-to -grain, axially loaded
- Again, different failure mechanisms occur: Splitting



Time-Crack width (and elastic) response

Joint Ductility: conclusions and remarks

- Multiple fastener connections with nails (spacing 5d):
  - Behaviour and Ductility depends on number of fasteners
  - Low number of fasteners → ductile behaviour
  - Large number of fasteners → brittle behaviour
- Self-drilling screws, perpendicular-to -grain, axially loaded:
  - Behaviour depends on number of fasteners, spacing and diameter
  - Low number (and large spacing, and d=12mm)→ withdrawal
  - Large number of fasteners (all other combinations)→ splitting
  - Even withdrawal of the screws is a rather brittle behaviour
  - Anchorage length doesn't affect the behaviour
  - Ductility nearly impossible to obtain

Discussion