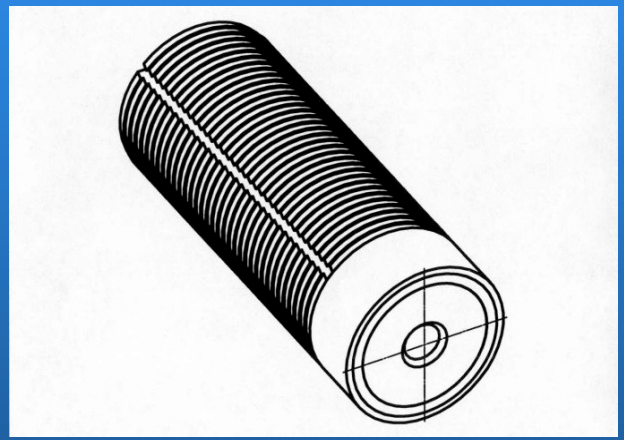
Determination of the Capacities of a new Composite Timber-Steel Connector System



Alexander Schreyer, Dipl.-Ing. (FH) - U.B.C.
Leander A. Bathon, Ph.D. - FH Wiesbaden, Germany
Helmut G.L. Prion, Ph.D., P.Eng. - U.B.C.

Outline

System

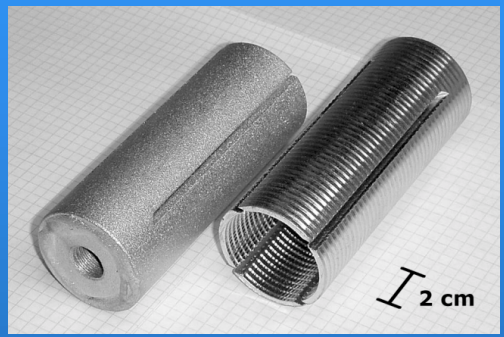
Manufacturing

Tests

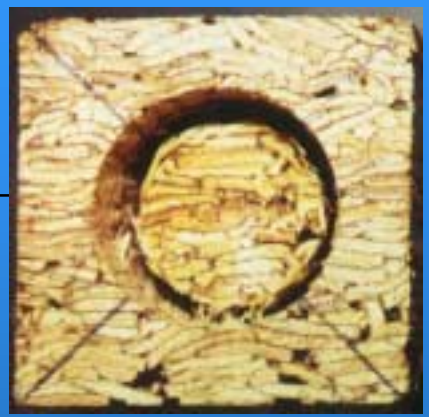
- Tension
- Compression
- Shear
- Climate Cycles

The Components

- Connector
  (Sandblasted Surface)
- Mortar: Upat UPM66®
- Drill



Manufacturing



Drill Ring Hole
and Countersink

Inject Mortar
Insert Connector

Hardening 10 min.
Remove Excess Material

Test Program

- Axial Tensile Tests, Single Connector (Glulam and PSL)
- Axial Compression Tests, Single Connector (Glulam)
- Shear Tests, Single and Double Connector Joints, Varying Edge Distances (Glulam)
- Tensile Tests after Cyclic Climate Changes (3 Cycles, 6 Weeks each)

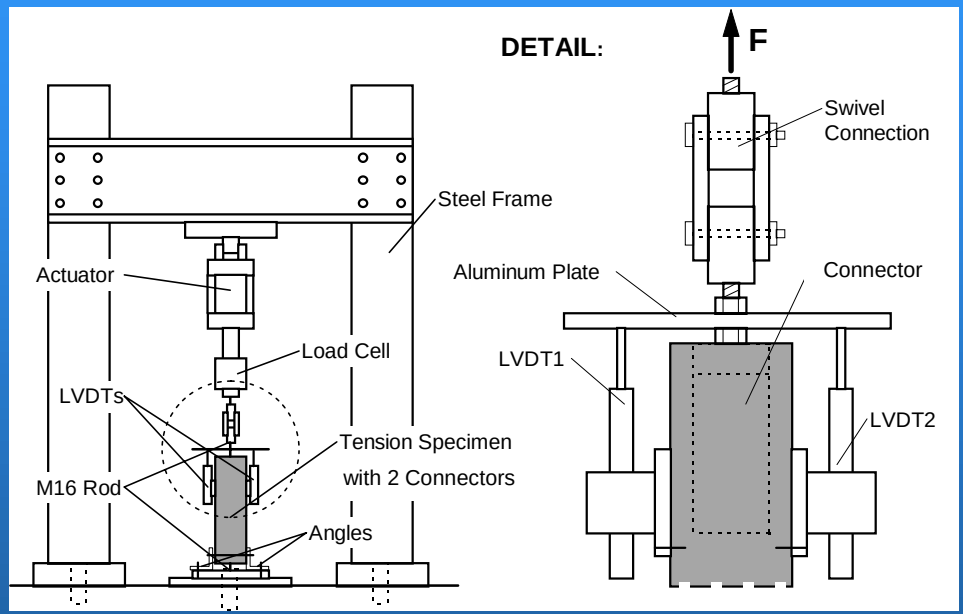
Test Setup

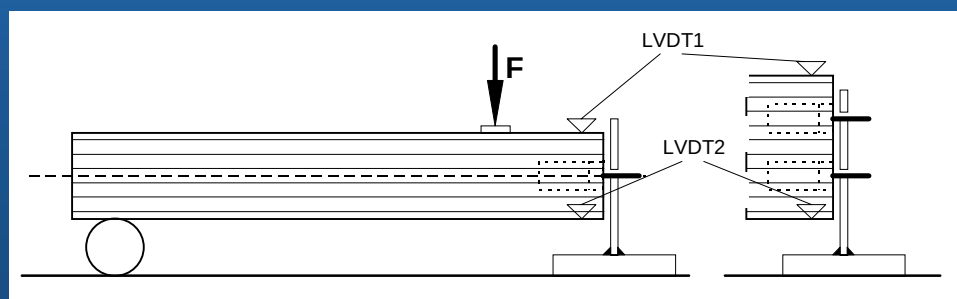
Tension / Compression Tests:

- EN 26 891
- 1 Load Cycle

Shear Tests:

- Ramp Load

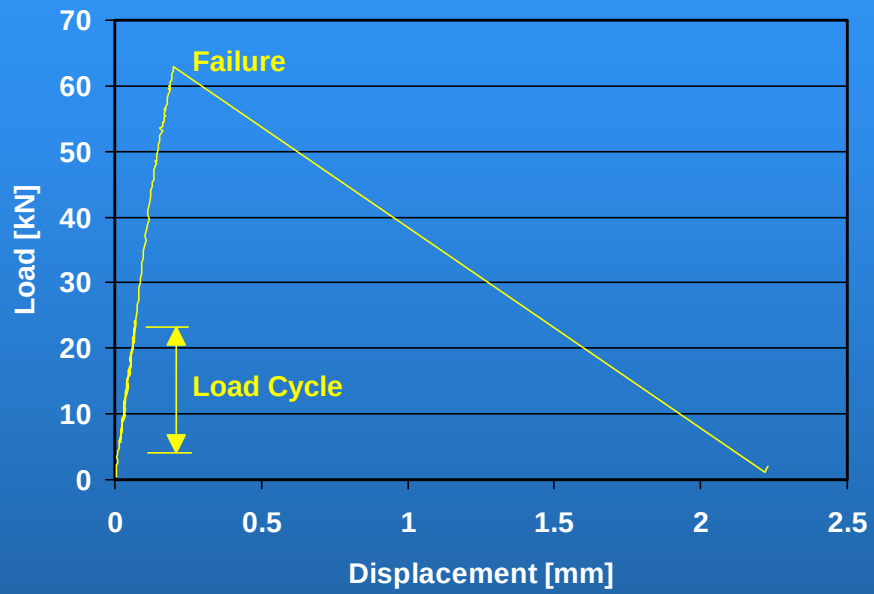




Tensile Tests

- 20 Tests
- 80/80/500 mm, Glulam
- 2 Connectors per Specimen, 1 End Clamped

Tensile Tests



	Average	COV
Failure Load	54.10 kN	13.8 %
Failure Displacement	0.214 mm	29.6 %
Slip Modulus k_s	336.44 kN/mm	10.8 %

Tensile Tests - PSL

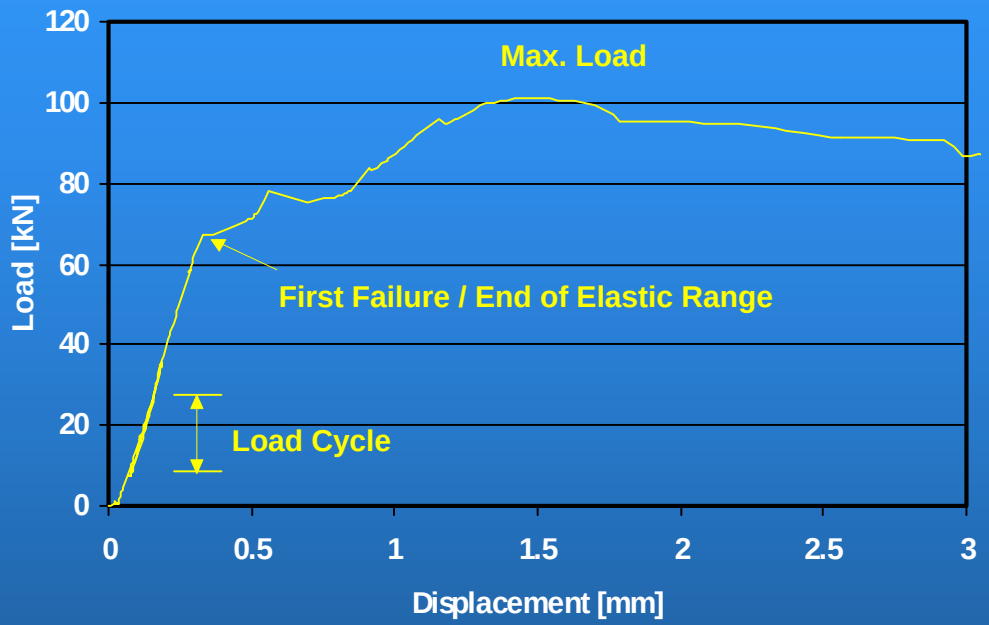
5 Tests

	Average	Difference	COV
Failure Load	59.69 kN	+10%	11.5 %
Failure Displacement	0.201 mm		10.5 %
Slip Modulus k_s	338.27 kN/mm		19.1 %

Compression Tests

- 30 Tests
- 80/80/300 mm, Glulam
- 1 Connector per Specimen

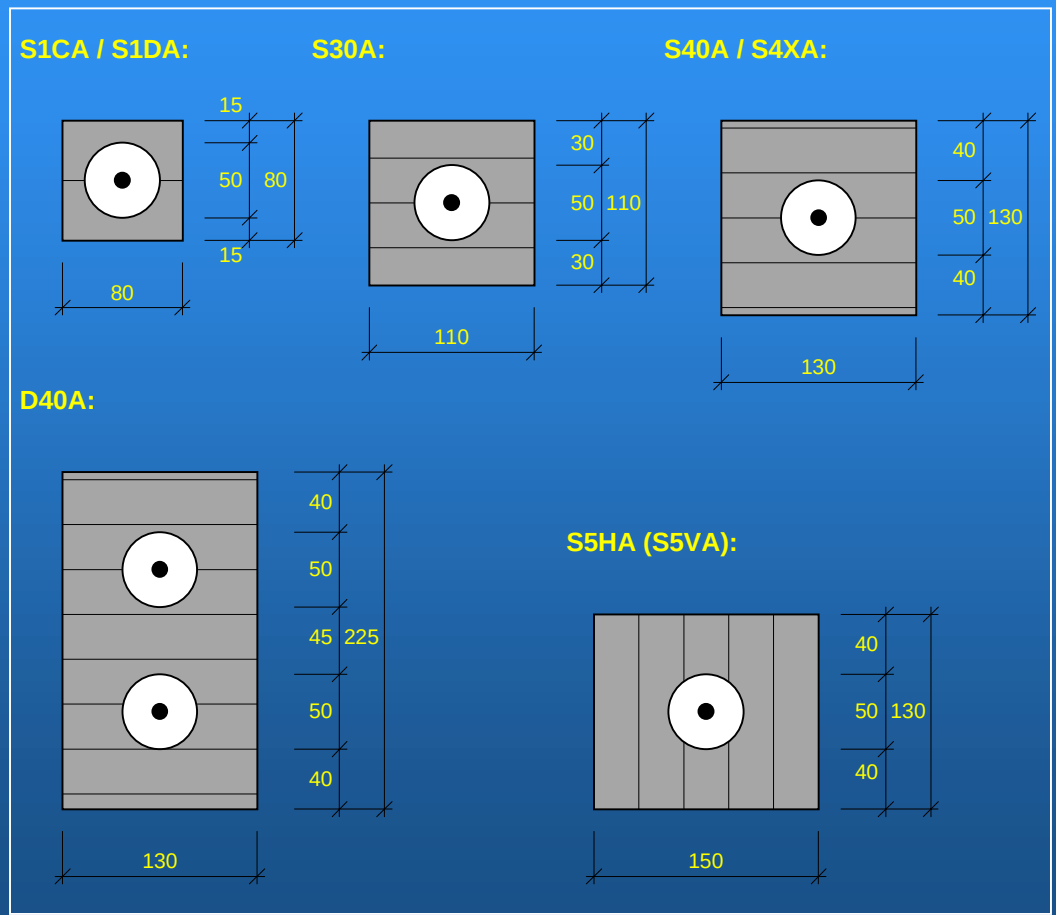
Compression Tests



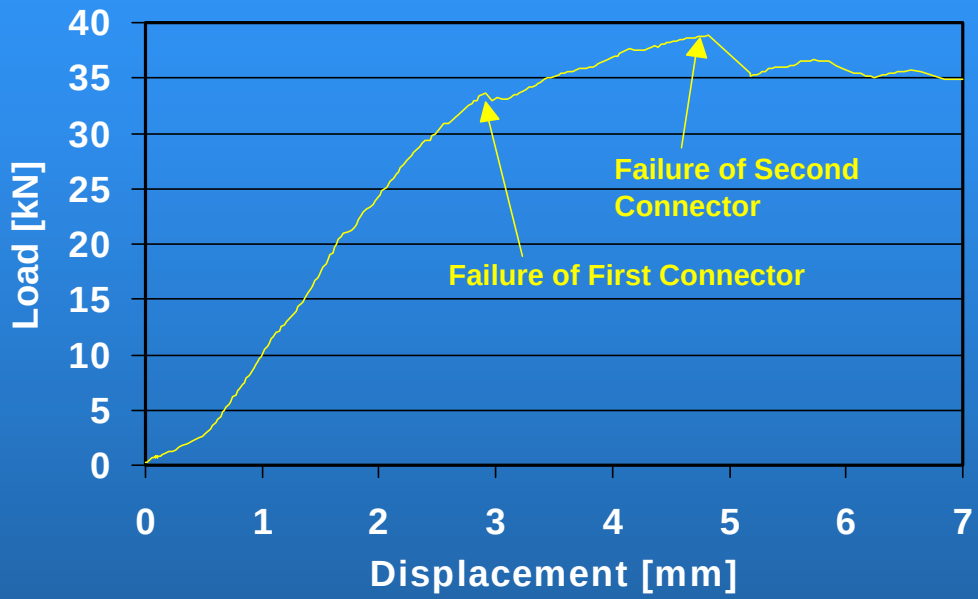
	Average	COV
Failure Load	68.85 kN	8.5 %
Max. Load	106.15 kN	5.9 %
Failure Displacement	0.311 mm	14.5 %
Slip Modulus	229.22 kN/mm	9.6 %

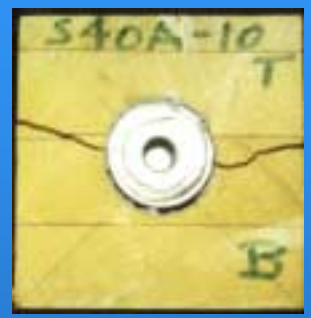
Shear Tests

- 50 Tests
- Varying Cross-Sections
- Glulam
- 1 or 2 Connectors



Shear Tests

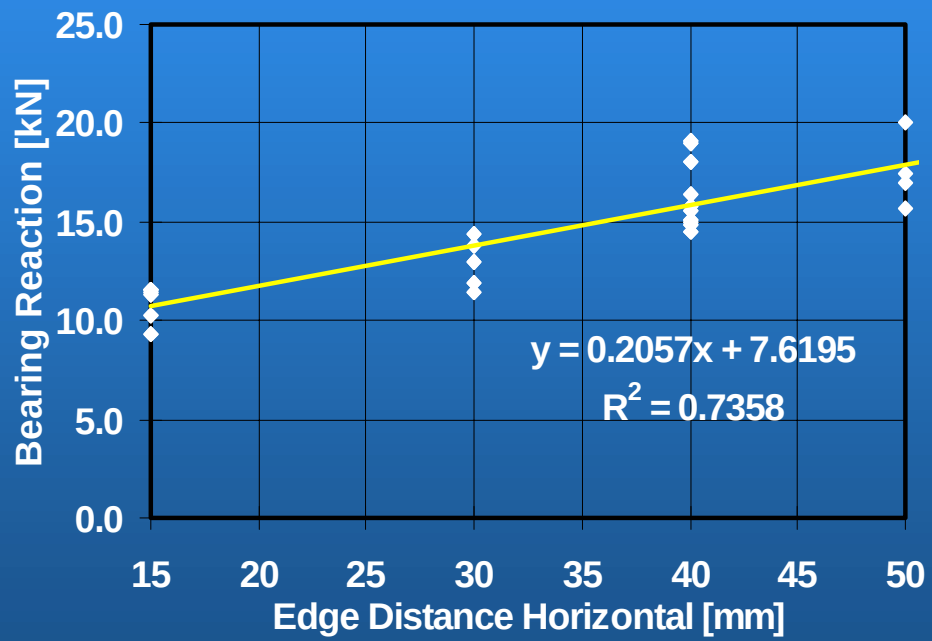




- Failure: Rotation of Connector and Debonding ➔ Split
- Double Failure Load for Double Connector Specimens

Shear Tests

Capacity - Edge Distance Relationship:



Climate Cycles

- 10 Specimens (5 Cycled, 5 Reference), Glulam
- 3 Cycles (6 Weeks Each), then Tension-Test:
  - 1st Cycle: 3°C / 90% R.H. (M.C. ➔ 20%)
  - 2nd Cycle: 25°C / 28% R.H. (M.C. ➔ 7%)
  - Normalization: 20°C / 65% R.H.

	Average	Difference	COV
Failure Load (Cycled)	45.55 kN	-15%	15.81 %
Failure Load (Ref.)	53.84 kN		10.82 %
Failure Load (Tension)	54.10 kN		13.8 %

Conclusions

- Low Variability of Results
- Ductile Failure in Compression
- Brittle Failure in Tension ➔ Ductile Elements Required
- PSL Yields Higher Failure Levels
- Shear Load - Edge Distance Relationship Established
- Reduction in Load Observed after Climate Cycles

Outlook

Improvements:

- *Surface*: Grooved
  ➔ Better Adhesion
- *Top Plate*: Thickness Reduced to 8 mm
  ➔ Ductility