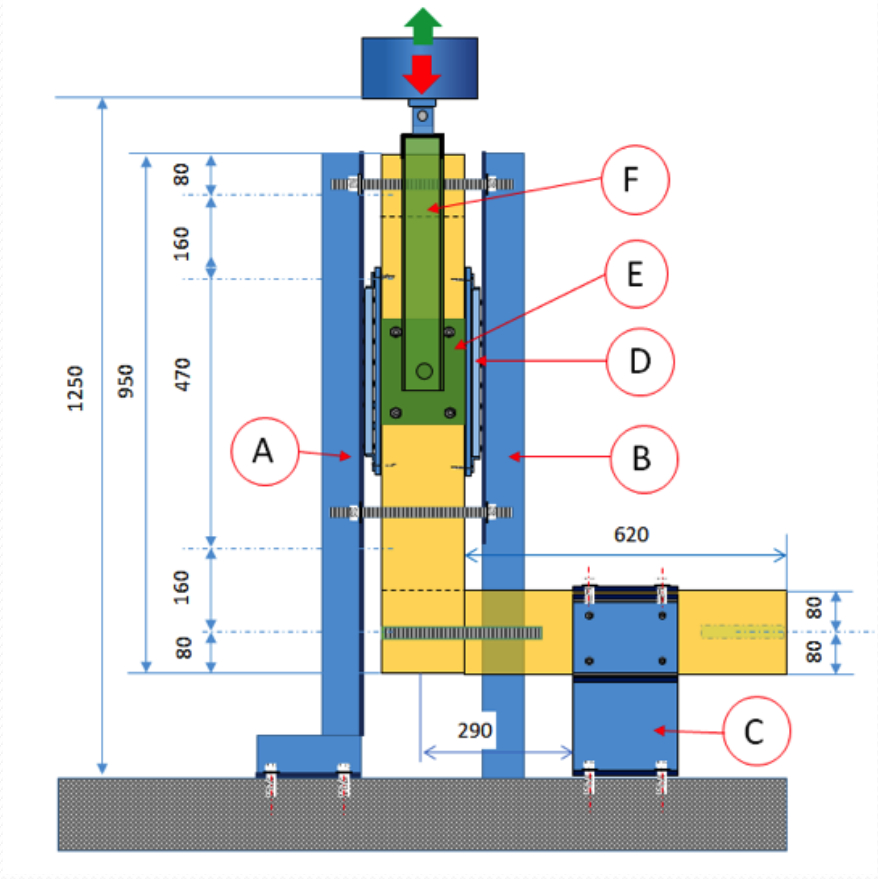
Demonstration Laboratory Testing of CLT Timber Frame Joint with Glued-in Steel rod

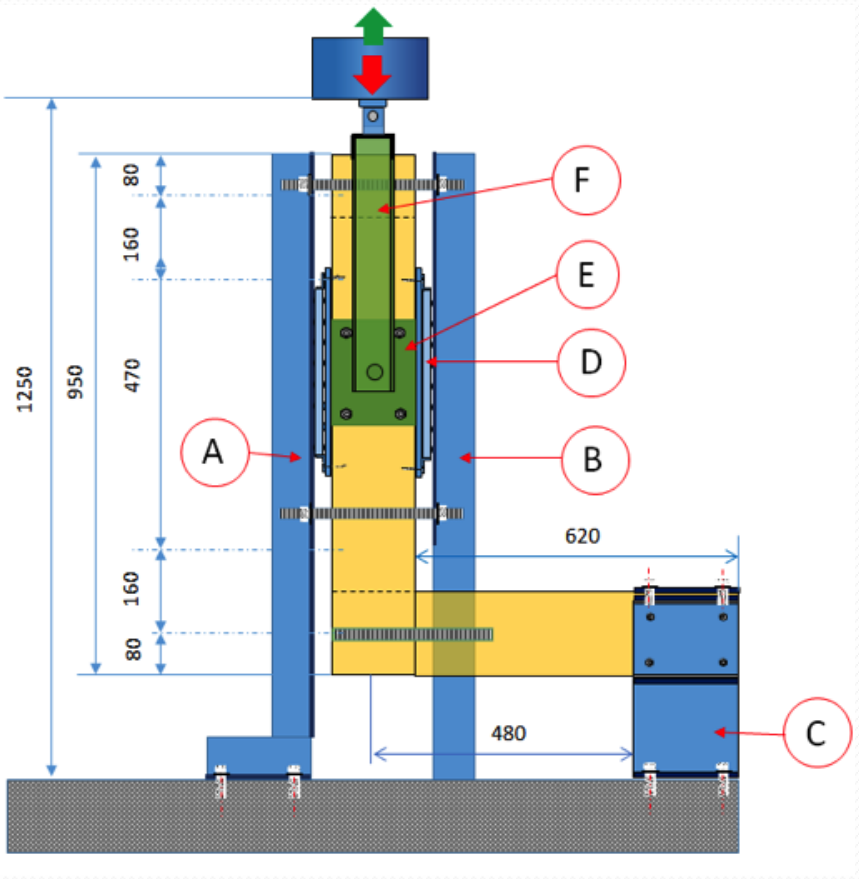
associate profesor DOMAGOJ DAMJANOVIĆ
Construction Testing Laboratory
Faculty of Civil Engineering
University of Zagreb

PROJEKT
HRVATSKE ZAKLADE ZA ZNANOST
VETROLIGNUM
HRZZ
Hrvatska zaklada za znanost

Test set-up



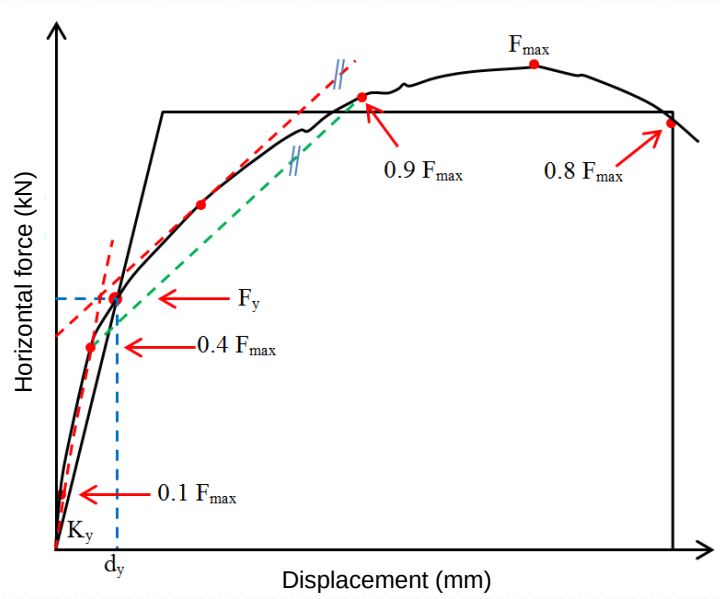
Setup A

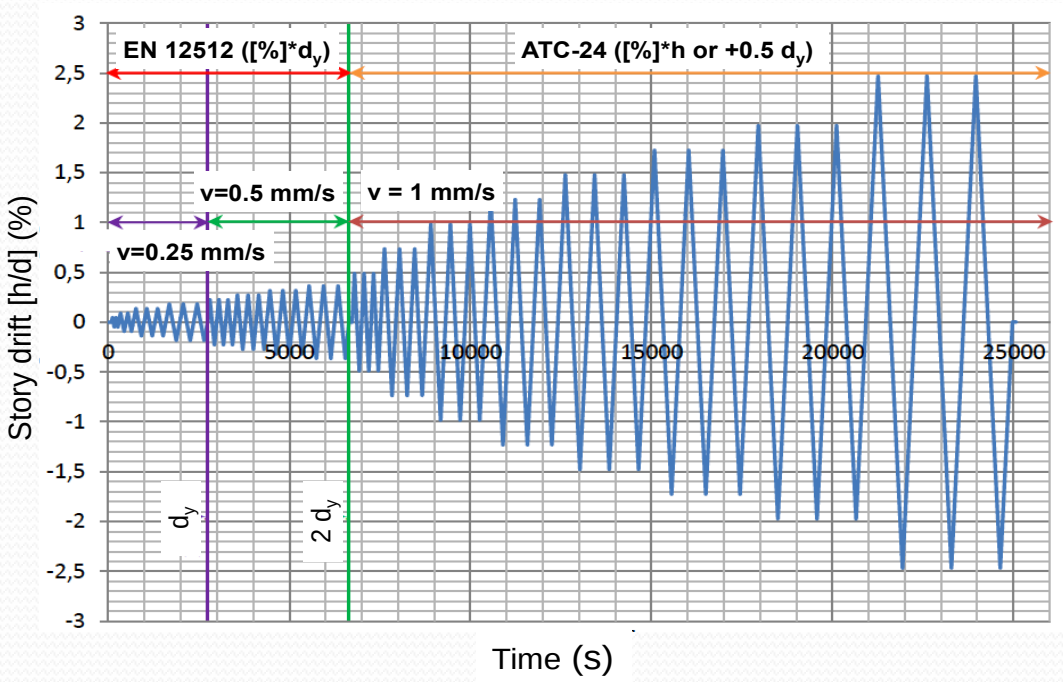


Setup B

Test protocol

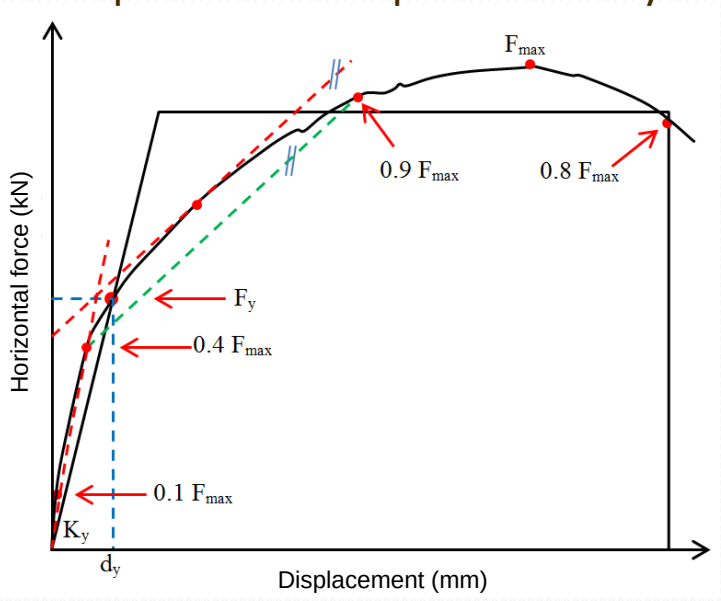
- The cyclic horizontal load protocol is composed of three sets of rules:
  - Definition of a yielding point (the Yasumura and Kawai (1997) procedure for timber shear wall)
  - Cyclic protocol EN 12512:2001 in the range of low displacement amplitudes (up to 2dy)
  - Cyclic protocol ATC-24 in the range of high displacement amplitudes (over 2dy)

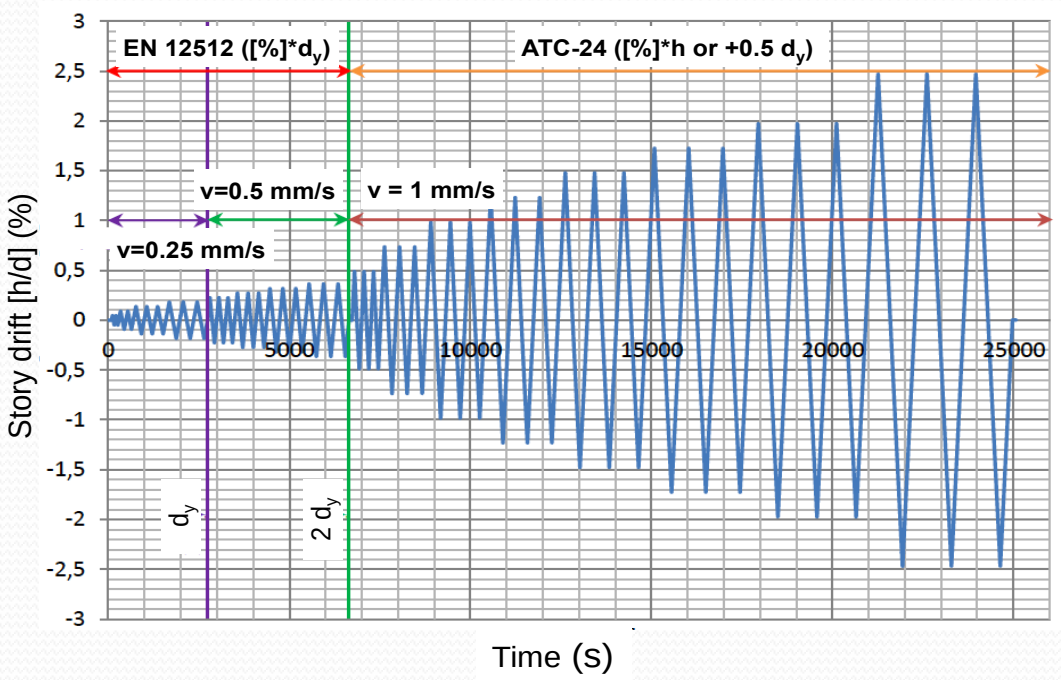




Test protocol

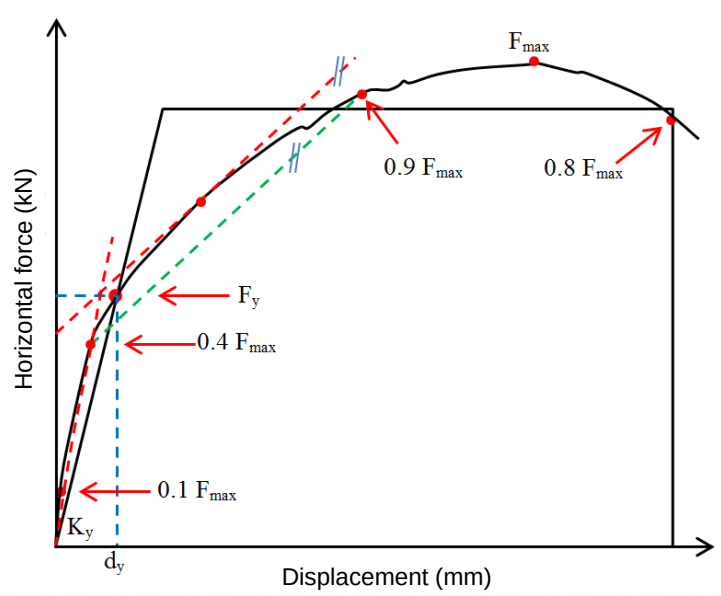
- Specimens of each type of joints were loaded by monotonous lateral loads until reaching a 20% drop of load bearing capacity to obtain the load-deformation curve which was used to determine the displacement at a yielding point (dy)
- The range of low amplitudes is divided into parts concerning the actuator velocity of 0,25 mm/s up to displacement amplitude equal to dy and velocity of 0,50 mm/s up to a displacement amplitude of 2dy.

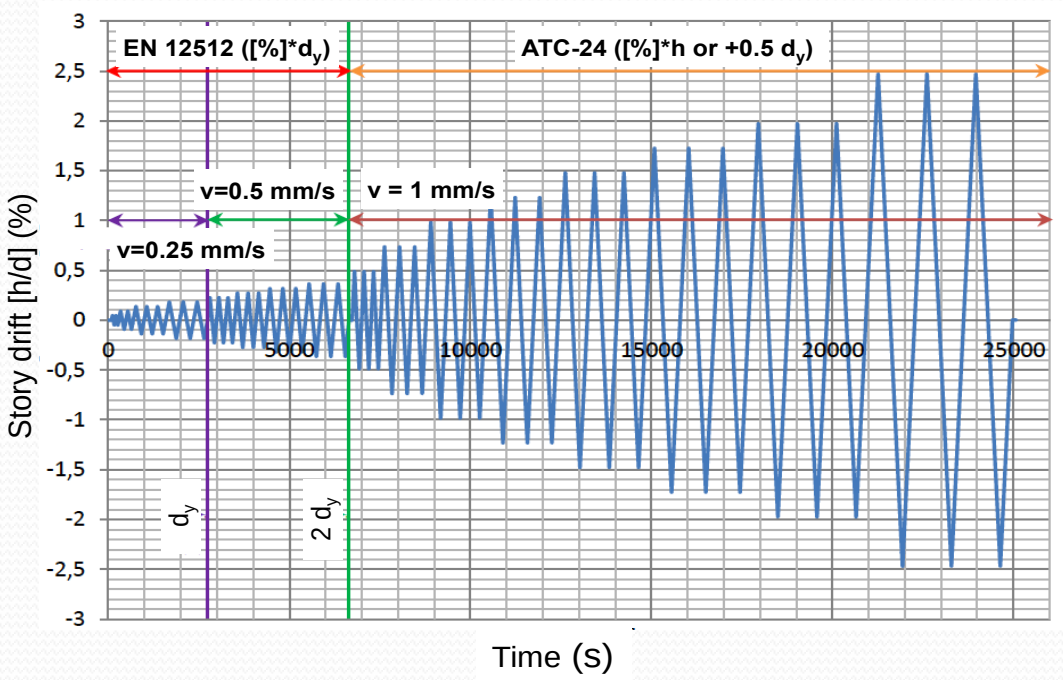




Test protocol

- After reaching the limit of 2dy the speed of actuator increased to 1,00 mm/s
- Three cycles of loading were performed for each selected amplitude
- Testing ended when the complete failure of joints was achieved

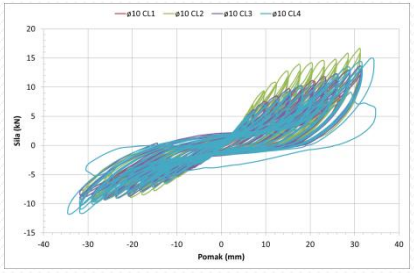




Test results

- for *Φ10 mm* threaded glued–in steel bar and *Setup A*

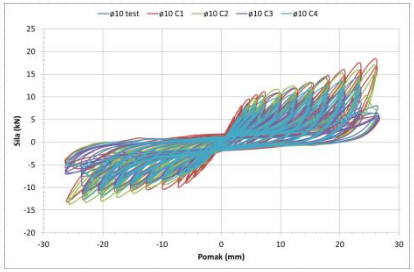
	ø10 CL1	ø10 CL2	ø10 CL3	ø10 CL4
f_{max} (kN)	11,51	16,67	13,64	15,02
pomak pri f_{max} (mm)	23,24	31,14	31,18	34,20
f_{min} (kN)	-8,40	-10,14	-9,49	-11,81
pomak pri f_{min} (mm)	-21,09	-31,35	-28,93	-34,47
(P1+P2)/2 max (mm)	26,75	31,37	31,60	34,73
(P1+P2)/2 min (mm)	-26,63	-31,44	-31,84	-34,58
(P3+P4)/2 max (mm)	10,13	11,32	10,45	10,38
(P3+P4)/2 min (mm)	-18,08	-17,39	-16,79	-18,16
P5 max (mm)	1,16	0,86	1,27	1,31
P5 min (mm)	-4,67	-4,32	-4,70	-5,17



failure due to timber compressive crushing and reaching tensile strength of steel bar

- for *Φ10 mm* threaded glued–in steel bar and *Setup B*

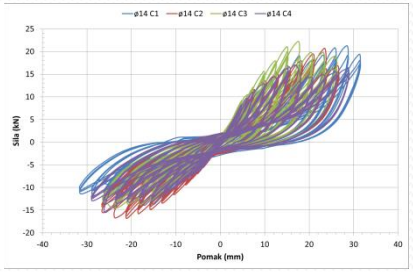
	ø10 test	ø10 C1	ø10 C2	ø10 C3	ø10 C4
f_{max} (kN)	14,42	18,43	16,99	12,18	14,18
pomak pri f_{max} (mm)	17,59	26,02	25,91	23,34	22,75
f_{min} (kN)	-10,11	-13,19	-13,71	-11,19	-12,39
pomak pri f_{min} (mm)	-17,71	-25,92	-25,63	-23,36	-22,93
(P1+P2)/2 max (mm)	26,49	26,74	26,26	26,60	26,21
(P1+P2)/2 min (mm)	-26,32	-26,39	-26,04	-26,35	-26,02
(P3+P4)/2 max (mm)	4,01	4,59	4,57	3,71	3,73
(P3+P4)/2 min (mm)	-6,12	-6,41	-7,71	-5,99	-6,19
P5 max (mm)	1,05	0,92	0,72	1,05	0,75
P5 min (mm)	-2,71	-2,70	-2,89	-2,75	-2,65



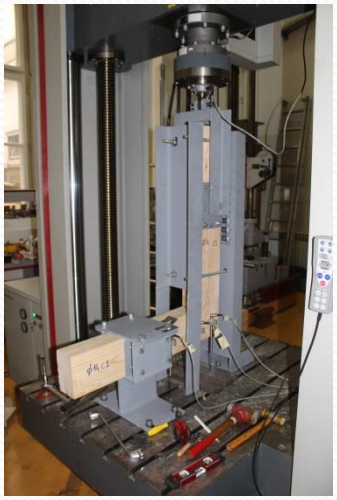
Test results

- for *Φ14 mm* threaded glued–in steel bar and *Setup A*

	ø14 C1	ø14 C2	ø14 C3	ø14 C4
f_{max} (kN)	21,26	20,72	22,25	17,00
pomak pri f_{max} (mm)	28,57	23,51	17,54	16,98
f_{min} (kN)	-13,93	-16,82	-14,55	-15,51
pomak pri f_{min} (mm)	-17,00	-21,08	-23,50	-26,04
(P1+P2)/2 max (mm)	31,55	26,71	26,30	28,98
(P1+P2)/2 min (mm)	-31,67	-26,66	-26,49	-29,02
(P3+P4)/2 max (mm)	6,18	5,73	6,29	5,25
(P3+P4)/2 min (mm)	-11,82	-12,07	-13,33	-12,59
P5 max (mm)	1,84	1,27	1,81	1,50
P5 min (mm)	-6,01	-6,00	-6,75	-6,36

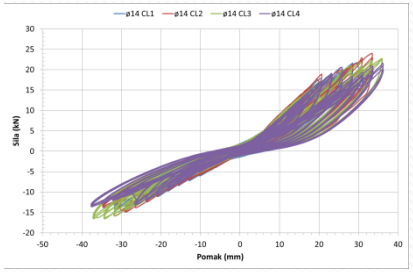


failure due to timber compressive crushing



- for *Φ14 mm* threaded glued–in steel bar and *Setup B*

	ø14 CL1	ø14 CL2	ø14 CL3	ø14 CL4
f_{max} (kN)	21,63	24,01	22,74	21,57
pomak pri f_{max} (mm)	28,49	33,35	35,80	36,14
f_{min} (kN)	-15,04	-15,83	-16,59	-13,60
pomak pri f_{min} (mm)	-31,66	-31,83	-34,32	-37,65
(P1+P2)/2 max (mm)	31,31	33,51	35,98	36,26
(P1+P2)/2 min (mm)	-31,81	-34,76	-37,23	-37,71
(P3+P4)/2 max (mm)	20,49	23,98	24,53	22,47
(P3+P4)/2 min (mm)	-26,71	-28,50	-30,96	-32,25
P5 max (mm)	3,14	4,24	4,24	3,61
P5 min (mm)	-8,70	-9,47	-9,87	-10,61



Test demonstration

- for *Φ20 mm* threaded glued–in steel bar and *Setup A*