COST E55, March 26-27, 2009, Trondheim, Norway

Ductility of timber connections - discussion on the base of examples

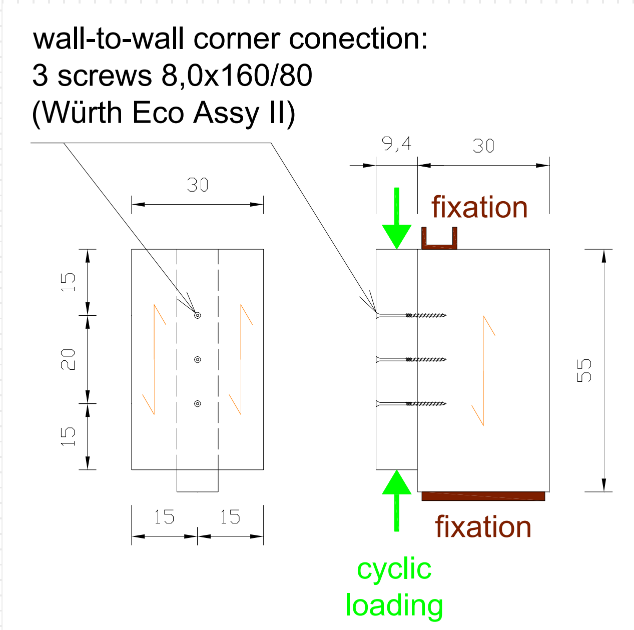
Bruno Dujic

bruno@cbd.si

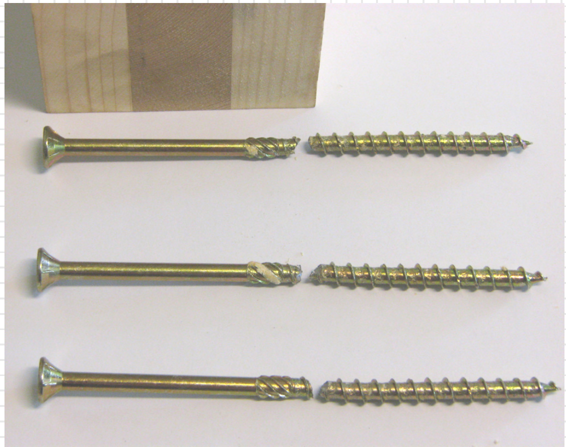
UL FGG
Ljubljana

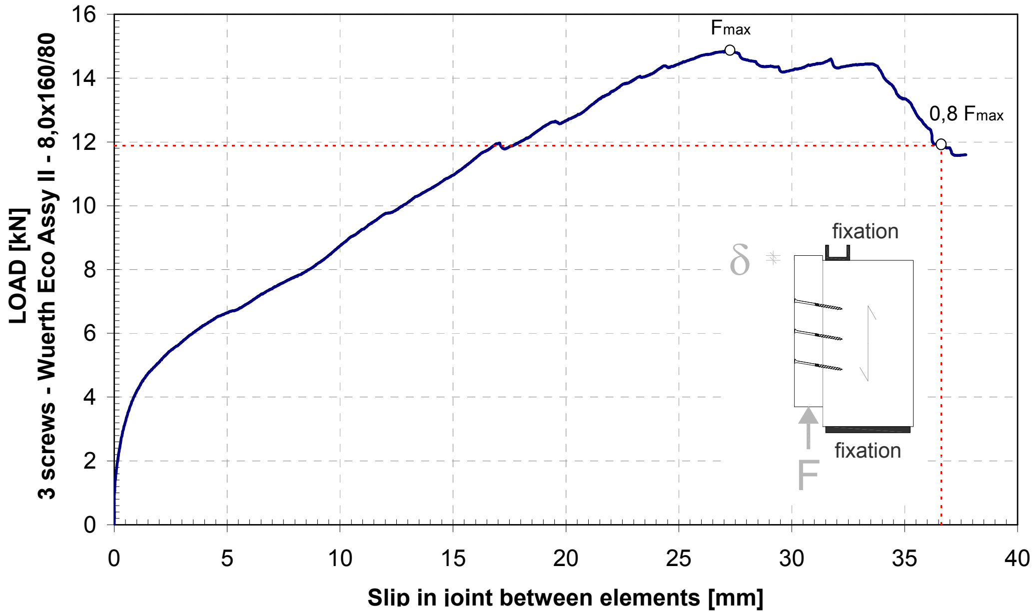
Joint ductility – example 1: dowel type shear connection

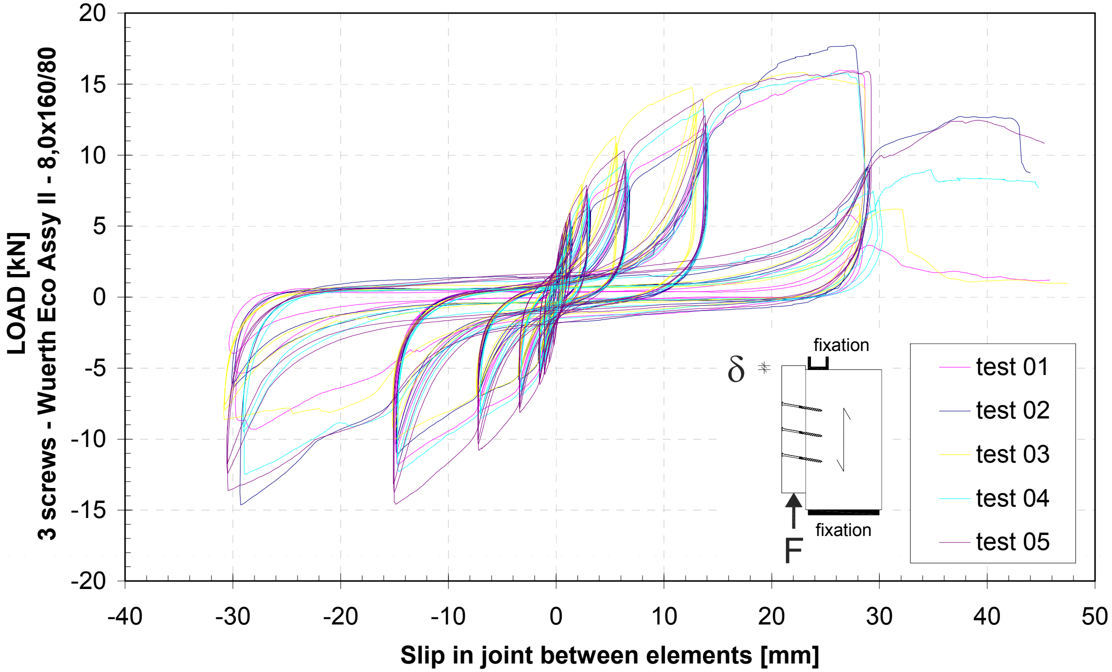
- Evaluation of cyclic response of wall-to-wall screwed connection in CLT construction system
- One monotonic and 5 quasi-static reversed-cyclic tests according ISO 16670 (following also requirements in EN 12512)
- Structure of joint - two CLT wall segments mechanically connected by 3 screws 8,0x160/80 (Würth Eco Assy II screw)



Results (1)

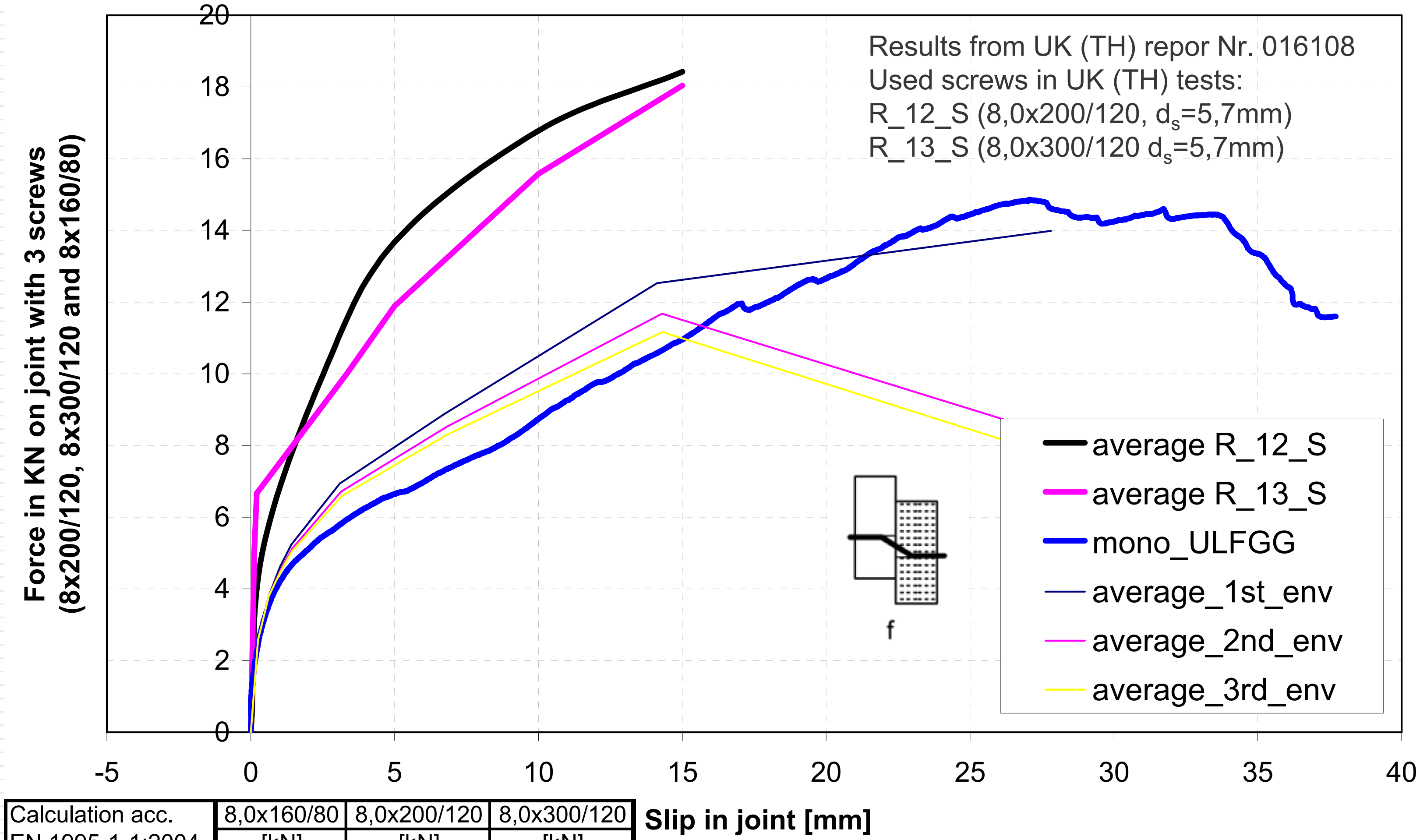






UL FGG
Ljubljana

Comparison with similar tests on CLT



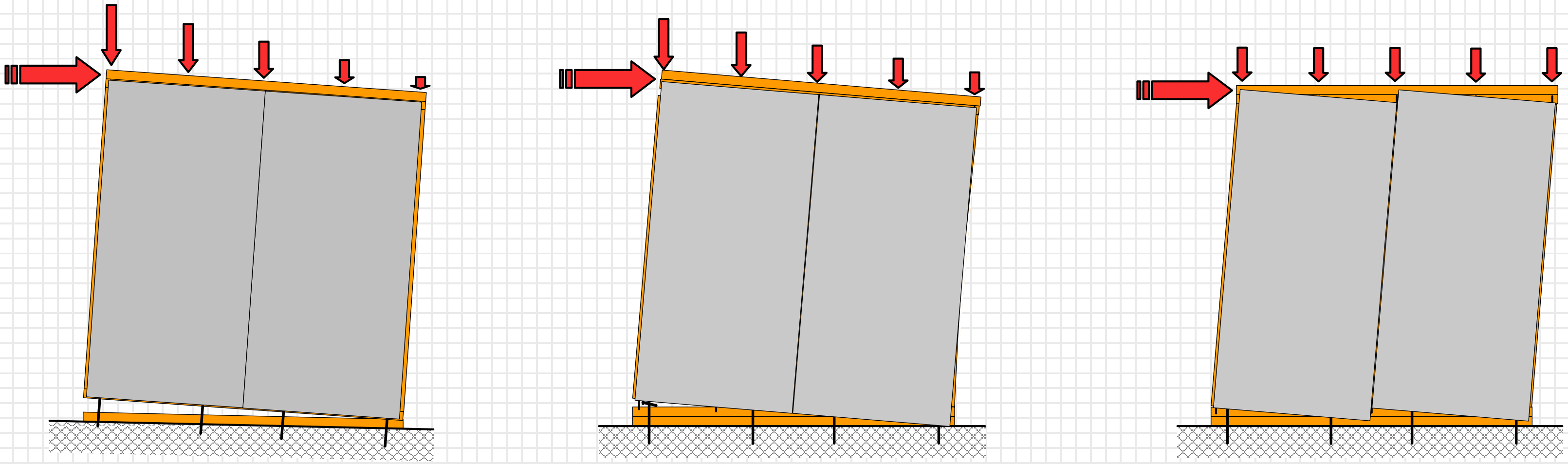
Calculation acc. EN 1995-1-1:2004	8,0x160/80 [kN]	8,0x200/120 [kN]	8,0x300/120 [kN]	
F_v,Rk_min (f)	7,18	7,18	7,18	rope effect is not taken into account
	13,41	17,19	18,47	rope effect is taken into account
	13,41	14,36	14,36	limitation of 100% of l.b.c - JYT

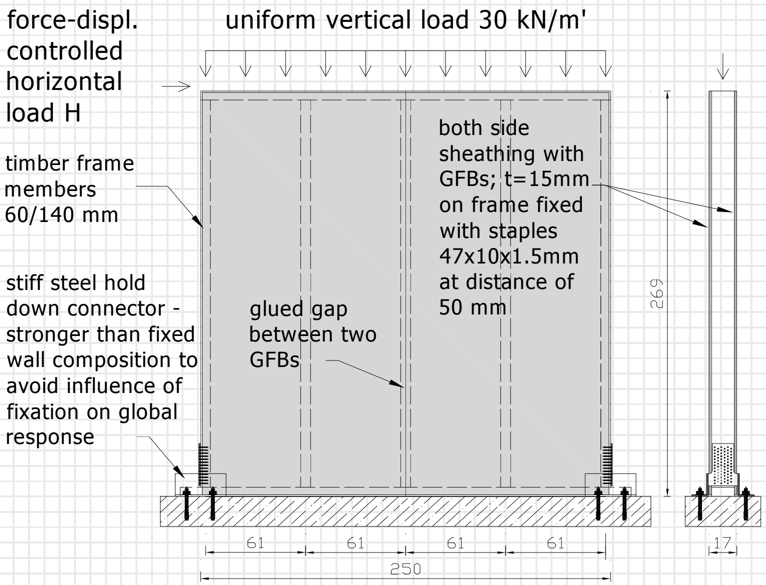
UL FGG
Ljubljana

Discussion – example 1

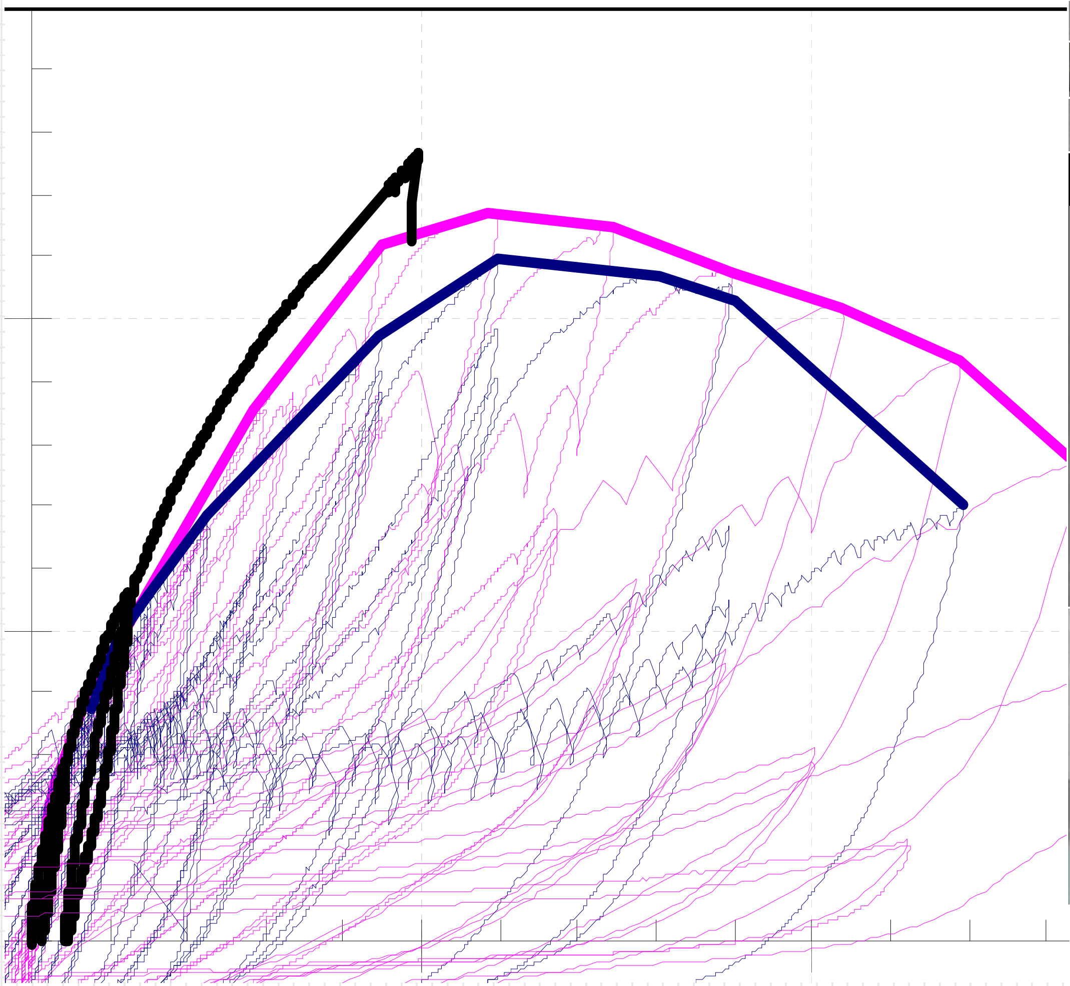
- Big difference in tests results comparing visibly just slight difference in specimens configurations
- Important changing parameter was the length of the treated shank and its position in the shear layer
- In calculation the most important parameter is the "rope effect"
- Initial friction between members is not taken into account but importantly influence on test results
- Definition of ductility is questionable from monotonic results as it returns higher values comparing evaluation from cyclic response
- Impairment of strength in repeated cycles has to be recognized as important parameter for definition of static ductility

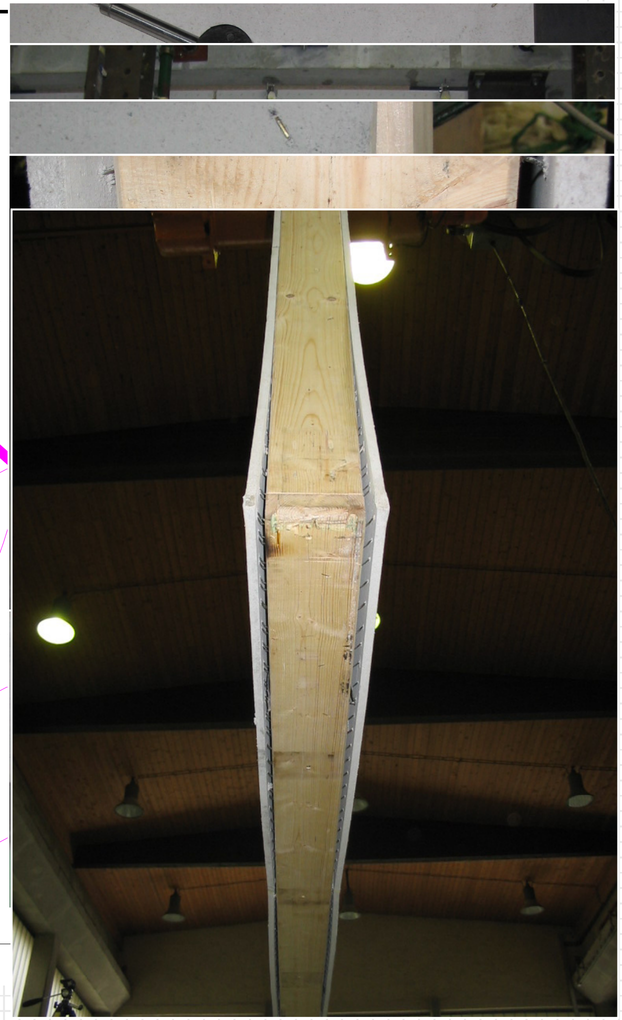
Structural ductility – example 2: shear response of timber frame wall



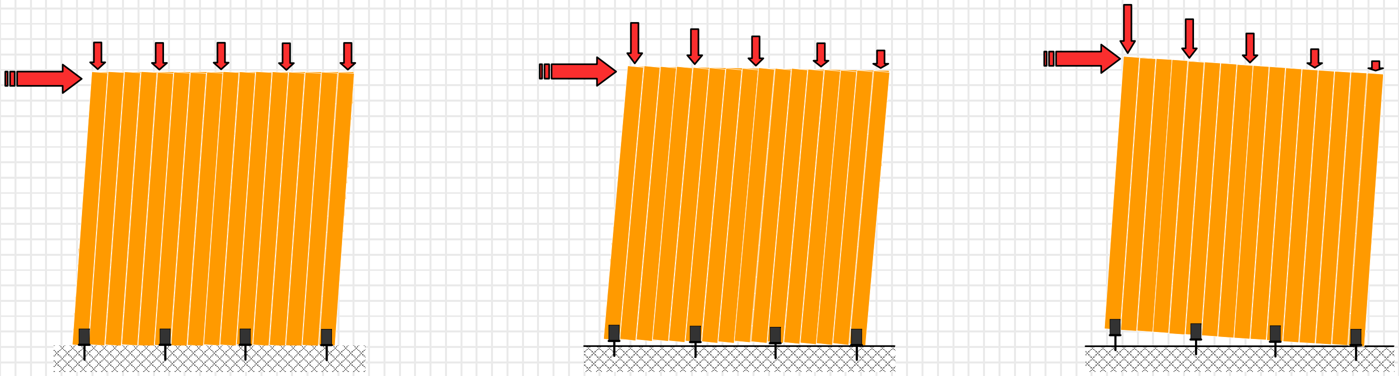


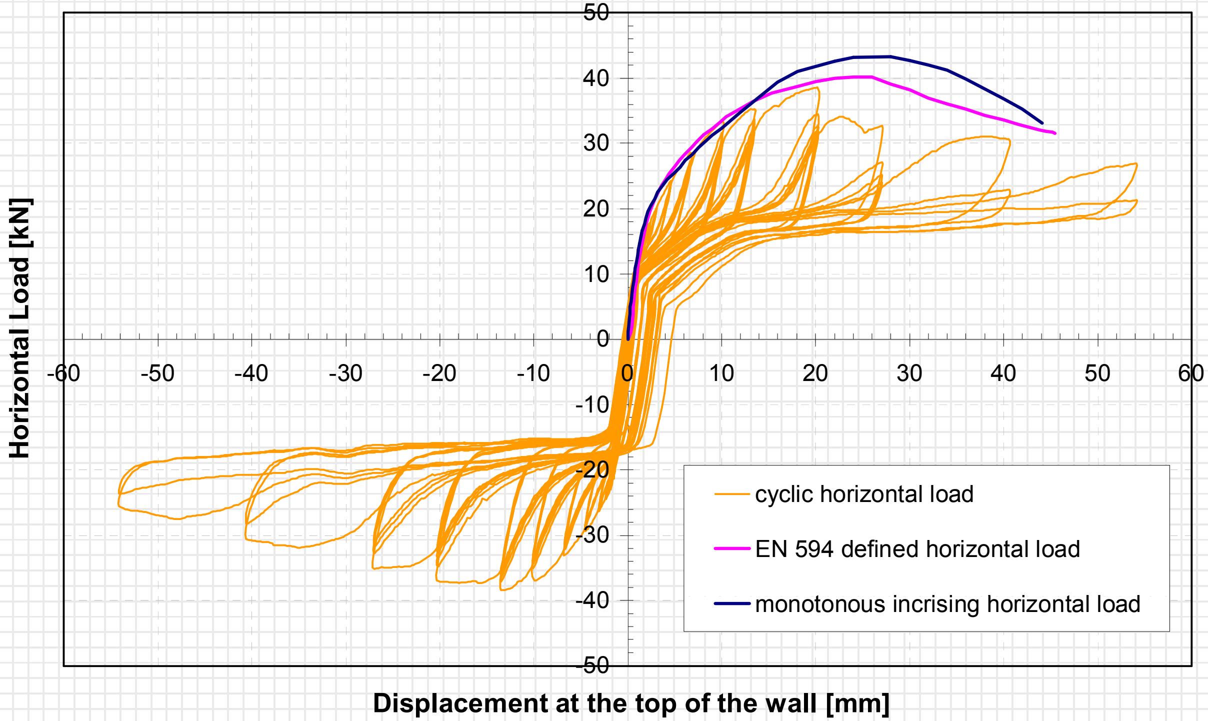
Structural ductility – example 2: shear response of timber frame wall





Structural ductility – example 3: shear response of massive wall of CLT



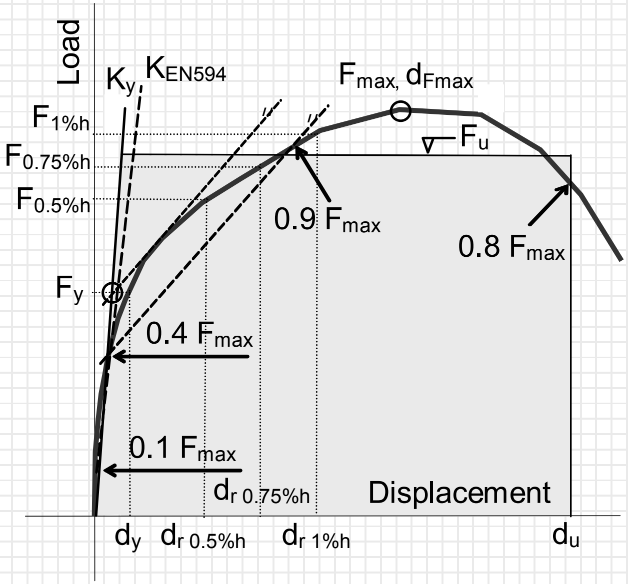


UL FGG
Ljubljana

Discussion – example 2, 3

- Difference in tests results between monotonic and cyclic response
- System could behave ductile even if it includes main construction elements with brittle behavior
- If construction system is composed of different elements, ductile element have to prevent with their capability of non-linear (plastic) behavior failure of brittle ones (method of "fuse")
- In the system dissipative zones have to be carefully designed as ductile construction parts
- Brittle and/or non-ductile parts of construction have to be designed with overstrengths
- Ductile element have to be weaker than non-ductile elements – principle of the weakest element in chain

General conclusions



- How to define ductility on the base of monotonic and cyclic test?
- What is a different?
- How could be used monotonicaly defined ductility in seismic engineering?
- For definition of ductility the basic parameters as evaluation of deformation at the end of elastic behavior and definition of ultimate deformation for different responses have to be agreed!

UL FGG
Ljubljana