Progetto DPC-ReLUIS 2022-2024 WP 13

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Task 3 – Edifici a telaio pesante

UR: UNINA – Responsabile scientifico: Prof. Beatrice Faggiano
Componenti di Unità di ricerca: PhD Eng. Giacomo Iovane, Dante Marranzini

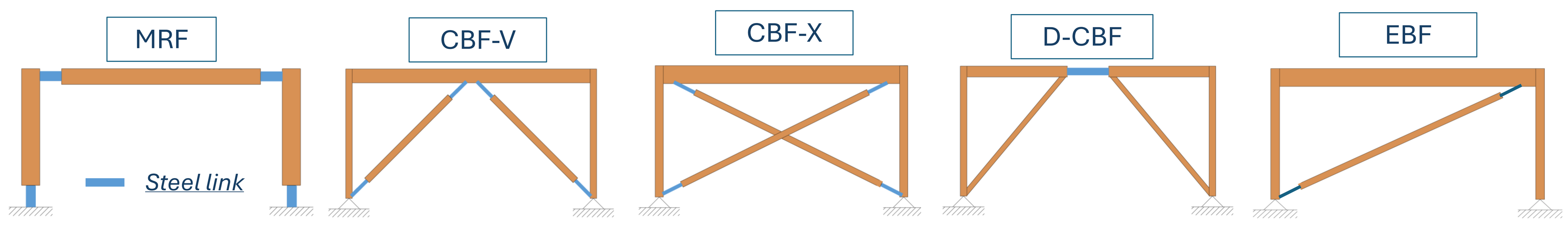
MULTI-STOREYS TIMBER BUILDINGS

Faggiano and Iovane, 2016

OVERVIEW

Seismic-resistant heavy timber frame structures with dissipative steel links

STRUCTURAL TYPES EXAMINED



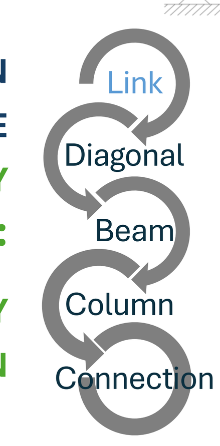
CURRENT DESIGN CRITERIA [EUROCODE 8]

Ductility classes	q	Examples of structures
Medium capacity to dissipate energy	2,5	Portals of hyperstatic frames with bolted nodes and pins
High capacity to dissipate energy	4	Portals of hyperstatic frames with knots with pins or bolts

~~Dissipative capacity concentrated in the connections~~ → Dissipative capacity concentrated in the steel links ✓

APPLICATION OF THE CAPACITY DESIGN:

HIERARCHY CRITERION



OBJECTIVES AND ACHIEVEMENTS

Goals of the research

- Definition of seismic-resistant heavy timber frame structural types;
- Design criteria for dissipative seismic heavy timber frame structures;
- Evaluation of structural seismic performance.

Methodology

- Incremental-static analysis.

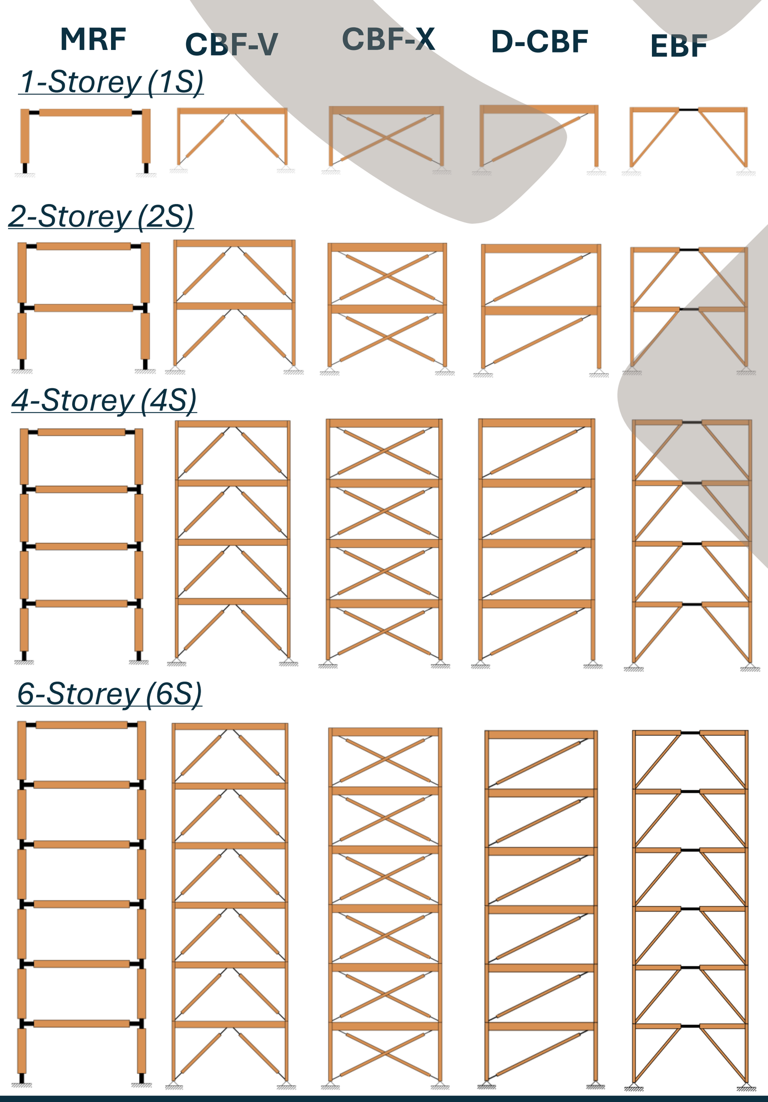
Main issues

- Reduction of structural mass respect to Non-Dissipative structures;
- Reduction of construction costs;
- High dissipative and ductile capacity;
- Re-centering of the structures.

GENERAL FUTURE IMPROVEMENTS

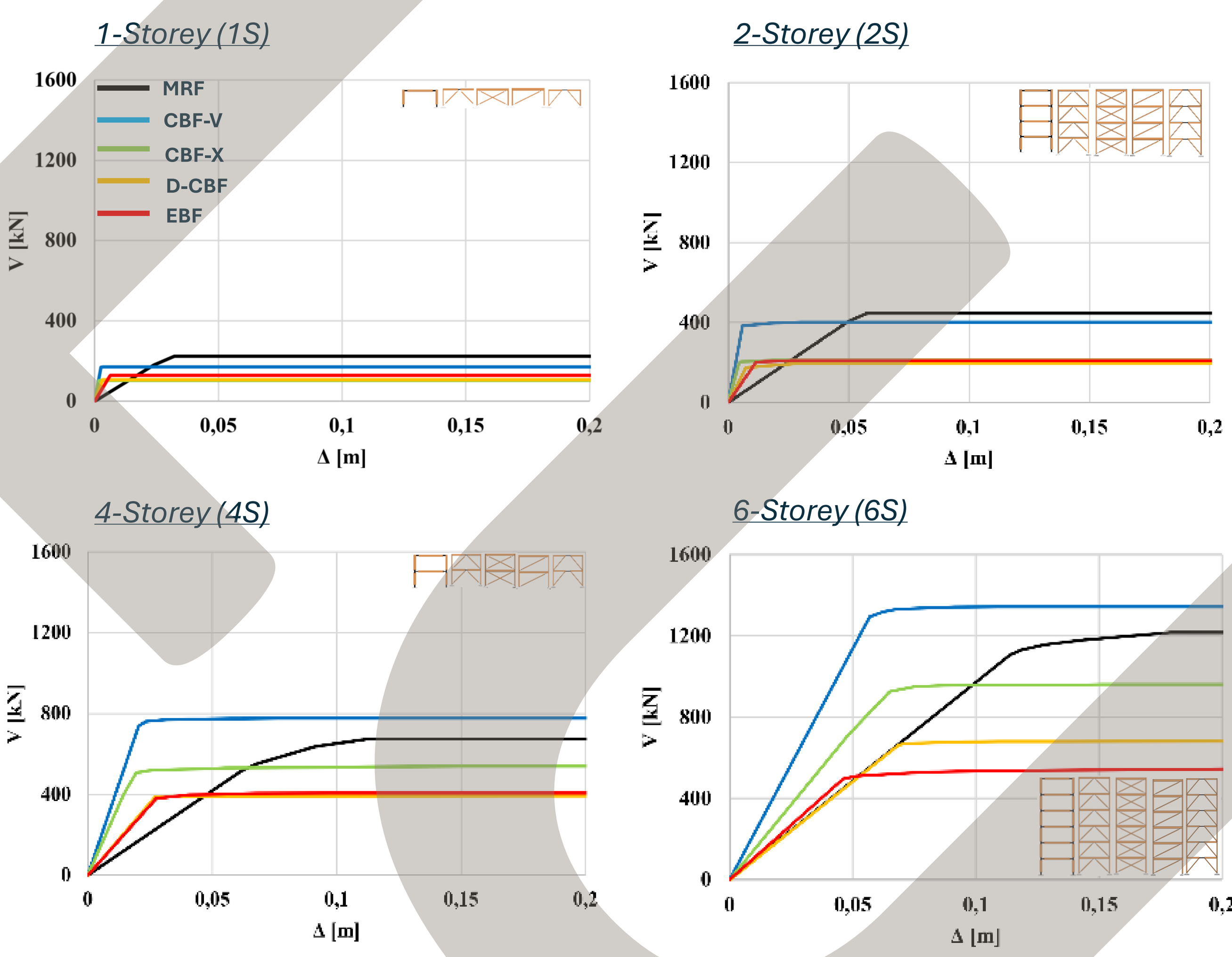
- Cyclic behaviour;
- Non-Linear Dynamic analysis;
- Experimental tests;
- Design rules calibration:
  - *Behaviour factor, q_0, for different ductility classes*
  - *Material overstrength factor, γ_{Rd}*
  - *Overstrength factor for dissipative elements, Ω*

STUDY CASES



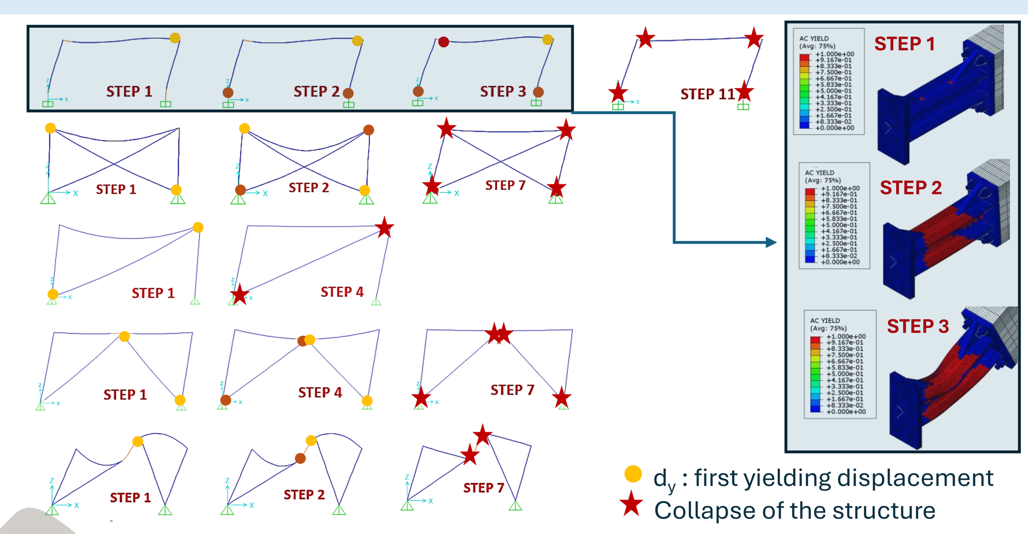
PUSH-OVER CURVES

Iovane et al, 2022



GLOBAL BEHAVIOUR

Incremental-static numerical analysis



STRUCTURAL MASS RATIO AND BEHAVIOUR FACTORS

D Dissipative, ND Non Dissipative	Structural Mass M_D/M_{ND} [%] 1S-6S	Design q_d CD'B'	Evaluated $q_{LifeSafe}$
MRF	10-15	4	5
CBF-V	6-8	2	4
CBF-X	29-33	4	5
D-CBF	30-36	4	4
EBF	30-72	4	4

OBJECTIVES AND ACHIEVEMENTS

Goals of the research

- Design criteria proposal;
- Evaluation of the mechanical behaviour of joints.

Methodology

- Numerical analysis;
- Parametric analysis;
- Monotonic and cyclic experimental tests.

Main issues

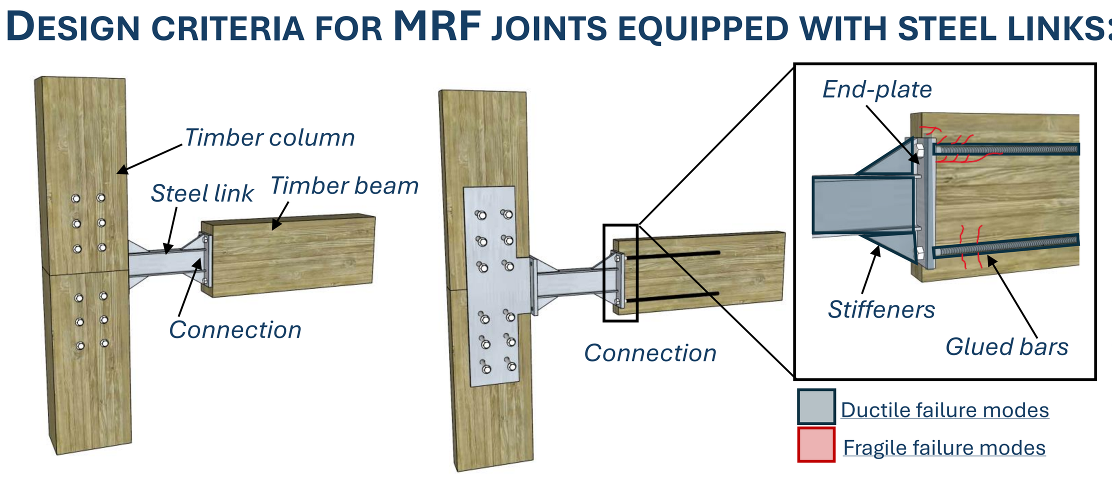
- Suitability of steel link as dissipative device.

GENERAL FUTURE IMPROVEMENTS

- Extension of the numerical analysis and experimental campaign;
- Improvement of the joint details: removable link;
- Focus on bars-to-timber glued connection.

DESIGN CRITERIA FOR MRF JOINTS EQUIPPED WITH STEEL LINKS: CAPACITY DESIGN

Faggiano et al, 2018
Iovane et al, 2021a, 2021b, 2023a, b, 2024



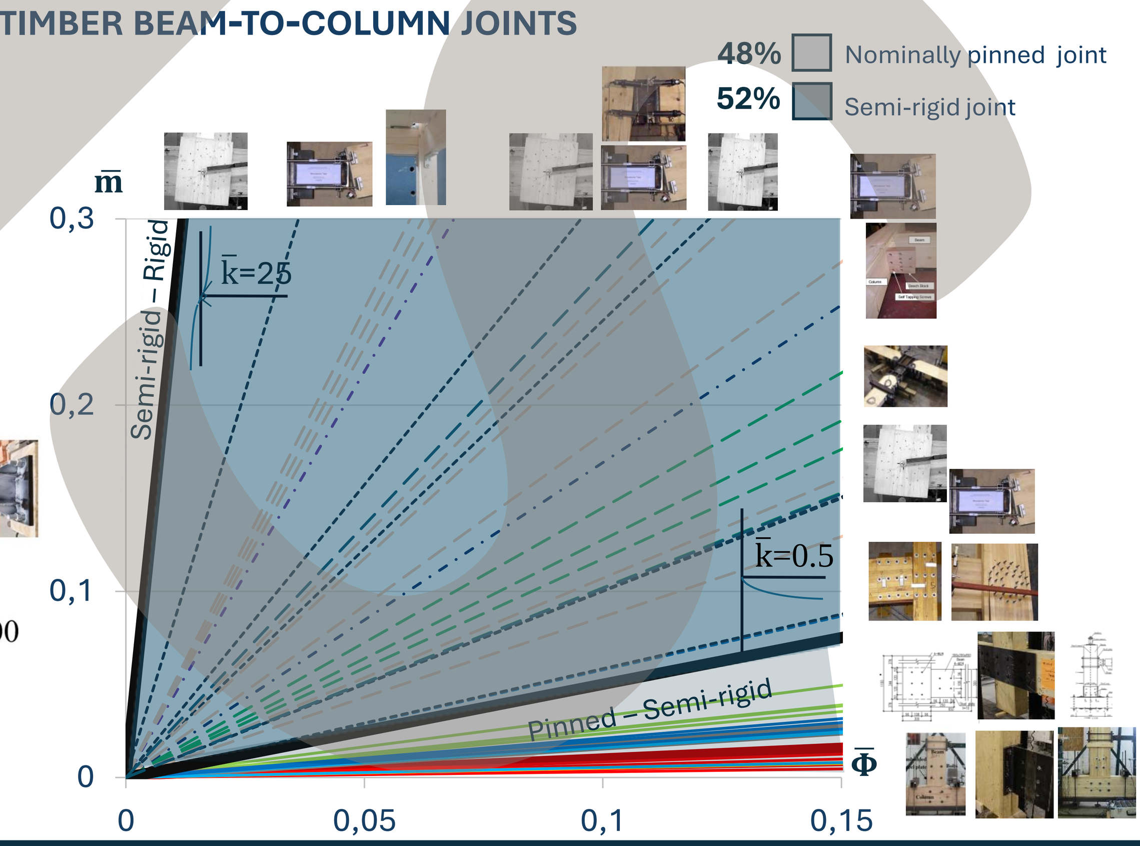
Steel links
Dissipative [D] elements
Timber elements and steel connections
Non-dissipative [ND] elements

Macro-components: link; timber elements; connections
Sub-components: end-plate, bolts, stiffeners, etc. (connection's components)

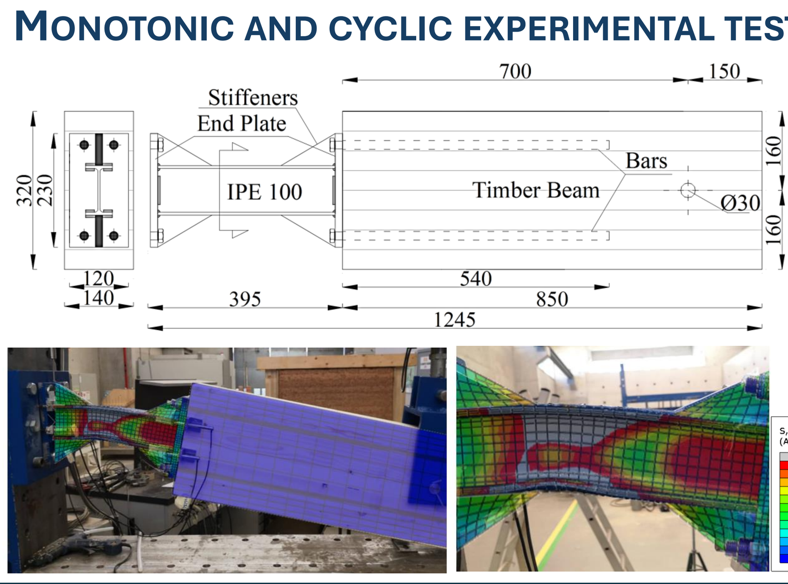
LOCAL BEHAVIOUR

Joints equipped with dissipative steel links

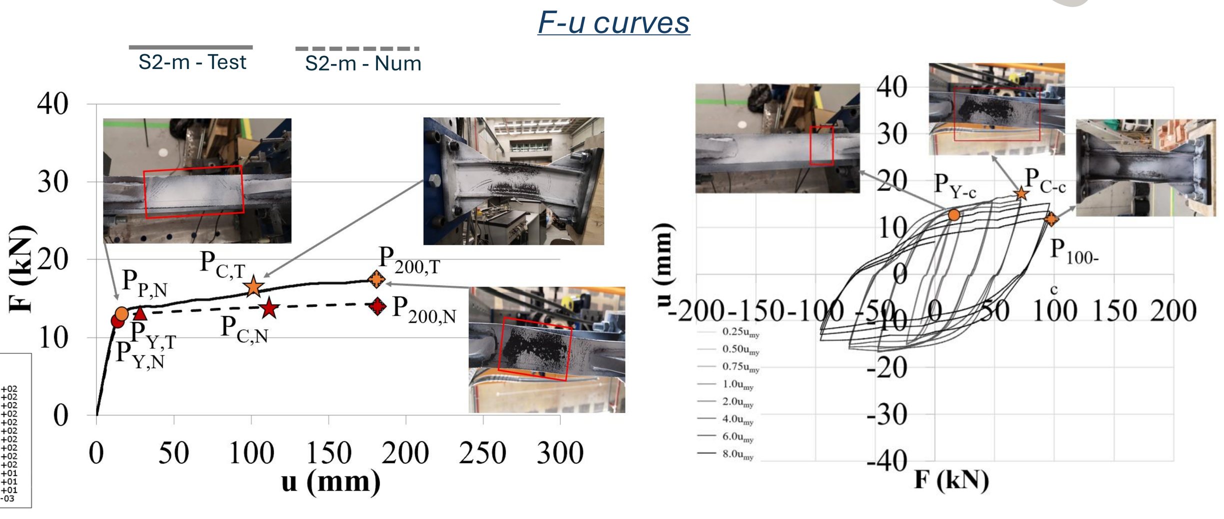
PROPOSED MECHANICAL CLASSIFICATION METHOD FOR TIMBER BEAM-TO-COLUMN JOINTS



MONOTONIC AND CYCLIC EXPERIMENTAL TESTS VS NUMERICAL ANALYSIS



F-u curves



MAIN REFERENCES

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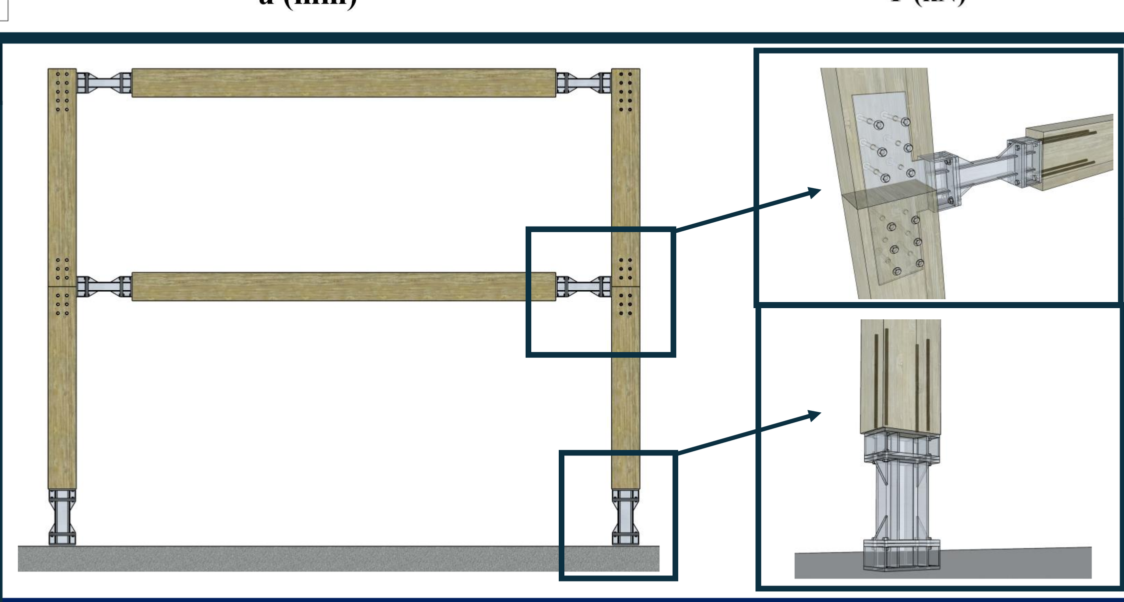
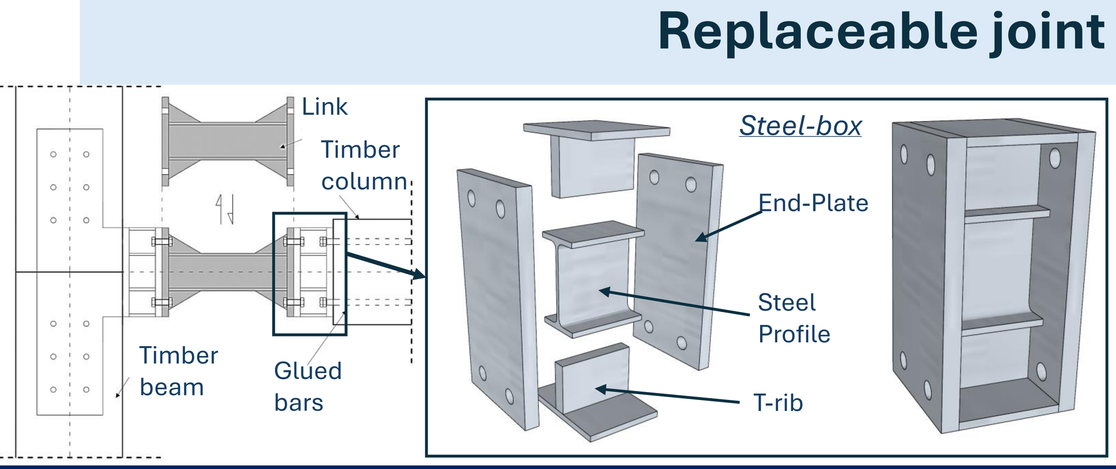


STRUCTURAL DETAILS

Replaceable joint



Convegno ReLUIS - Napoli, 17-18 ottobre 2024