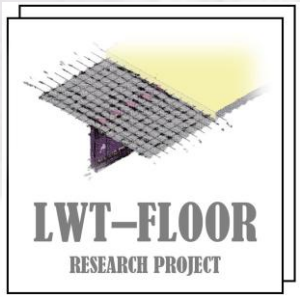
Project title: **Innovative lightweight cold-formed steel-concrete composite floor system**
Acronym: **LWT-FLOOR** Project ID: **UIP-2020-02-2964**
5th LWT-FLOOR Project Workshop, Zagreb, 18th-19th December 2025

Experimental Investigation on the Behaviour of the demountable shear connection in Cold-Formed Steel-Concrete Composite Beam

Ivan Ćurković | Ivan Lukačević | Vlaho Žuvelek | Andrea Rajić | Marko Bartolac



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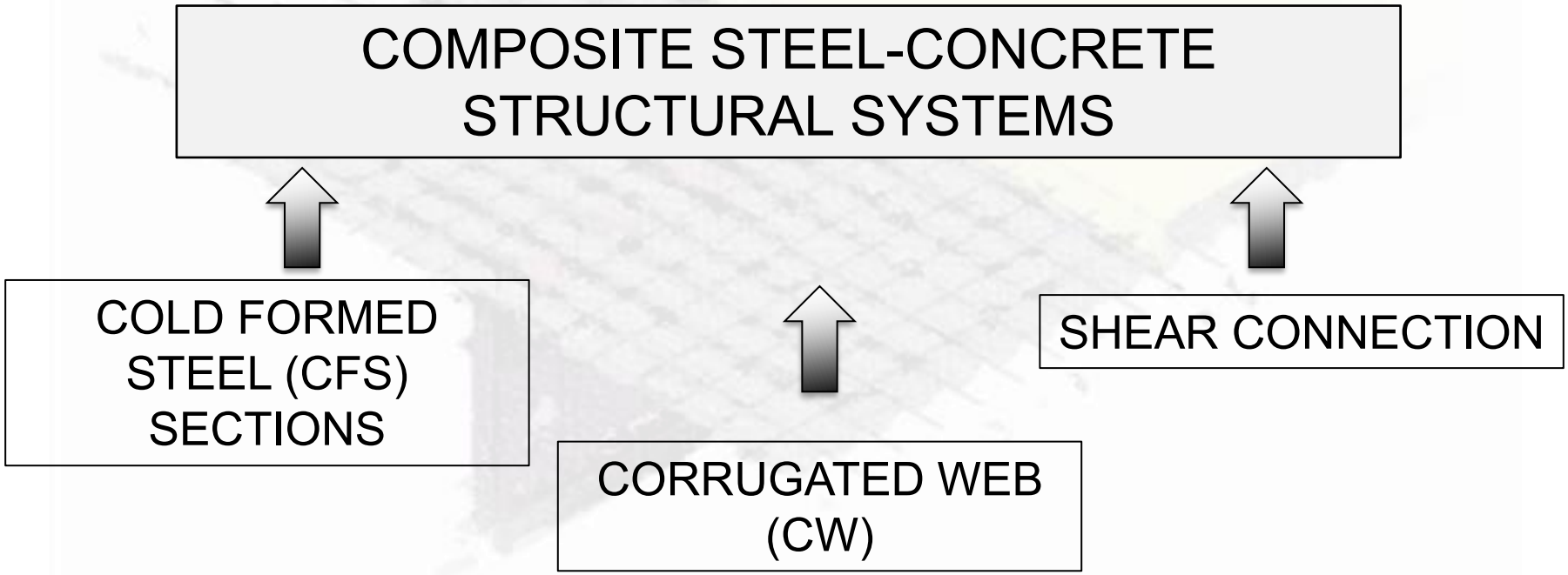
Agenda

- Introduction
- Experimental programme
  - Push test specimens
  - Material properties
  - Test set-up and loading protocol
- Experimental results
  - Force-slip curves and key parameters
  - BB vs BCWB specimens
- Conclusion

1. Introduction

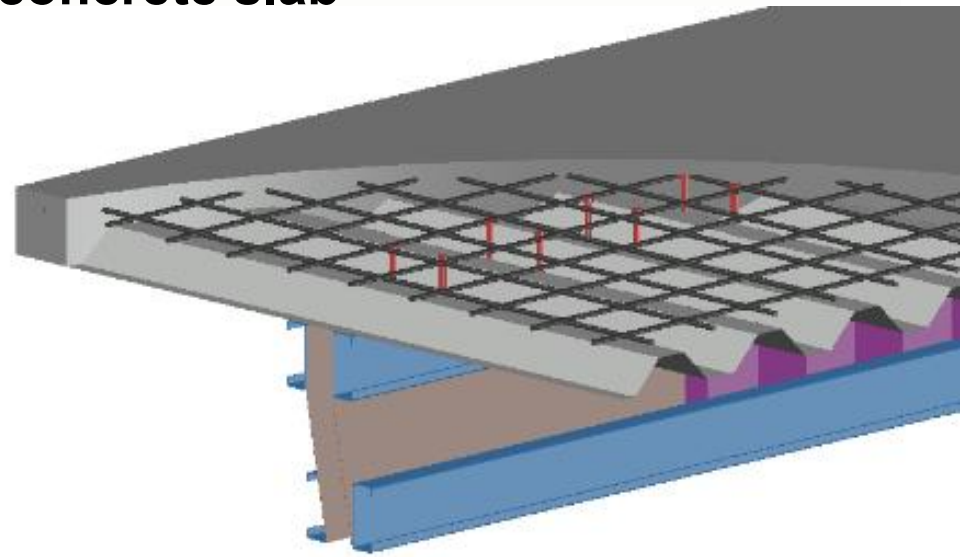
- Sustainability of the built environment (construction industry)
  - Energy conservation
  - Conservation of raw material – increase value of structural components and building materials through entire lifecycle

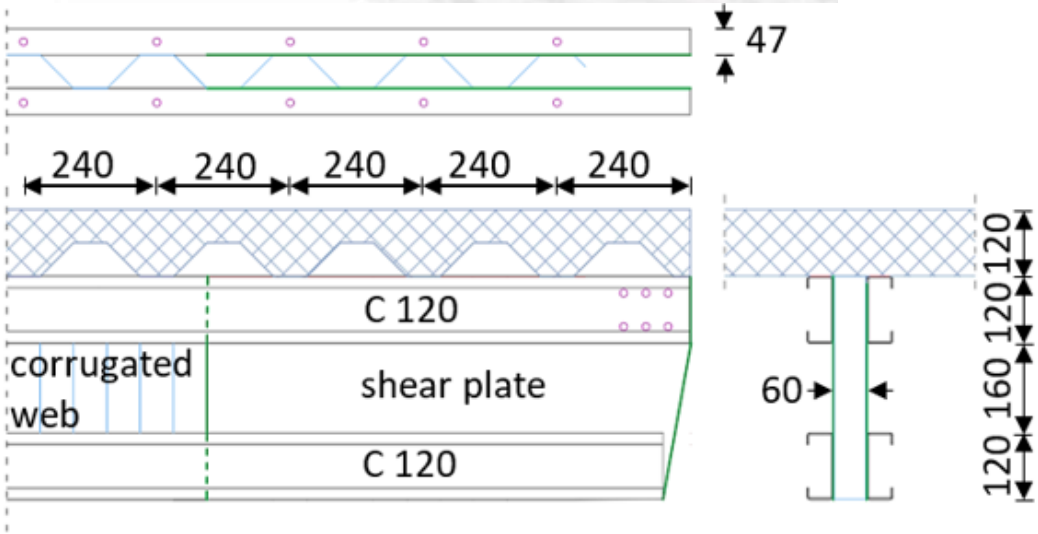


1. Introduction

LWT-FLOOR project

Composite built-up cold-formed steel girders (CFS) with a corrugated web and concrete slab



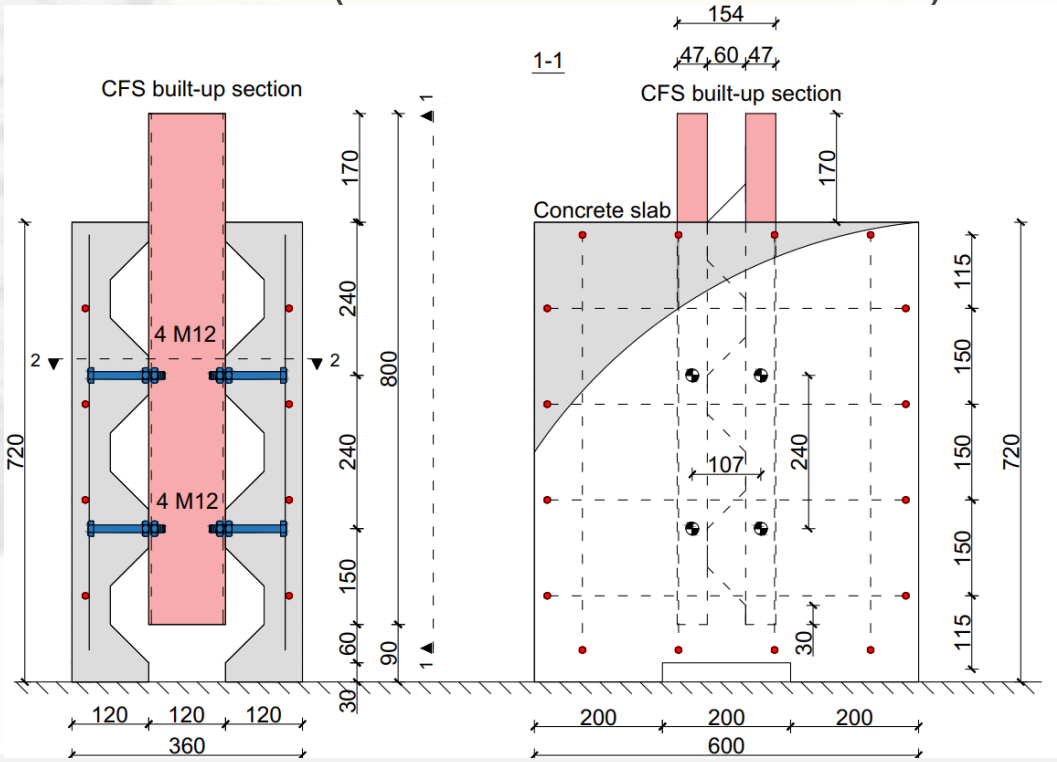


2. Experimental programme

- Push test specimens
  - Standard specimen geometry (minor adjustments)
  - CFS C profiles - 120x47x(2.5/3.0) mm
  - Concrete slab - 720x600x120 mm (Q524 reinforcement mesh)
  - Profiled steel sheeting 720x600x1.0 mm (ribs transverse to the beam)
  - Bolts M12/M16

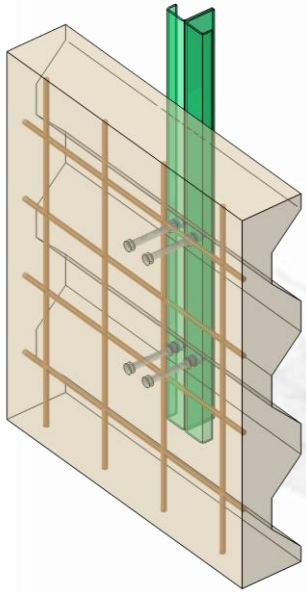
    (+)
  - Corrugated web

    780x120x1.25 mm

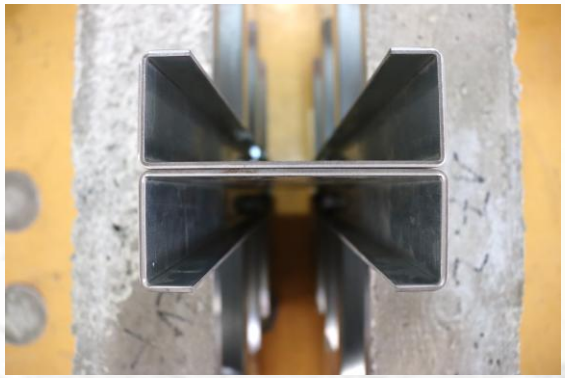


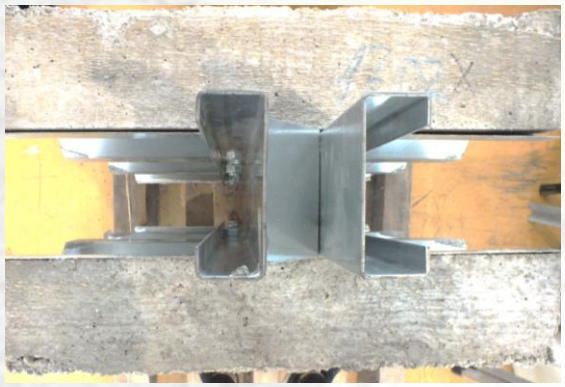
2. Experimental programme

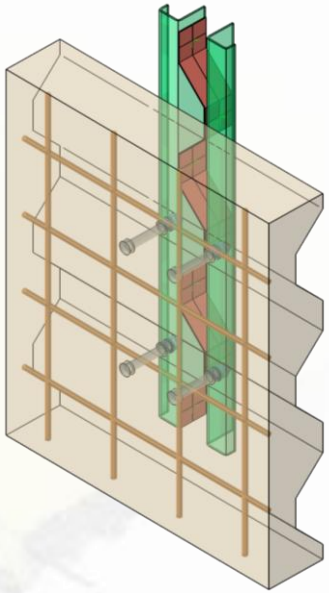
- Push test specimens



BB series







BCWB series

Specimen name	Bolt diameter [mm]	C profiles steel grade	C profile thickness [mm]
BB_01-03	12	DX51 Z275	3
BB_04-06	16	DX51 Z275	3
BCWB_01-03	16	DX51 Z275	3
BCWB_04-06	12	DX51 Z275	3
BCWB_25_01-03	12	DX51 Z275	2.5
BCWB_S350GD_01-03	16	S350GD	3

2. Experimental programme

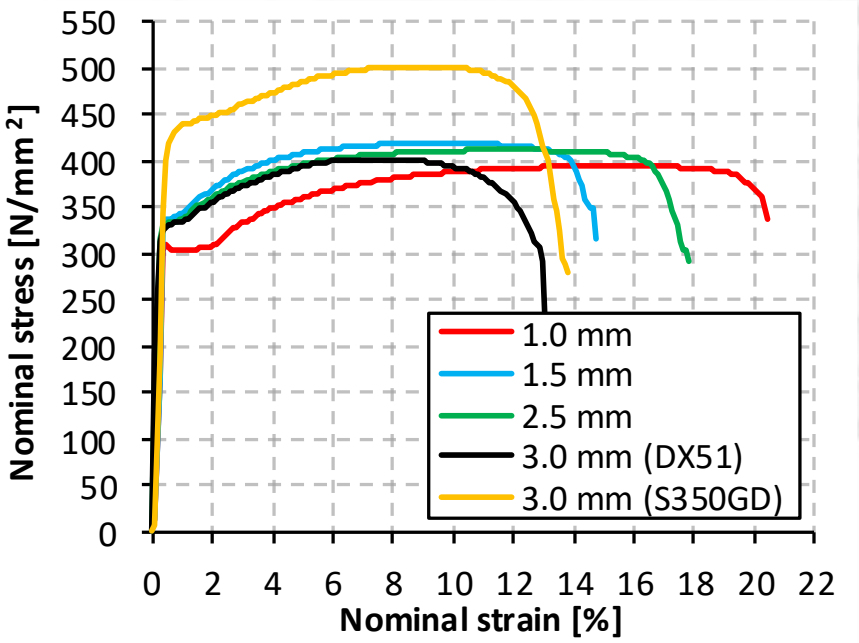
- Push test specimens

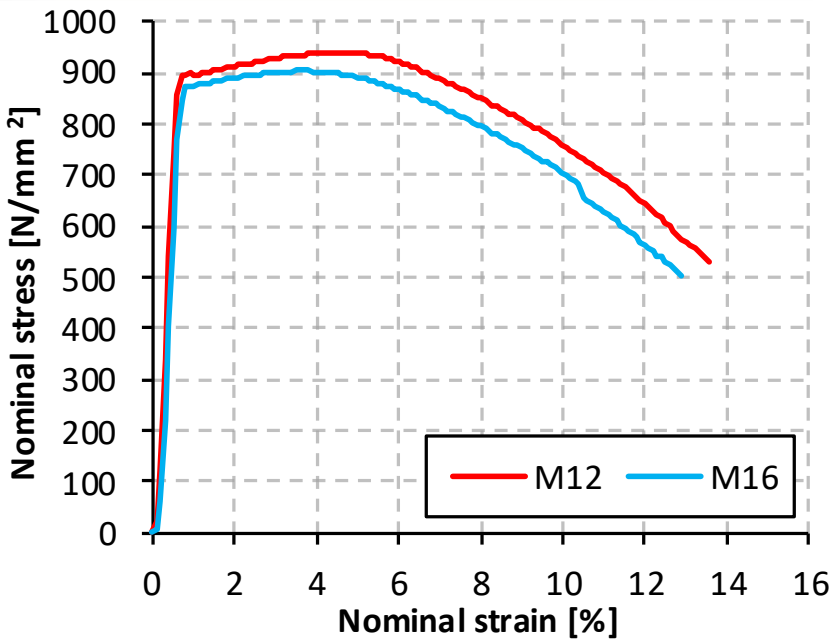
Built-up CFS girder spot-welding

Push test specimen assembly

2. Experimental programme

- Material properties
  - CFS
  - Bolts
  - Concrete (f_c=28.1 MPa, E=29526 MPa)
  - Reinforcement mesh (f_y=513 Mpa, f_u=598 Mpa)
  - Spot-welds (558 specimens)



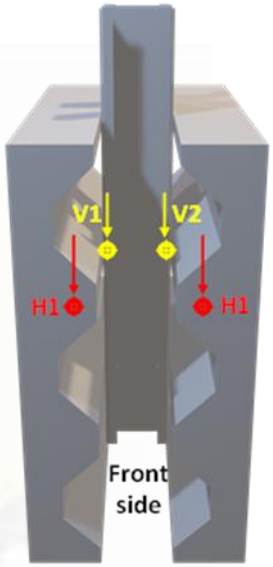


2. Experimental programme

- Test set-up and loading protocol

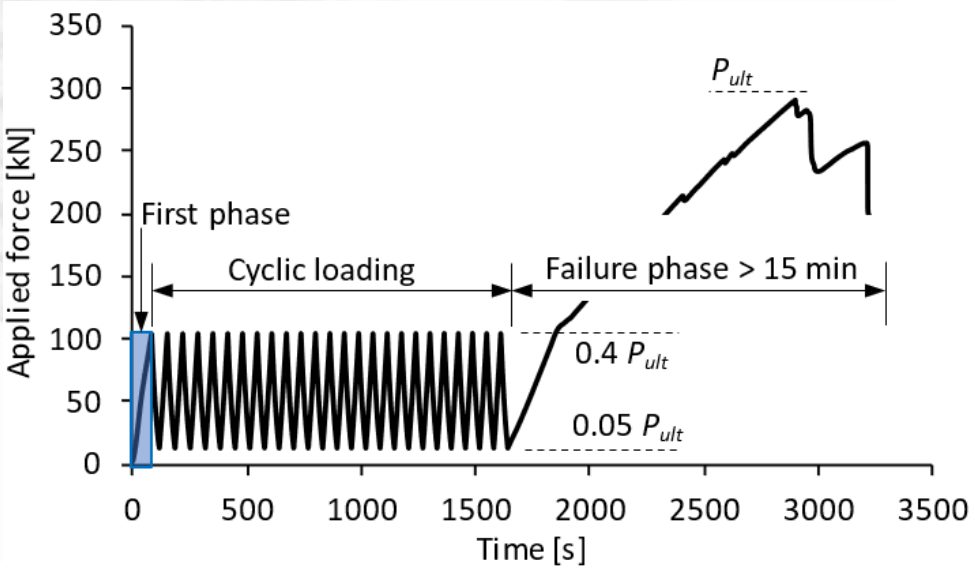
Stiffeners

LVDTs
(8 pieces)



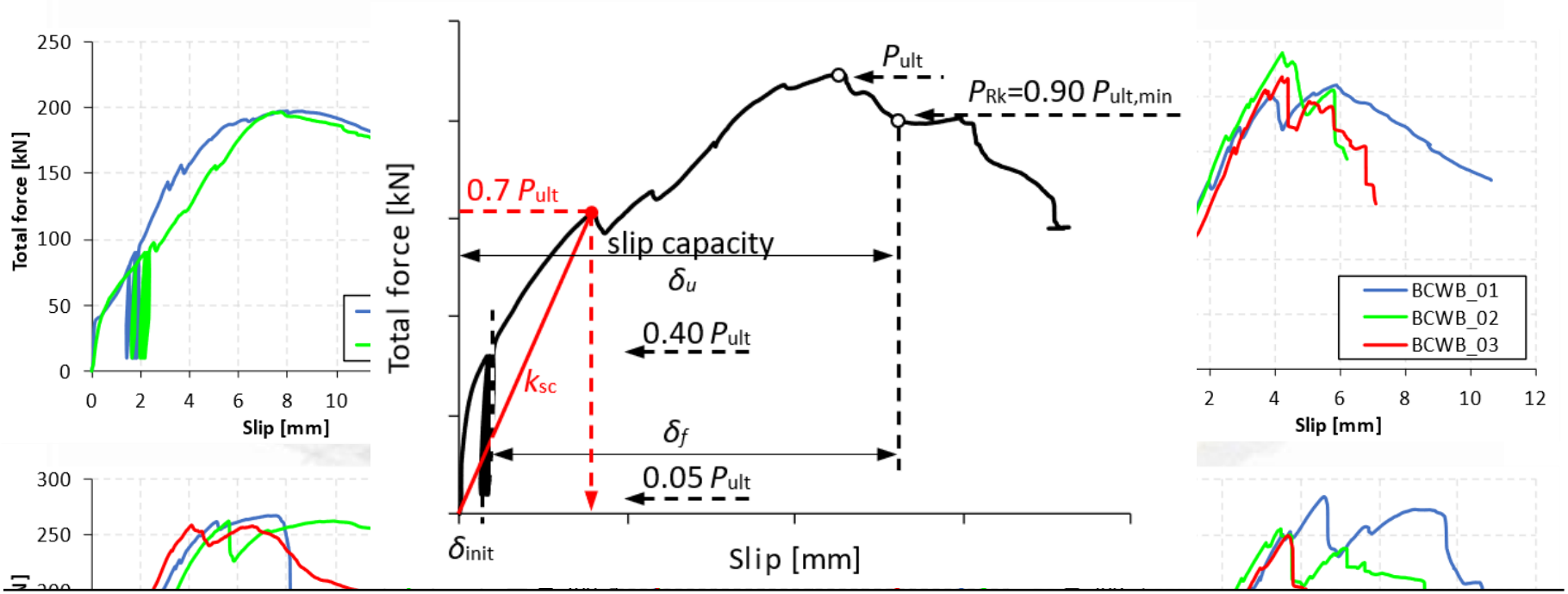
Insertion of the concrete slab

Stiffeners



3. Experimental results

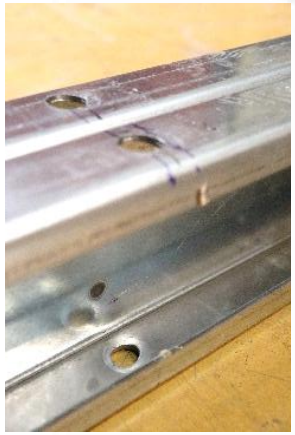
- Force-slip curves and key parameters



Specimen	Ultimate force	Slip initial	Slip failure	Slip ultimate	Stiffness	Failure modes	Ductility
	P_{ult} [kN]	δ_{init} [mm]	δ_f [mm]	δ_u [mm]	k_{sc} [kN/mm]		
BB_01_03	197.2	1.99	9.91	11.90	39.0	B-Y-C	Ductile
BB-04-06	217.3	0.69	5.70	6.39	74.9	B-C	*Ductile*
BCWB_01-03	273.3	1.06	5.25	6.32	79.4	B-C	*Brittle*
BCWB_04-06	263.0	1.11	8.64	9.75	70.6	B-Y-C	Ductile
BCWB_25_01-03	248.6	0.88	29.15	30.02	58.3	B-Y-C	Ductile
BCWB_S350GD_01-03	263.4	1.15	4.42	5.57	82.2	B-C	*Brittle*

3. Experimental results – BB spec.

- **Bolt diameter:**
  - ↑ (12 mm to 16 mm) → ↑ ~10% shear capacity
    ↑ ~50% initial stiffness
    ↓ ductility (still ductile)
  - Complex interaction of multiple failure modes due to thin steel section
  - Resistance and ductility → Degree of failure modes interaction



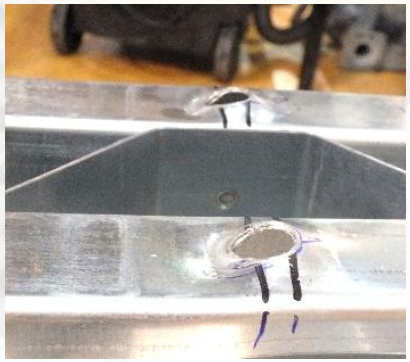
BB_02-03 (12 mm)


BB_04-06 (16 mm)

3. Experimental results – BCWB spec.

- **Bolt diameter:**
  - ↑ (12 mm to 16 mm) → ↑ ~4% shear capacity
    ↑ ~12% initial stiffness
    ↓ ~50% ductility
- **CFS thickness:**
  - ↓ (3 mm to 2.5 mm) → ↓ ~6% shear capacity
    ↓ ~18% initial stiffness
    ↑ ~3x ductility


BCWB_04-05 (3 mm)

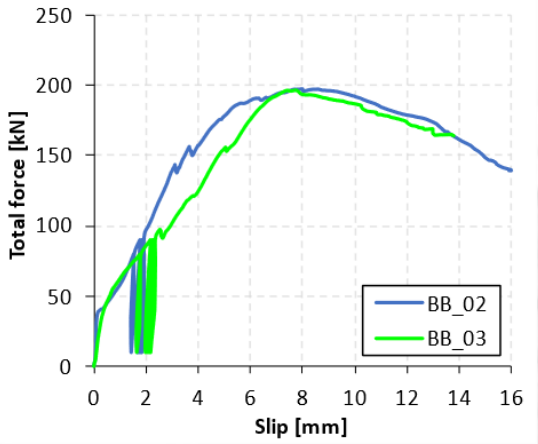


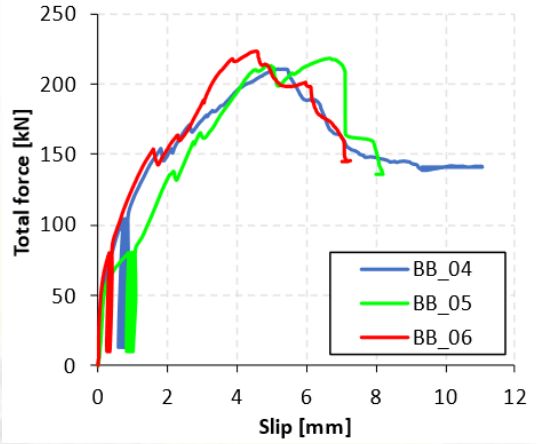

BCWB_25_01-03 (2.5 mm)

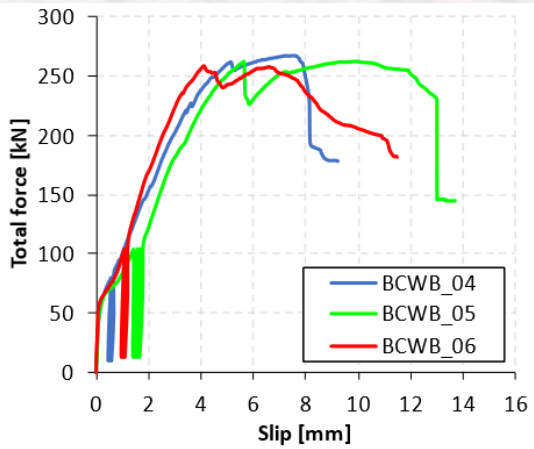
- **CFS grade:**
  - ↑ (f_y ~ 20%) → ↓ ~4% shear capacity
    ↓ ~14% ductility

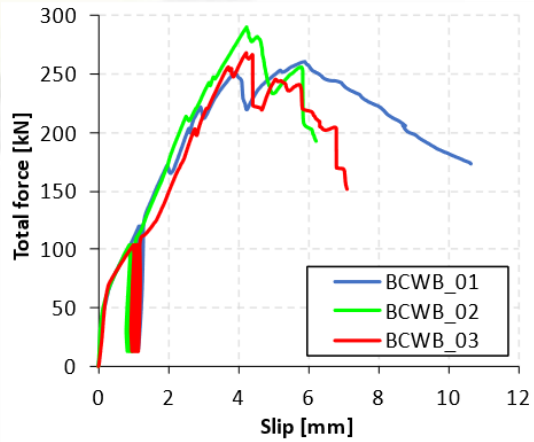
3. Experimental results – BB vs.BCWB

- **Corrugated web (CW)**
  - ❑ + → ↑ ~25% shear capacity









↑ ~ 80% initial stiffness / initial stiffness

↓ ~ 20% ductility / ductility

4. Conclusions

- A complex interaction of failure modes significantly influences the ultimate resistance and ductility of the shear connections.
- Increased bolt diameter enhanced the ultimate load capacity in both systems, but in turn reduced the connection ductility (smaller bolt diameter indicates greater stress distribution toward the steel component).
- Reduced CFS section thickness slightly decreased ultimate load but notably improved ductile behaviour (consistent with the previous conclusion regarding stress distribution).
- An increase in the ultimate strength of the CFS sections led to a slight reduction in both resistance and ductility (attributed to variations in the interaction between failure modes).
- Transverse bolt spacing significantly affected the development of the ultimate shear capacity.

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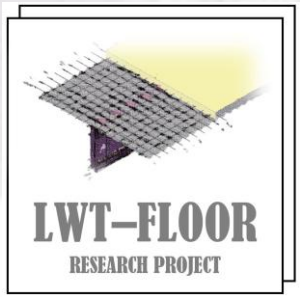

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