Performance of LWT-FLOOR Steel-concrete Composite Floor Beams: Full-Scale Experimental Study

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

LWT–FLOOR
RESEARCH PROJECT

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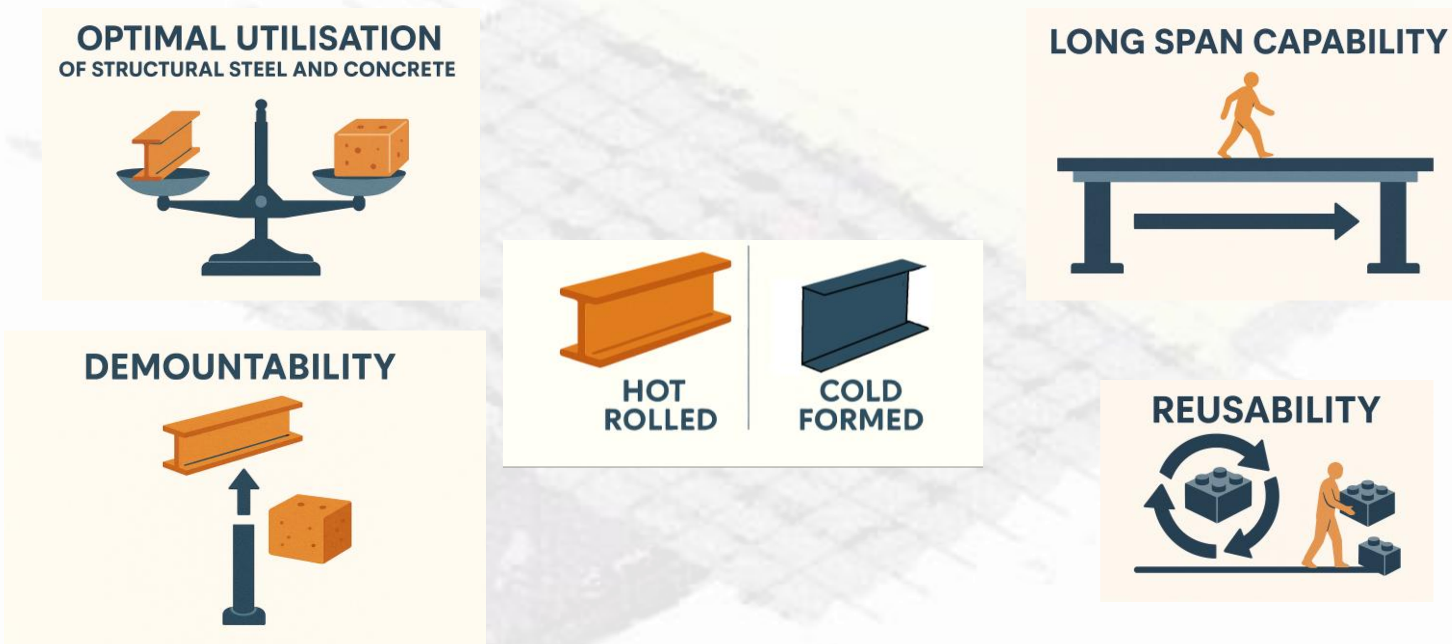
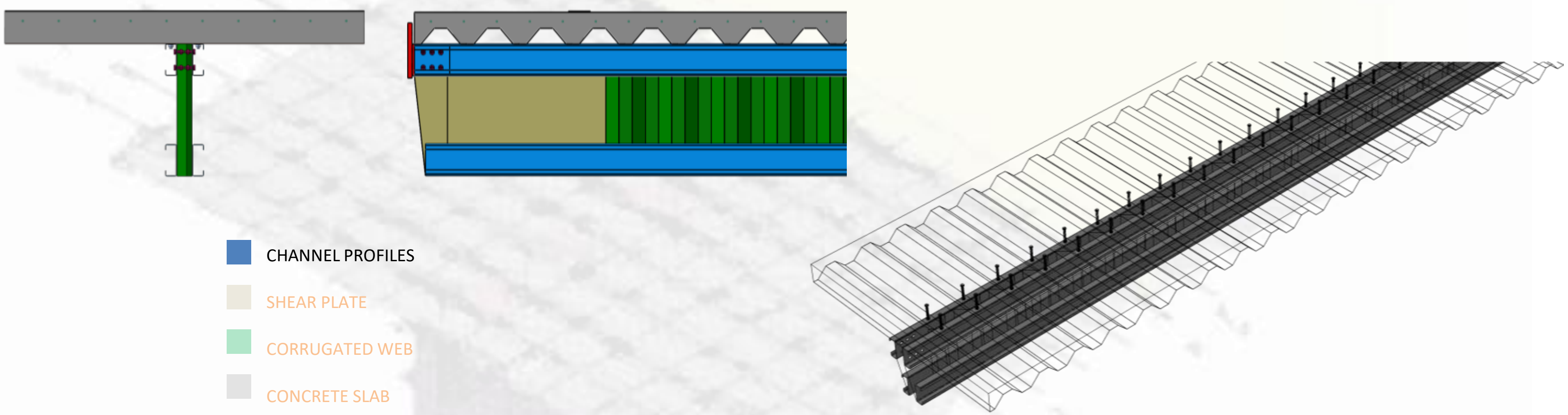
1. Introduction

- Advantages of composite steel-concrete systems:



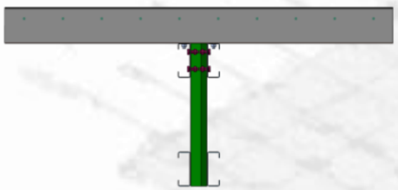
LWT-FLOOR Composite System

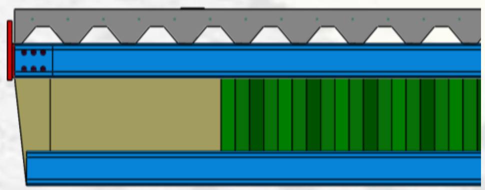
- System components:

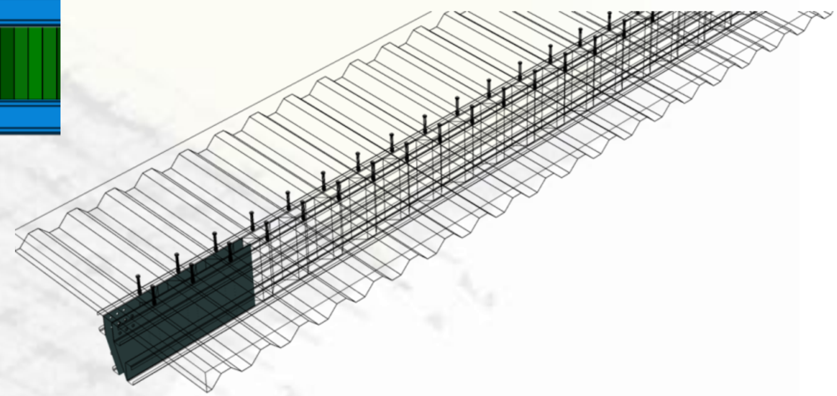


- System components:

LWT-FLOOR Composite System







CHANNEL PROFILES

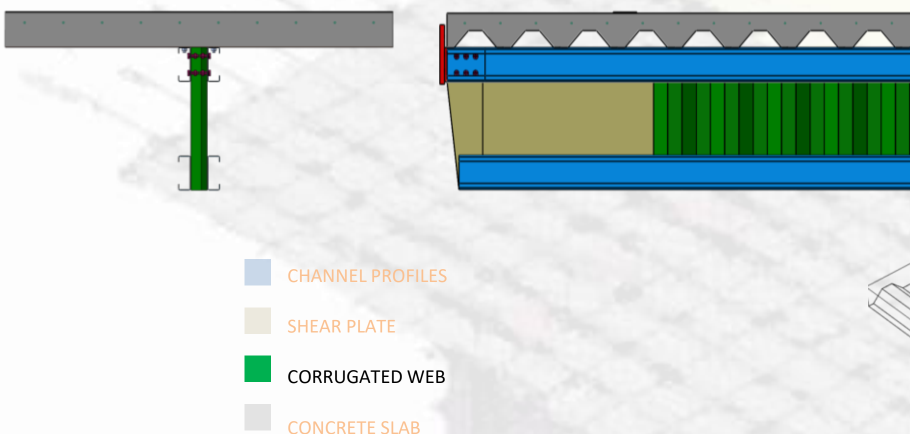
SHEAR PLATE

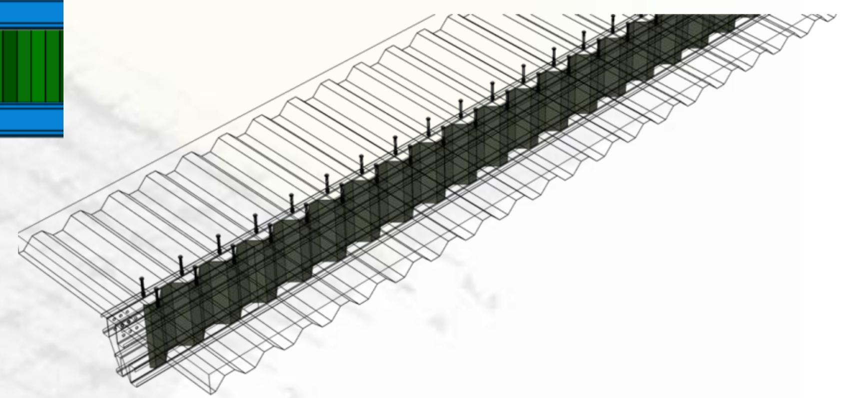
CORRUGATED WEB

CONCRETE SLAB

- System components:

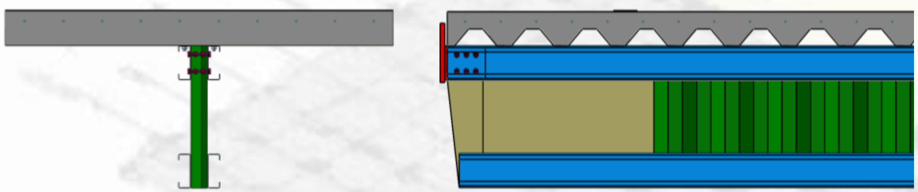
LWT-FLOOR Composite System

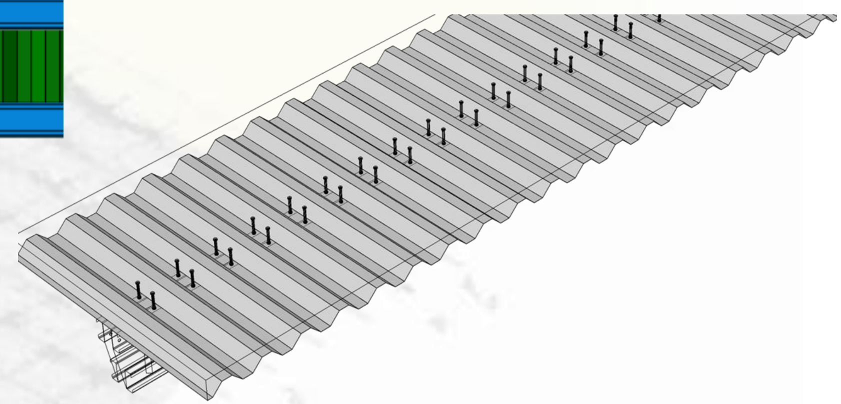




- # System components:

LWT-FLOOR Composite System





CHANNEL PROFILES

SHEAR PLATE

CORRUGATED WEB

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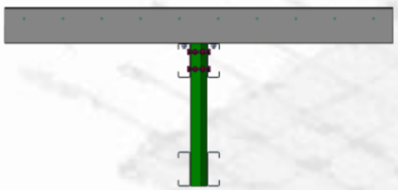
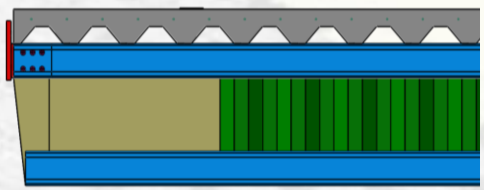
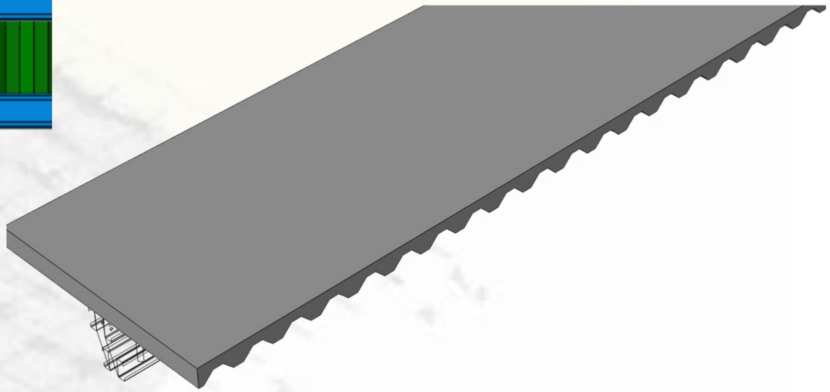
- System components:

LWT-FLOOR Composite System





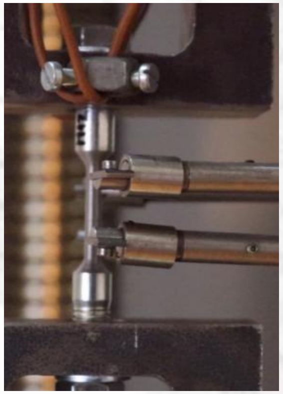
- CHANNEL PROFILES
- SHEAR PLATE
- CORRUGATED WEB
- CONCRETE SLAB



Experimental testing

- ## Material testing and testing of system components

Steel sheets: 0,8 mm, 1,0 mm, 1,25 mm, 1,5 mm, 2,0 mm, 2,5 mm and 3,0 mm, steel grades DX51 and GD 350 for 3,0 mm only, **135 specimens**



Bolts: M12 and M16, grade 8.8, **11 specimens**

Reinforcement: bars 8 mm and mesh 10 mm, B500, **10 specimens**

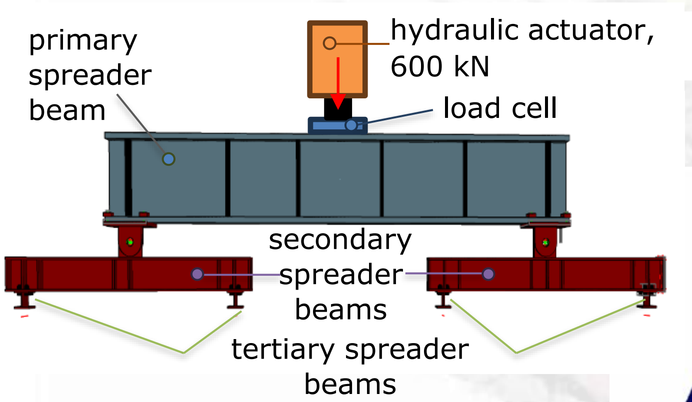
Concrete: LC 20/22 and NC 20/25, **43 specimens**

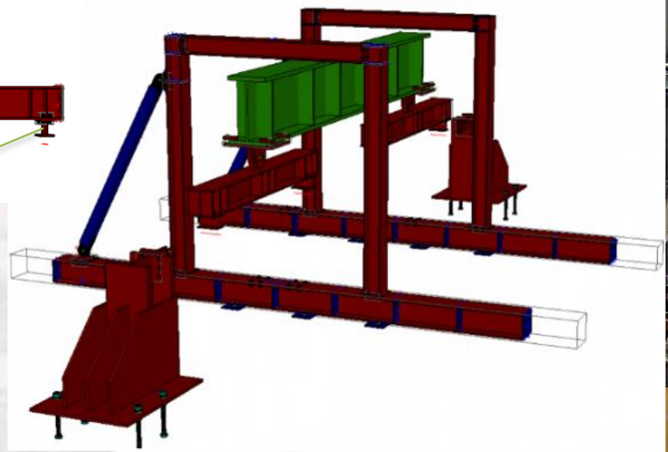
Spot welds: different combinations of steel sheet thicknesses, **558 specimens**

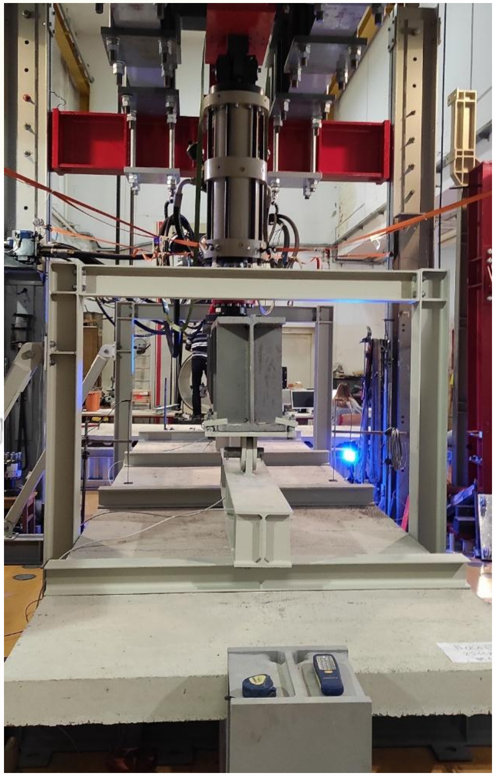
Shear connections: different types (with concrete dowels (LC and NC) and demountable types with and without additional corrugated web (NC only)), **30 specimens**

• Full-Scale Beam Bending Tests

Experimental testing



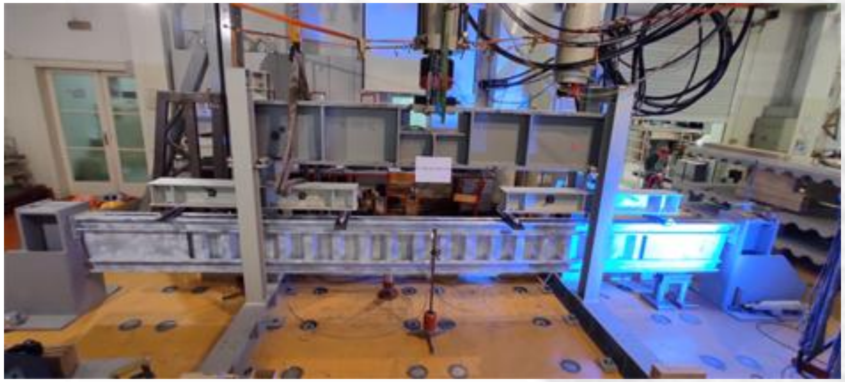




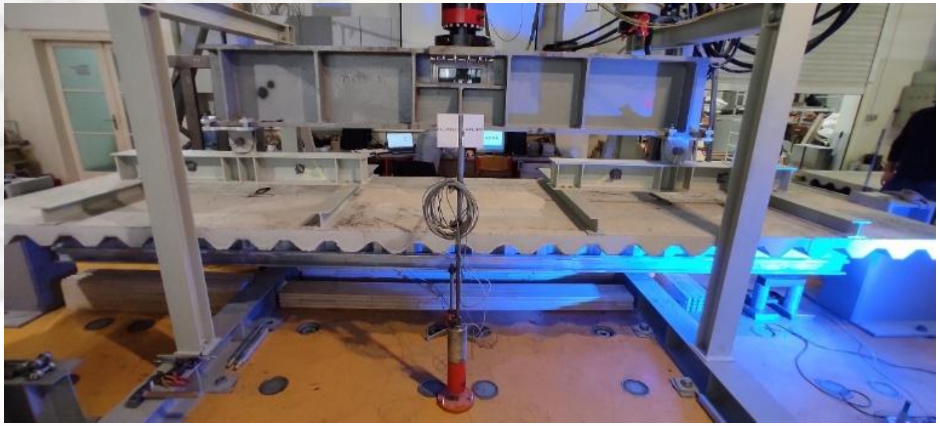
• Full-Scale Beam Bending Tests

Experimental testing

CWB beam				
	height [mm]	channel thickness [mm]	CW thickness [mm]	Shear plate thickness [mm]
SB1 (CB1)	400	3.0	1.5	1.5
SB2 (CB2)	500	2.0	1.0	1.0
SB3 (CB3) WO	400	2.5	1.0	1.0



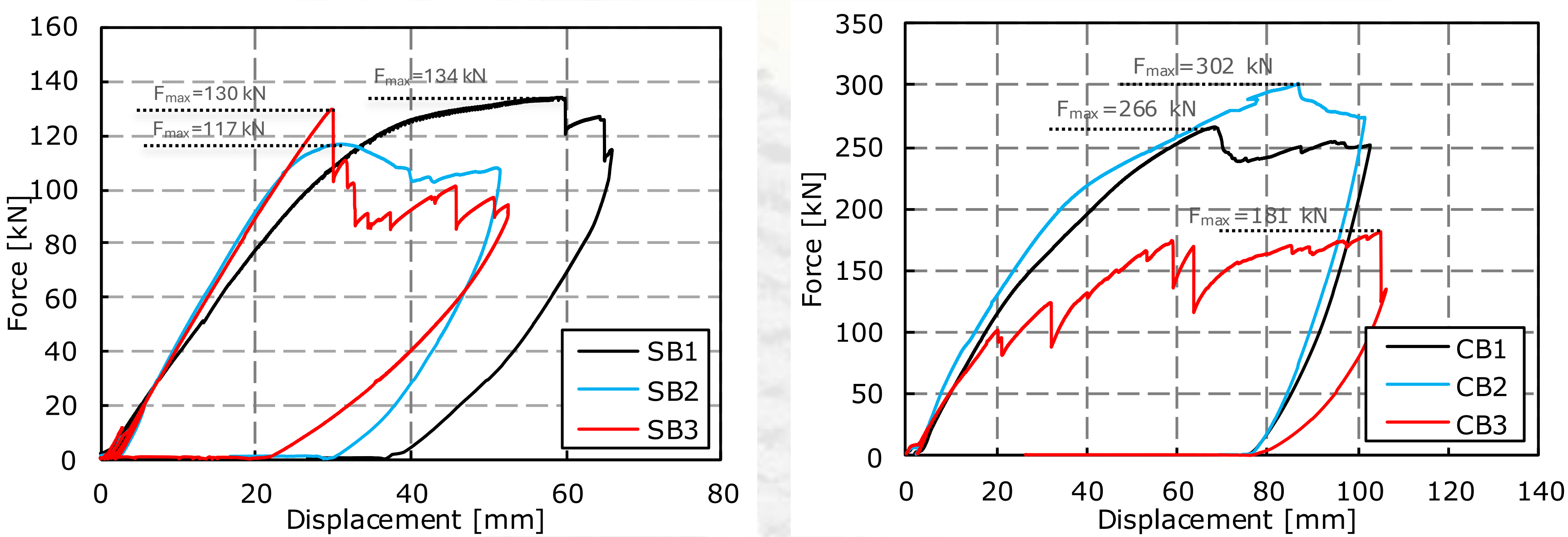
Steel beam SB1 during testing



Composite beam CB1 during testing

Results and discussion

- **Load-displacement curves for tested steel and composite beams**

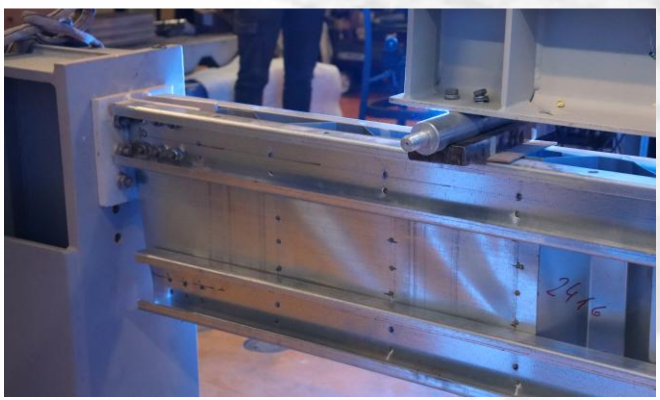


Experimentally obtained load-displacement curves for steel and composite beams

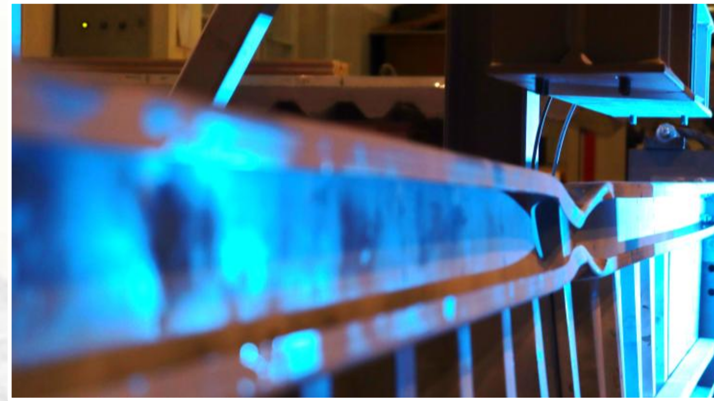
- # Observed failure modes

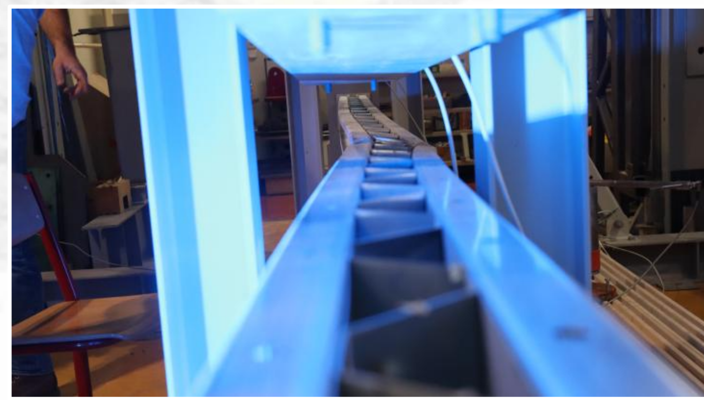
Results and discussion

SB1



SB2





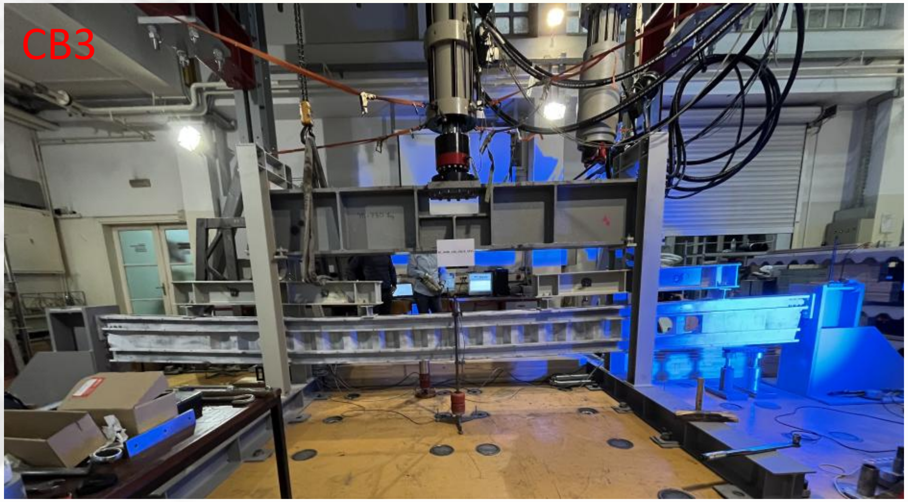
- SB1 and SB2 failed due to local/distortional buckling of the channel section, lateral deflection due to buckling of the channel sections and shear plate buckling.

• Observed failure modes

Results and discussion

- SB3 failed due to non-ductile interfacial fracture of the spot welds in the area connecting the thicker channel sections (3.0 mm) to the shear plate and corrugated web (1.5 mm) which interrupted the formation of shear fields in the shear plate and corrugated web.

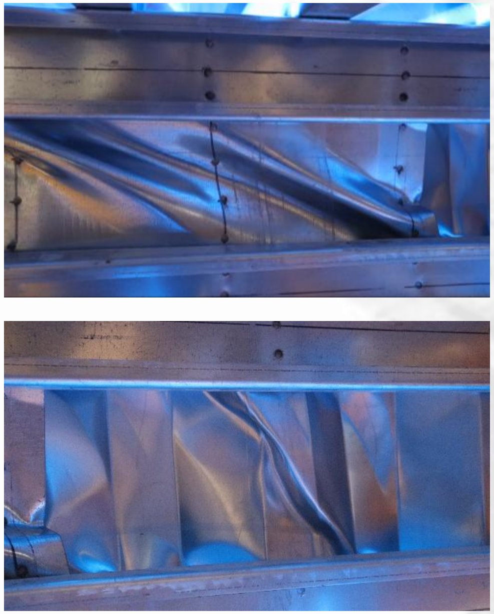
SB3



• Observed failure modes

Results and discussion

CB1



CB2

- CB1 and CB2 failed due to shear plate buckling and corrugated web buckling with large midspan deflection.
- No surface cracks were observed in the concrete slabs for any of the composite beams, although the separation between the concrete slab and the profiled steel sheeting was observed.

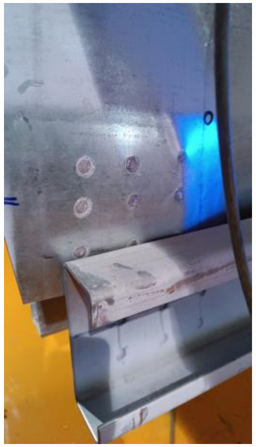
- # Observed failure modes

Results and discussion

• Observed failure modes

Results and discussion

CB3



- CB3 failed due to non-ductile interfacial fracture of the spot welds in the area connecting the thicker channel sections (3.0 mm) to the shear plate and corrugated web (1.5 mm), which interrupted the formation of shear fields in the shear plate and corrugated web.

CB3

Conclusions

- The load-bearing capacity and failure modes of both steel and composite beams are fundamentally **influenced by the geometric characteristics** of the steel elements (thickness and height) and **the performance of the spot weld connections**.
- Premature failure of spot welds can significantly limit the overall load-bearing capacity of both steel and composite beams and can change the expected failure mechanisms, as clearly demonstrated in the behaviour of SB3 and CB3.
- The composite beam with the higher steel section (CB2) exhibited the highest load-bearing capacity among the composite specimens, highlighting the efficiency of increased structural depth.

Conclusions

- The demountable shear connection performed as intended without surface cracks in the concrete slabs.
- The results of this experimental study provide essential data for further development and optimisation of the LWT-FLOOR system, such as:

  - calibration and validation of detailed numerical models
  - conducting parametric FE analyses
  - development of a reliable analytical design procedure for the LWT-FLOOR system
  - further investigation into the long-term performance and demountability aspects of the LWT-FLOOR system.

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