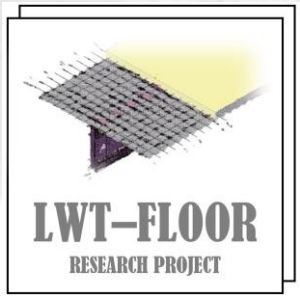
Project title: **Innovative lightweight cold-formed steel-concrete composite floor system**
Acronym: **LWT-FLOOR** Project ID: **UIP-2020-02-2964**
4th LWT-FLOOR Project Workshop

Numerical parametric study of LWT-FLOOR system: effect of various web openings

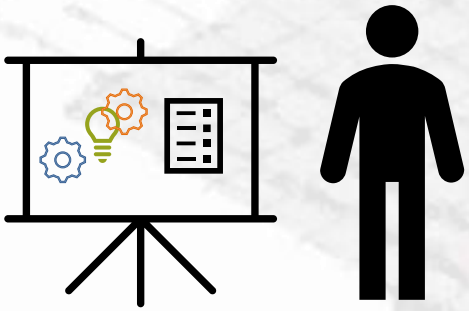
Numerička parametarska analiza sustava LWT-FLOOR: utjecaj različitih oblika otvora u hrptu

Andrea Rajić, Ivan Lukačević, Ivan Ćurković, Vlaho Žuvelek



University of Zagreb/Faculty of Civil Engineering
http://www.grad.unizg.hr/lwtfloor

Presentation agenda



01 Introduction.

02 Numerical model.

03 Results and discussion.

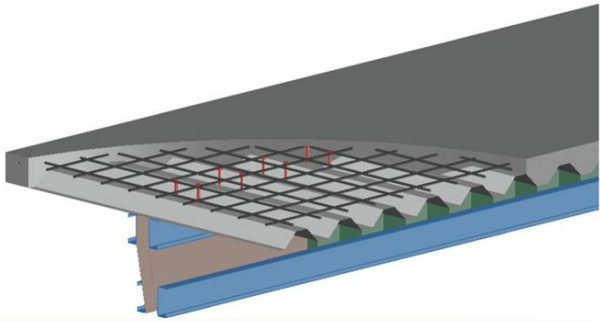
04 Conclusions.

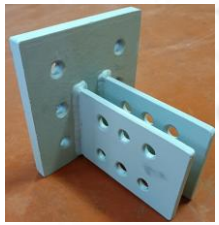
Introduction

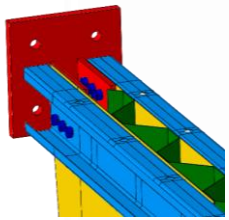
How do **corrugated web thickness** and **web openings** influence on the composite beams of **different lengths**?

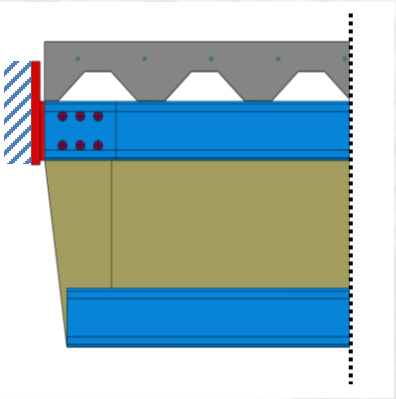
Numerical model

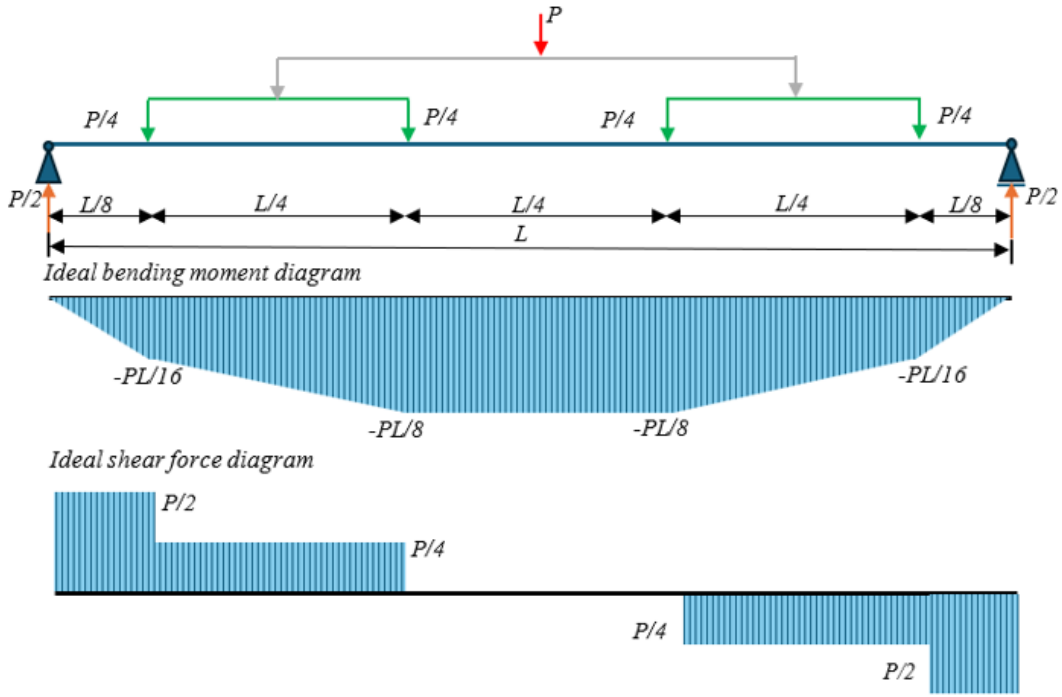
- CONCRETE SLAB
- CHANNEL PROFILES
- SHEAR PLATE
- CORRUGATED WEB



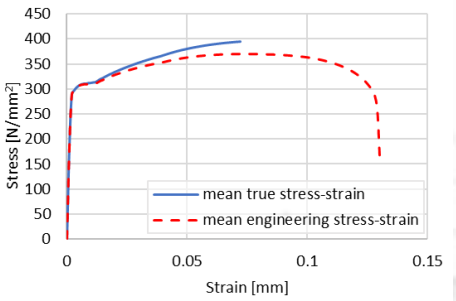




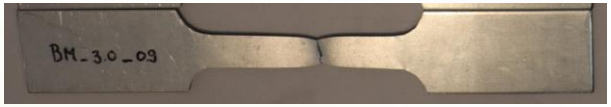


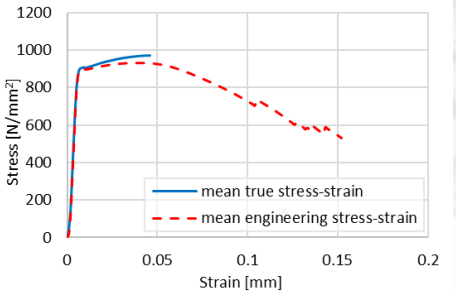


Materials and characteristics of SW

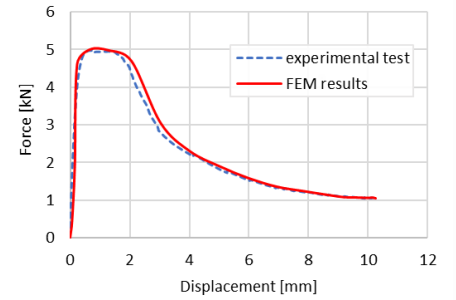


STEEL SHEETS

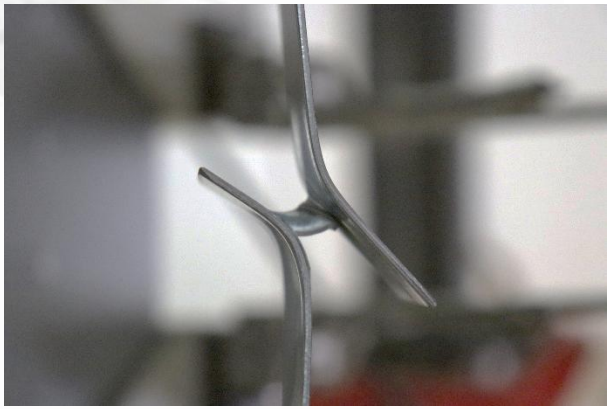




SHEAR CONNECTORS

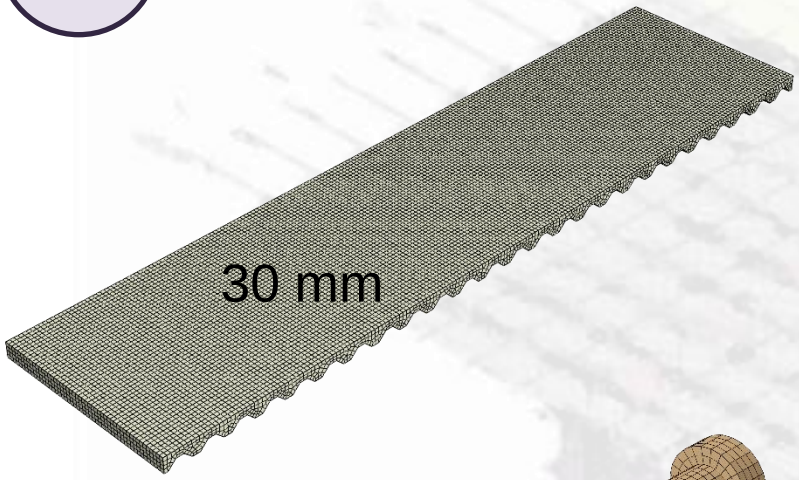


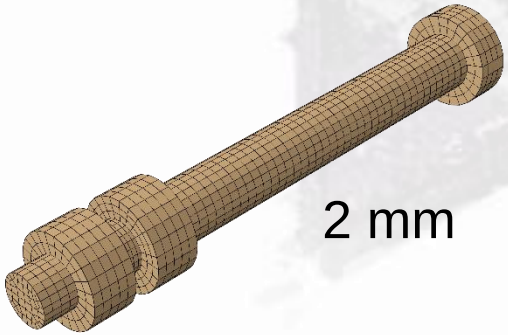
SPOT WELDS



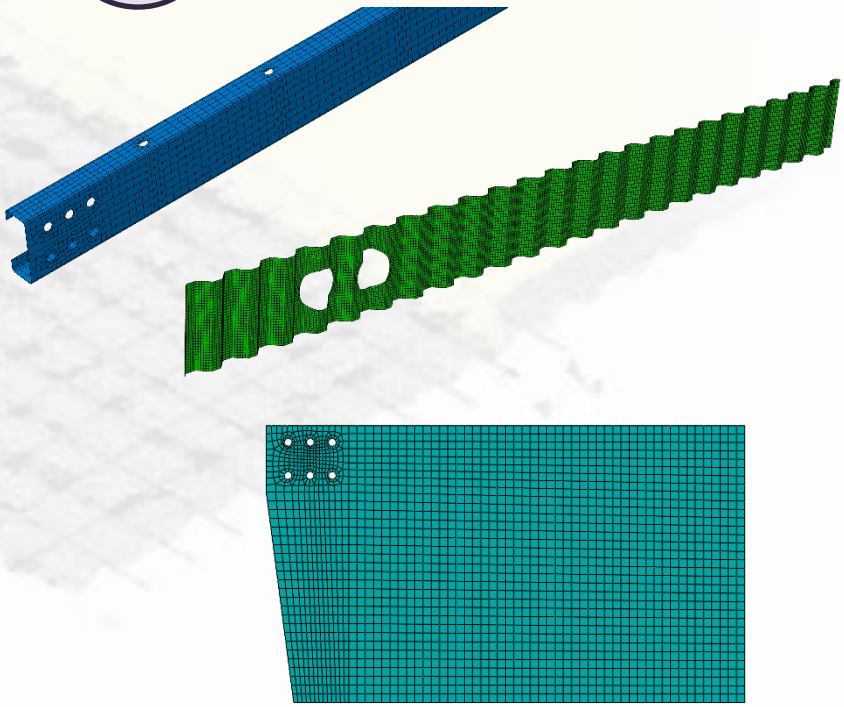
Finite element types and mesh sizes

01 SOLID



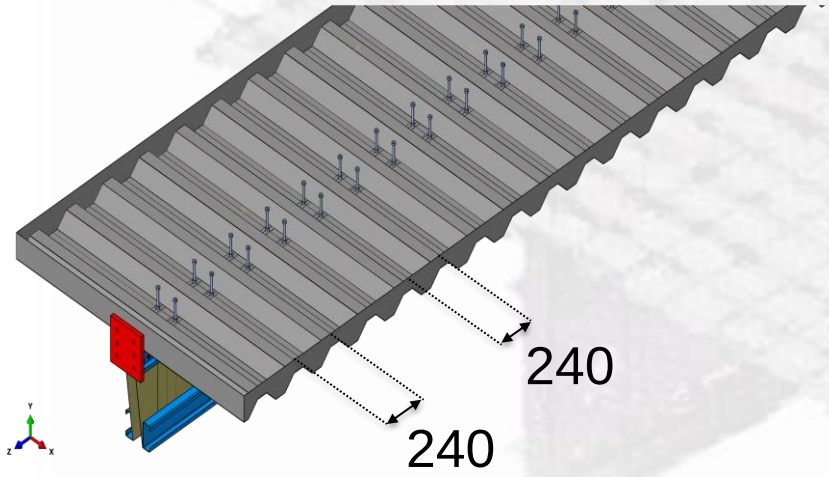


02 SHELL – 15 mm

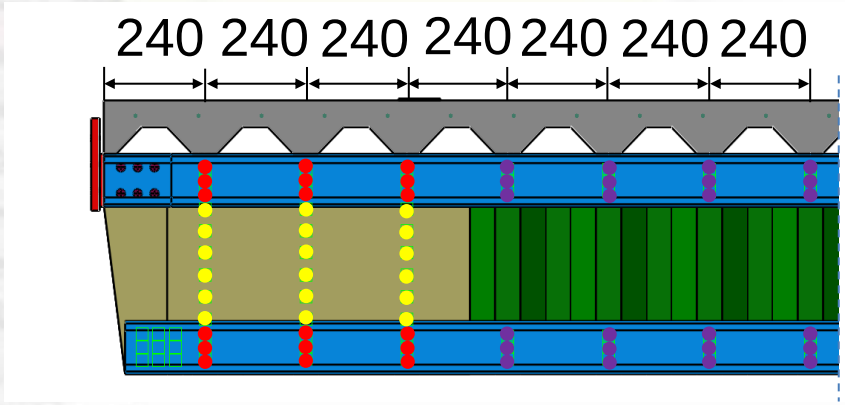


Connection

01 SHEAR CONNECTION



02 BETWEEN ELEMENTS



Connection

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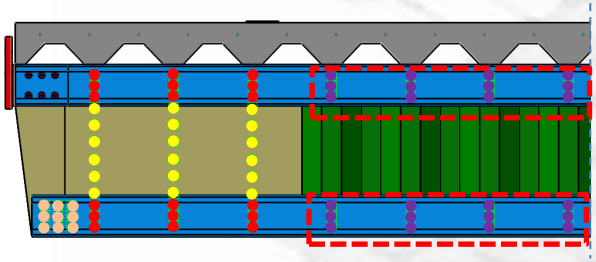
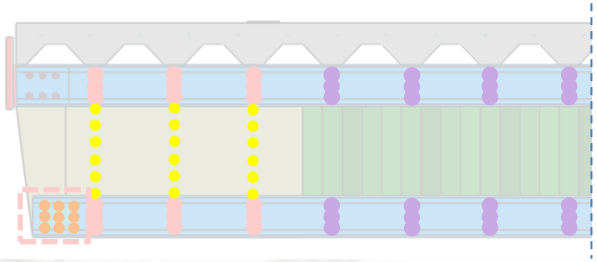
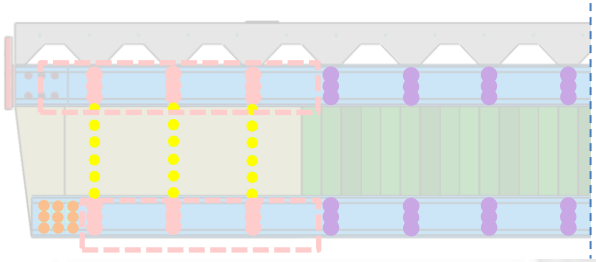
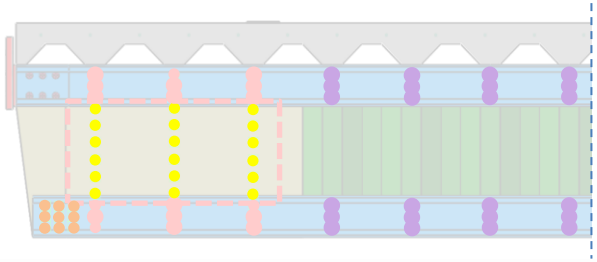
BETWEEN ELEMENTS



A) C-CW
B) C-CW-SP
C) C-SP
D) SP-CW







Connection

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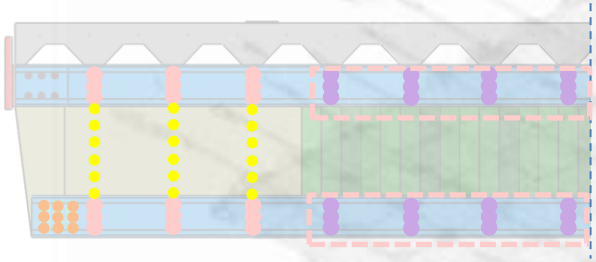
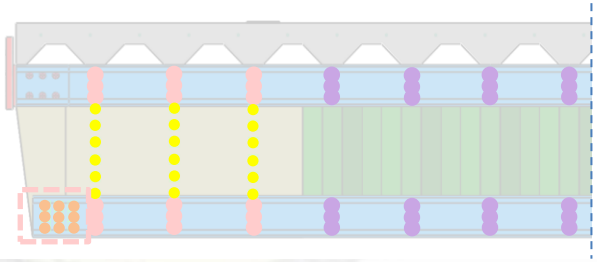
BETWEEN ELEMENTS





A) C-CW
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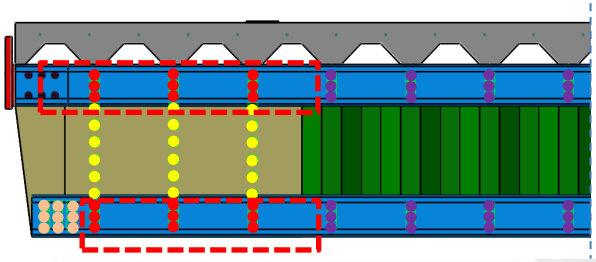
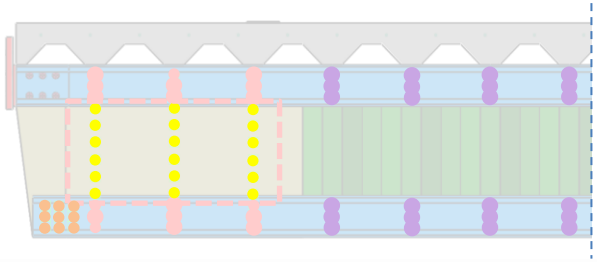
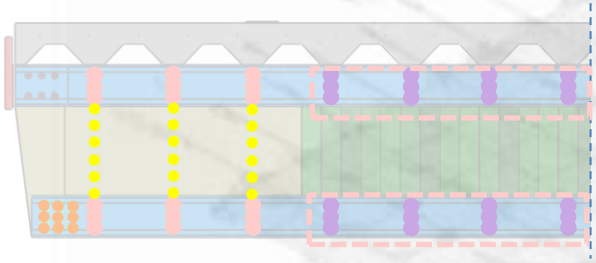




Connection

02

BETWEEN ELEMENTS



A) C-CW
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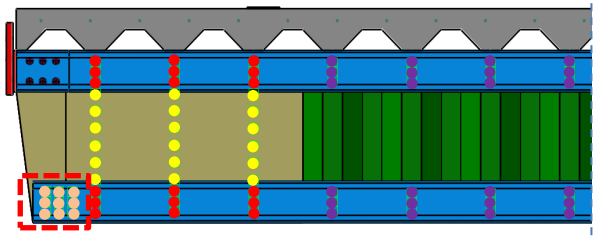
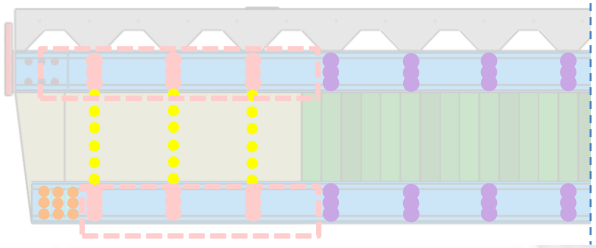
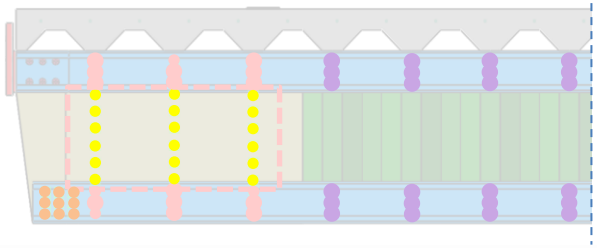
C) C-SP
D) SP-CW



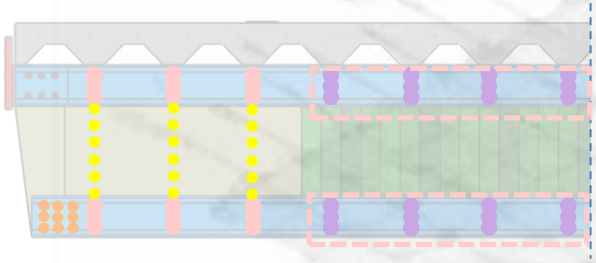




Connection

02

BETWEEN ELEMENTS



A) C-CW
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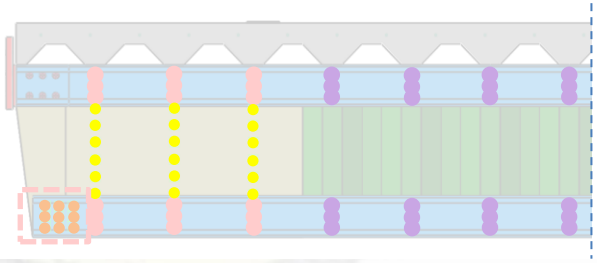
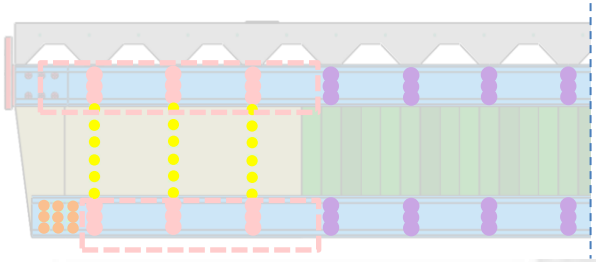
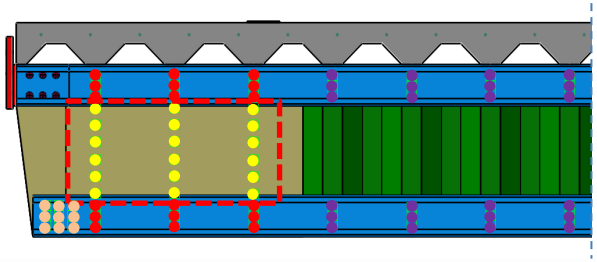






Web openings

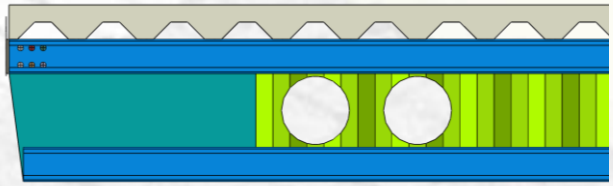
CIRCULAR SHAPE

CONDITIONS

$0.5 \leq h_b/h_t \leq 3$

$h_0 \leq 0.8\ h$

$l_0: -$



$h_b/h_t = 1$

$h_0 = 0.4\ h$

$$A_a = \frac{d^2\pi}{4}$$

$$A_a = \frac{240^2\pi}{4}$$

$$A_a = 0.045\ m^2$$

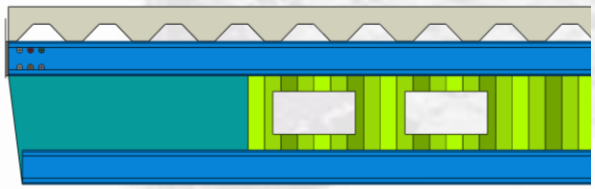
RECTANGULAR SHAPE

$1 \leq h_b/h_t \leq 2$

$h_0 \leq 0.7\ h$

$l_0 \leq 1.5\ h_0$

$2t_w \leq r_0 \leq 15\ mm$



$h_b/h_t = 1$

$h_0 = 0.4\ h$

$l_0 = 0.8\ h_0$

$r_0 = 15\ mm$

$$A_a = l_0 \times h_0$$

$$A_a = 300\ mm \times 150\ mm$$

$$A_a = 0.045\ m^2$$

Criterion: *equal orthogonal projection area of the opening*

Calibration of numerical model

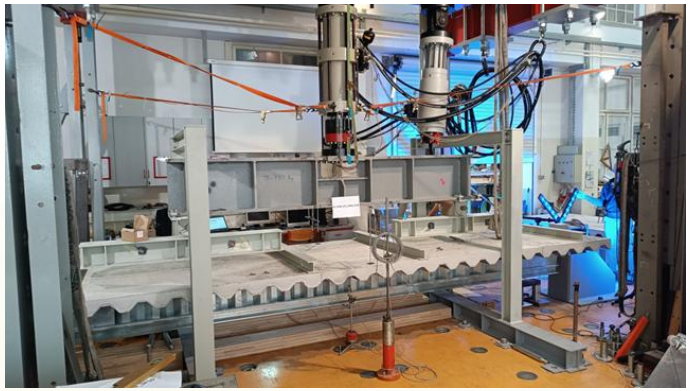
01 Span: 6 m

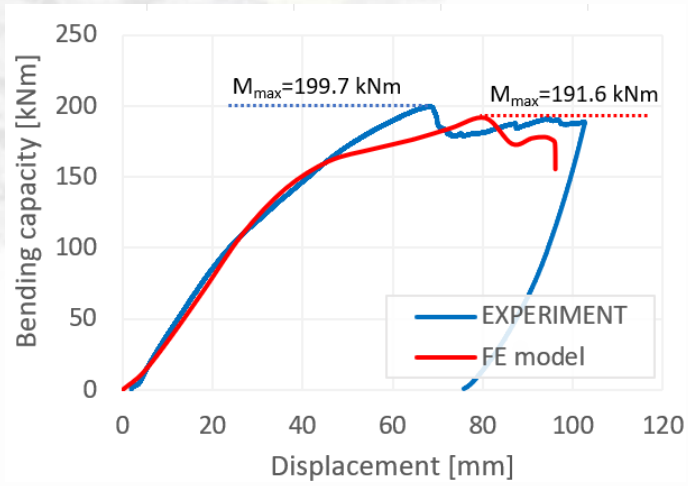
02 **Steel section height: 400 mm**

03 Channel section
- height: 120 mm
- thickness: 2.5 mm

04 **Corrugated web thickness: 1.0 mm**

05 Shear plate thickness: 1.0 mm





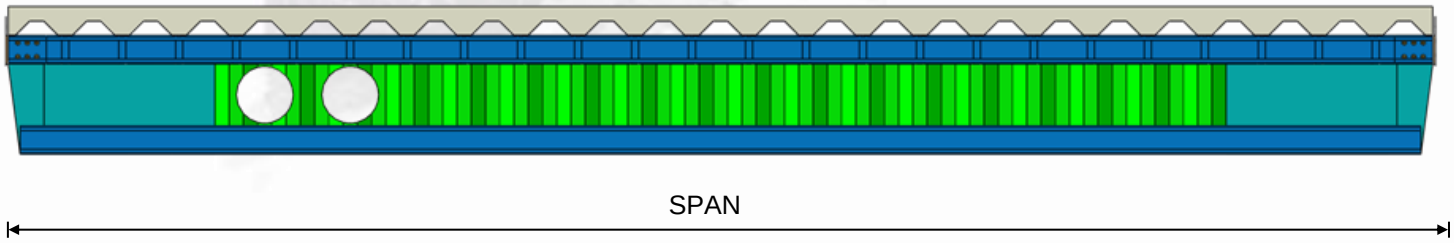
Analysed parameters

01 Span
- 6 m
- 12 m

02 Steel beam height

03 Corrugated web thickness

04 Web opening



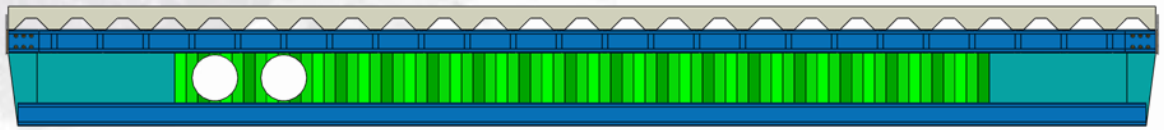
Analysed parameters

01 Span

02 Steel beam height
- 500 mm
- 1000 mm

03 Corrugated web thickness

04 Web opening



Criterion: *steel beam height=span/12*

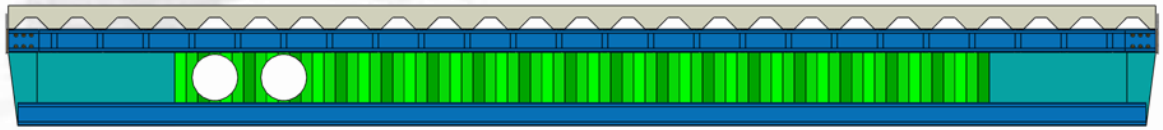
Analysed parameters

01 Span

02 Steel beam height

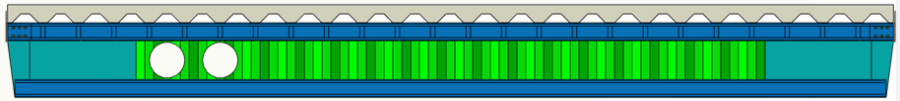
03 Corrugated web thickness
- 0.8 mm
- 1.5 mm

04 Web opening

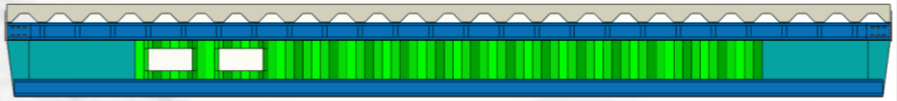


Analysed parameters

01 Span



02 Steel beam height

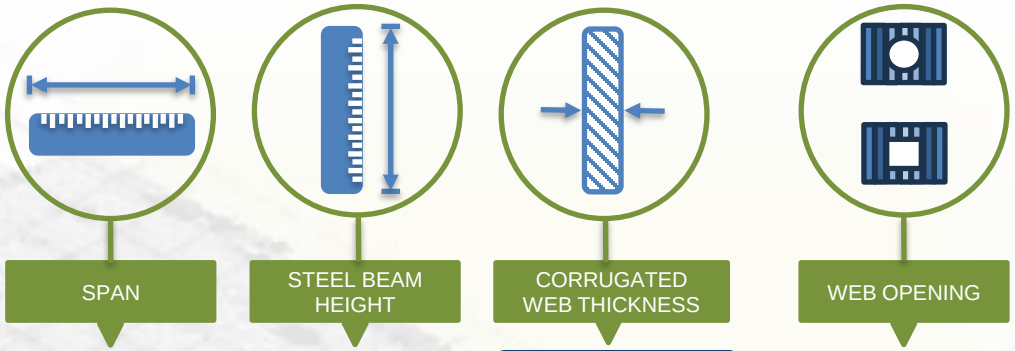


03 Corrugated web thickness

04 Web opening

- Circular shape
- Rectangular shape

Nomenclature



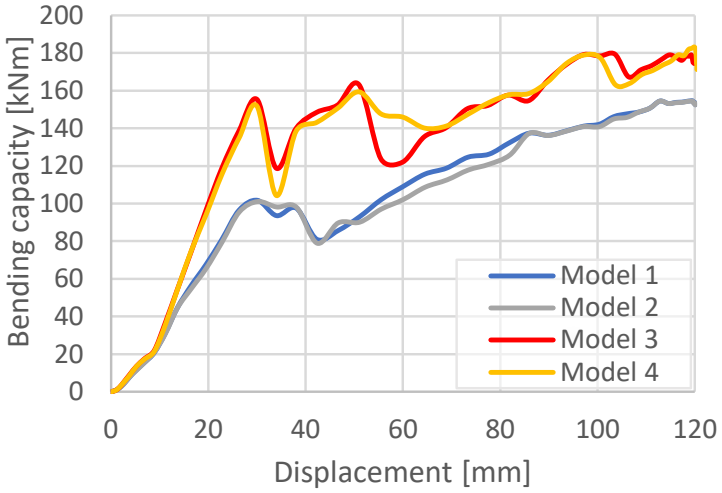
	SPAN	STEEL BEAM HEIGHT	CORRUGATED WEB THICKNESS	WEB OPENING
Model 1	6 m	500 mm	0.8 mm	circular
Model 2	6 m	500 mm	0.8 mm	rectangular
Model 3	6 m	500 mm	1.5 mm	circular
Model 4	6 m	500 mm	1.5 mm	rectangular
Model 5	12 m	1000 mm	0.8 mm	circular
Model 6	12 m	1000 mm	0.8 mm	rectangular

Results and discussion

Different corrugated web thickness and web opening configurations

Note:
beam span 6 m

01

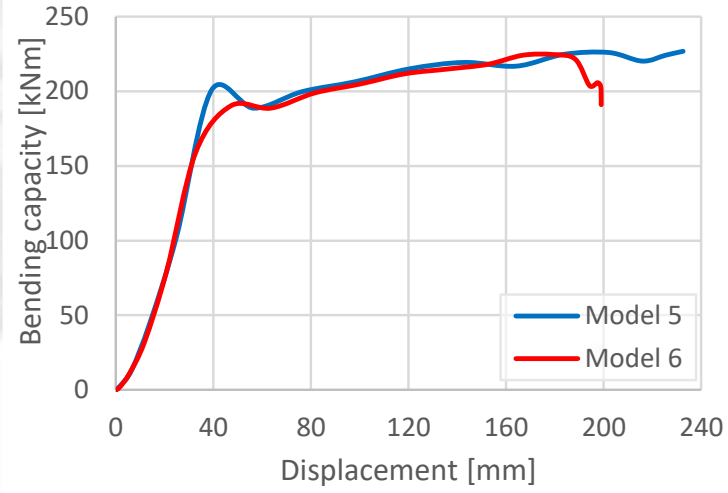


M1: 6m_500mm_0.8 mm_C
M2: 6m_500mm_0.8 mm_R
M3: 6m_500mm_1.5 mm_C
M4: 6m_500mm_1.5 mm_R

Different web opening configurations

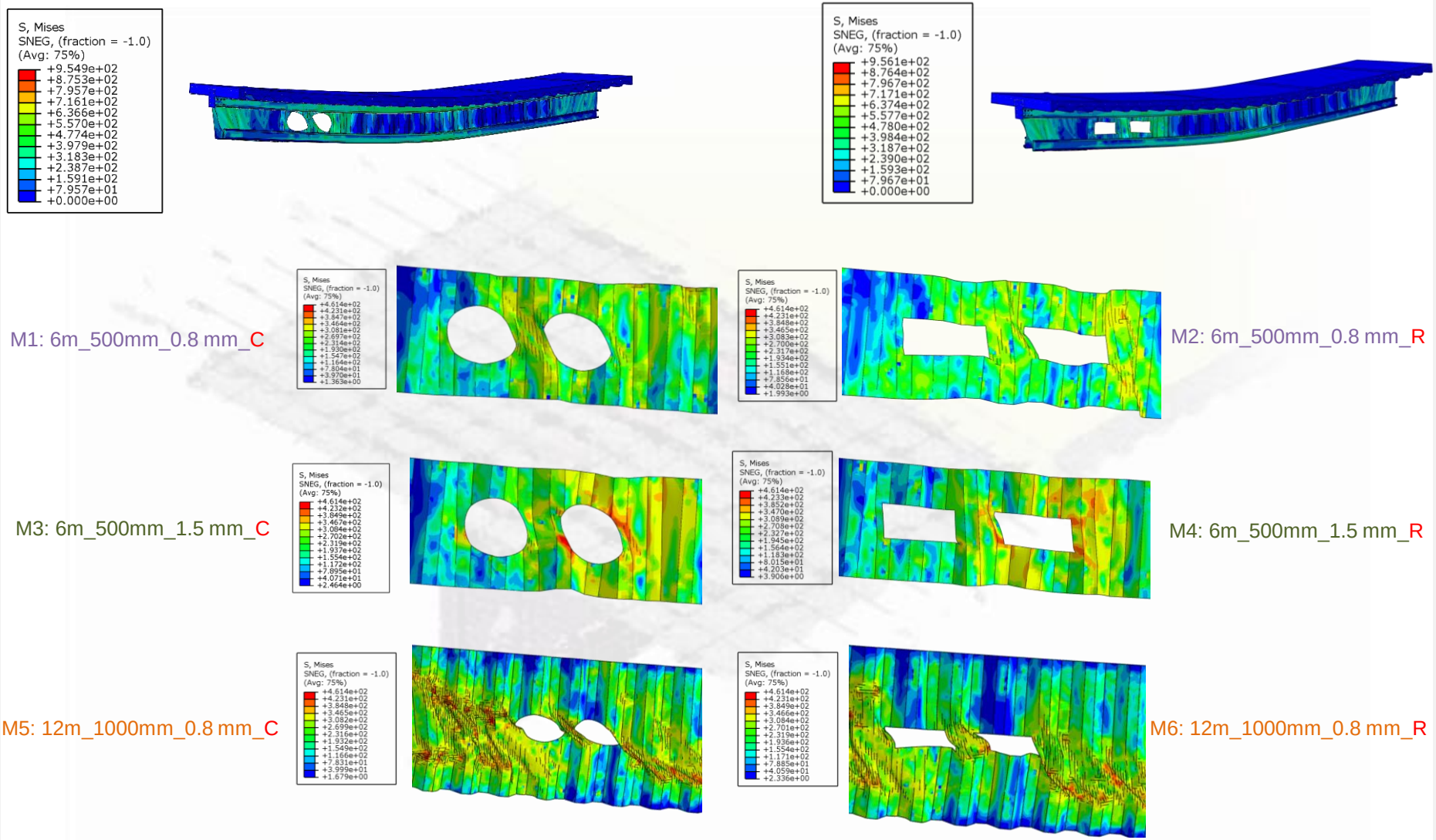
Note:
beam span 12 m

02



M5: 12m_1000mm_0.8 mm_C
M6: 12m_1000mm_0.8 mm_R

Results and discussion



Conclusions

CORRUGATED WEB THICKNESS = the greatest impact on the load-bearing capacity of the system

SPOT WELDS = spot welds failure at the beam ends -> separation of the lower C profiles from the corrugated web and shear plates-> significant impact on the structural integrity of the beam

SPAN and WEB OPENING CONFIGURATIONS =

6 m – circular opening - Von Mises stress concentrations occurred around the edge of opening

– rectangular opening - Von Mises stress concentration was observed at the corners of the opening

12 m - significant deformation occurred in the corrugated web, leading to the failure of both the web and the opening (This behaviour can be attributed to the insufficient thickness of the structural elements.)

Conclusions

CORRUGATED WEB THICKNESS

=

the greatest impact on the load-bearing capacity of the system

SPOT WELDS

=

spot welds failure at the beam ends
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SPAN and WEB OPENING CONFIGURATIONS

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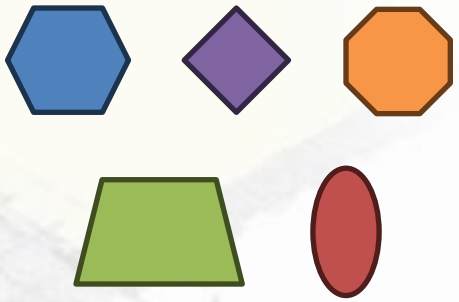
Further research

STIFFENERS — 01 — SHAPE, POSITION AND THICKNESS

WEB OPENINGS — 02 — CONFIGURATIONS

- Hexagonal shape
- Diamond shape
- Octogonal shape
- Trapezoid shape
- Elliptical shape



03 — NUMBER OF OPENINGS

SPAN — 04 — 6 m, 9 m, 12 m, 15 m, 18 m

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4th LWT-FLOOR Project Workshop

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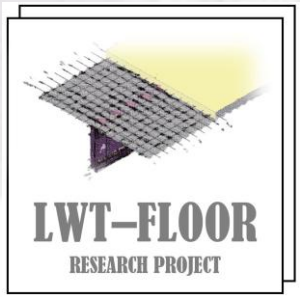
Numerical parametric study of LWT-FLOOR system: effect of various web openings

Andrea Rajić, Ivan Lukačević, Ivan Ćurković, Vlaho Žuvelek



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