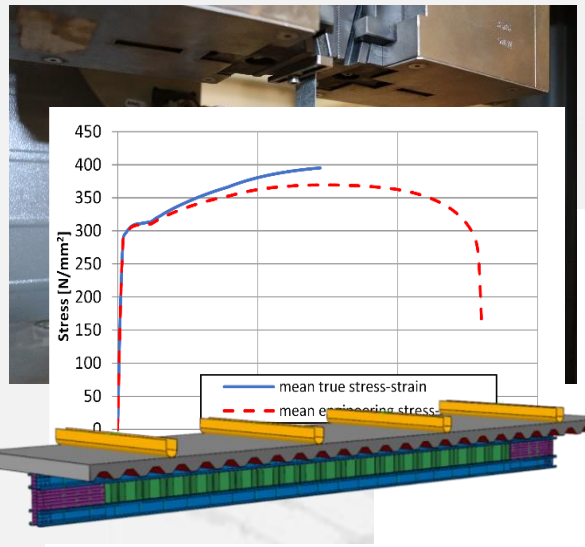
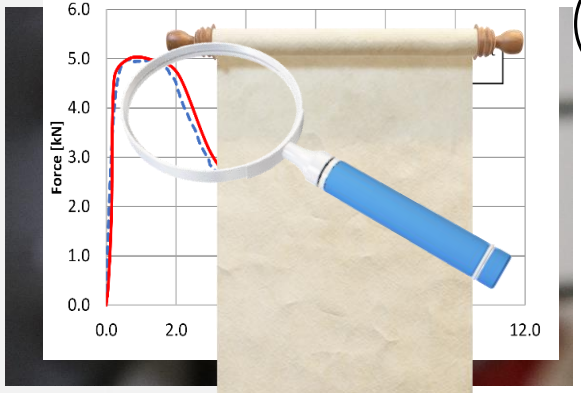
Numerical study of cold-formed steel-concrete composite floor system with demountable shear connectors

Andrea Rajić
Ivan Lukačević
Ivan Ćurković
Vlaho Žuvelek





Finish

3

4

2

1

- laboratory tests
- validation of system
- analysis
- s

Laboratory tests of base materials and spot welds

1) Base material testing

Steel sheets

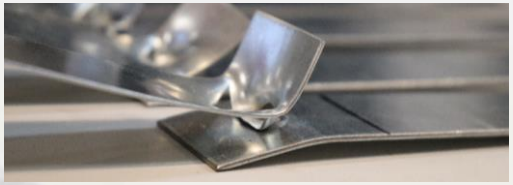
Thickness:

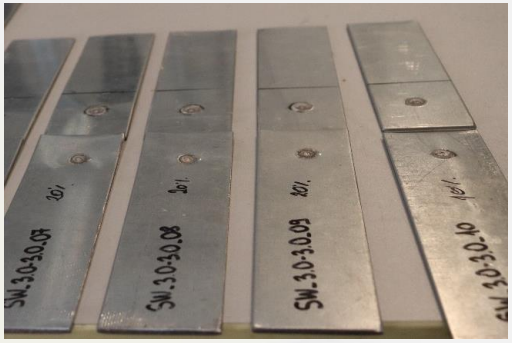
- 0.8 mm
- 1.0 mm
- 1.5 mm
- 2.0 mm
- 2.5 mm
- 3.0 mm

Bolts

Laboratory tests of base materials and spot welds

2) Spot weld testing

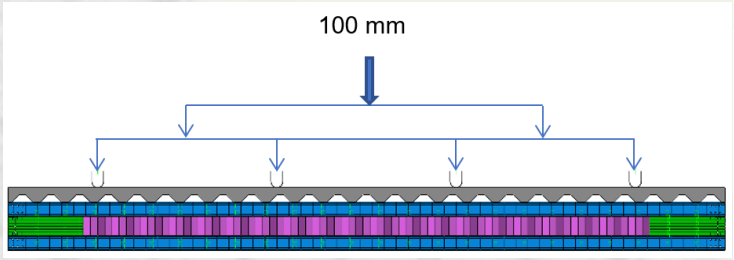


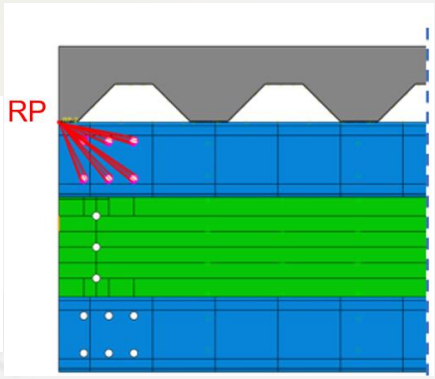


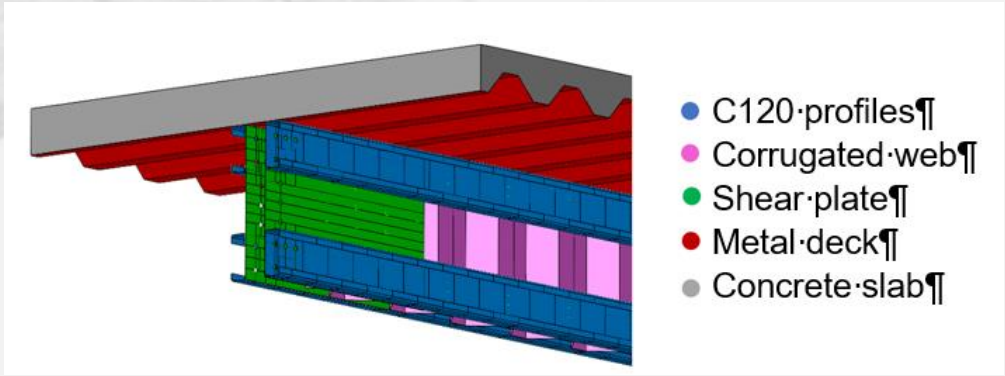
No	Name	The thickness of the first sheet [mm]	The thickness of the second sheet [mm]
1	SW 0.8-1.0	0.8	1.0
2	SW 0.8-2.5	0.8	2.5
3	SW 0.8-3.0	0.8	3.0
4	SW 1.0-1.5	1.0	1.5
5	SW 1.5-2.5	1.5	2.5
6	SW 1.5-3.0	1.5	3.0
7	SW 2.5-2.5	2.5	2.5
8	SW 2.5-3.0	2.5	3.0

Numerical models

- Explicit analysis – large number of nonlinearities
- C profiles:
  - Height: 120 mm
  - Thickness: 2.5/3.0 mm
- Corrugated web:
  - Height: 400 mm
  - Thickness: 0.8/1.5 mm
- Shear plate:
  - Height: 400 mm
  - Thickness: 1.0 mm
- Metal deck:
  - Eff. width: 1500 mm
  - Thickness: 1.0 mm
- Concrete slab:
  - Eff. width: 1500 mm
  - Height: 120 mm







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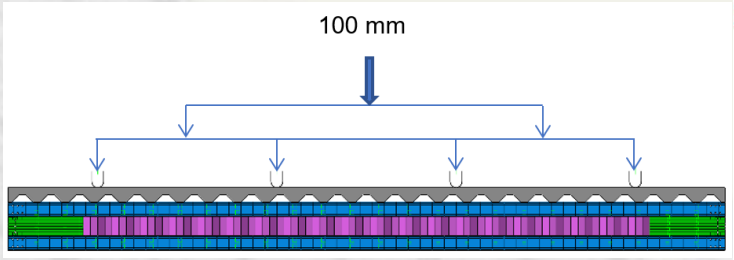

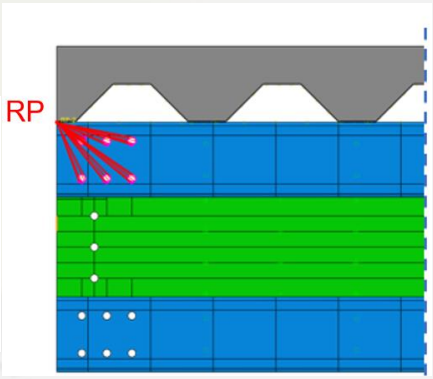

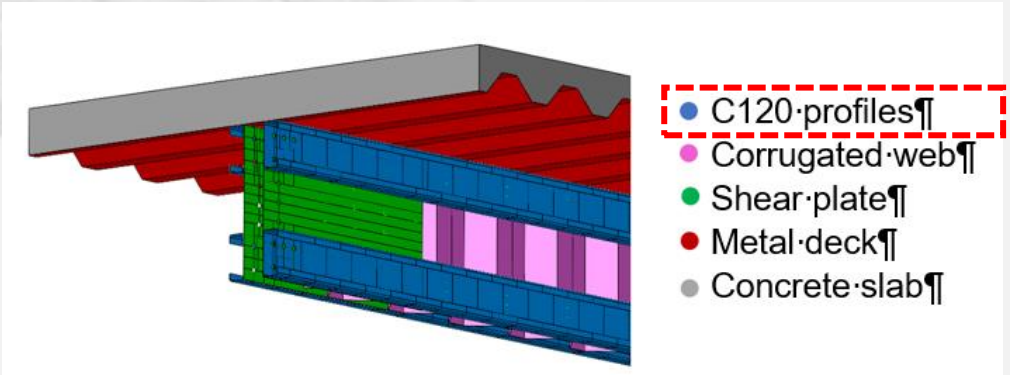

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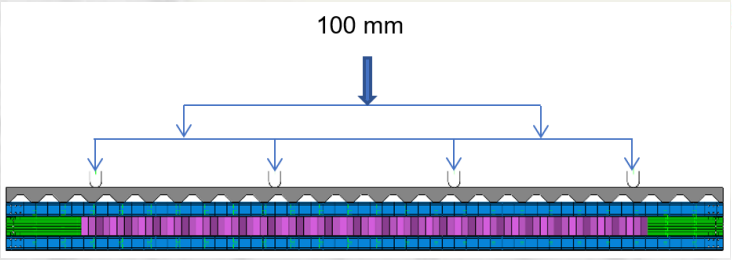

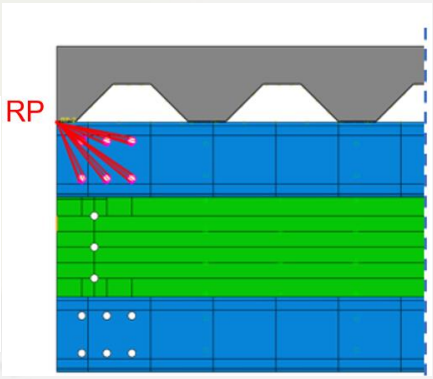

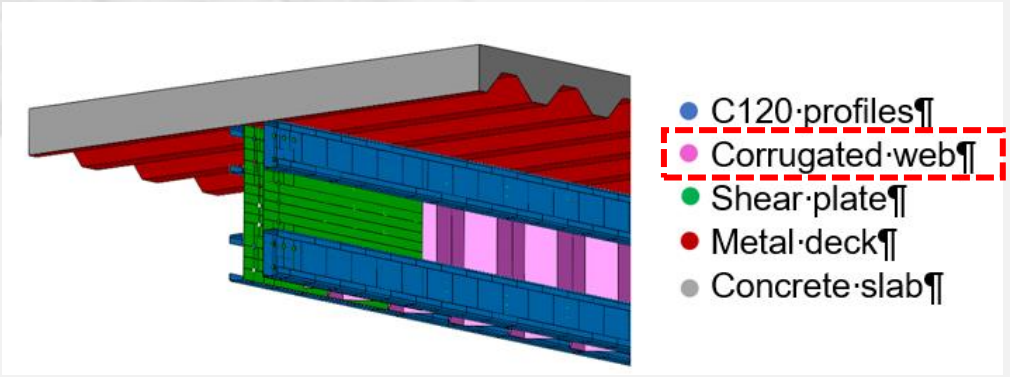

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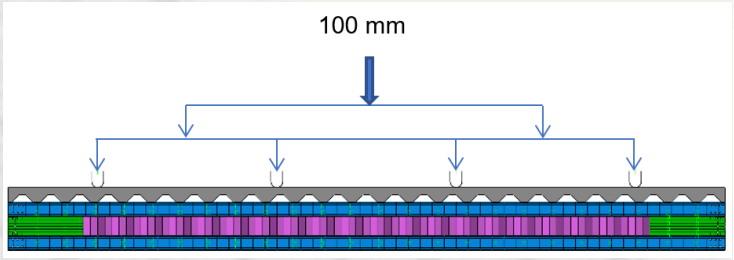

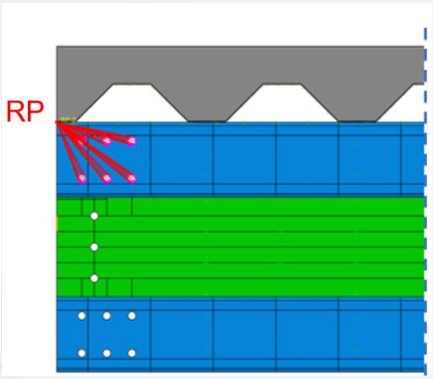

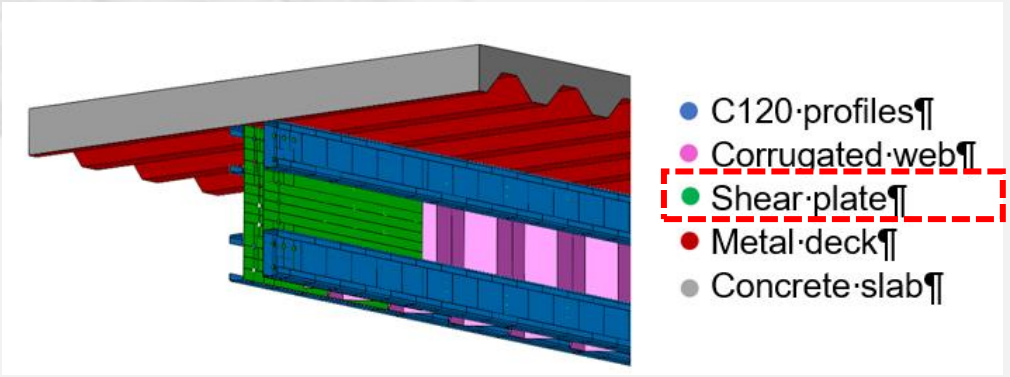

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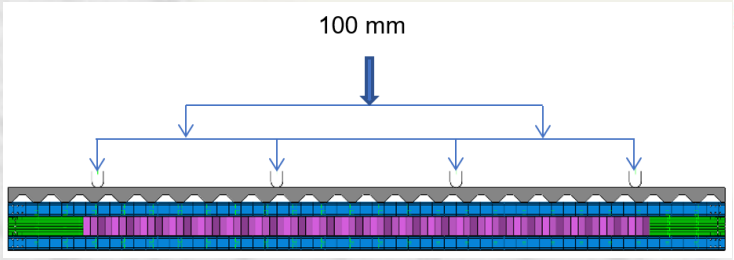

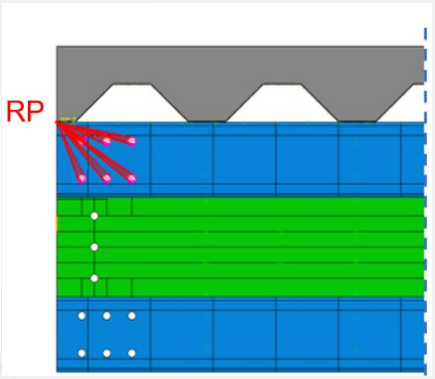

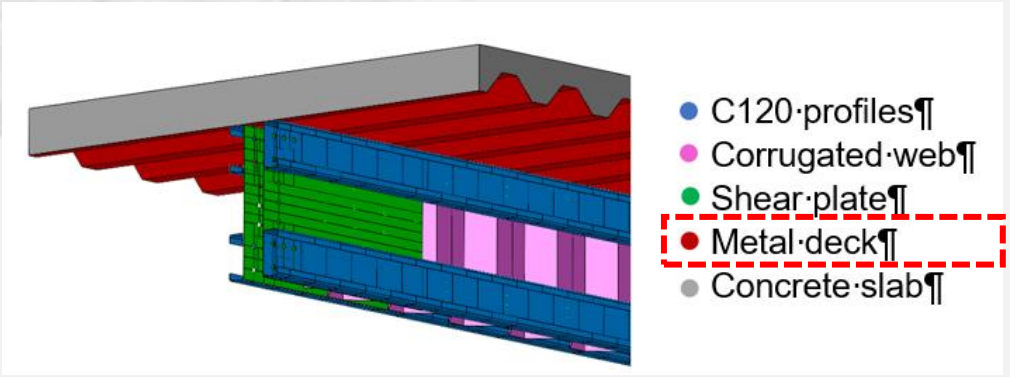

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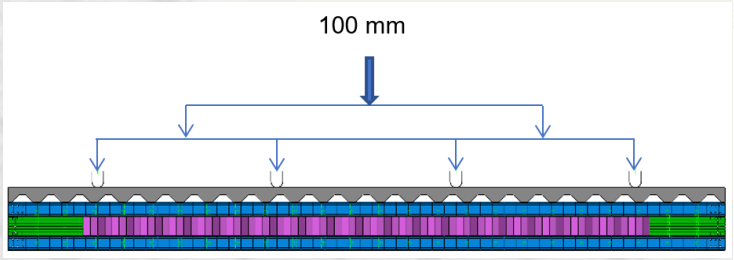
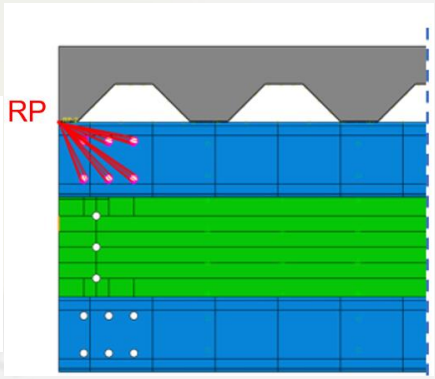
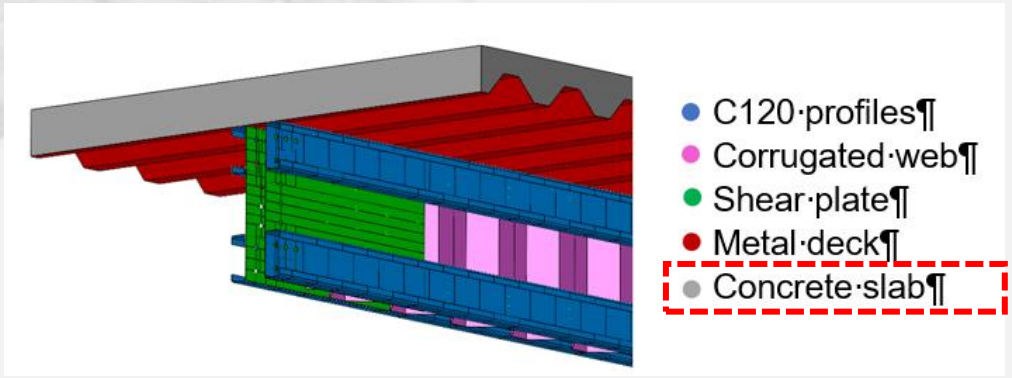


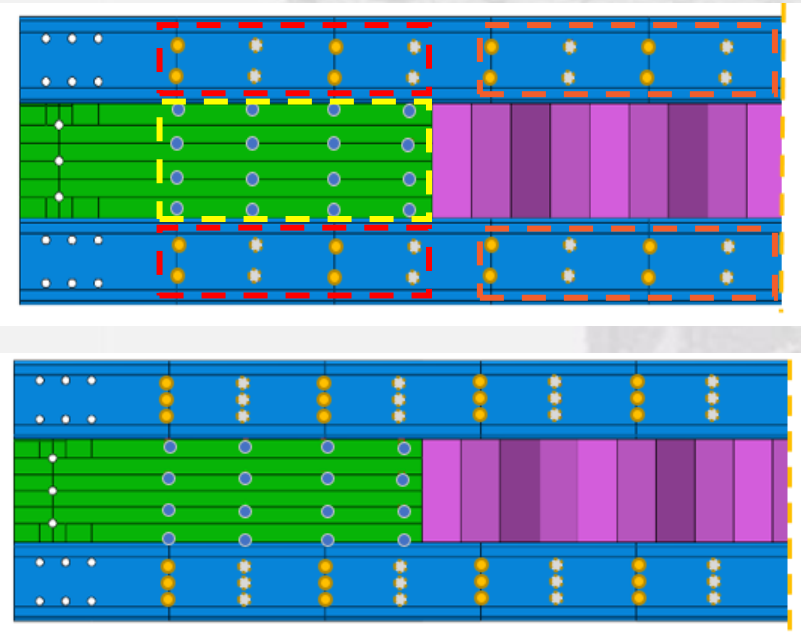


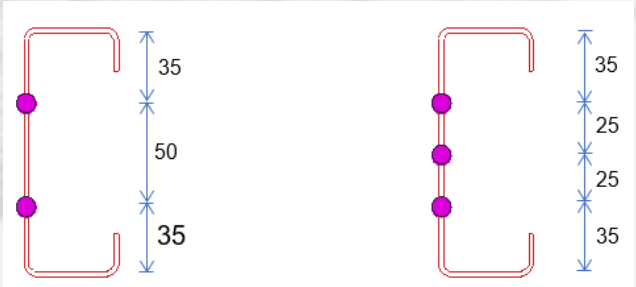


Numerical models

Connection between steel elements

Spot welds



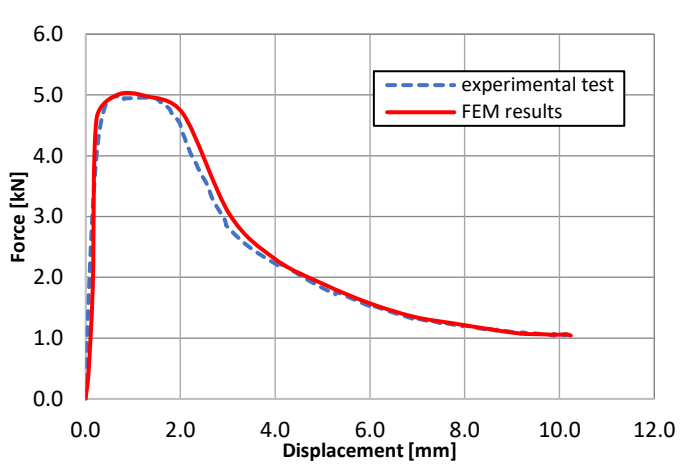


Tie connection

formed between contact areas in the models and it ties the nodes only where surfaces are close to each other

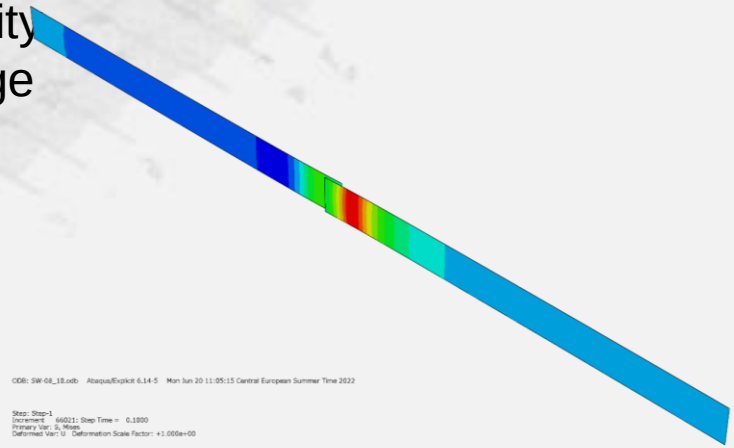
Numerical models

Connection between steel elements – spot welds



Spot weld testing for specimen SW 0.8-1.0

- Type of connector section: bushing
- Connector section behaviour:
  - Elasticity
  - Plasticity
  - Damage
  - Failure

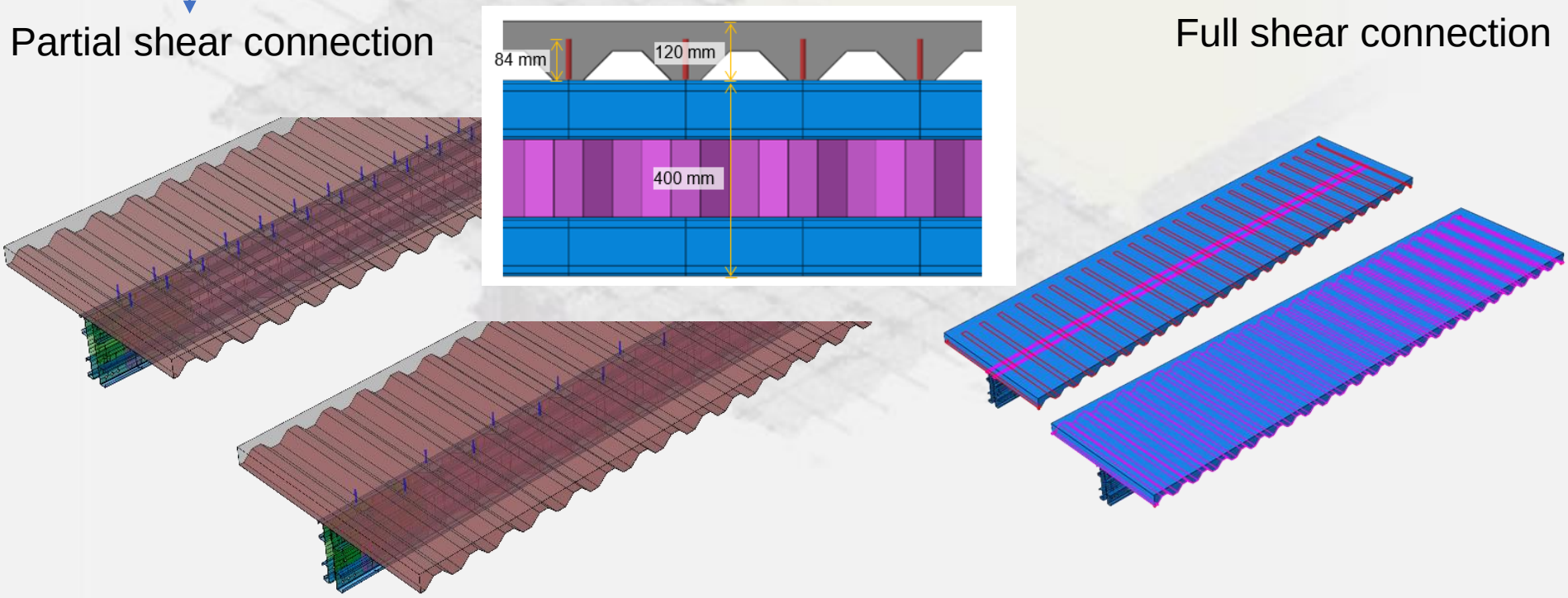


Numerical models

Shear connection

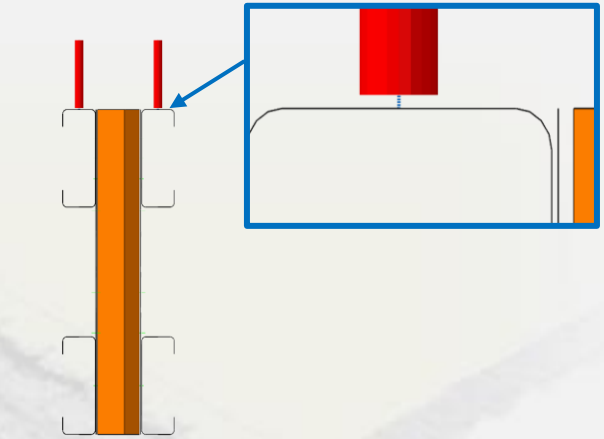
Partial shear connection

Full shear connection

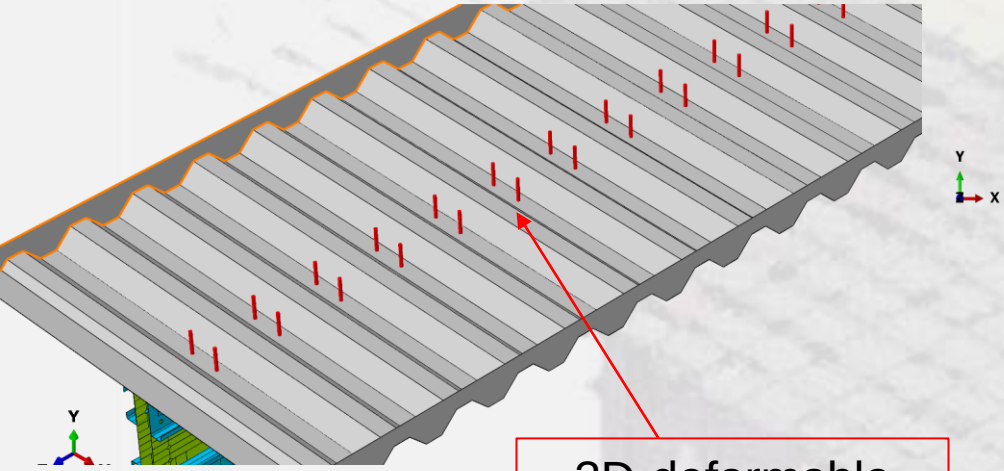


Numerical models

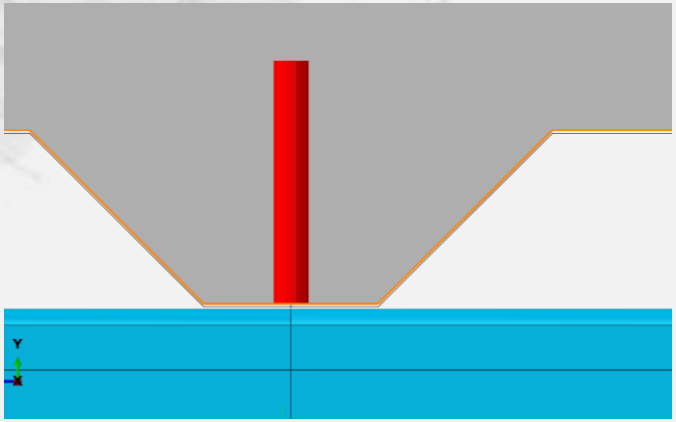
wire element- MPC beam connection type



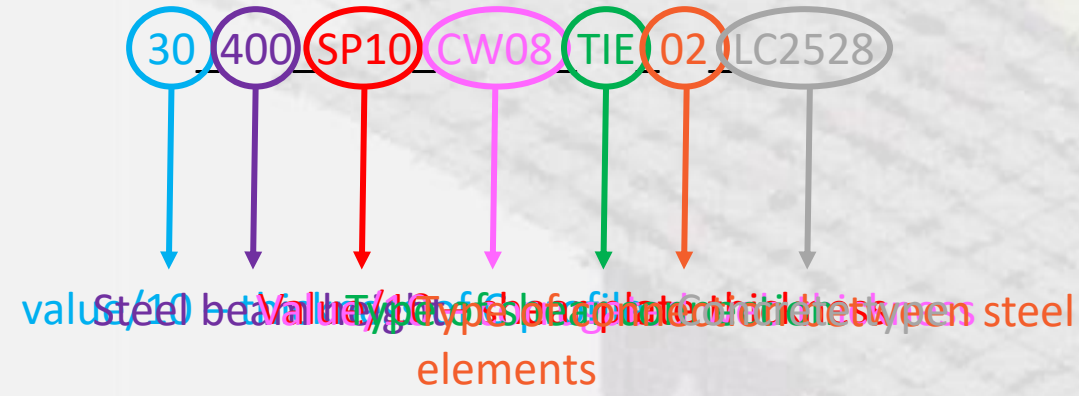
Shear connection - connectors



3D-deformable element – wire - beam



Nomenclature

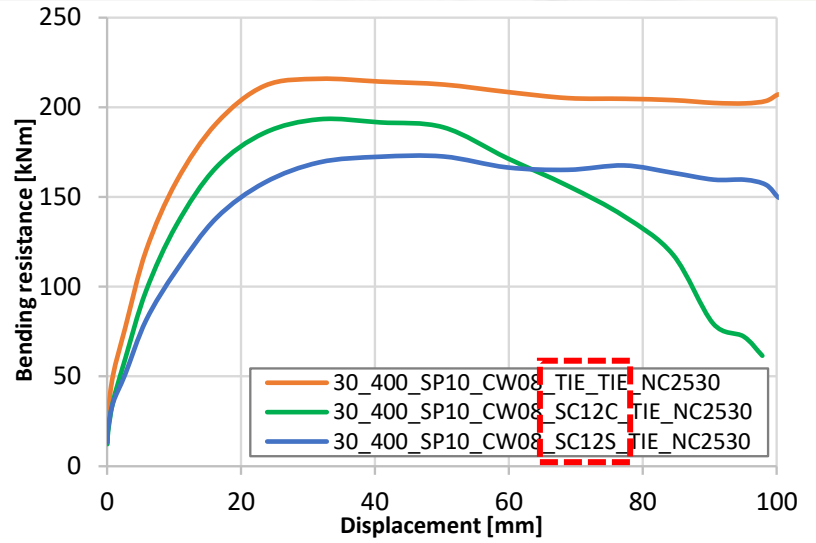


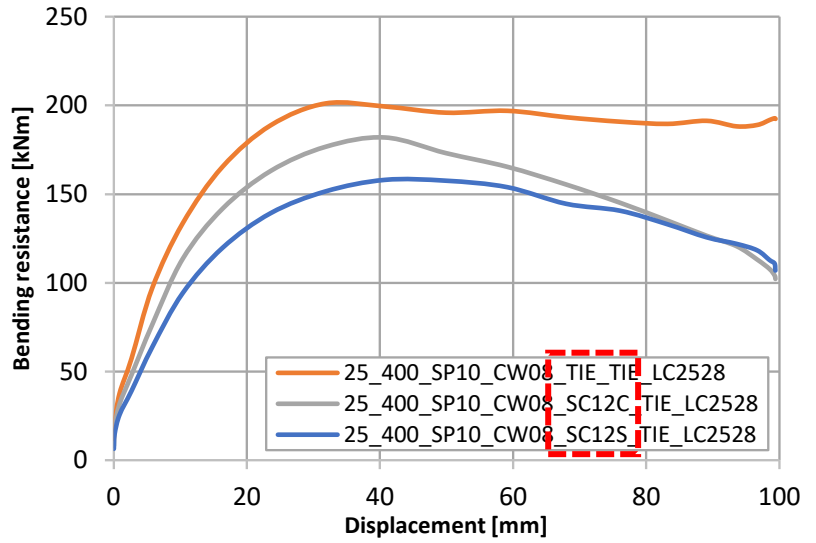
Analysed parameters

- Influence of degree of shear connection
- Influence of spot weld density
- Influence of the concrete type
- Influence of steel cross-section thickness
- Influence of the diameter of the shear connector

Results

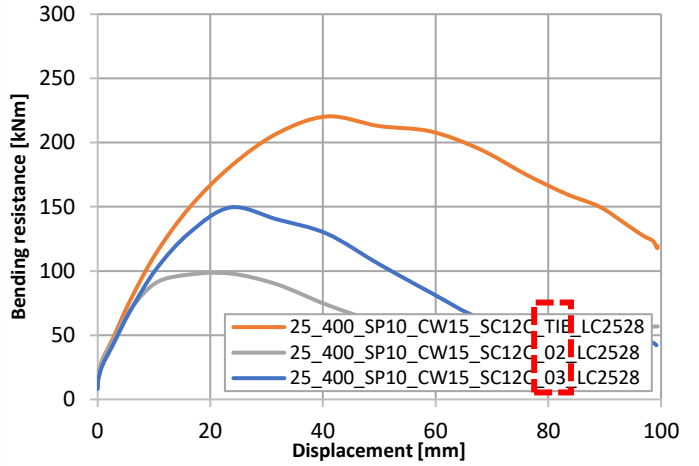
Influence of the degree of shear connection

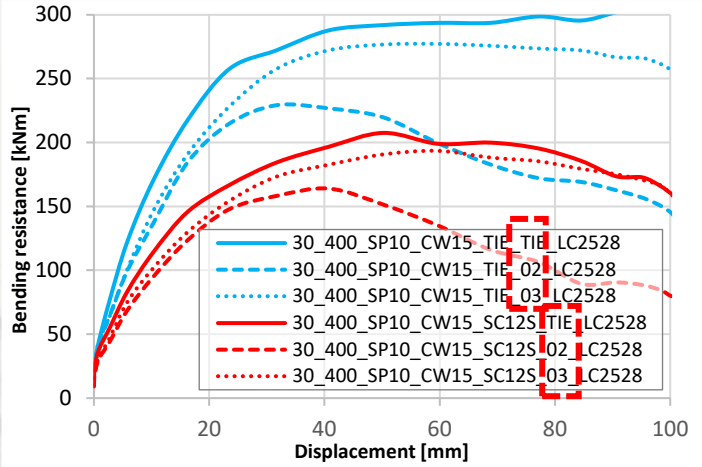


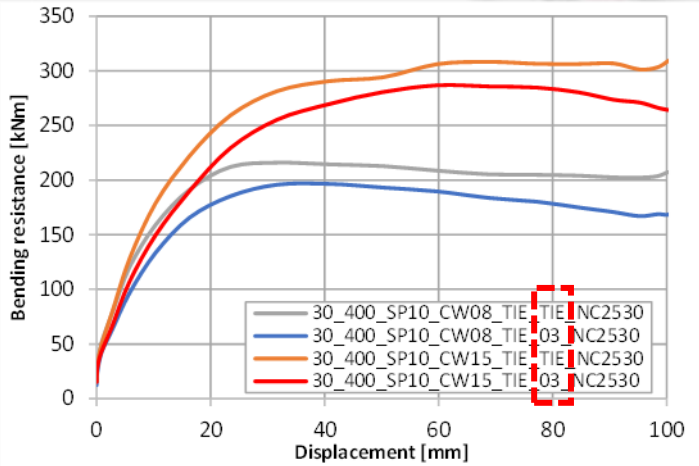


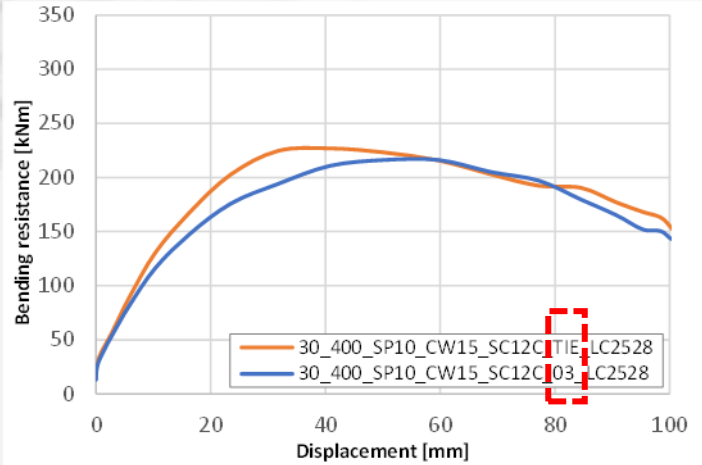
Results

Influence of spot weld density



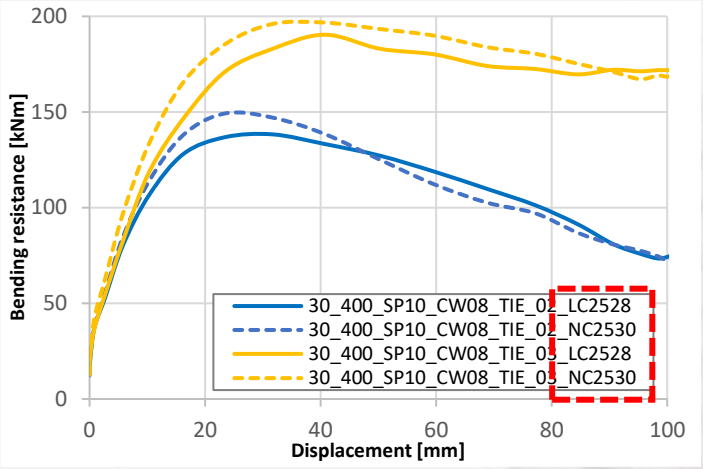


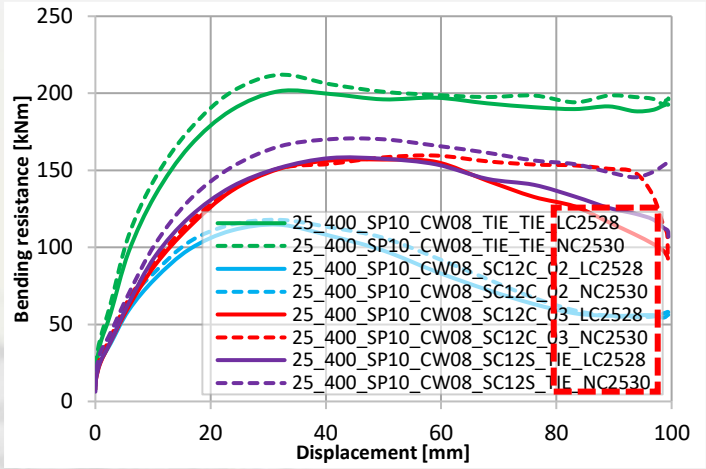


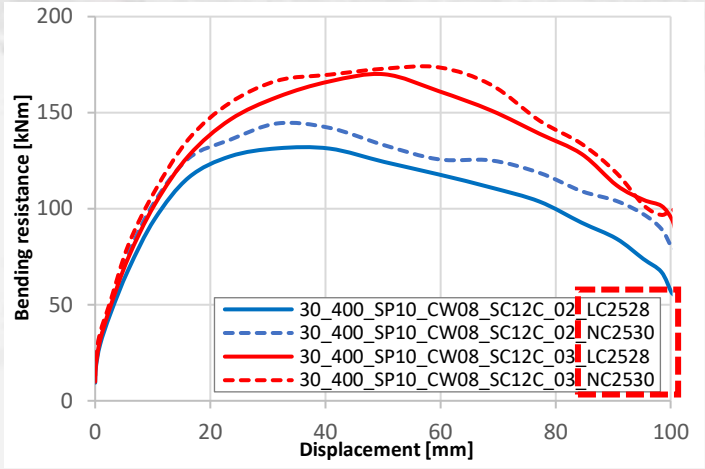


Results

Influence of the concrete type

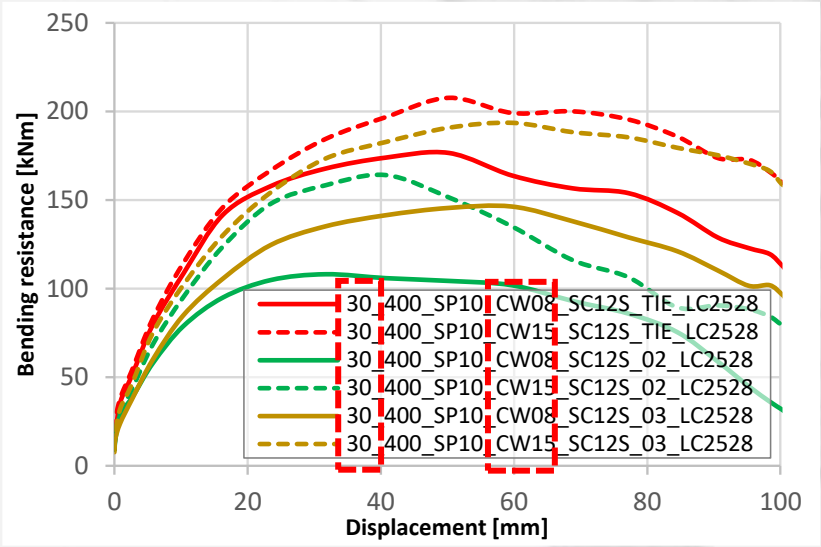


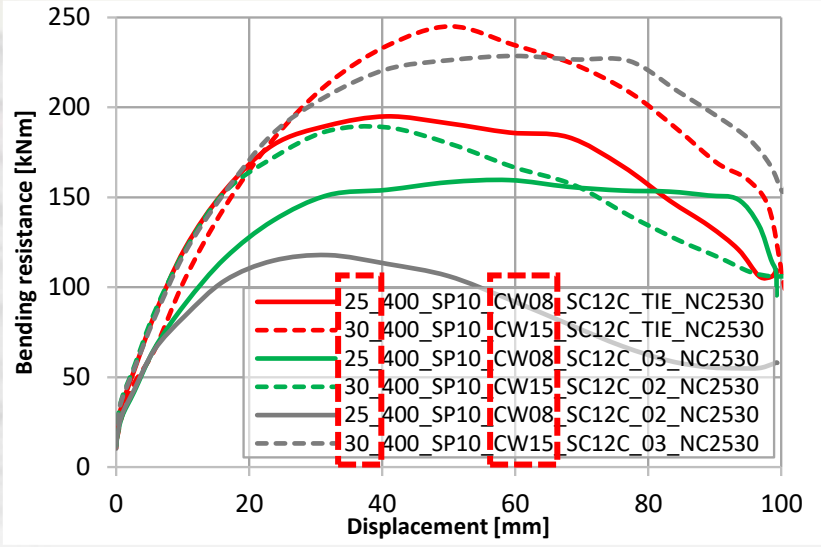




Results

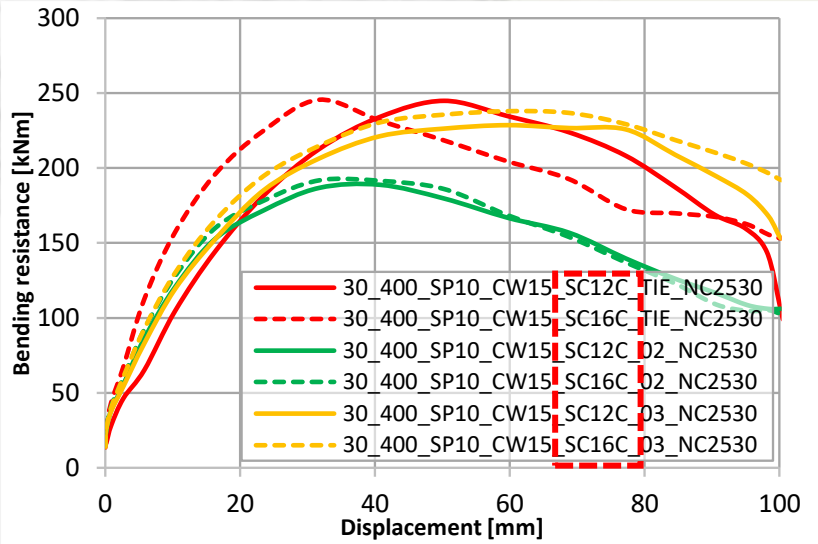
Influence of steel cross-section thickness





Results

Influence of the diameter of the shear connector

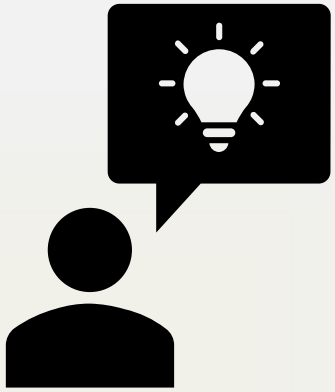


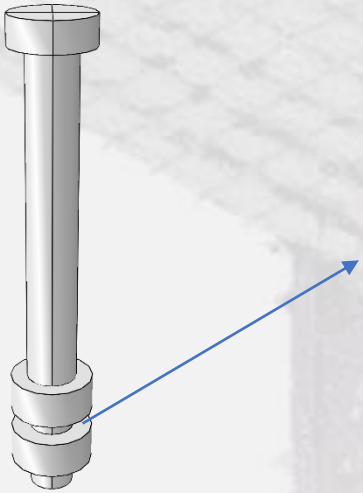
Conclusions

- The influence of the degree of shear connection has the greatest influence between analysed parameters on the bending resistance.
- Spot weld density was analysed for two different arrangements and in the case when the elements are connected by the whole surface. It is concluded that spot weld density has a great influence on the bending resistance of the analysed system.
- The influence of concrete type is negligible when comparing the models with the same spot weld density and full shear connection. The same influence becomes greater for models with the partial shear connection.
- The thickness of both analysed elements, i.e. corrugated web and C profiles, highly influences the bending resistance of the analysed system
- The diameter of the shear connector has a negligible influence on the bending resistance of the analysed system due to the failure mode, of concrete, which is concrete crushing

Further research

- Geometry
- Web openings
- Bolts!





partition →

PROBLEM = MESH SIZE
(bolts diameter 12 mm vs
beam length 6000 mm)

Questions/Comments?