Numerical parametric study on corrugated web built-up beams with pinned end supports

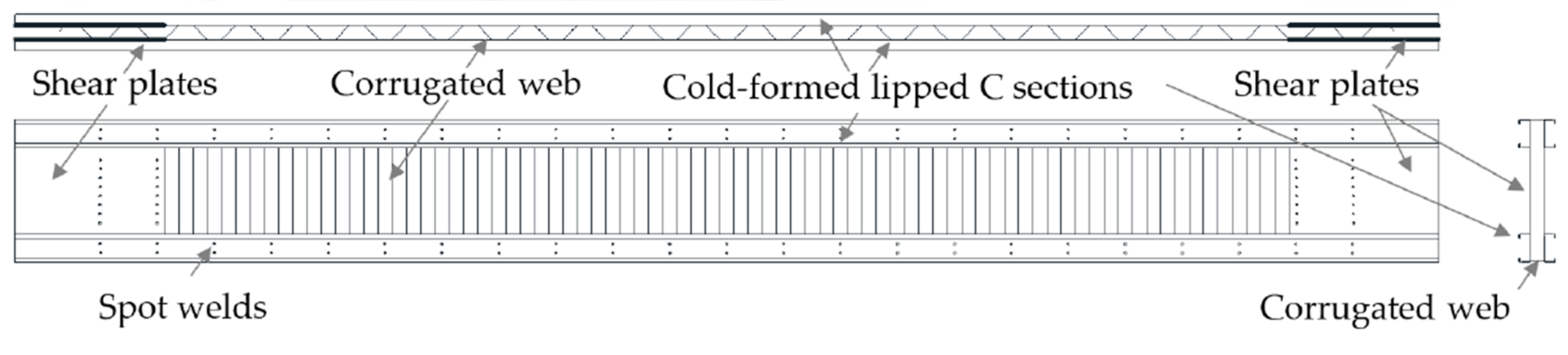
Ivan Lukačević, Viorel Ungureanu

LWT–FLOOR
RESEARCH PROJECT

HRZZ
Croatian Science Foundation

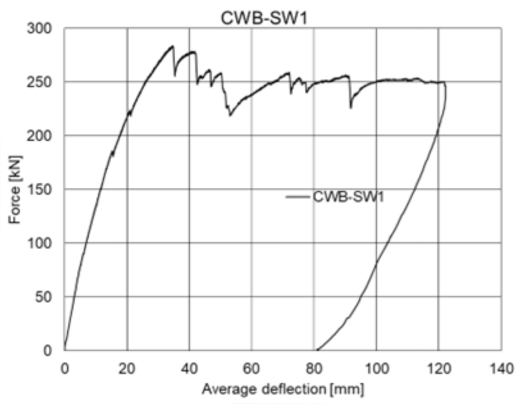
Introduction

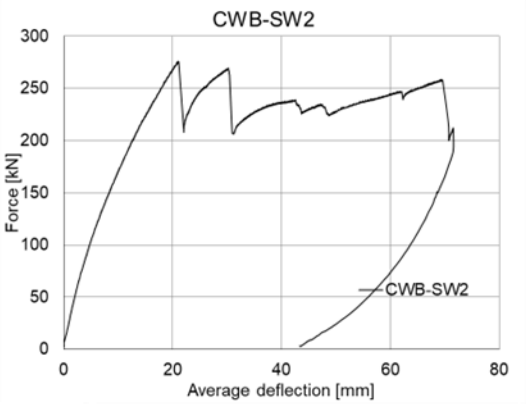
- Built-up cold-formed steel elements are efficient structural elements, very attractive due to material savings, but also for ease of construction.



Introduction

- The experimental work included…





Calibration of the numerical model

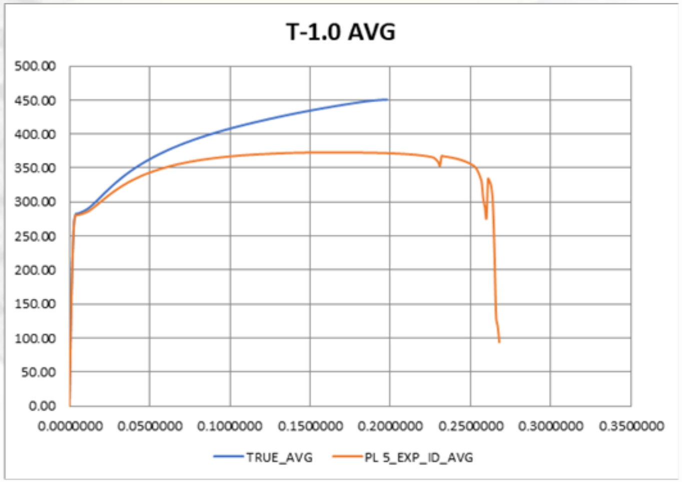
- Numerical considerations

Geometric and material non-linear analyses including the effects of initial imperfections (GMNIA)

MATERIAL: converted from tensile tests on base material

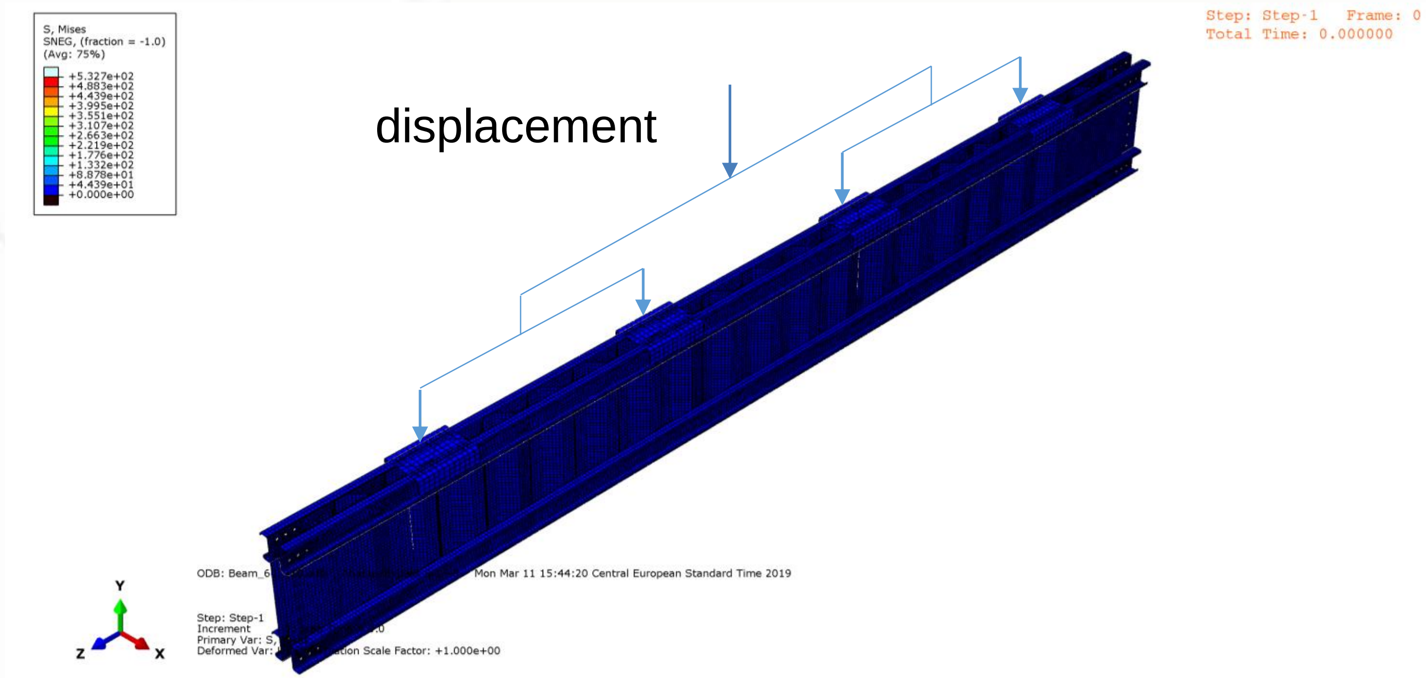
$$\sigma_{true} = \sigma_{engineering}(1+\varepsilon_{engineering})$$

$$\varepsilon_{true} = \ln(1+\varepsilon_{engineering}) \quad \varepsilon_{\ln}^{plastic} = \varepsilon_{true} - \frac{\sigma_{true}}{E}$$



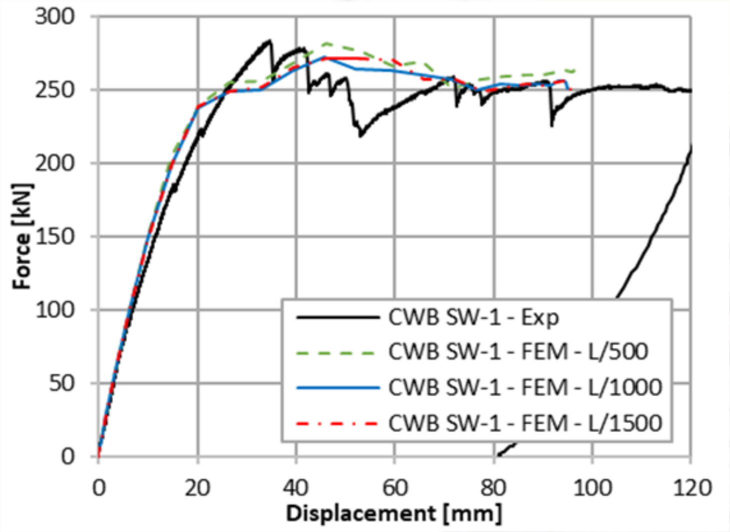
3D shell elements – S4R
Global mesh size of 15mm

Calibration of the numerical model

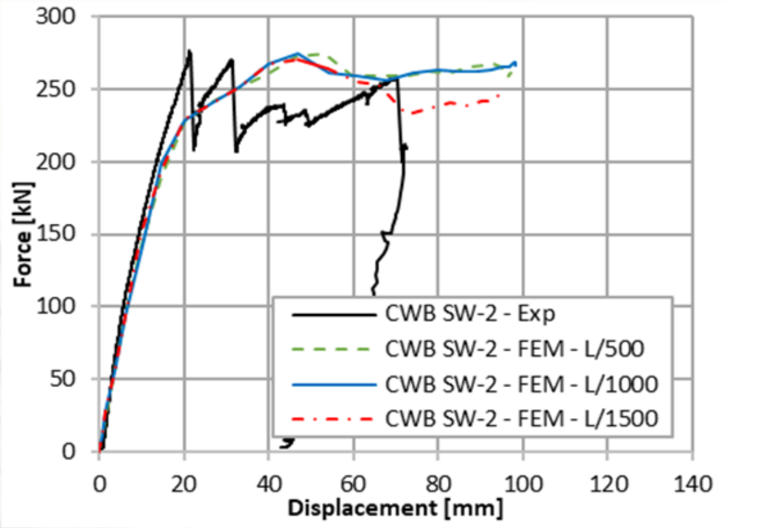


Calibration of the numerical model

- Effect of initial imperfections L/500, L/1000, L/1500



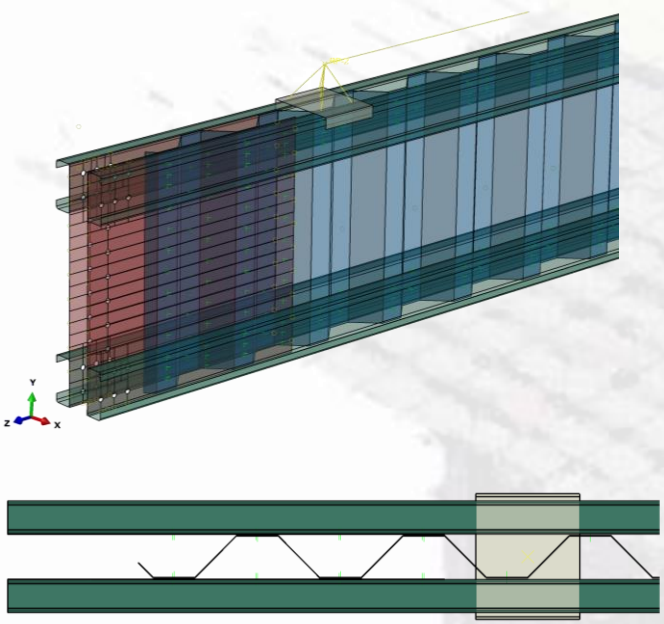
Experimental vs. FEM load-displacement curves for CWB SW-1 beam



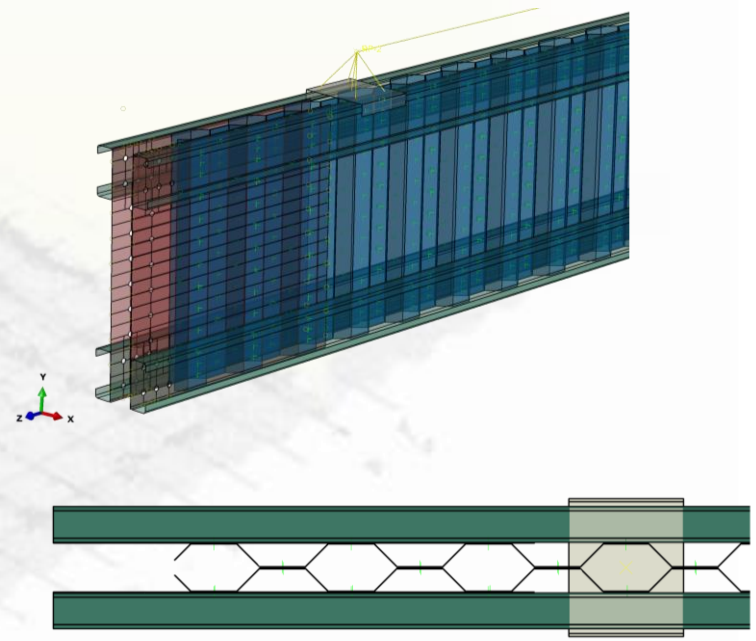
Experimental vs. FEM load-displacement curves for CWB SW-2 beam

Preparation of the numerical model

- Parts of the CWB FE models by components: green (flanges), red (shear panels), blue (web)



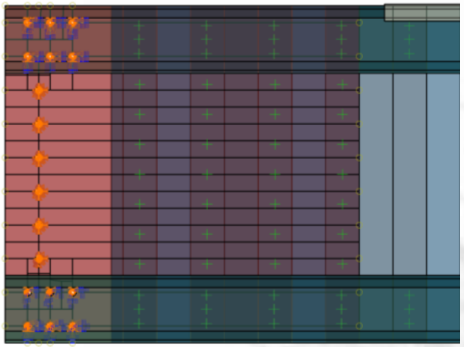
calibrated FE model of CWB



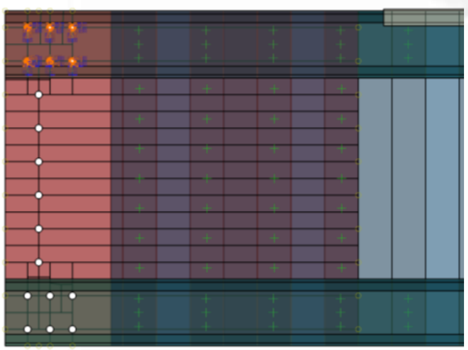
FE model of double CWB

Parametric numerical study

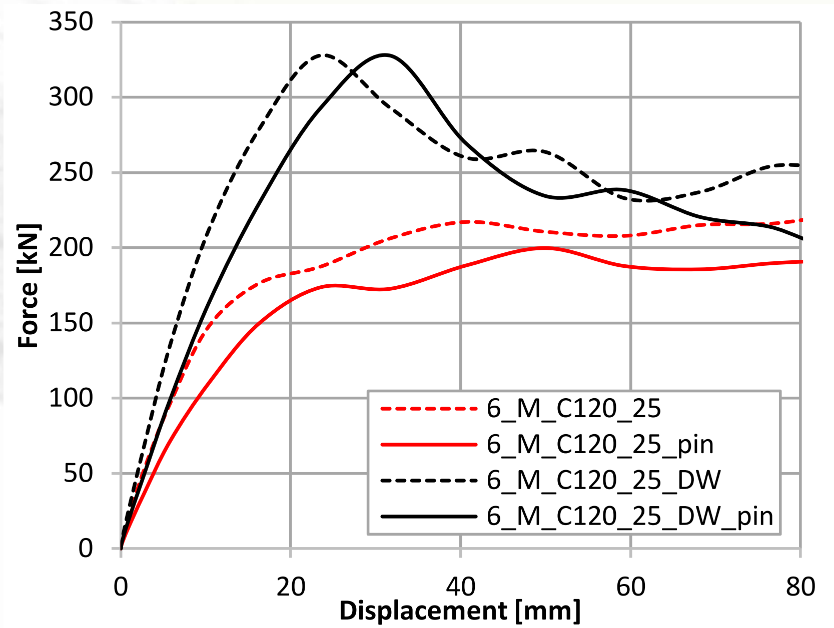
- Influence of different end supports condition

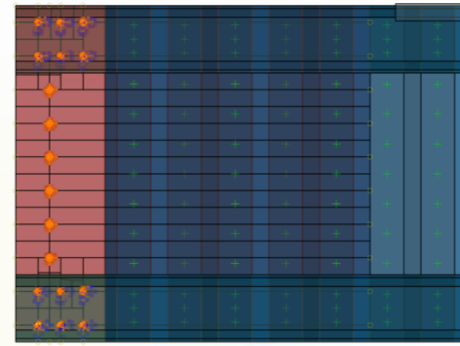


CWB fixed end supports

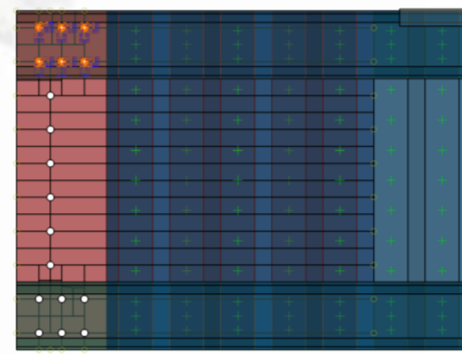


CWB nominally pinned supports





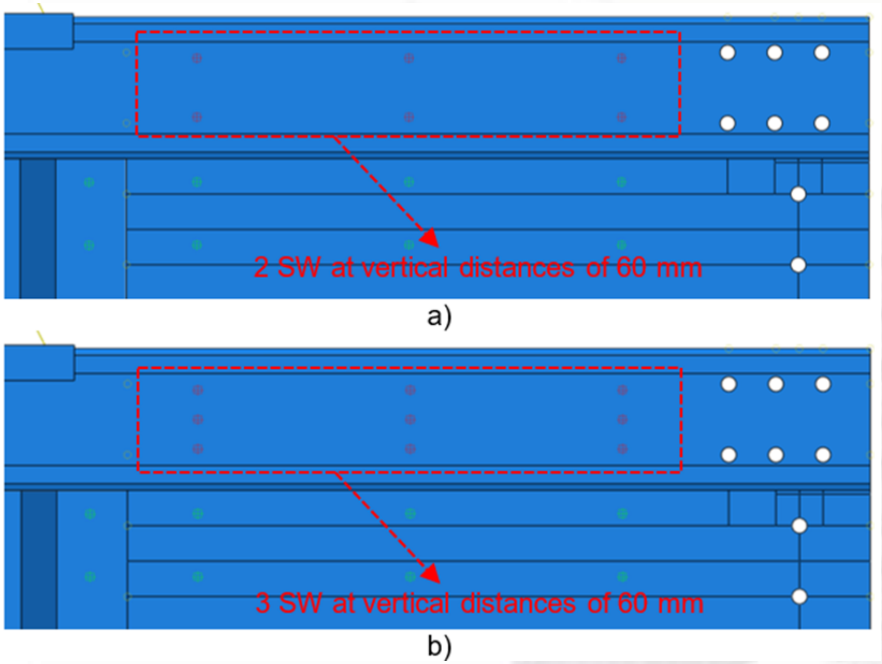
double CWB fixed end supports

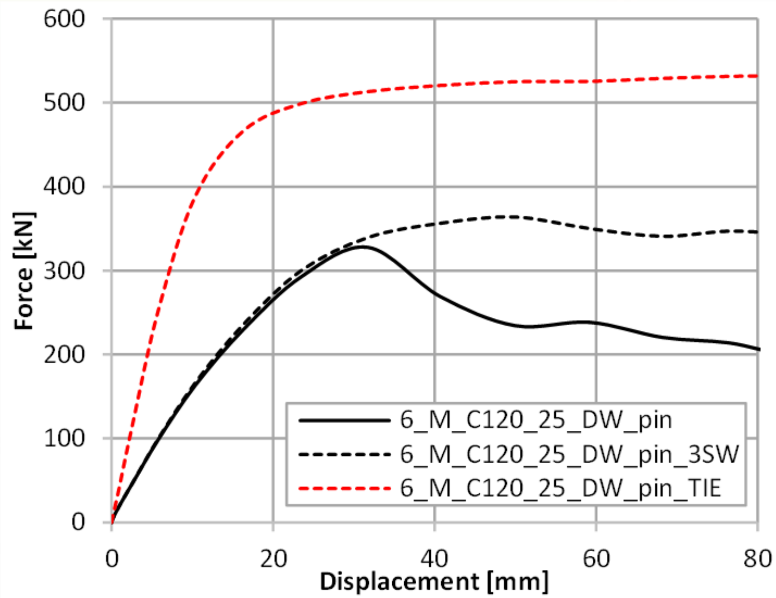


double CWB nominally pinned supports

Parametric numerical study

- Influence of the number of spot welds on flanges



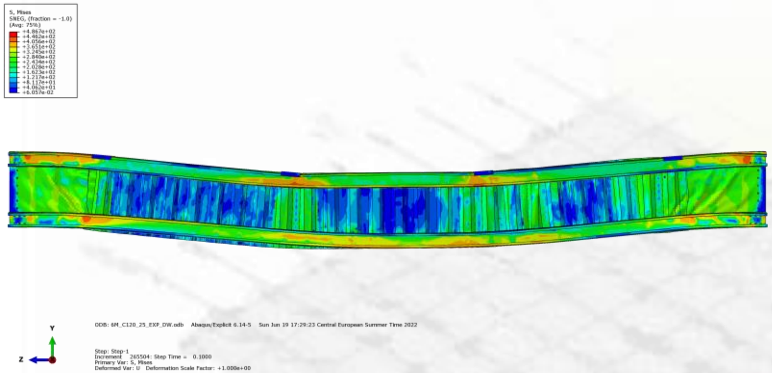


Number of SW: a) 2SW, b) 3SW

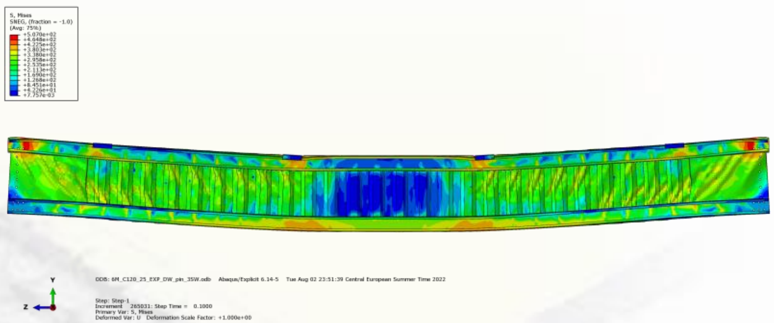
Influence of the number and distance between spot welds on flanges

Parametric numerical study

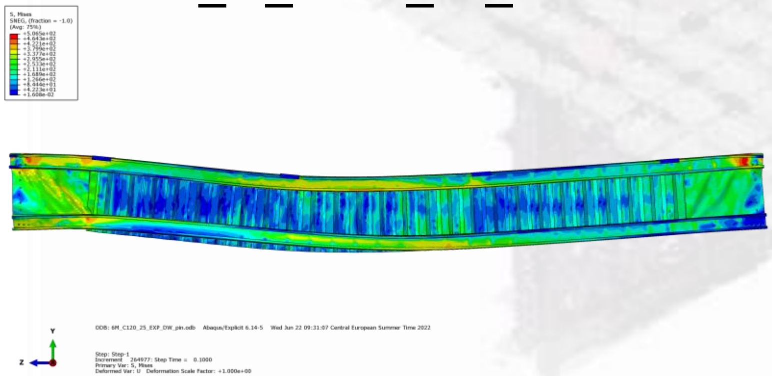
- Influence of the number of spot welds on flanges



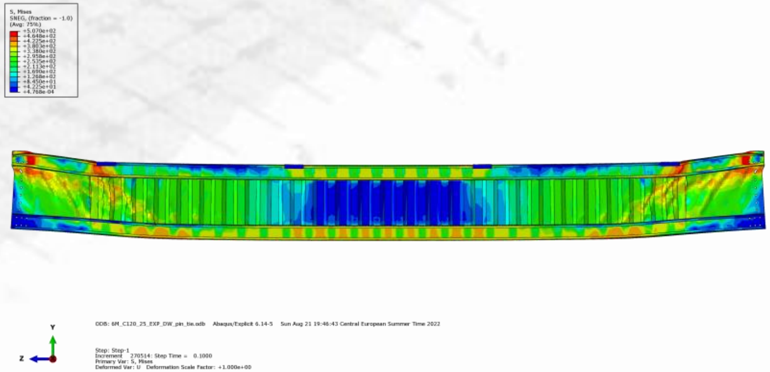
6_M_C120_25_DW



6_M_C120_25_DW_pin_3SW



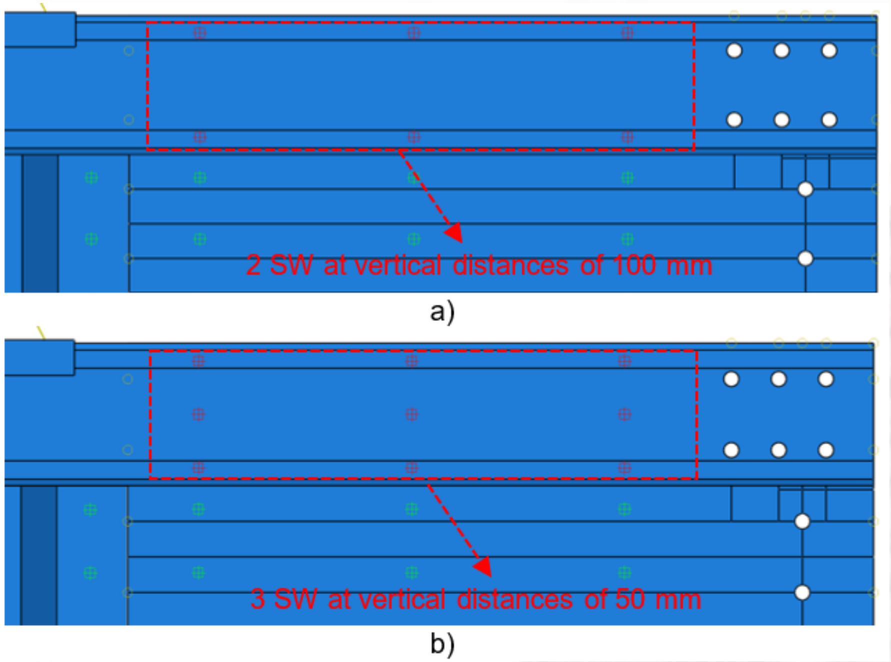
6_M_C120_25_DW_pin



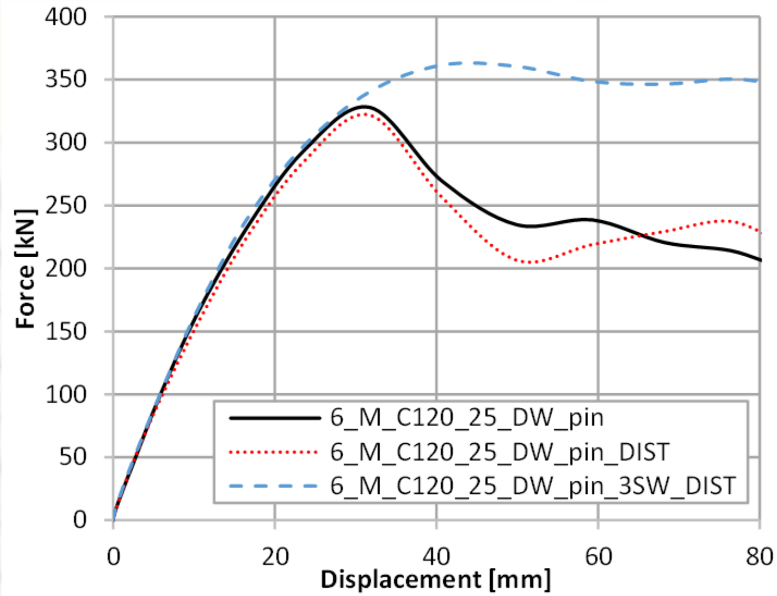
6_M_C120_25_DW_pin_TIE

Parametric numerical study

- Influence of the distance between spot welds on flanges



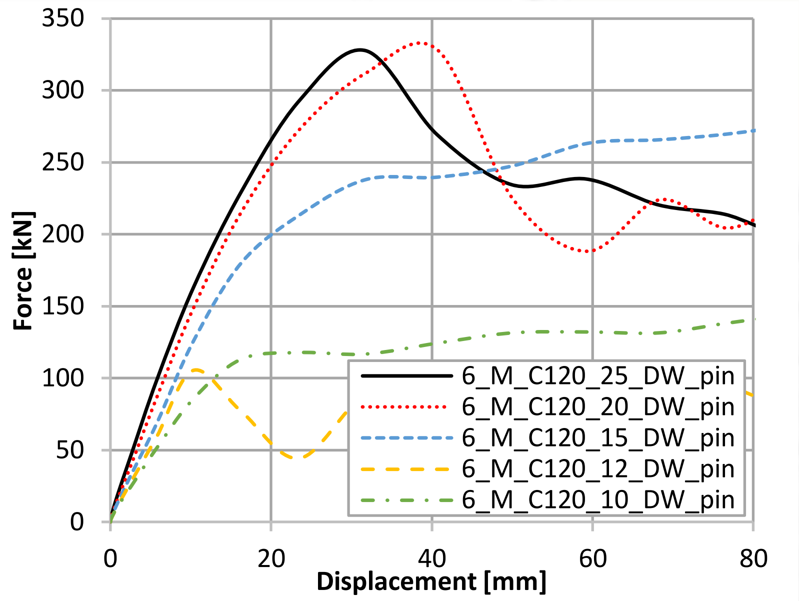
Increased vertical distance between SW: a) 2SW, b) 3SW

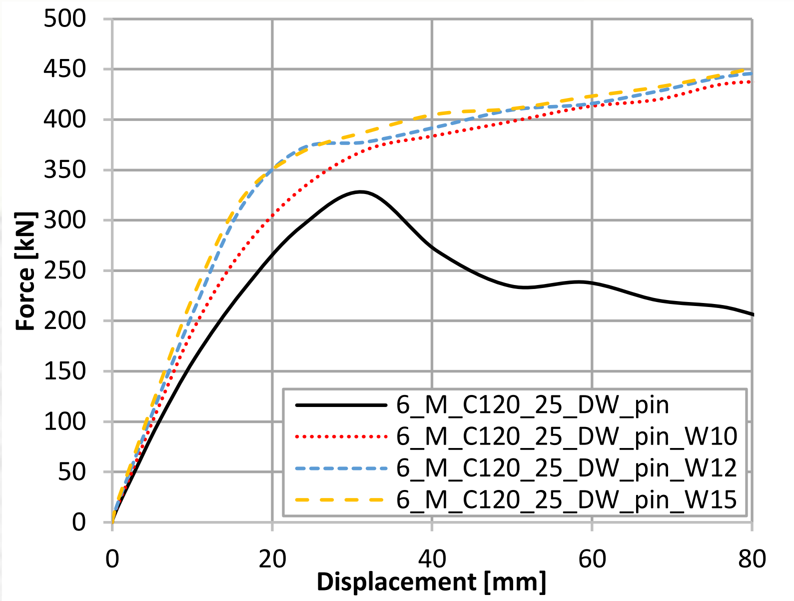


Influence of the distance between spot welds on flanges

Parametric numerical study

- Influence of the flange and corrugated web thicknesses



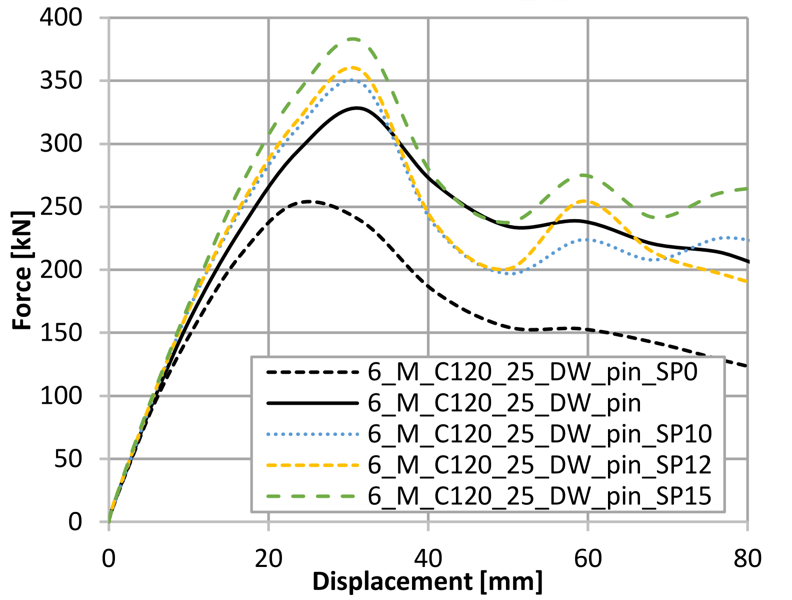


Influence of the flange's thickness

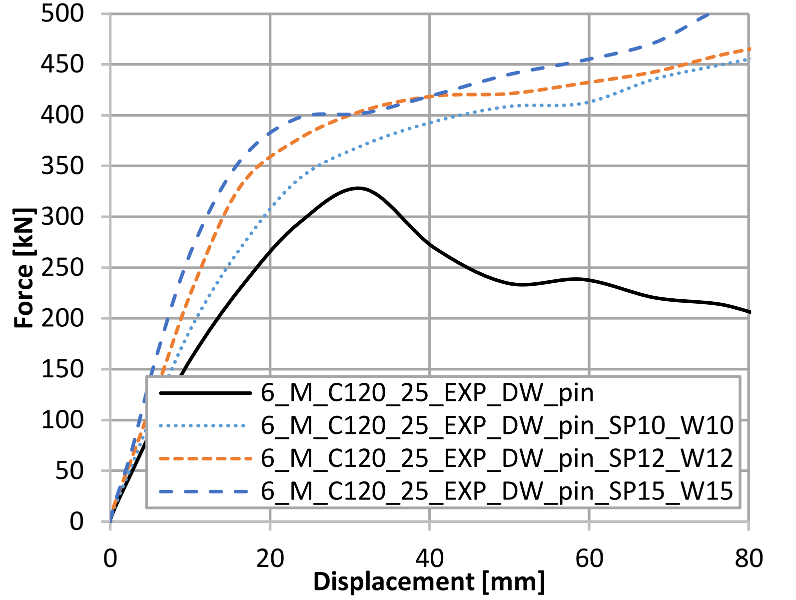
Influence of corrugated web thickness

Parametric numerical study

- Influence of increased shear panel and corrugated web thicknesses



Influence of the shear panel thickness



Influence of increased web and shear panel thicknesses

Conclusions

- The parametric study shows that changing end support conditions can significantly reduce the complexity of CWB beam support and, consequently, its cost without a significant decrease in beam performance related to its rigidity and bending capacity.
- A new solution of CWB with the double corrugated web significantly contributes to the rigidity and capacity of CWB.
- Changing the type of connection between beam elements from discrete SW to continuous TIE connection results in the beam's highest capacity and rigidity. On the other hand, changing the number of SW from 2 to 3 can have a certain influence on increasing the ultimate bending capacity while the initial flexural stiffness remains almost the same.
- It is observed that an increased number of SW can change the beam failure mode.

Conclusions

- The distance between the SWs on the flanges shows minimal influence on beam behaviour.
- Decreasing the C profile thicknesses can result in very low beam capacity, especially for thicknesses below 1.5 mm.
- A higher thickness of the corrugated web increases the flexural stiffness and bending capacity of the beam by changing the beam failure mode.
- The thickness of the shear panel is not negligible, but its influence is less than that of the thickness of the web.
- Combining the increased thicknesses of the web and the shear panel can significantly increase the flexural stiffness and bending capacity of the beam.

Numerical parametric study on corrugated web built-up beams with pinned end supports

Ivan Lukačević, Viorel Ungureanu

LWT–FLOOR
RESEARCH PROJECT

HRZZ
Croatian Science Foundation