The 12th International conference
"Structural Integrity of Welded Structures

Universitatea Politehnica Timişoara
Piaţa Victoriei nr. 2
RO 300006 - Timişoara
Tel: +40 256 403000
Fax: +40 256 403021
rector@rectorat.upt.ro
www.upt.ro

Experimental Investigations on Spot Welded Built-Up Cold-Formed Steel Beams

UNGUREANU Viorel, BOTH Ioan, BURCA Mircea, BENZAR Ştefan, NGUYEN Thai Hoang, NEAGU Calin, DUBINA Dan

Universitatea Politehnica Timisoara

CEMSIG
Centrul de cercetari pentru mecanica materialelor si siguranta structurilor

Timisoara
2017

Context

- **Built-up light-weight structural elements with material and workmanship savings.**

Objective

- **To present new research developments on cold-formed steel beams of corrugated web (CWB)**

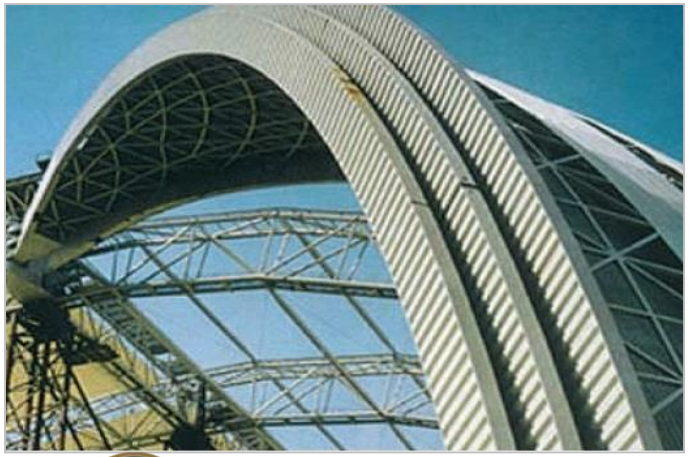
CORRUGATED WEB BEAMS – classical solution

- **Thick flanges – Thin web**
- **Automatic welding**

Zeman & Co
(http://www.zeman-stahl.com/)

CORRUGATED WEB BEAMS – classical solution

Not limited to classical single story industrial buildings



Exemplification by Zeman & Co (http://www.zeman-stahl.com/)

CORRUGATED WEB BEAMS – classical solution

The main benefits:

•the corrugated webs increase the beam's stability against buckling (buckling resistance of commonly used sinusoidal corrugated sheeting is comparable with 12 mm flat webs);

•the use of thinner webs results in lower material cost (an estimated cost savings of 10-30% in comparison with conventional fabricated sections and more than 30% compared with standard hot-rolled beams);

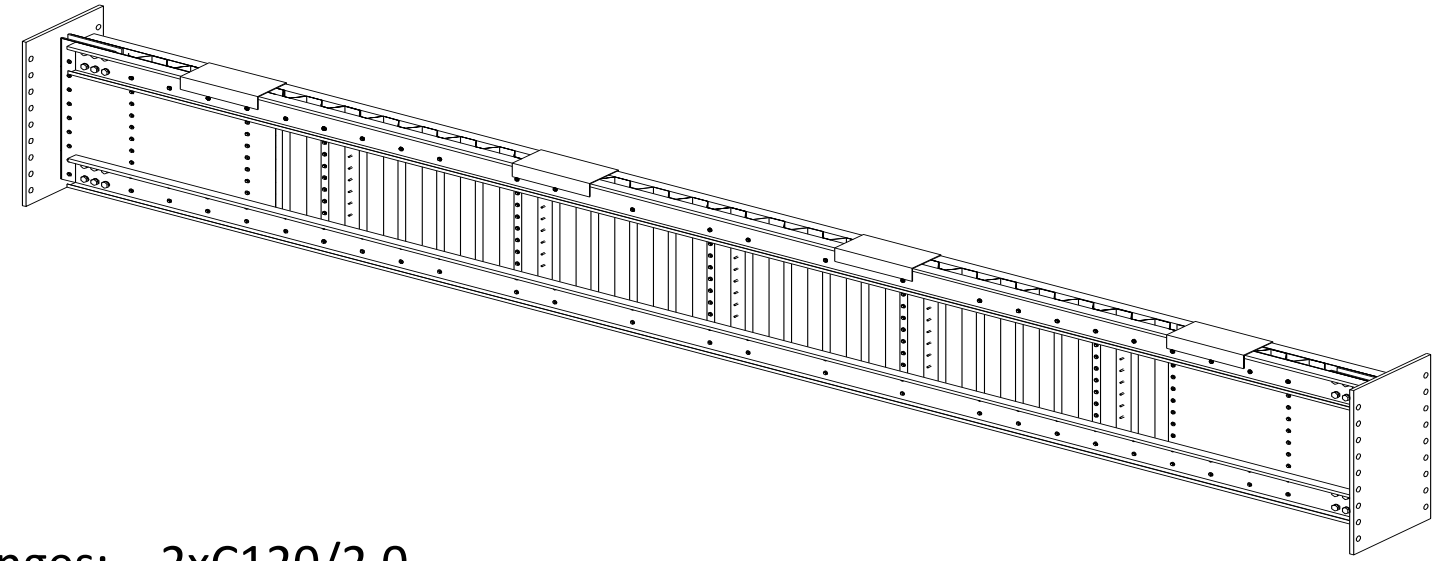
ALTERNATIVE SOUTION

- Corrugated web beams with entirely made of cold-formed parts

- is 100% composed of cold-formed steel elements, avoiding the combination of two types of products;
- high protection to corrosion due to the fact that all components are galvanized;
- to develop a structural system able for easy and/or automated prefabrication, reduced erection time, mass production and possibility of high-precision quality control.

EXPERIMENTAL PROGRAM

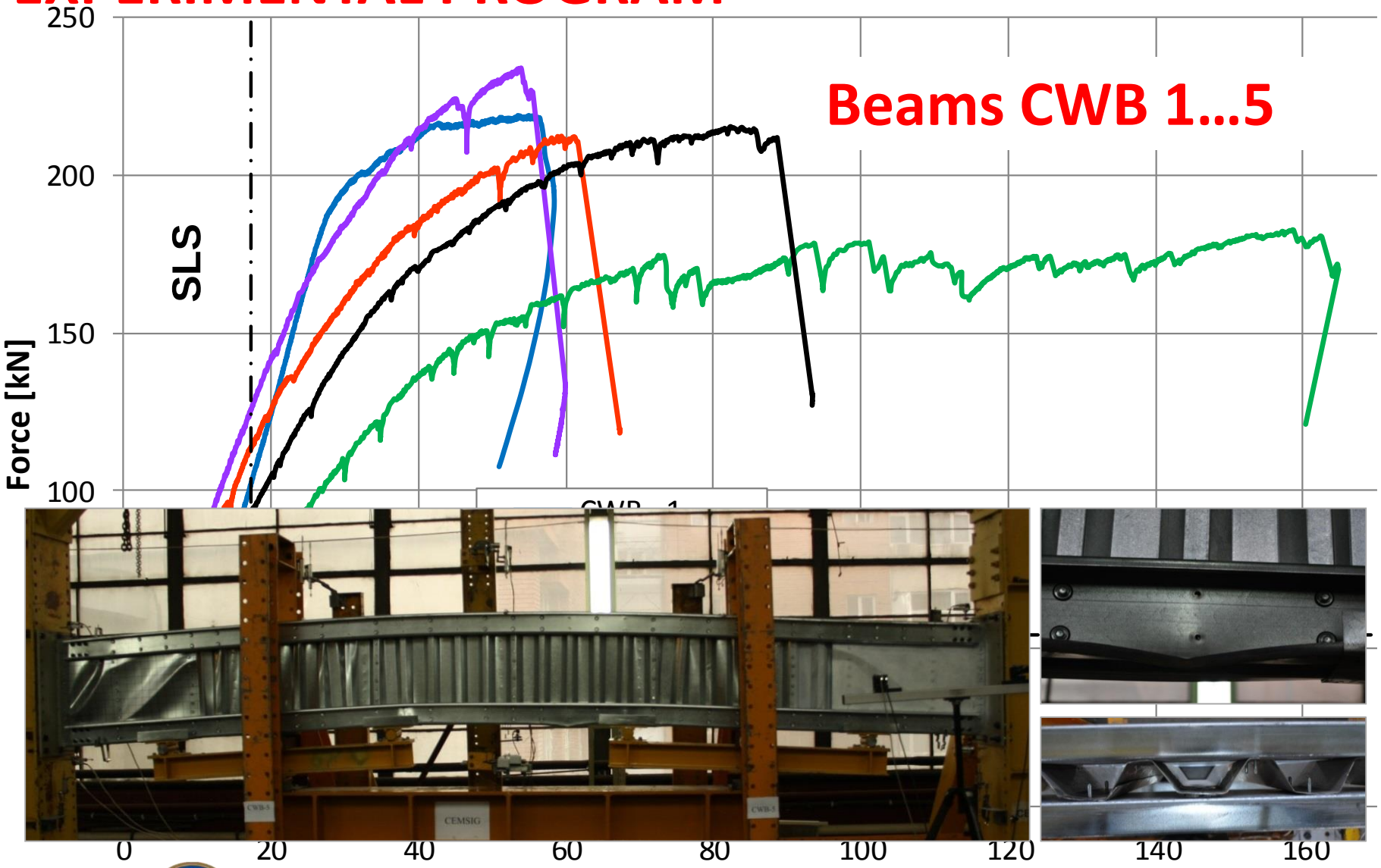
CEMSIG Research Centre of PU Timisoara



- flanges: – 2xC120/2.0
- corrugated web: -A45/0.7
- supplementary shear panels of 1mm thickness
- self-drilling screws for flange-to-web connections – 6.3x25
- self-drilling screws as seam fasteners – 4.8 x20
- M12 class 8.8 bolts for end connections of back-to-back lipped channels to the supports

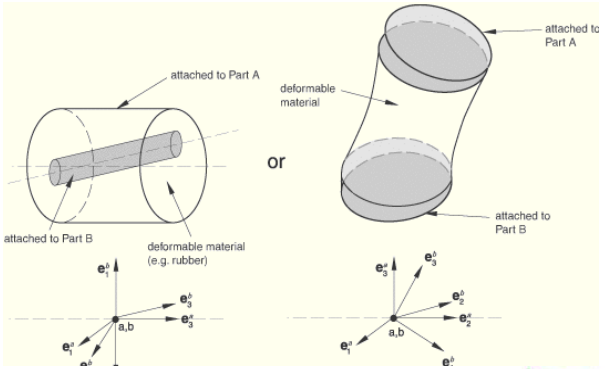
Actual solution : SCREWED !

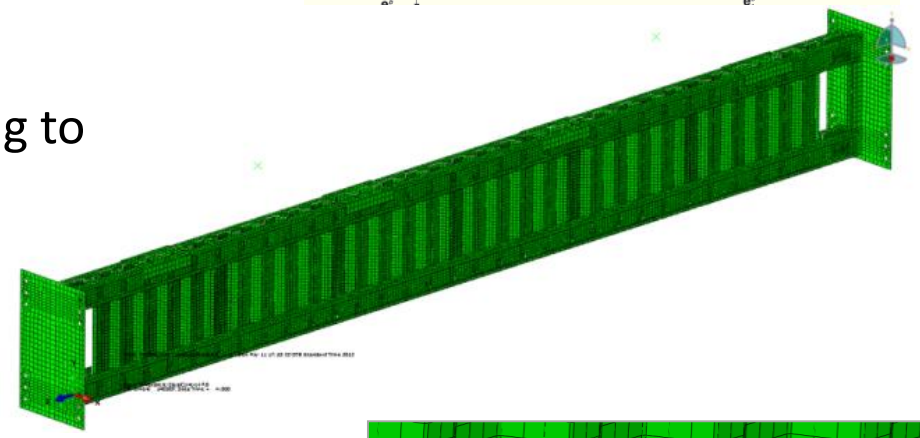
EXPERIMENTAL PROGRAM

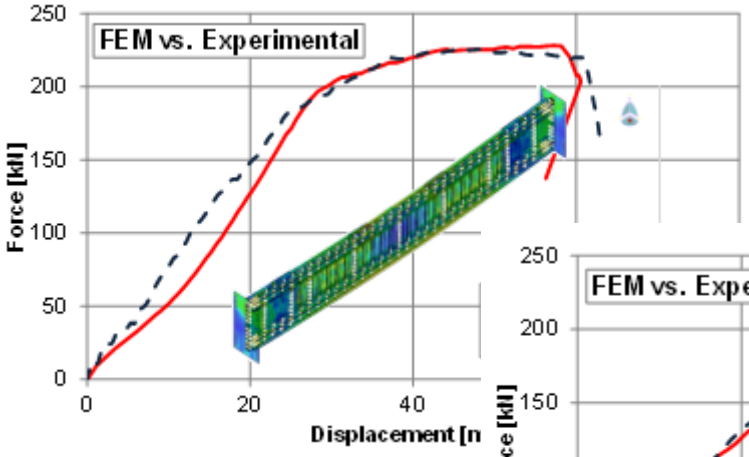


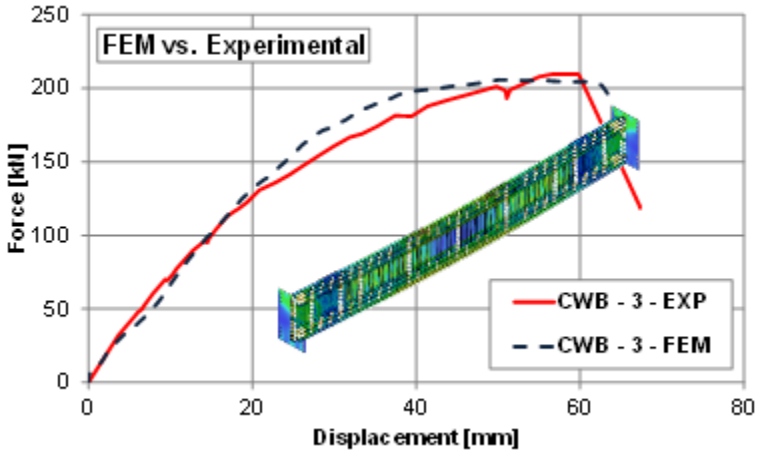
Numerical model calibration and validation

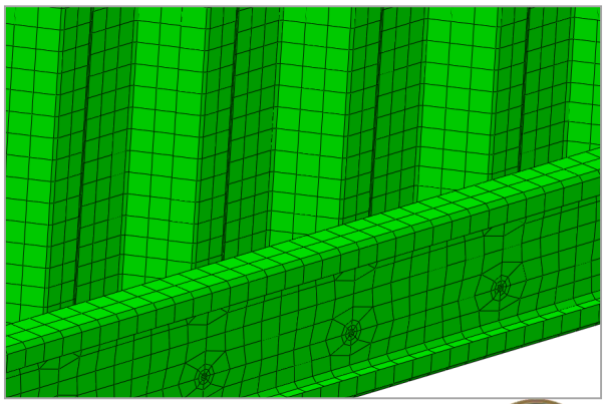
- SHELL Element – S4R type
  - 4 nodes, reduced integration
- CONECTOR Element – CONN3D2 type
  - for self-drilling screws and bolts
  - 2 nodes, 6 DOF per node
  - Non-linear deformation according to imposed load











Universitatea Politehnica Timişoara

Fast welding cold-formed steel beams of corrugated sheet web

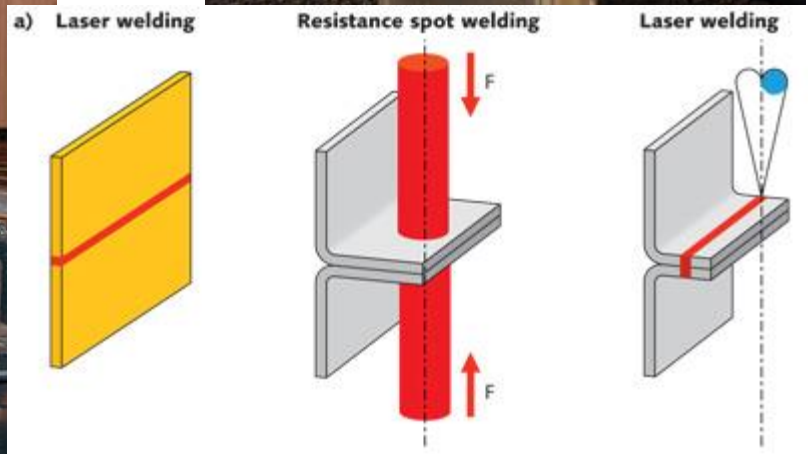
WELLFORMED

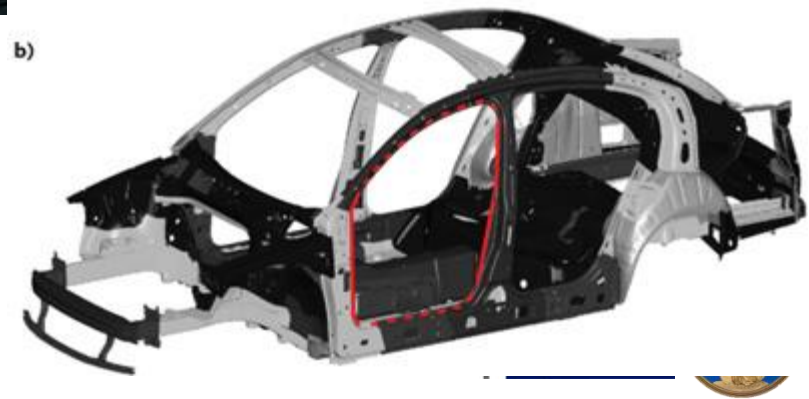
PN-III-P2-2.1-PED-2016-1684

The main objectives of the project:

- to validate a new technological solution, CWB where the connections made of intermittent SW and MIG/MAG W;
- to validate it by a parametric study via numerical models using ABAQUS FEM tool;
- to adapt/extend the rules of the EN 1993-1-5, Annex D to this new type of beams;
- to develop a structural system able to satisfy easy prefabrication, automation and mass production.

SPOT WELDING



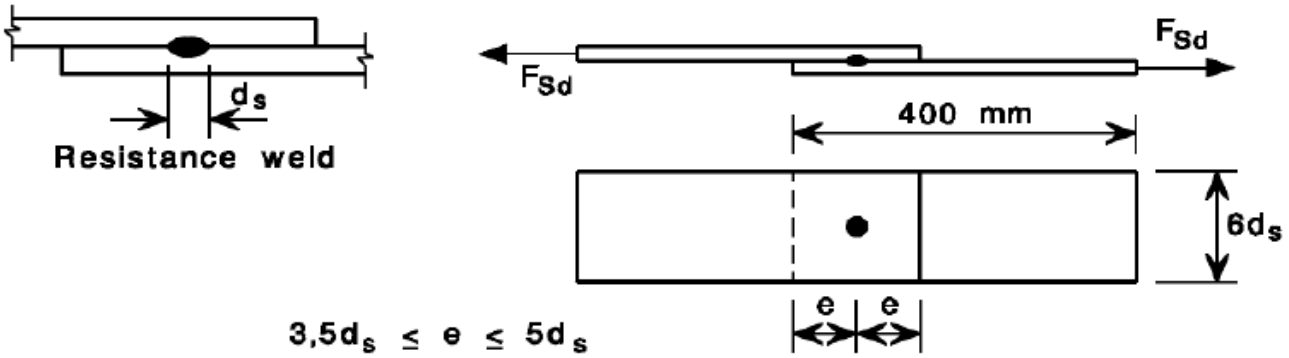


SPOT WELDING

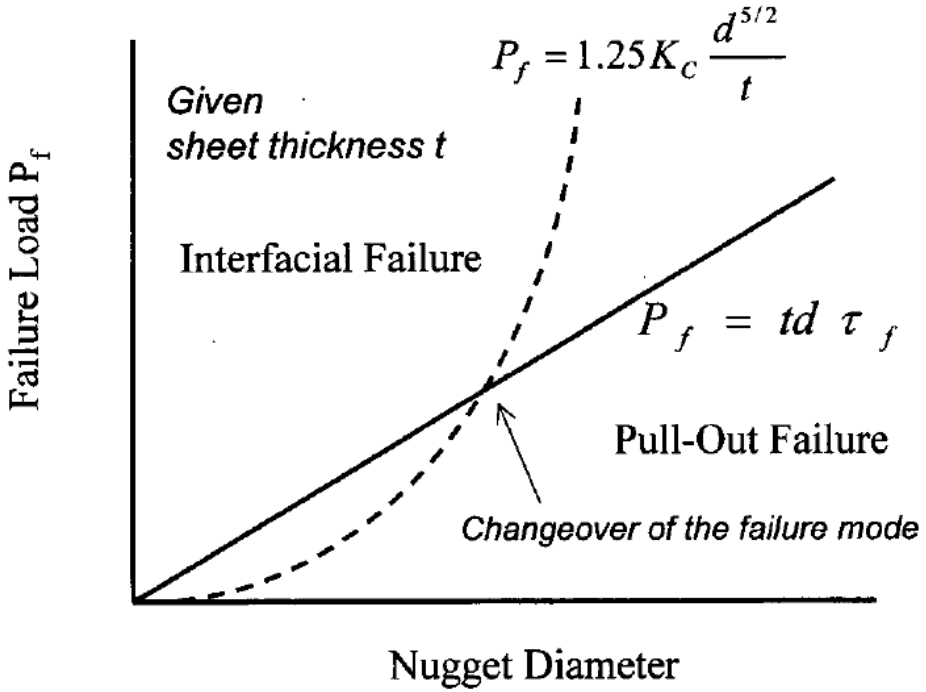
TELWIN

Universitatea Politehnica Timişoara

SPOT WELDING – preliminary investigations



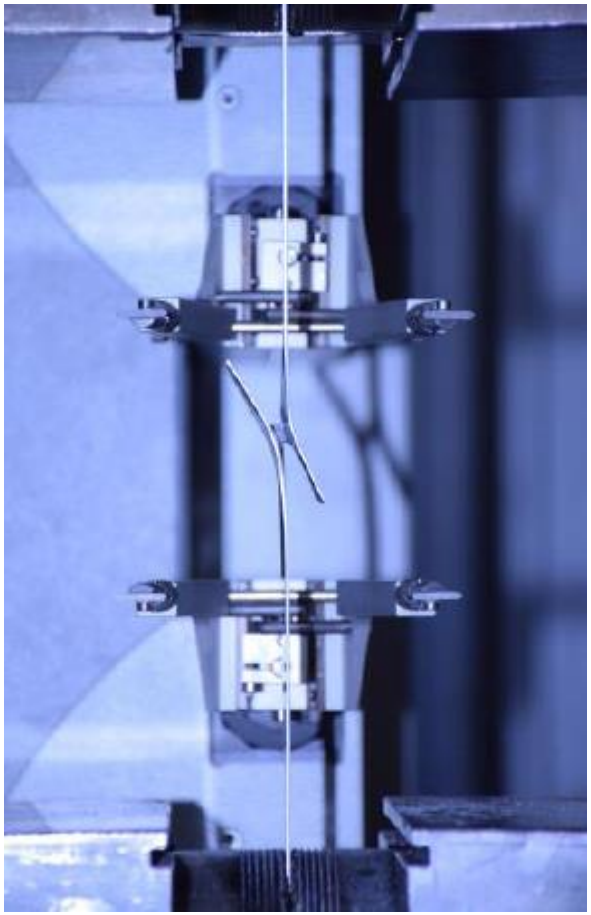
$$d = 4\sqrt{t}$$

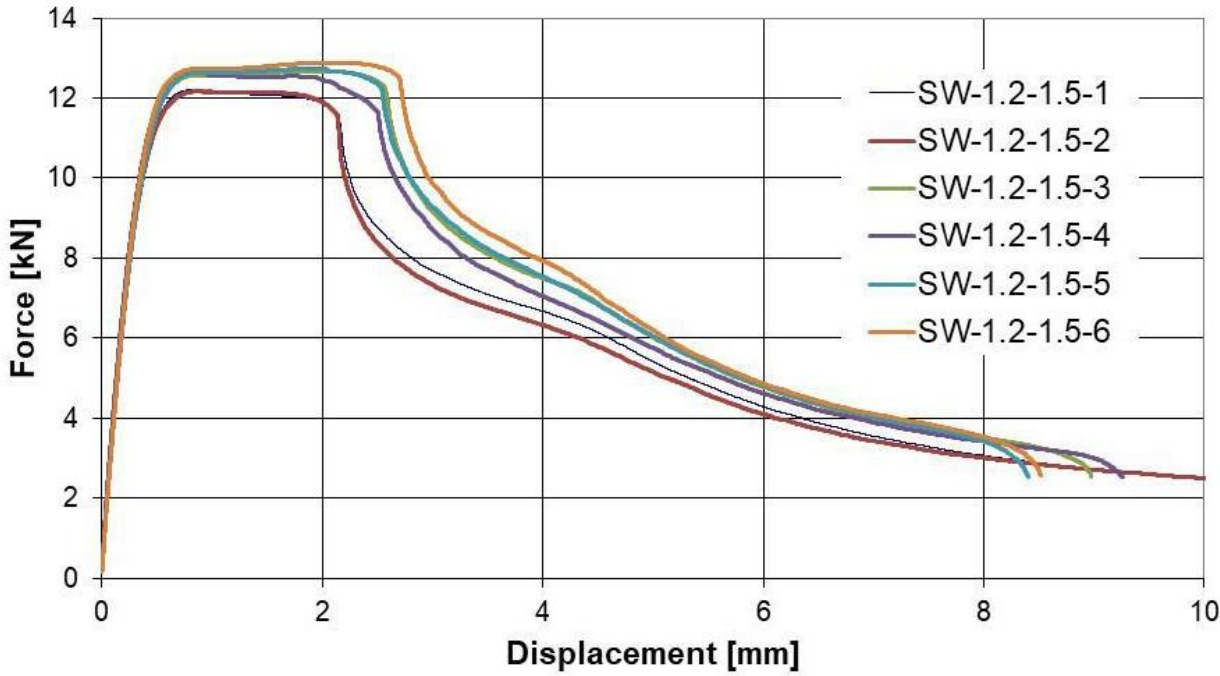


SPOT WELDING – preliminary investigations

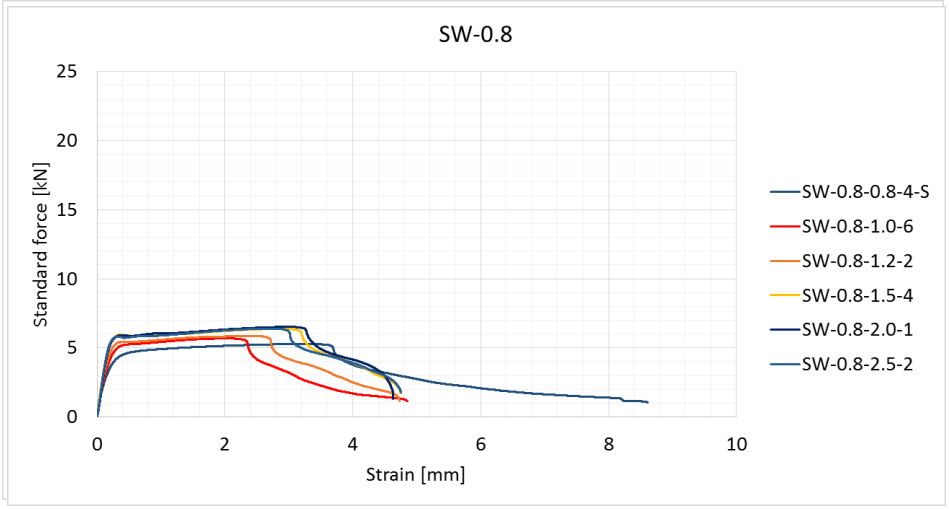
	Name	I_s [A]	Power [%]	F [daN]	pressure [bar]	t_s [ms]
REG 1	SW-1.2-1.5-1	10366	70	365	6	380
REG 2	SW-1.2-1.5-2	10336	70	365	-	380
REG 3	SW-1.2-1.5-3	11088	75	483	6.8	600
REG 4	SW-1.2-1.5-4	11088	75	472	6.6	600
REG 5	SW-1.2-1.5-5	11055	-	457	6.4	600
REG 6	SW-1.2-1.5-6	11775	80	449	6.2	600

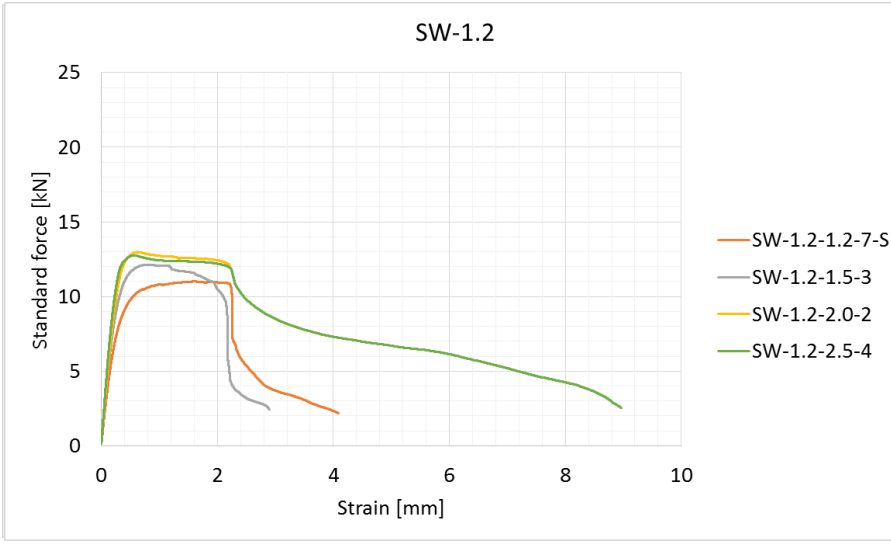
SPOT WELDING – preliminary investigations

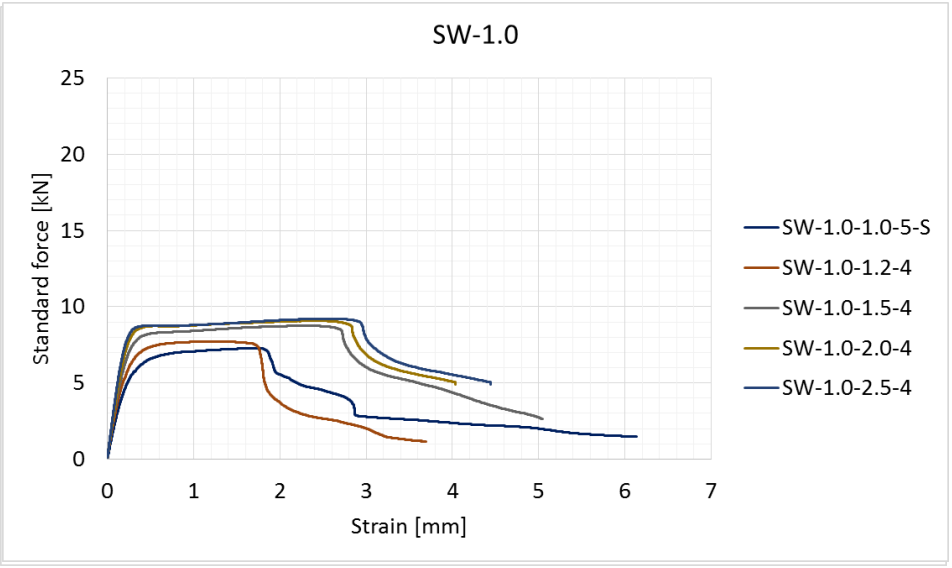


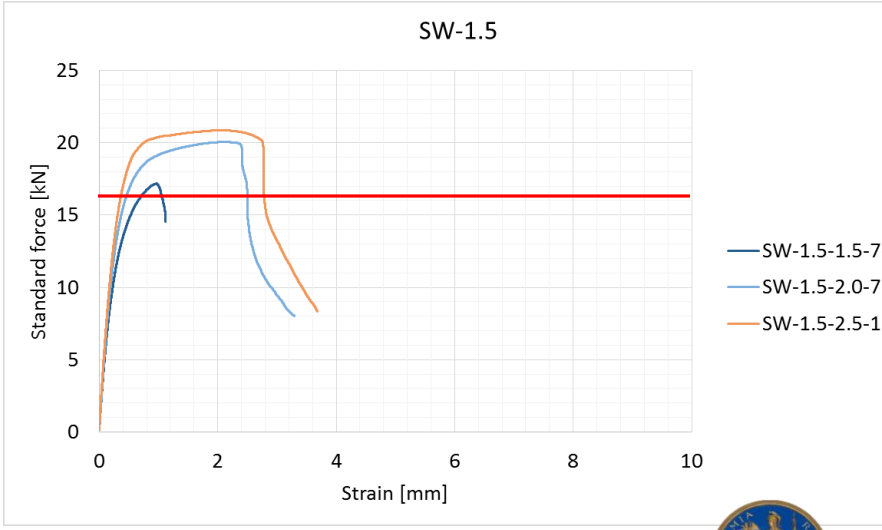


RESULTS


SW-0.8
Standard force [kN]
Strain [mm]
SW-0.8-0.8-4-S
SW-0.8-1.0-6
SW-0.8-1.2-2
SW-0.8-1.5-4
SW-0.8-2.0-1
SW-0.8-2.5-2


SW-1.2
Standard force [kN]
Strain [mm]
SW-1.2-1.2-7-S
SW-1.2-1.5-3
SW-1.2-2.0-2
SW-1.2-2.5-4


SW-1.0
Standard force [kN]
Strain [mm]
SW-1.0-1.0-5-S
SW-1.0-1.2-4
SW-1.0-1.5-4
SW-1.0-2.0-4
SW-1.0-2.5-4


SW-1.5
Standard force [kN]
Strain [mm]
SW-1.5-1.5-7
SW-1.5-2.0-7
SW-1.5-2.5-1

FAILURE MODES

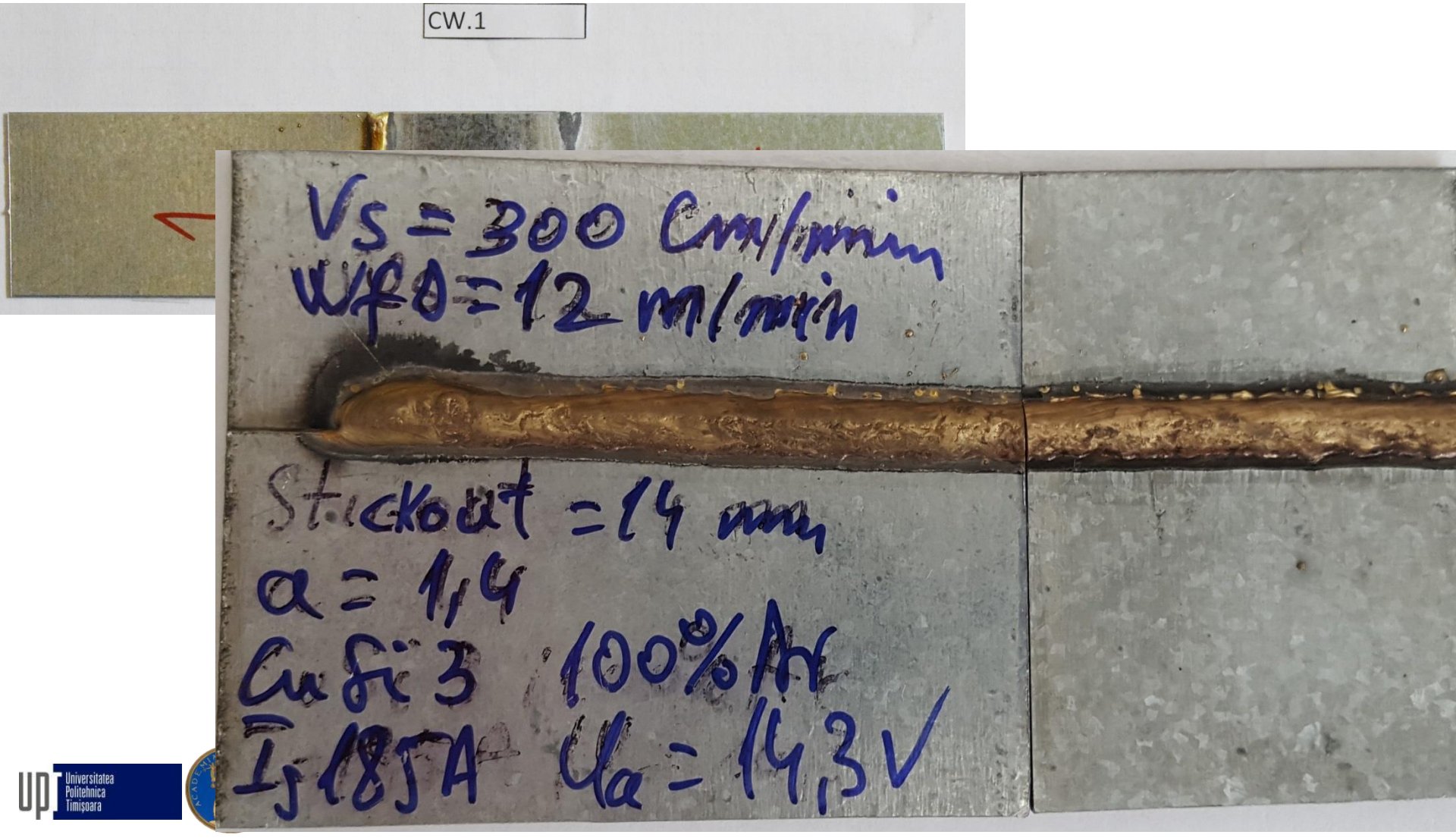
Nugget pullout
thin sheets

Interfacial failure
thick sheets

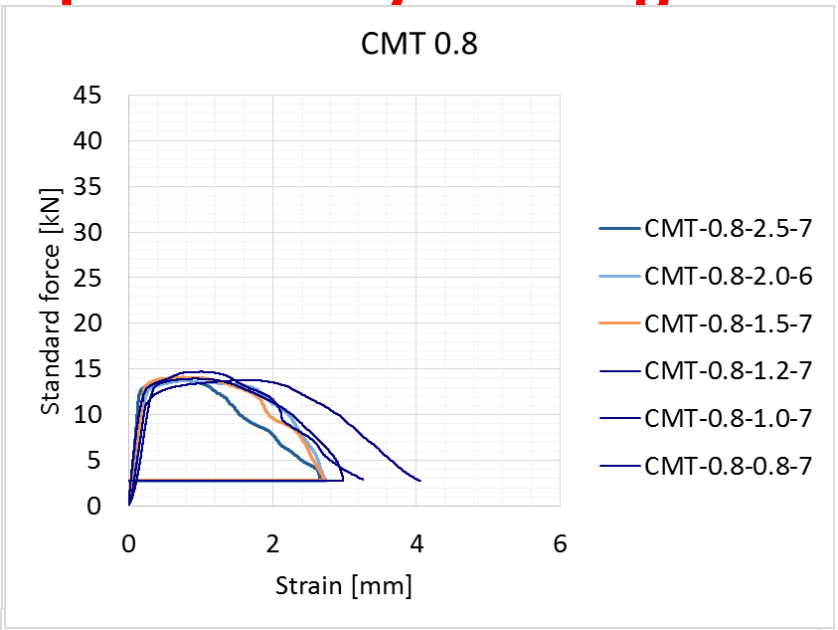
MIG/MAG welding equipment impulse welding

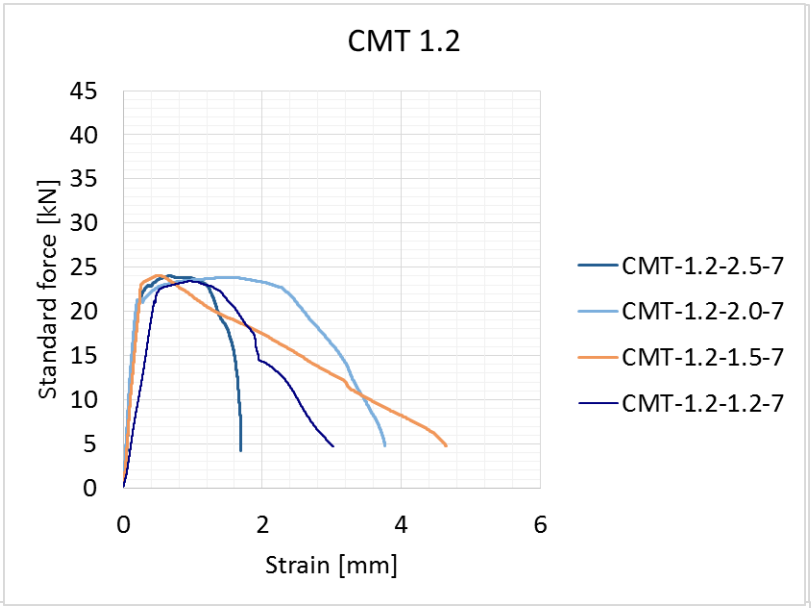
REHM® Welding Technology

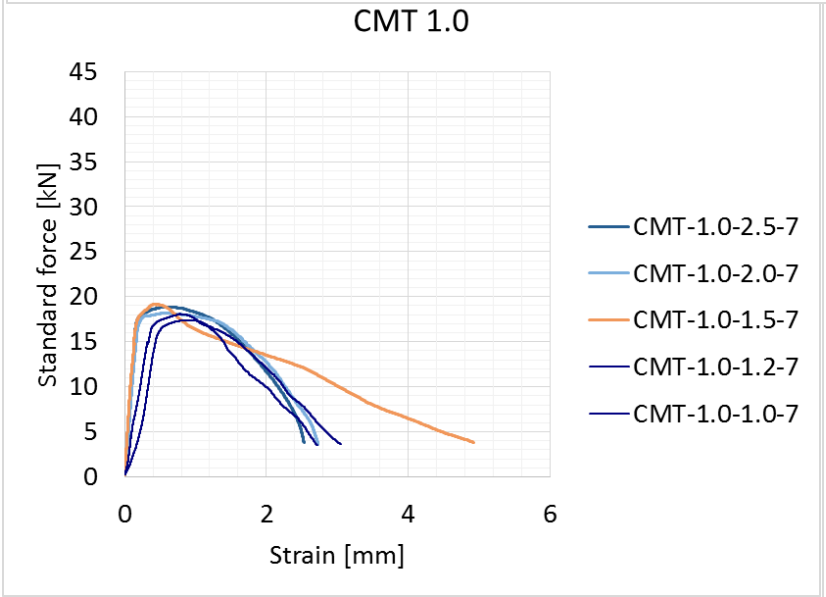
MIG/MAG welding equipment impulse welding - preliminary investigations

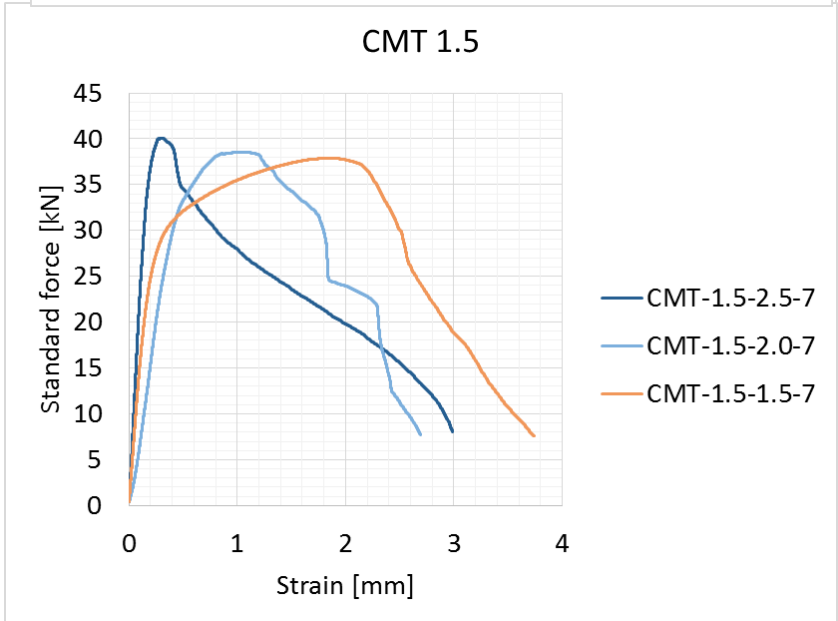


MIG/MAG welding equipment impulse welding - preliminary investigations





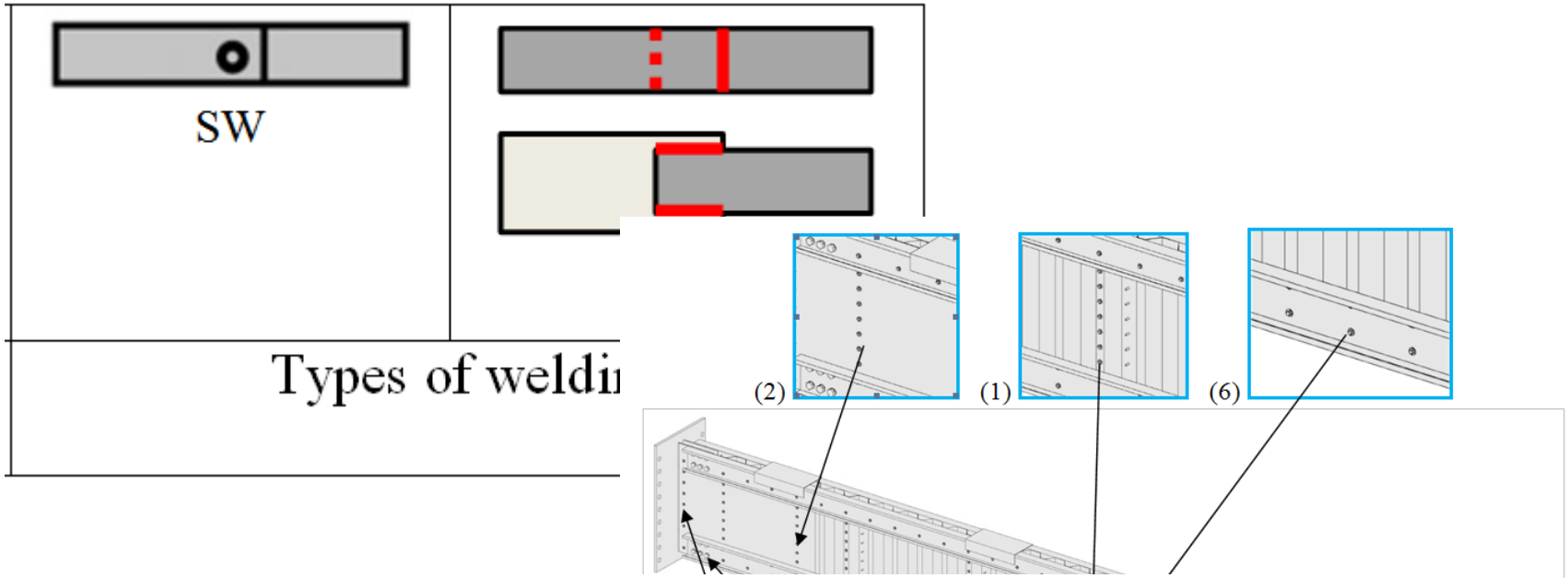




FAILURE MODES

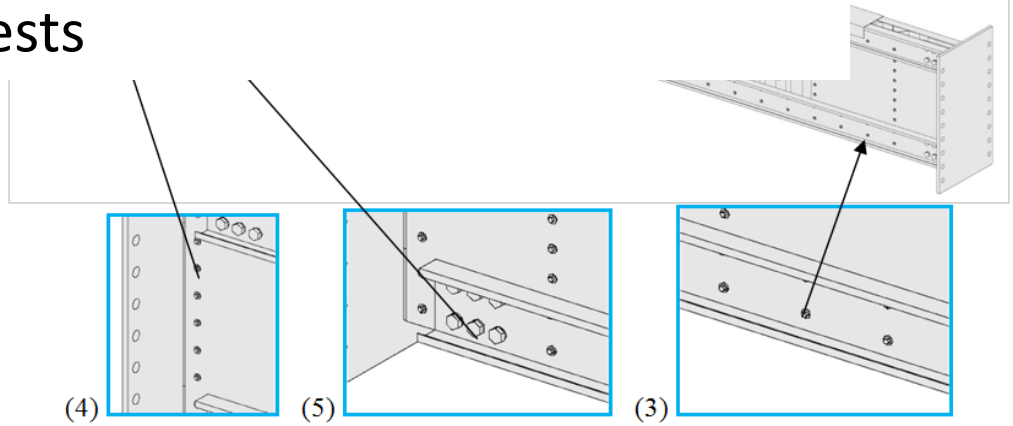
Near weld material fracture (HAZ)

Tests of welded connections and optimisation of fastening technology

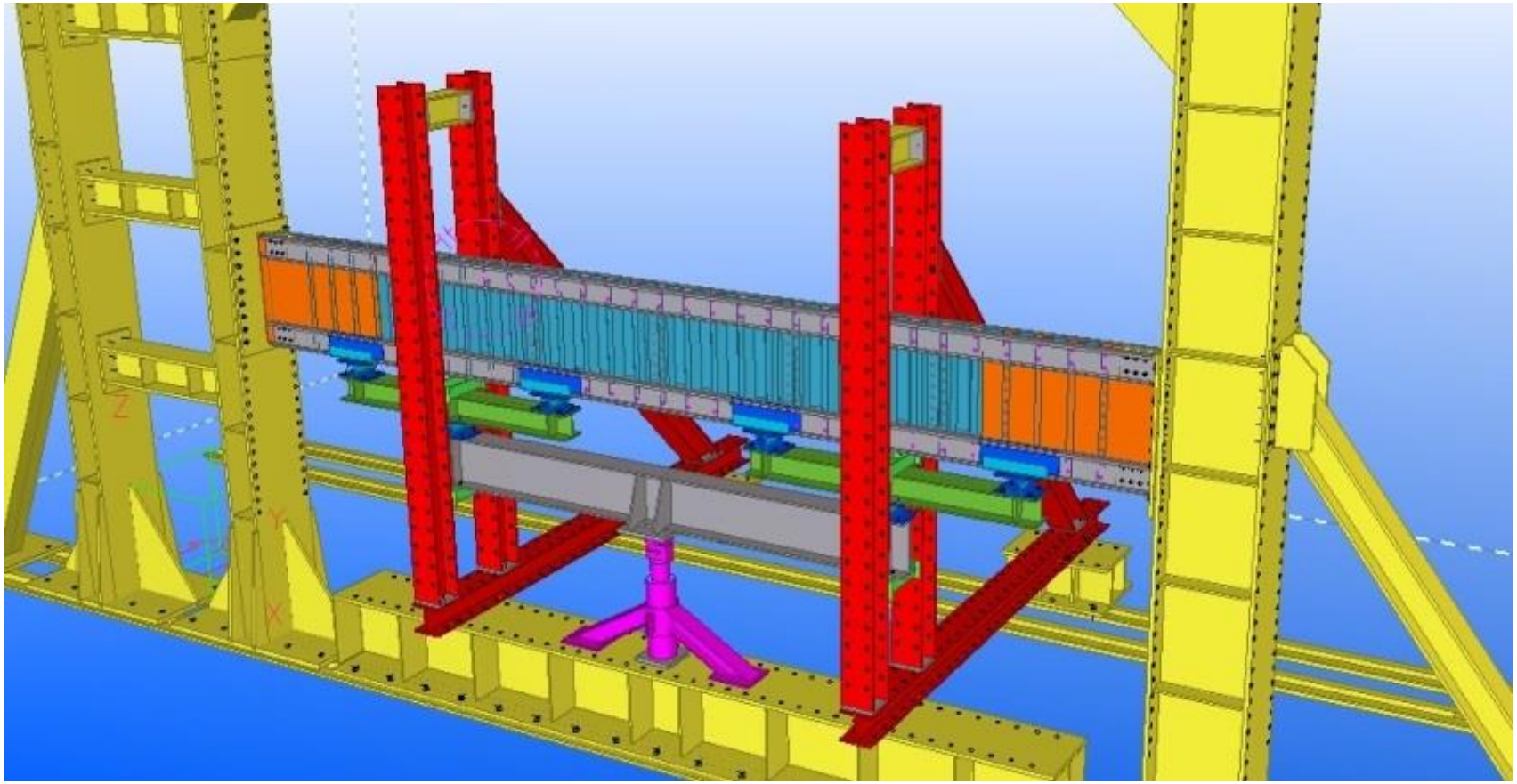


670 specimens for welded connections (SW and CMT)

95 specimens for tensile tests



Further study: Tests on full scale CWB beams



4 full scale beam specimens two using SW and two using CMT

CONCLUSIONS

A new experimental program on connecting details (using SW and MIG/MAG W) and full-scale beams has started at the PU Timisoara, on the purpose to demonstrate and evaluate the performances of proposed solutions;

The experiments shown:

-both the capacity and the ductility obtained for the tested specimens are very good;

-compare to similar specimens tested in [5] using self-drilling screws, the capacity of the tested specimens is double but the ductility is decreased;

-relevant tested specimens developed full button pull-out failure.

The results are encouraging and prove the potential of this solution to standardized beams and industrialized fabrication.

Thank you for your attention!

ACKNOWLEDGEMENT

This work was supported by the grant no. 57PED/2017, *WELLFORMED - Fast welding cold-formed steel beams of corrugated sheet web*, Project type PN-III-P2-2.1-PED-2016, financed by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), Romania.

Ioan Both
ioan.both@upt.ro