Clinching of Thick Sheets in a Framework Structure

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Bad Nauheim, 29.04.2009

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Global sourcing

45‘000 employees – more than 130 countries – more than 1000 branches

Technology Management – Escalators
Scope of Activities

Tasks:

– Technology Transfer

– Technology Generation (co-development with R&D Institutes)

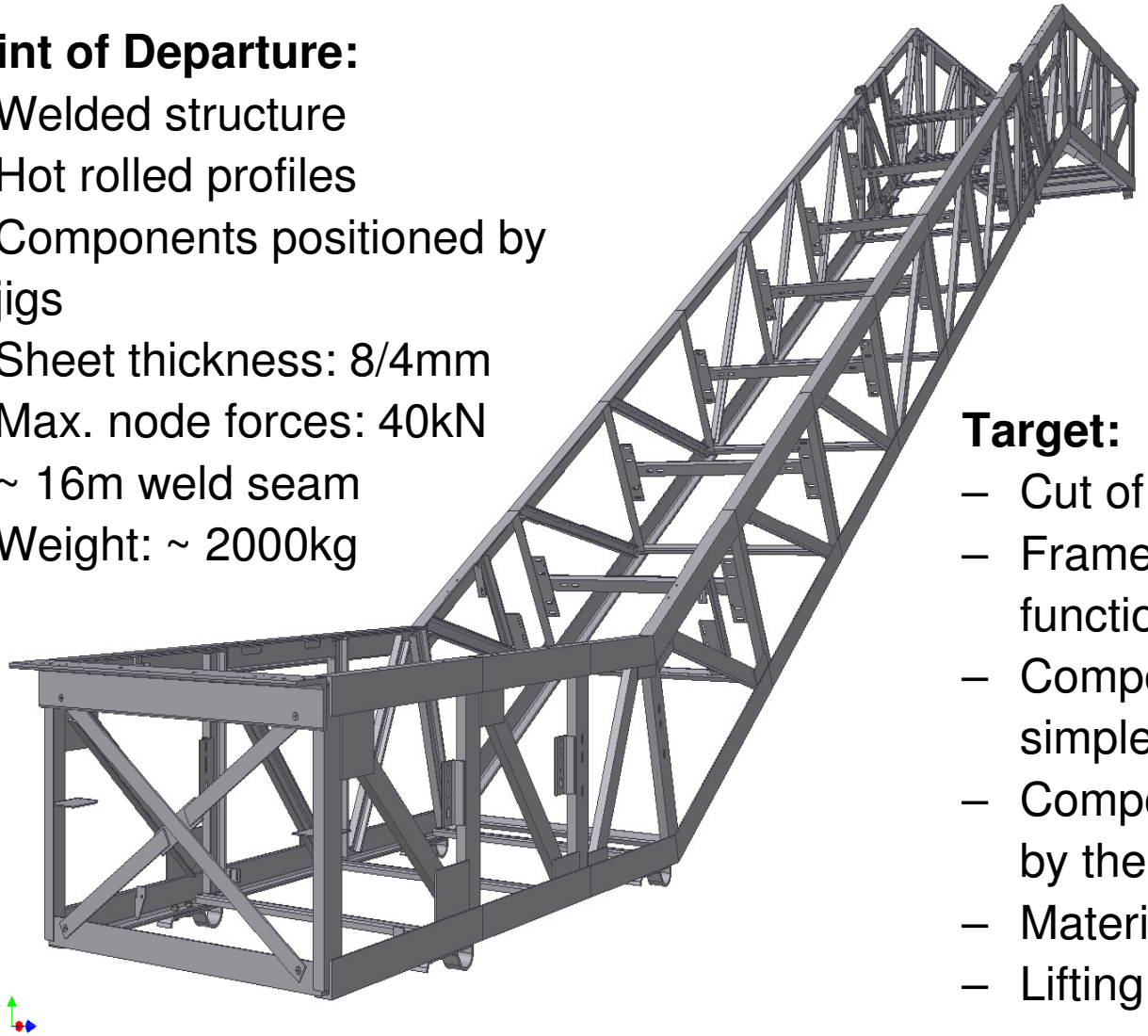
Target:

– Innovative products and components
focused on cost reduction due to a fierce price-competition on escalator market

Project Idea
Framework – New Platform

Point of Departure:

- Welded structure
- Hot rolled profiles
- Components positioned by jigs
- Sheet thickness: 8/4mm
- Max. node forces: 40kN
- ~ 16m weld seam
- Weight: ~ 2000kg



Target:

- Cut of production costs
- Framework takes on functions
- Components becomes simpler
- Components positioned by the framework
- Material savings
- Lifting height: 6m

Project Idea
Framework - Approach

New joining technology replacing welding

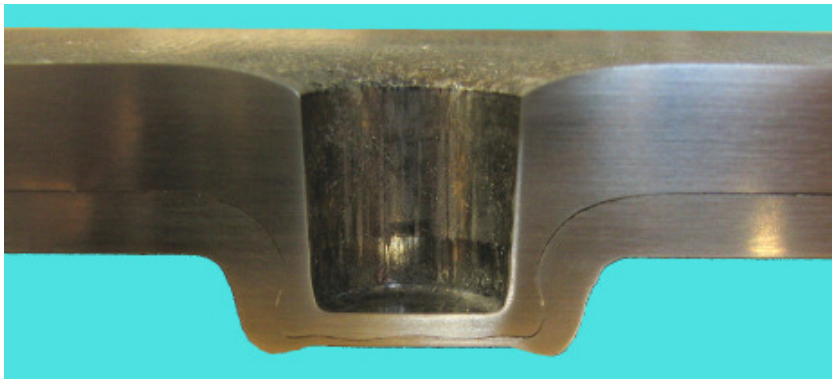
	Sheet Thickness	Strength	Preparation	Auxiliary Material	Zinc Plated Sheets	(Heat-) Distortion	Costs
– MIG welding	+	+	•	-	-	-	•
– Spot welding	•	-	+	+	-	•	+
– Self-piercing riveting	•	-	+	-	+	+	•
– Heavy load riveting	+	+	-	-	+	+	-
– Clinching	?	?	+	+	+	+	+

Cold rolled profiles instead of warm rolled

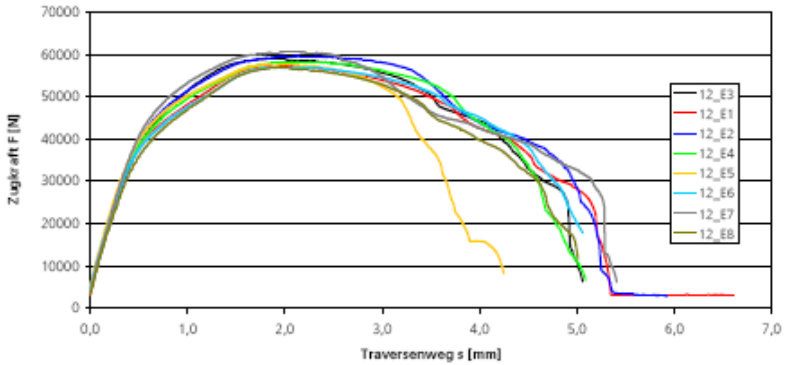
– Providing accuracy
– Taking the material there where it is necessary / material saving

Clinching of Thick Sheets
Surprising Result – High Strength

Tests yielded 60 kN in tensile shear test!

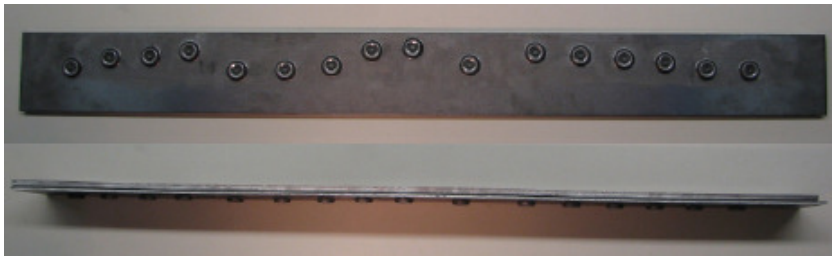


Point-ø22mm | Sheets: 8 to 4mm | Material: S355



Result of tensile shear test

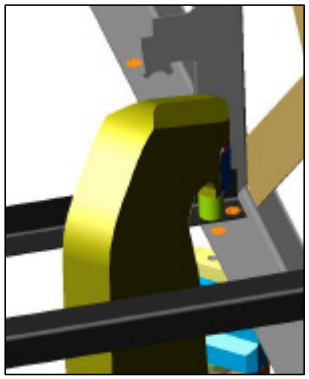
Distortion is manageable!

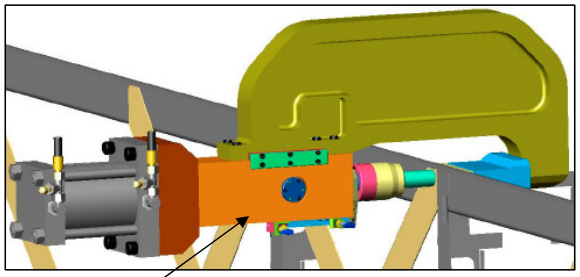


Result: 2 points per framework node are sufficient, required accuracy achievable!

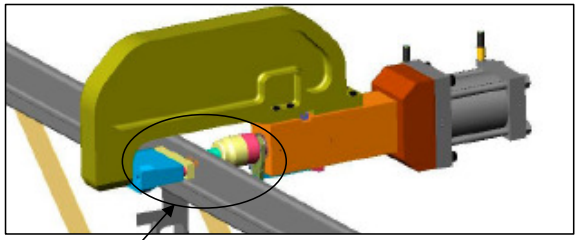
Concept of Clinching Plant
Workflow - Tools – Accessibility – Quality Assurance

Clinching force: ~ 400 kN



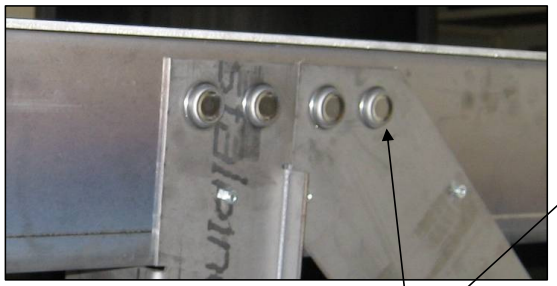


Pliers m~350kg



Quality of each clinching point checked by process parameters (online quality control)

Prototype pictures



Mould side

Punch side

Clinching Points

Pros – Cons
Clinching of Thick Sheets

Pros:

– High strength achievable
– Fast joining method
– Zinc plated raw material applicable
– No auxiliary material needed
– No preparation work necessary
– No distortion
– Practical to dynamic loadings
– Online quality control easily feasible
– Energy- and resource-saving
– Cost efficient joining technology

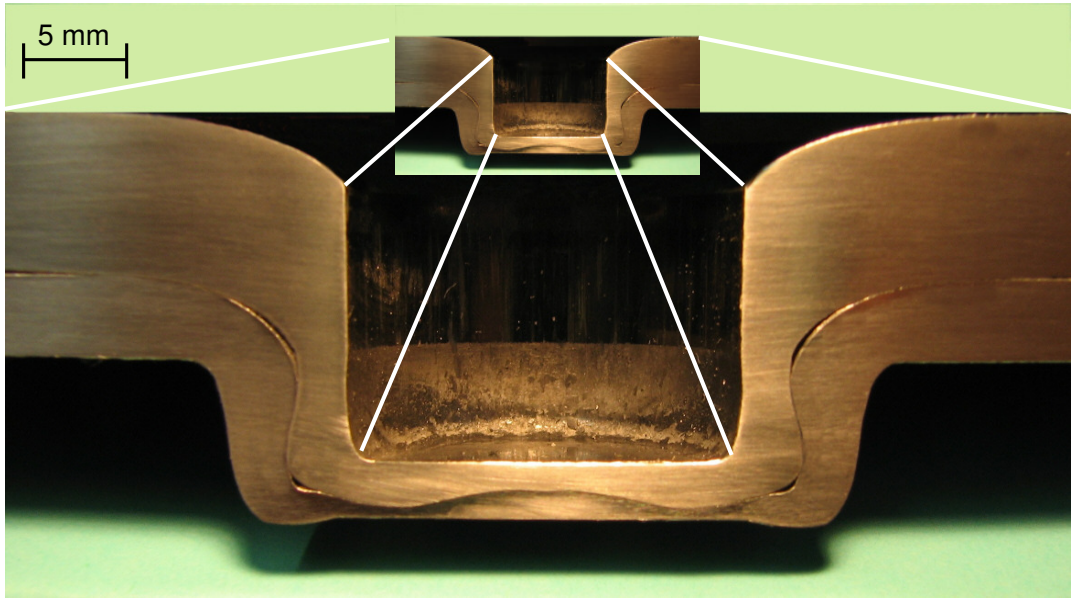
Cons:

– Heavy tools to manipulate
– High investment costs

… based on our experience

Clinching of Thick Sheets
Approach

- Realisation of bigger total thickness of plates by scaling the tools
- Standard are point diameters up to 12 mm
- Linear Scaling practical? Which Restrictions?

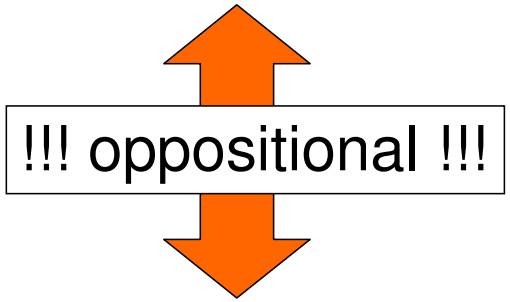


Linear scaling of clinching joints

Clinching of thick sheets
Restrictions

Main demands

- High Material strength (up to S700)
- High connection strength



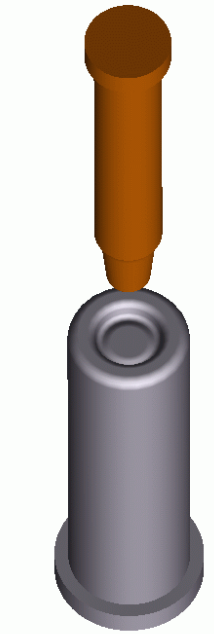
- Low process forces
- Small Flanges

- No standard tools for clinching of thick sheets
- Transferability of experiences in clinching thin sheet unknown

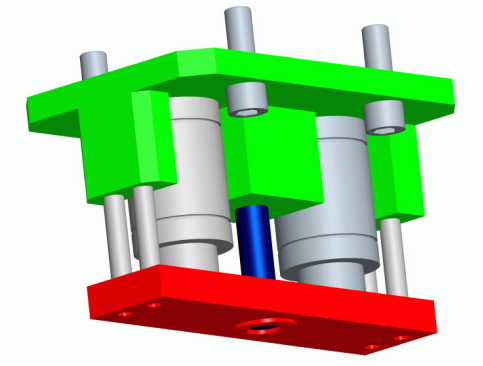
- FE-supported tool design
- Sensitivity analyses

Dimensioning of Clinching Joints
Influencing Factors

- Tool design and tuning
  - Anvil diameter (= point diameter)
  - Anvil depth
  - Design of anvil cavity
  - Punch diameter (match with anvil)
  - Radii of punch and anvil
  - Blank holder



punch and anvil

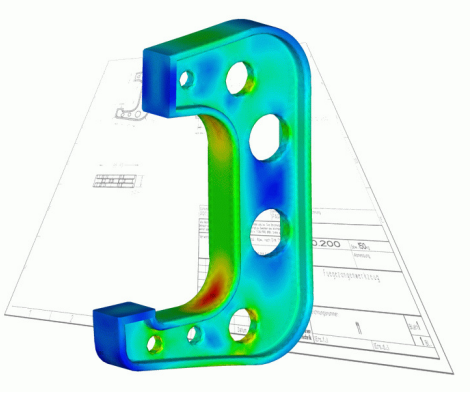


Scheme of a complete punchside tool

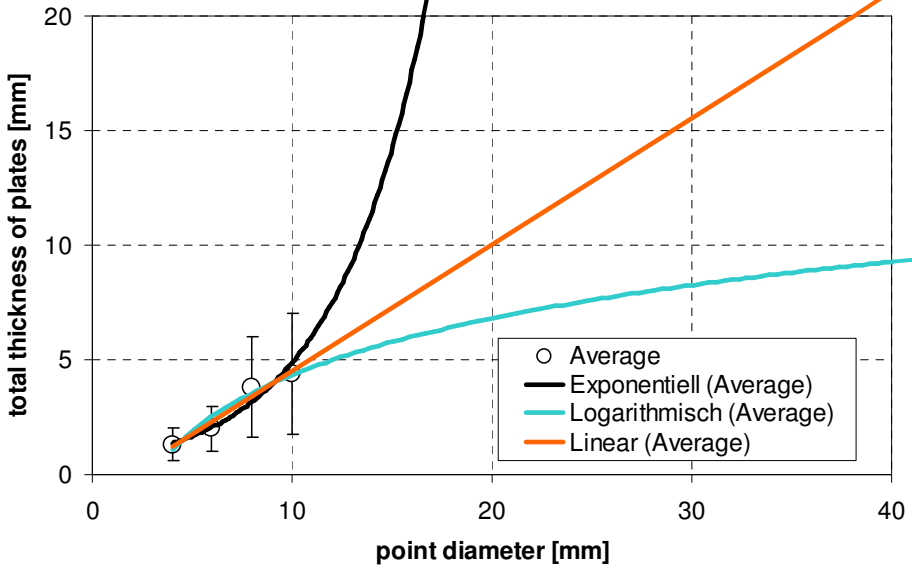
Dimensioning of Clinching Joints
Point Diameter

– low process force
– low thickness of neck
(risk of breaking neck)
– low connection strength

– average process force
– average thickness of neck
– average connection strength



Dimensioning tongs



based on TOX data sheet 80.100

– high process force
– high thickness of neck
– high connection strength

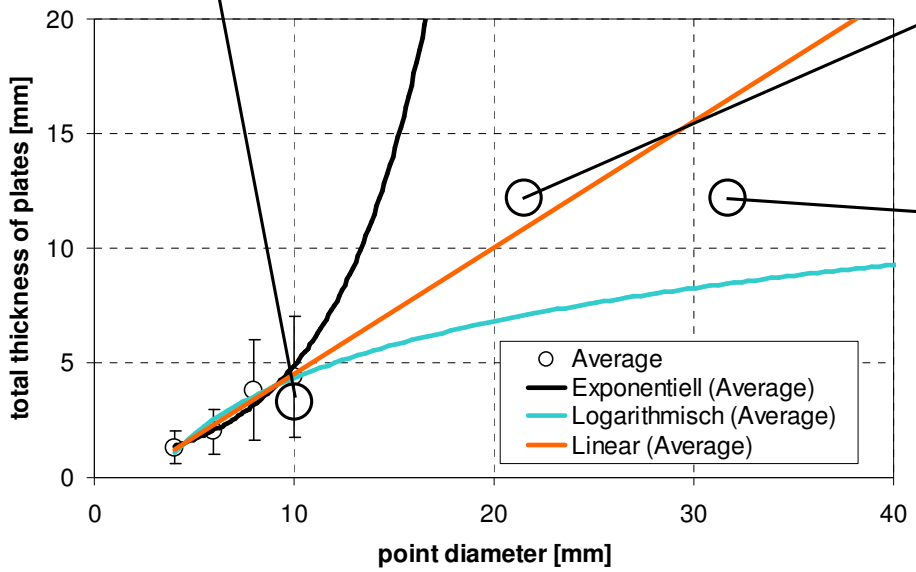
Dimensioning of Clinching Joints
Point Diameter

round joint
St1203 (2,0 mm + 0,9 mm)

$$\frac{\text{strength}}{\text{force}} = 0{,}082$$

– point diameter: 10 mm
– process force: 57 kN
– shear tensile strength: 4,7 kN

based on TOX data sheet 80.100



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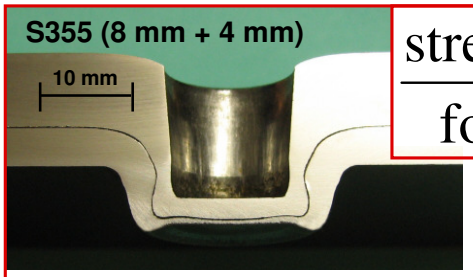
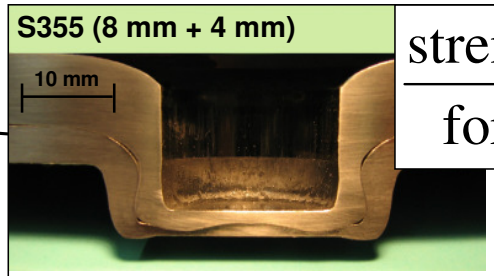


$$\frac{\text{strength}}{\text{force}} = 0{,}154$$

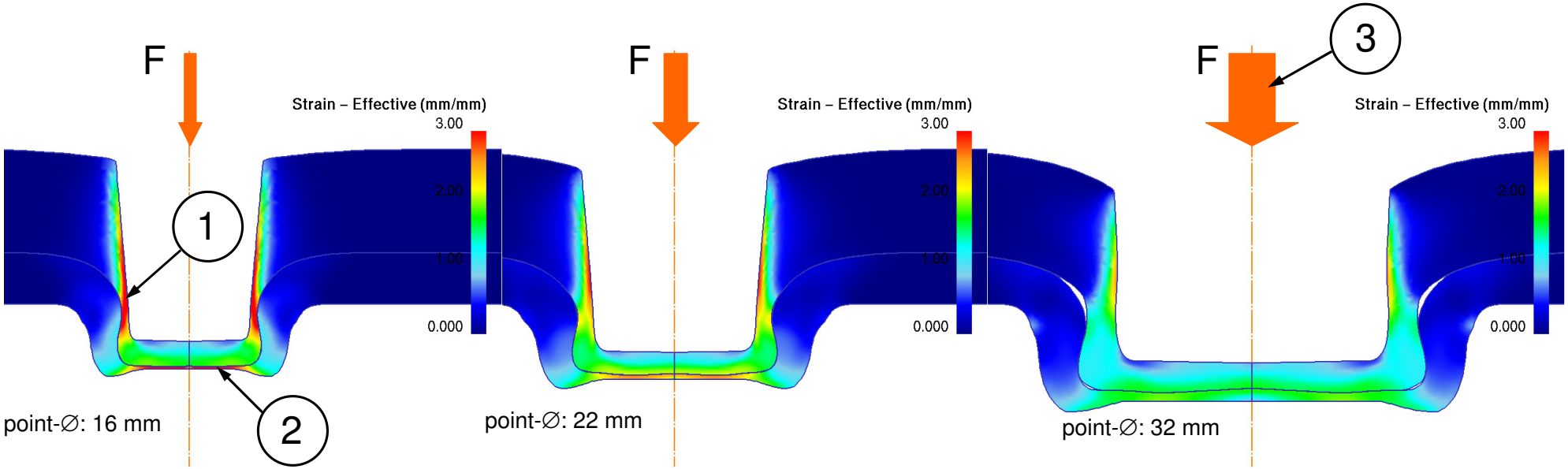
– point diameter: 22 mm
– process force: 390 kN
– shear tensile strength: 60 kN



$$\frac{\text{strength}}{\text{force}} = 0{,}179$$

– point diameter: 32 mm
– process force: 670 kN
– shear tensile strength: 120 kN

FE-Simulation of the Clinching Process
Basis for Tool Design



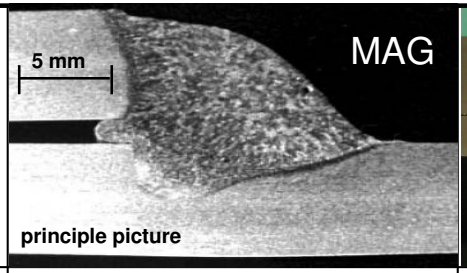
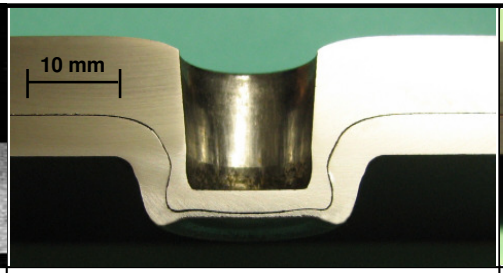
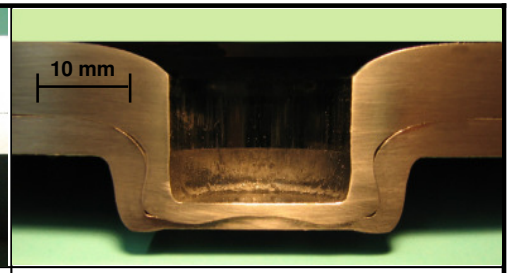
FE-based tool design

1 Consideration of critical strain hardening

2 Consideration of critical sheet thinning (danger of corrosion)

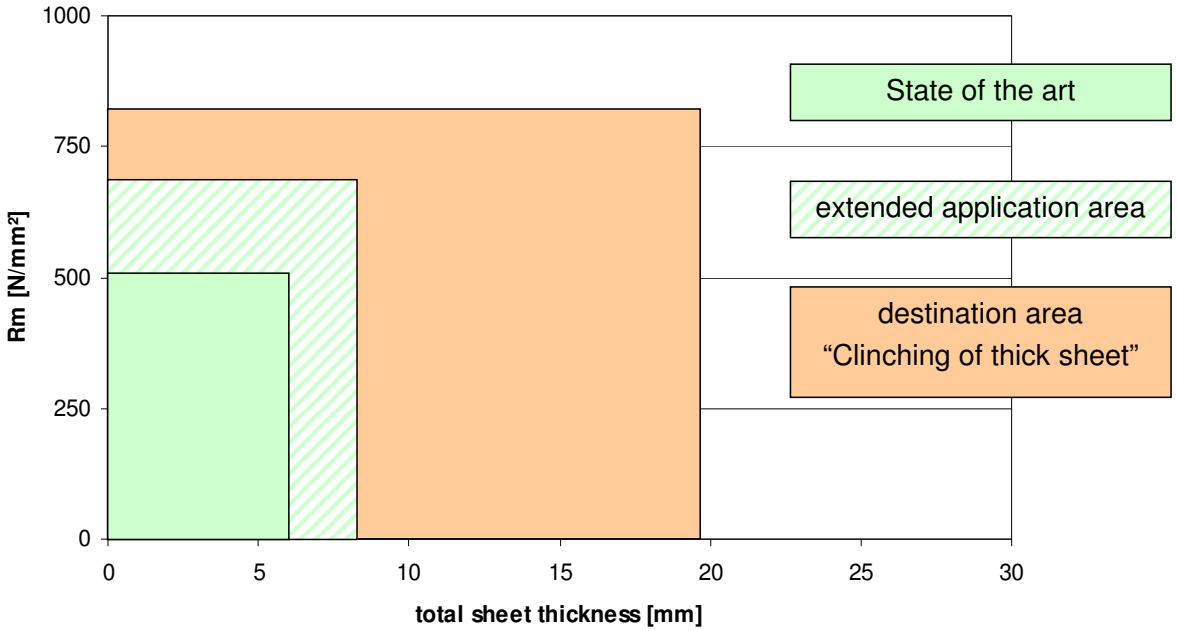
3 Consideration of critical forces and stresses (basis for dimensioning tongs and presses / danger of tool damage)

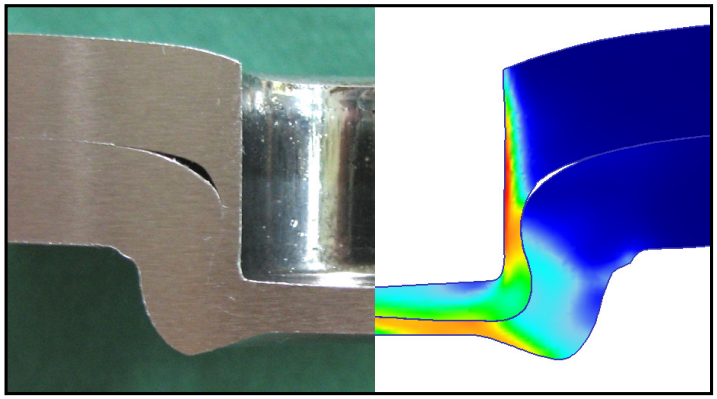
Energy Efficiency
Clinching vs. MAG

joining technology			
spezific process parameters	seam thickness: 4 mm Iw/Uw: 100 A / 20V	point-∅: 22 mm force: 390 kN	point-∅: 32 mm force: 670 kN
applied seam energy applied seam strength (quasi static)	300 kJ/m 2000 kN/m	53 kJ/m (16 points á 3,3 kJ) 960 kN/m	74 kJ/m (12 points á 6,15 kJ) 1440 kN/m
energy / strength	150 J/kN	55 J/kN	51J/kN

Clinching about 3 times better!

Outlook
Fields of Application





Total sheet thickness 16 mm, point-∅ 36 mm, strain effective (qualitative)

- Clinching of thick sheet is feasible!
- Alternative for welding and riveting and screwing

Further steps:
- Standardisation of tools for thick sheets
- investigations on tool life

Thank you for your attention.

Schindler Fahrtreppen International GmbH

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Supported by