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TECHNOLOGIECAMPUS DE NAYER SINT-KATELIJNE-WAVER

The strength of stainless steel fillet welds using GMAW

M. Fortan, A. Dejans, D. Debruyne & B. Rossi

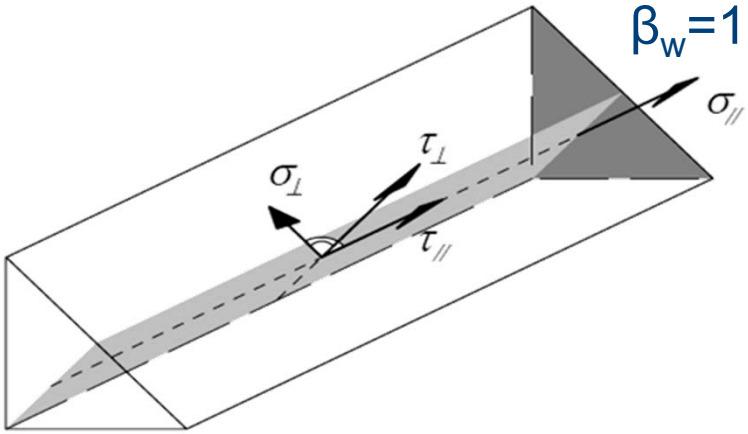
KU Leuven, Belgium

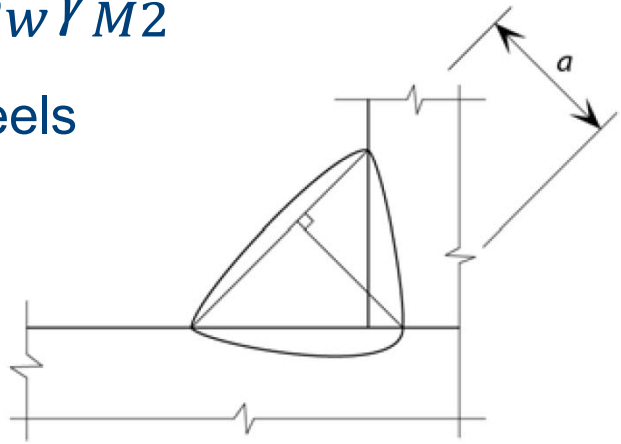
Objective

- Design of a weld based on Von Mises
  - $\sigma_\perp$ The normal stress perpendicular to the critical plane of the throat
  - $\sigma_{//}$ The normal stress parallel to the axis of the weld (neglected)
  - $\tau_\perp$ The shear stress in the critical plane of the throat perpendicular to the weld axis
  - $\tau_{//}$ The shear stress in the critical plane of the throat parallel to the weld axis

$$\sqrt{\sigma_\perp^2 + 3\left(\tau_\perp^2 + \tau_\parallel^2\right)} \leq \frac{f_u}{\beta_w \gamma_{M2}}$$

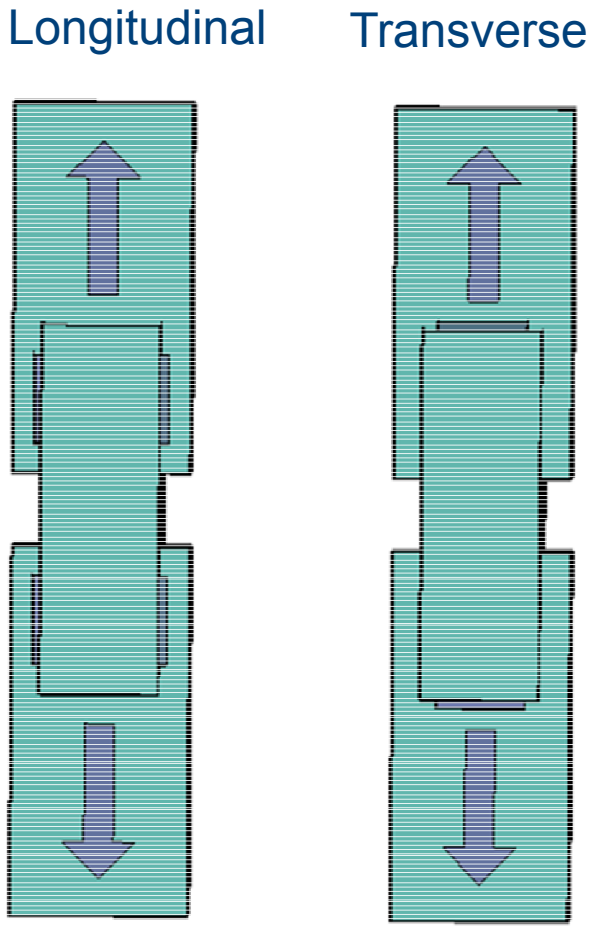
β_w=1 for all stainless steels





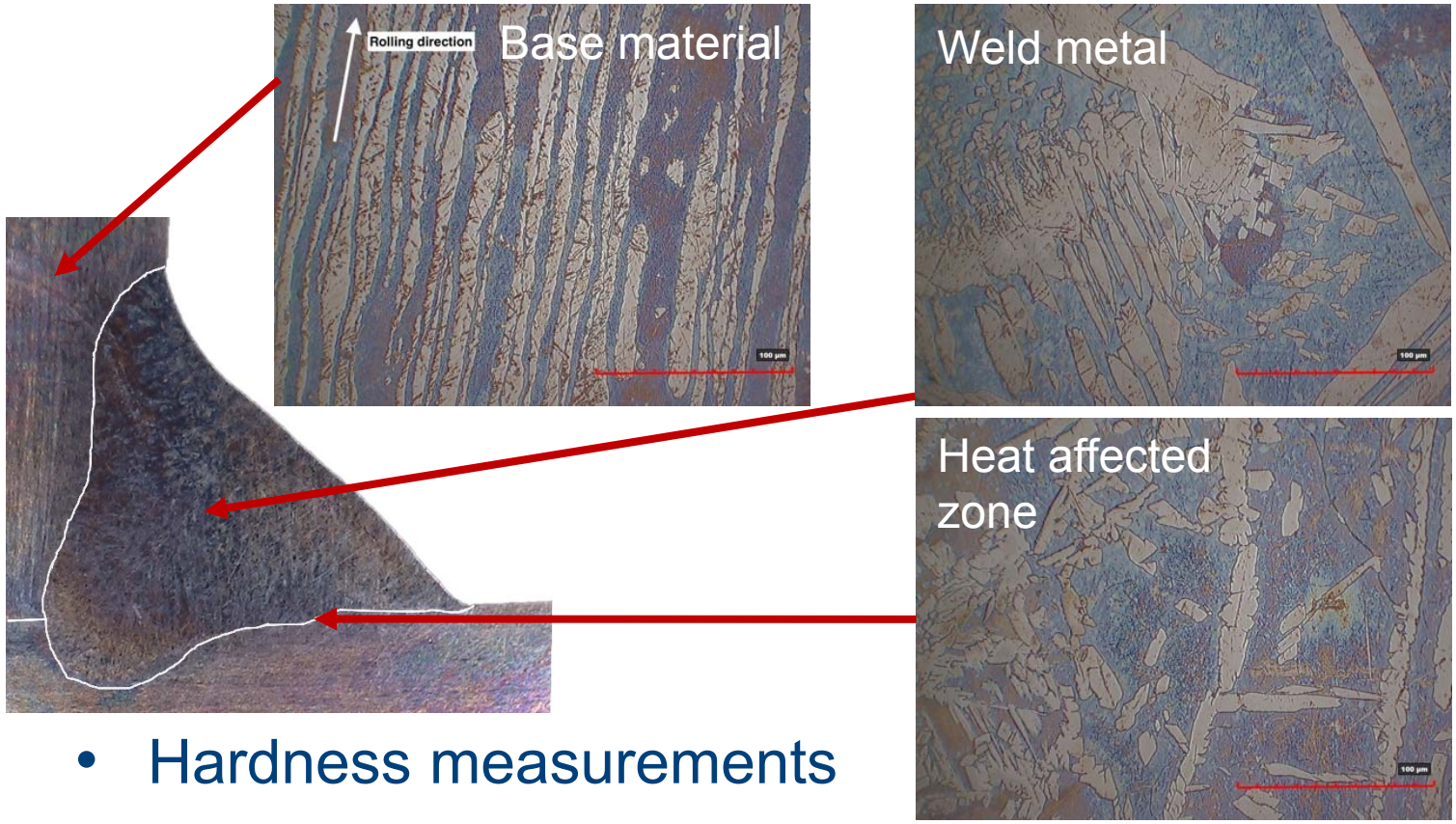
Test program

- 3 grades
  - EN 1.4062 Lean duplex (2202)
  - EN 1.4404 Austenitic (316L)
  - EN 1.4307 Austenitic (304L)
- 2 loading conditions
  - Longitudinal
  - Transverse
- 1 welding process
  - Manual GMAW
  - Overalloyed consumables
  - Matched mechanical strength
- Coupons base material, microstructure & hardness



Inspection of the welds

- Manual Gas Metal Arc Welding (GMAW)
- Macroscopic and microscopic investigation



- Hardness measurements

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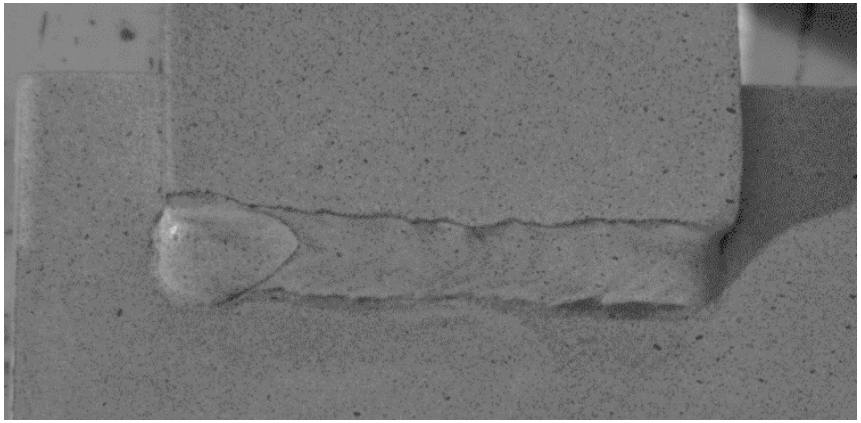
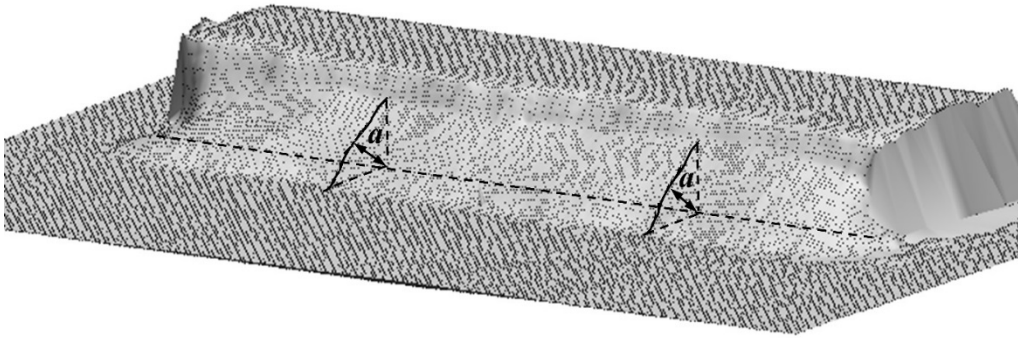
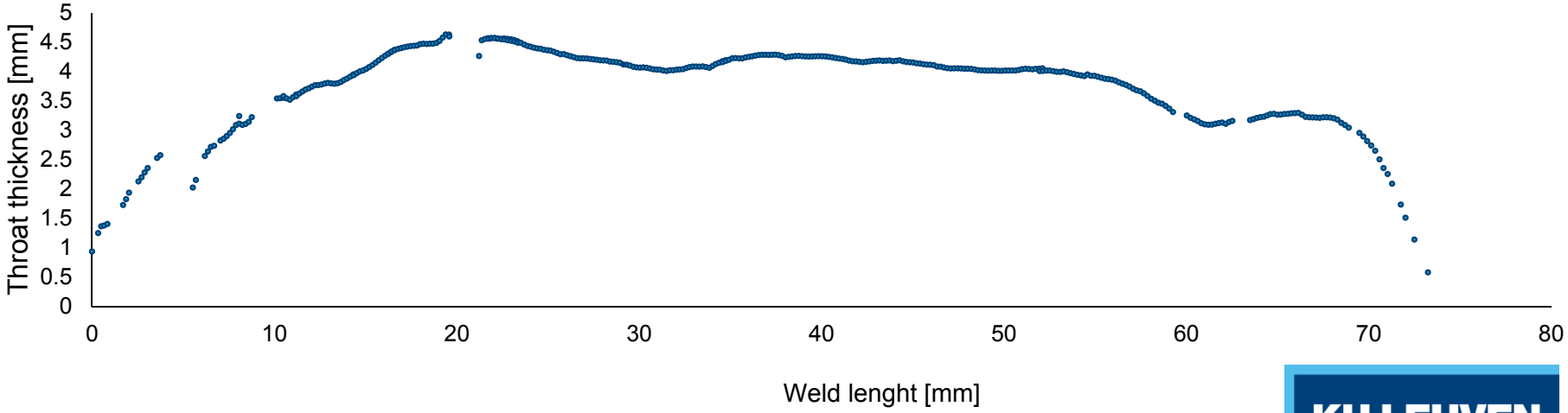
Initial geometry of the weld

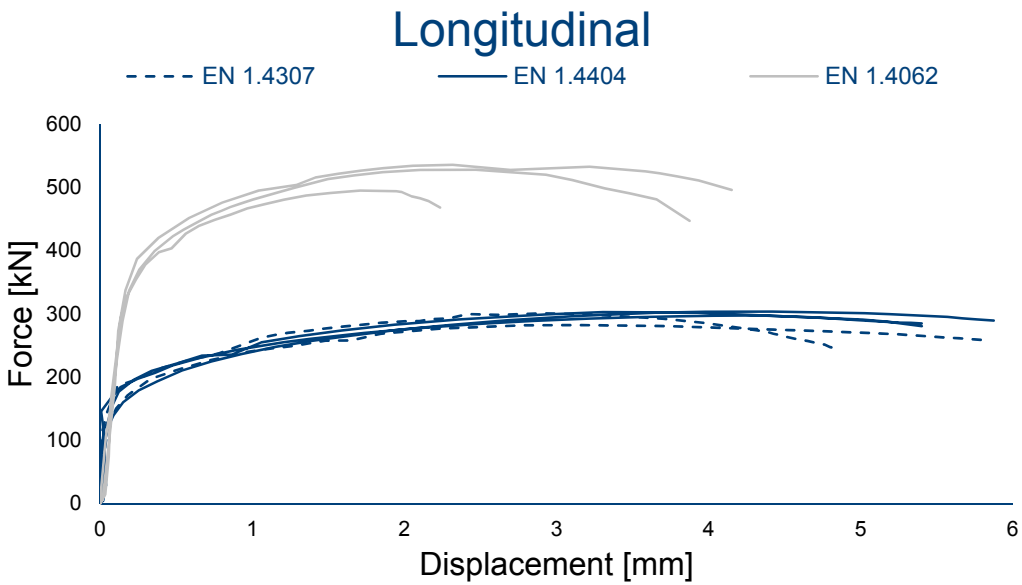


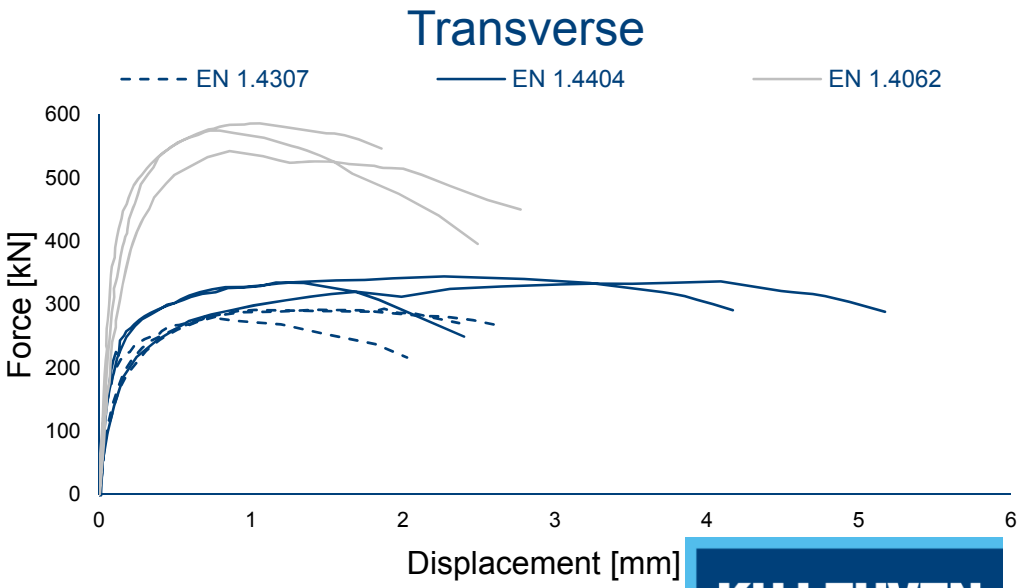


Cross-section weld



Test results





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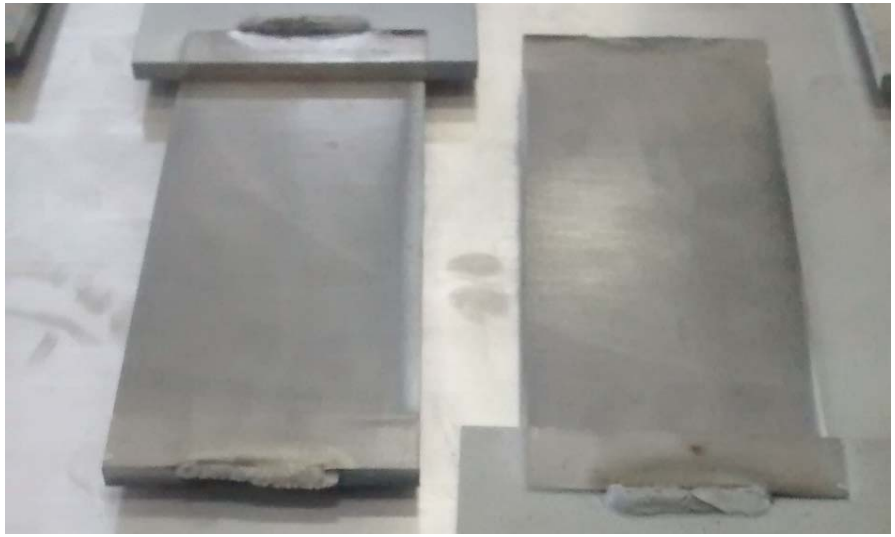
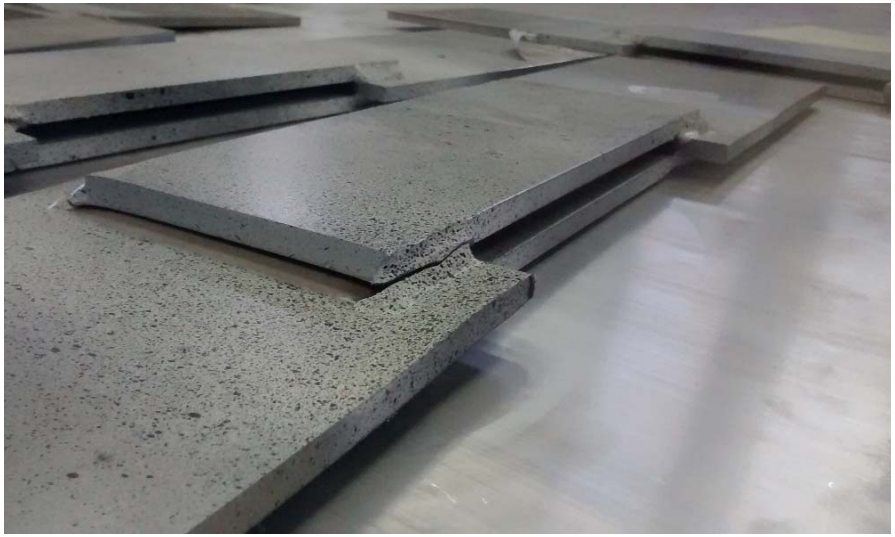
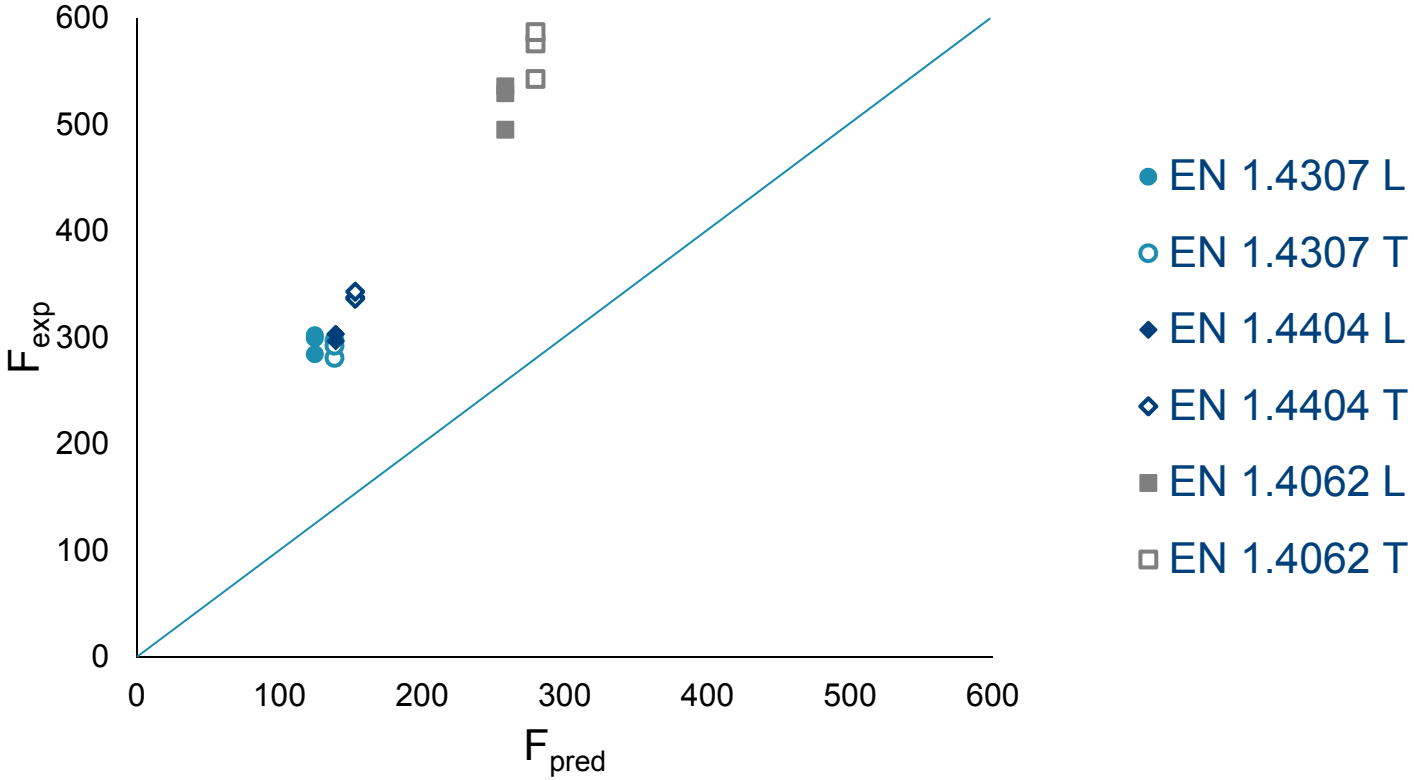
Test results





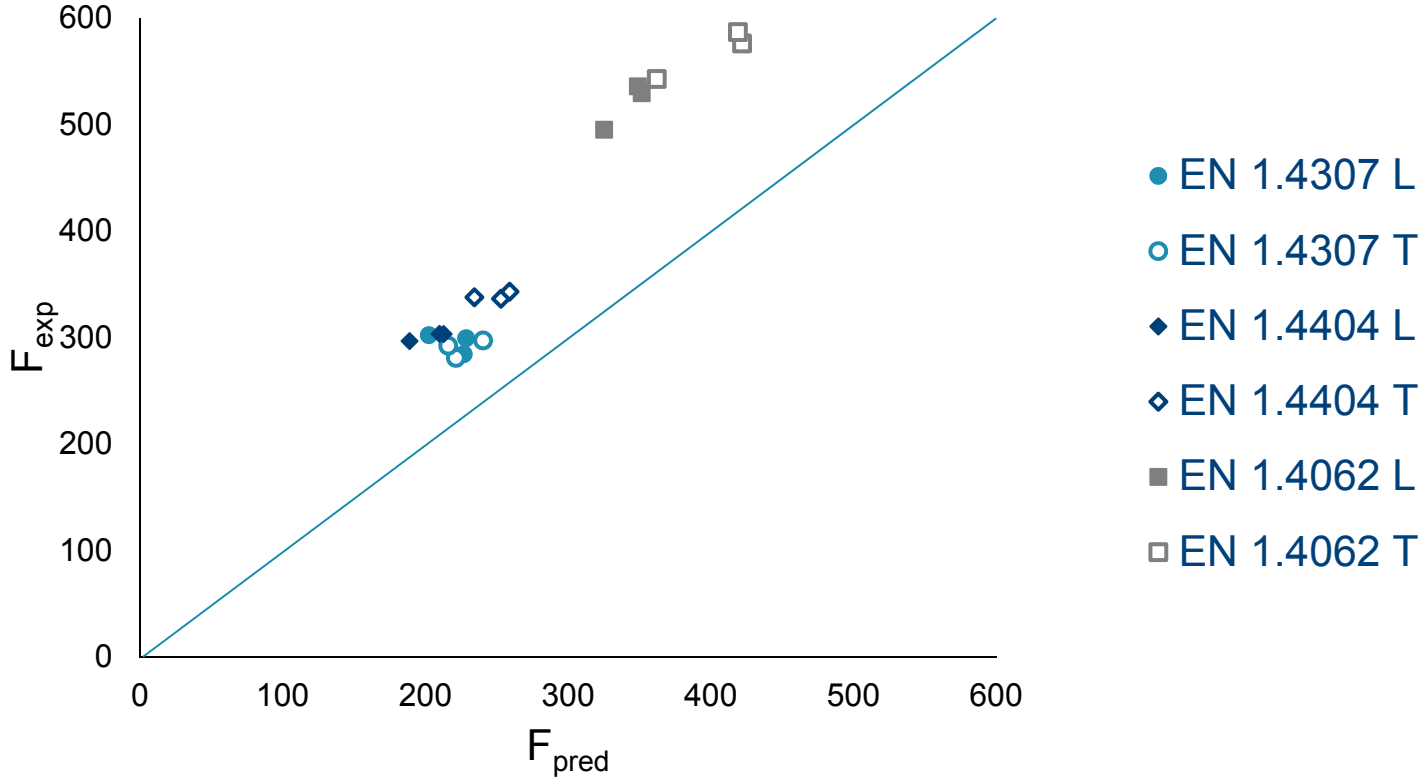
Assessment of the design rules

- Using design values
  - $A_1 = a_{nom} * (l_{nom} - 2a_{nom})$



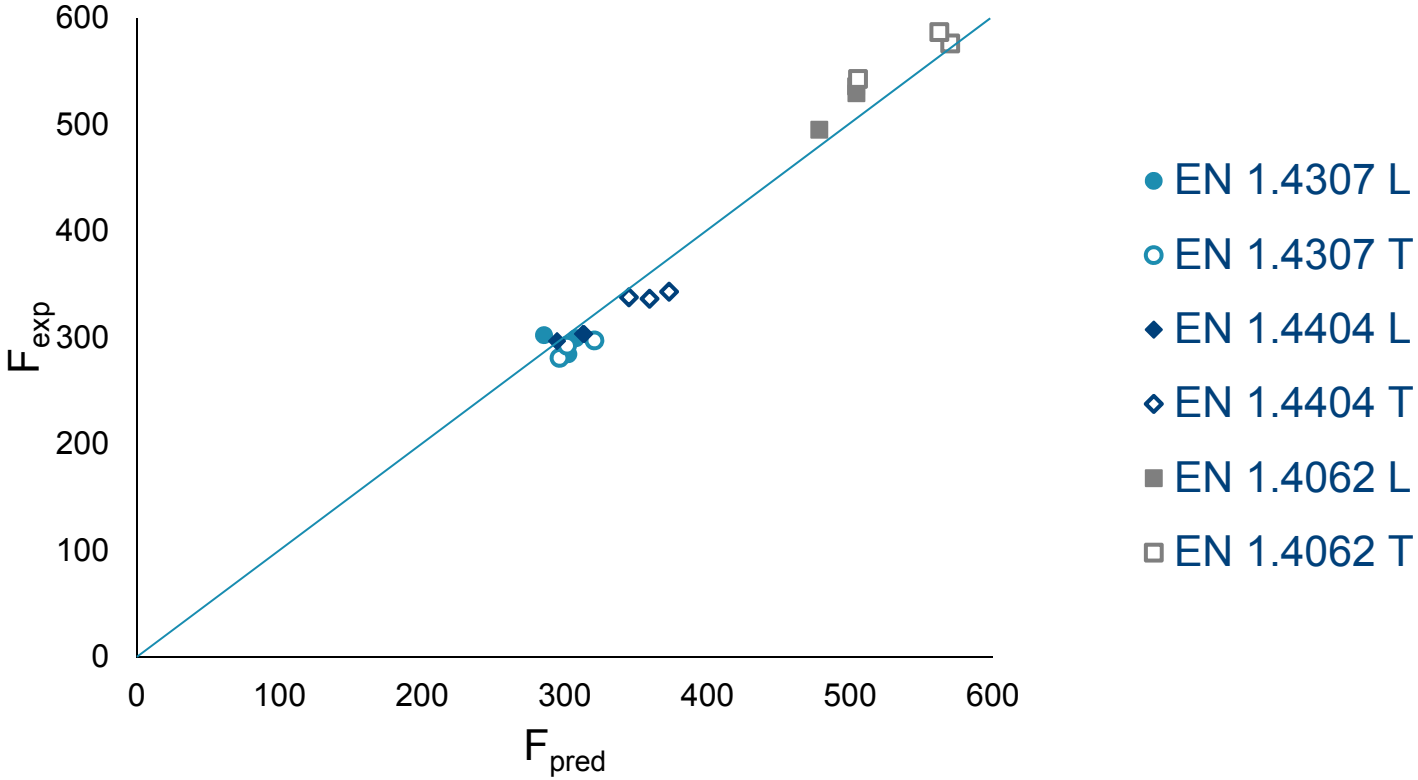
Assessment of the design rules

- Using measured geometry
  - $A_2 = a_{eff} * l_{eff}$



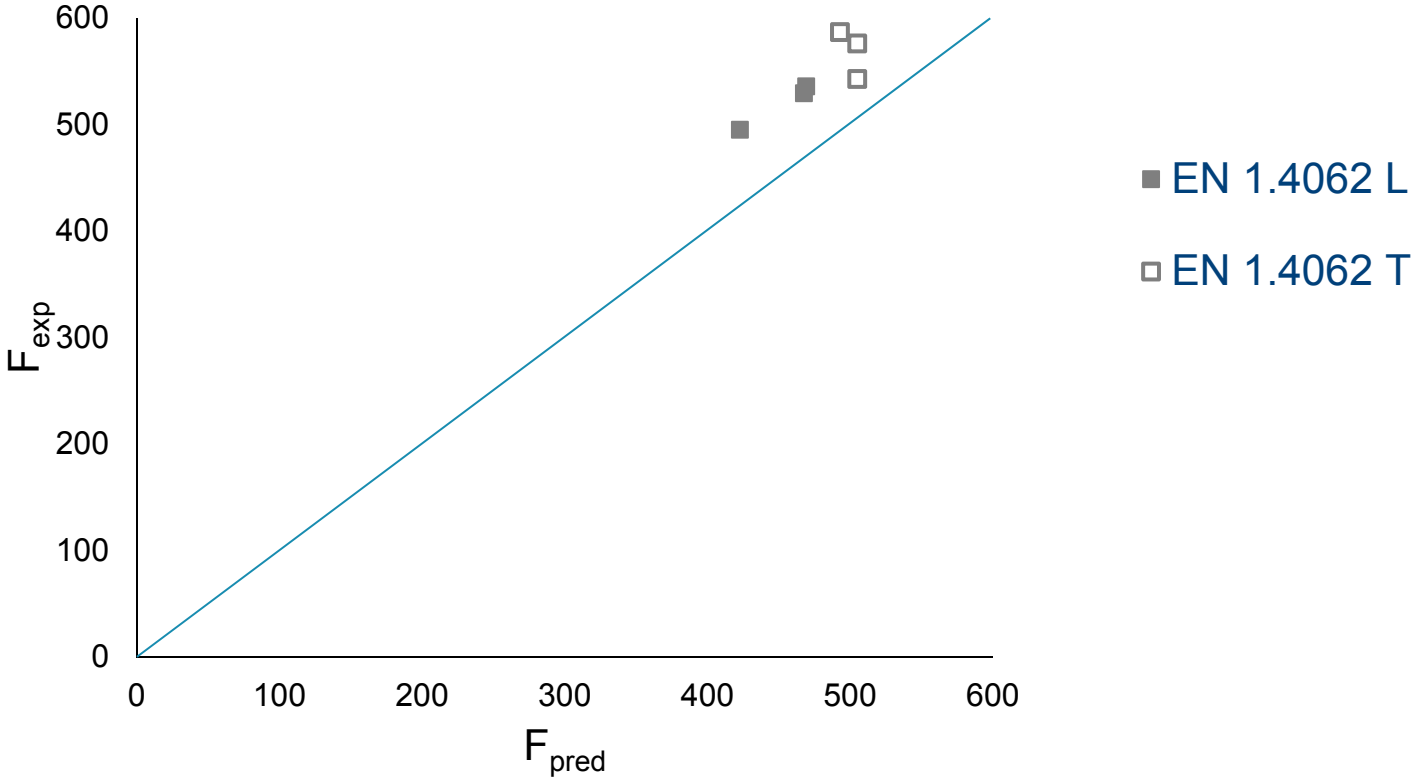
Assessment of the design rules

- Using the excessive penetration
  - $A_3 = a_{eff} * l_{eff} + i * (l_{eff} - 2a_{eff})$



Assessment of the design rules

- Using the measured fracture area
  - $A_4 = A_{fracture}$



Conclusions

- The test results show that it is safe to use the current design rules in EN1993-1-8 together with the correlation factor β_w of 1, as specified in EN1993-1-4.
- The tests on duplex suggest that a lower β_w value could be possible for this material, with an average experimental-to-predicted strength ratio of 1.14, using the fracture area.
- A slightly lower ratio was found for the austenitic grades, leading to the preliminary conclusion that a correlation factor β_w of 1 is suitable for these grades.
- Currently, a campaign of 30 additional tests using various welding procedures is ongoing. The additional results will enable us to conclude on the correlation factor for duplex and austenitic stainless steel.

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Thank you for your attention

Questions?