A Study of Joining Conditions in Self Piercing Riveting of Aluminum Alloy Sheets

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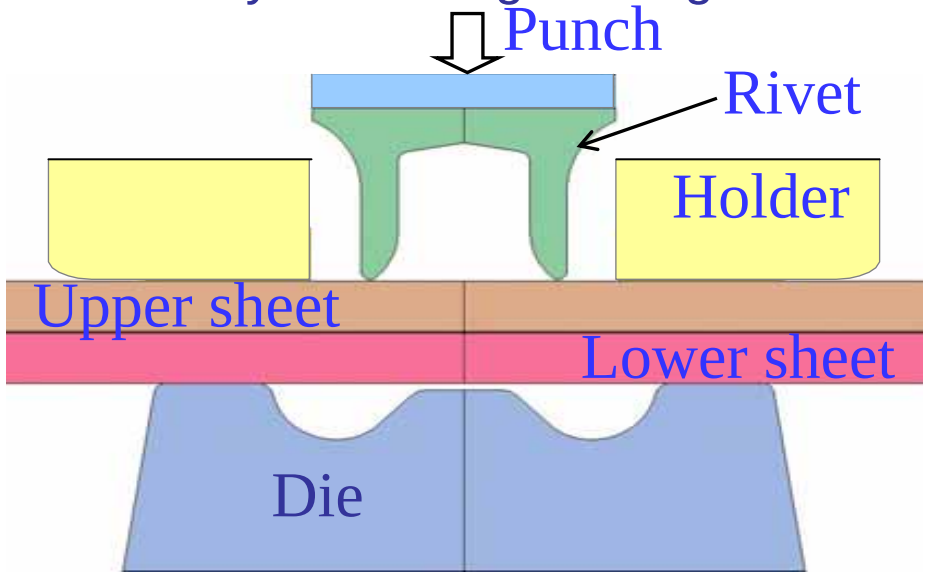
Light weight

Aluminum car Audi A8



Self piercing riveting

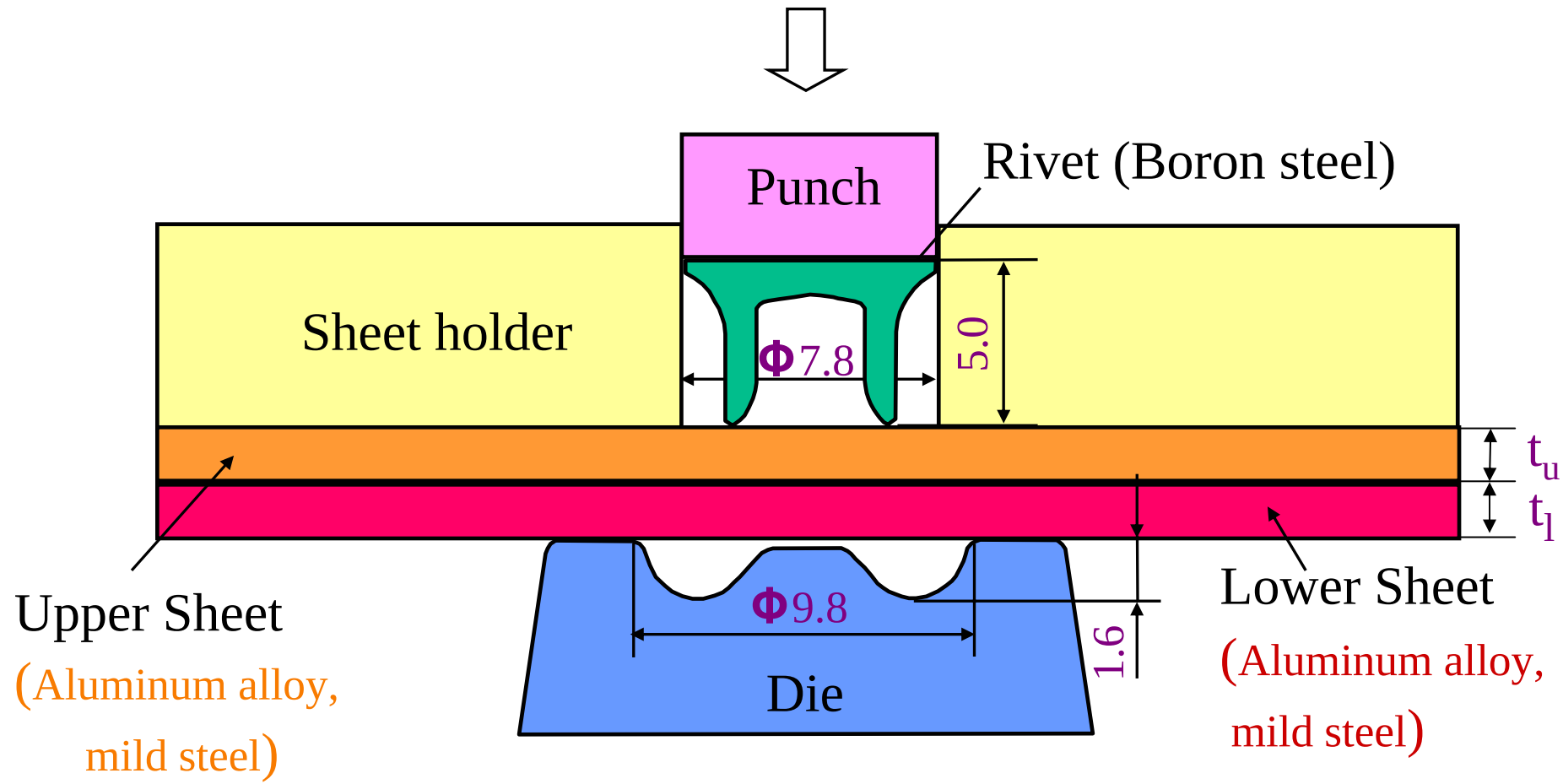
Advantages of SPR

- Simple and fast process
- Possibility of joining different materials: aluminum, steel

Purpose

- Joining process by both experiment and finite element simulation
- Influence of various joining conditions on joint performance

Experimental method of SPR



Experimental conditions of SPR

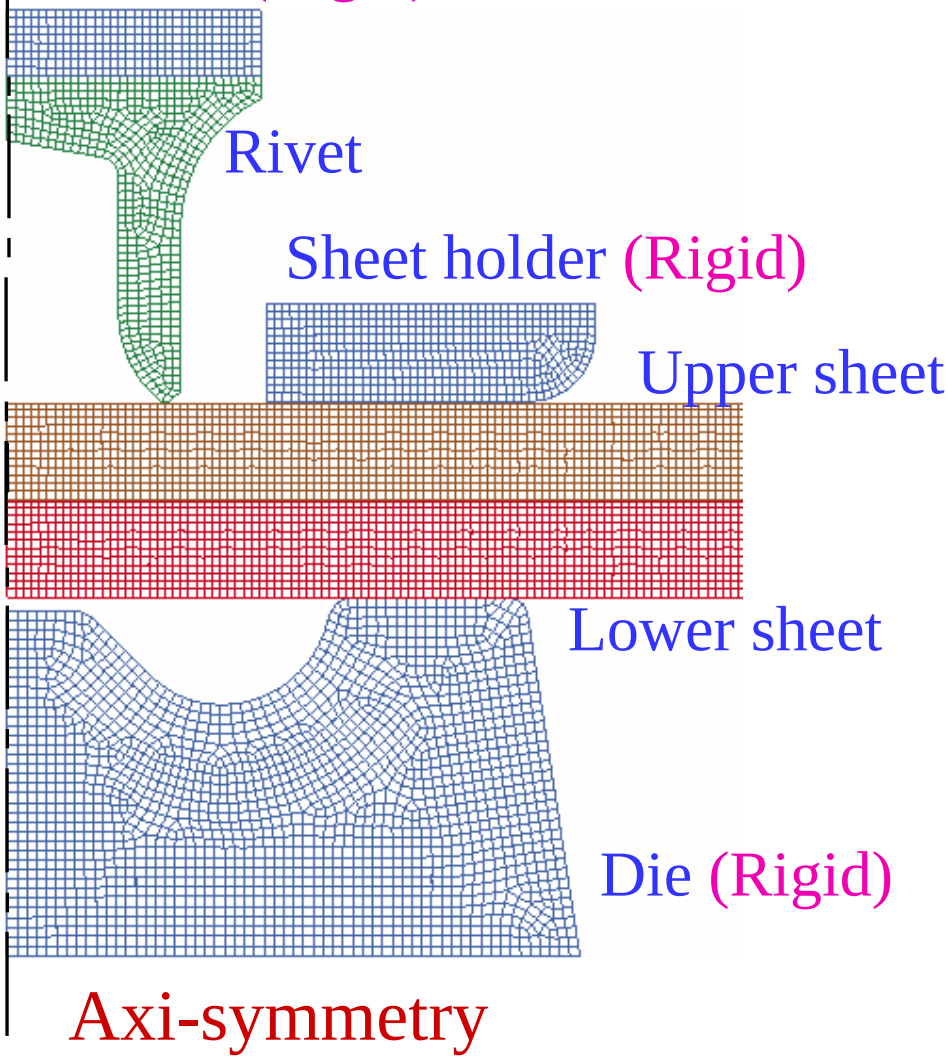
1. Thickness of sheet

Sheet	Thickness
Aluminum alloy: A5052-H34	1.0mm, 1.5mm, 2.0 mm
Mild steel: SPCC	0.8mm, 1.2mm, 1.6mm, 2.0mm

2. Combination of sheets :

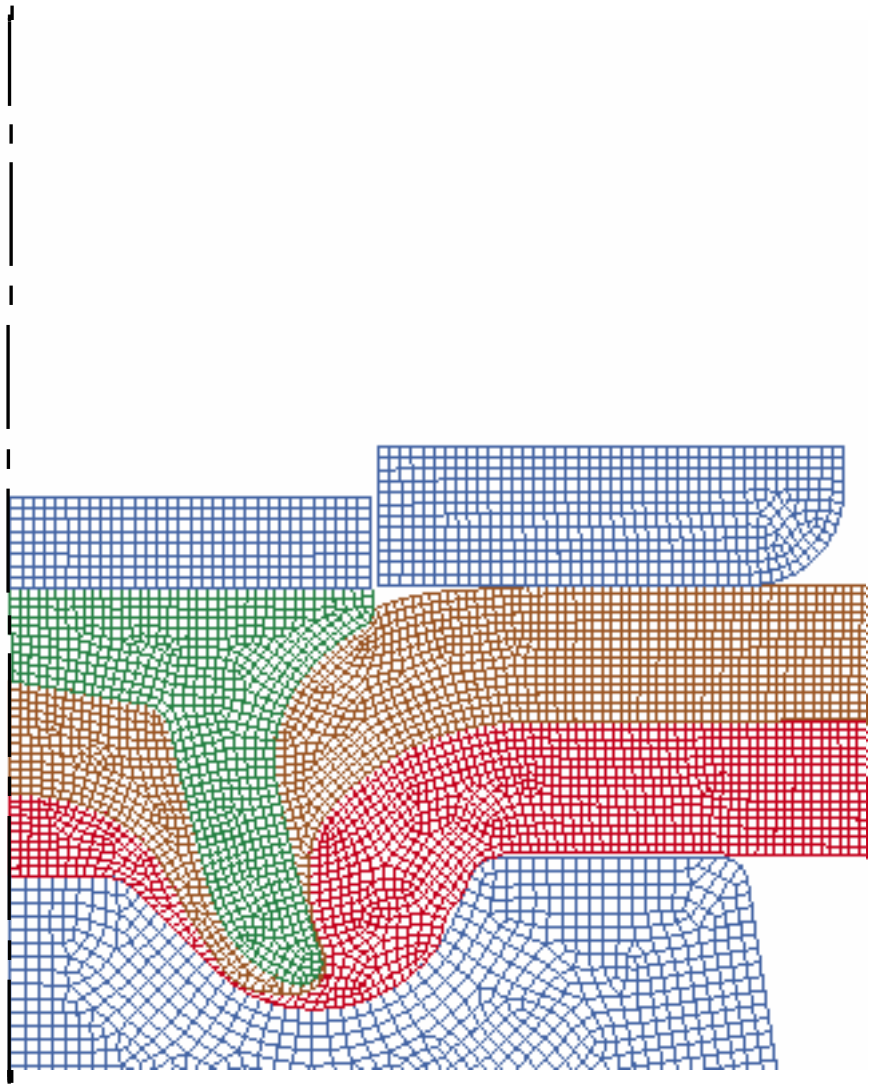
	Upper sheet	Lower sheet
Aluminum-aluminum	Aluminum	Aluminum
Aluminum-steel	Aluminum	Steel
Steel-aluminum	Steel	Aluminum

Conditions of calculation of SPR

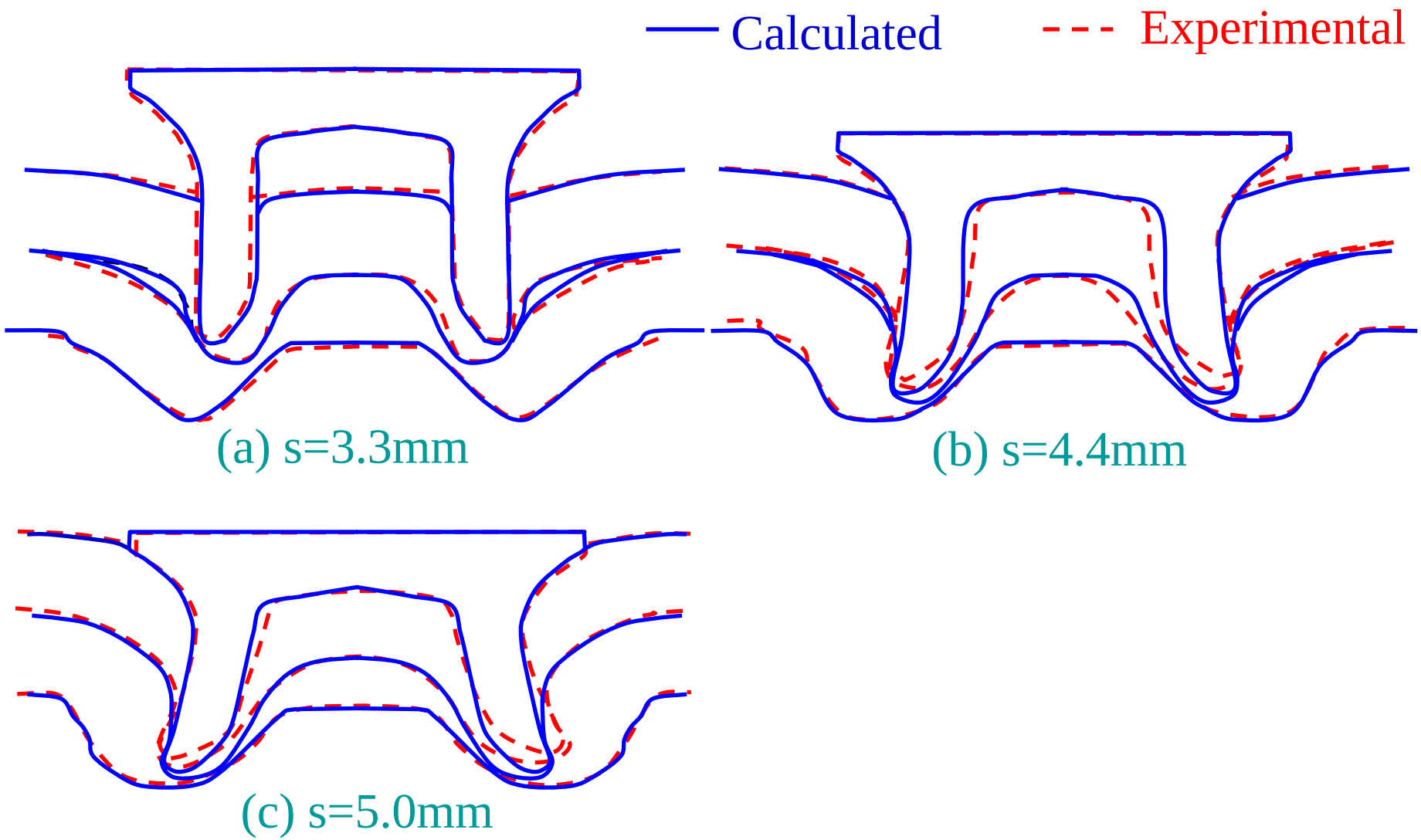


Solver	LS-DYNA
Rivet and sheets	Solid
Coefficient of friction	0.20
Calculation time	75min

Animation of joining process of SPR obtained by finite element simulation for aluminum-aluminum



Comparison between cross-sectional shapes obtained from calculation and experiment in different strokes for aluminum-aluminum



Prediction of defects from calculation for aluminum-steel

Defects

Penetration

t_u=1.0mm

t_l=0.8mm

Necking

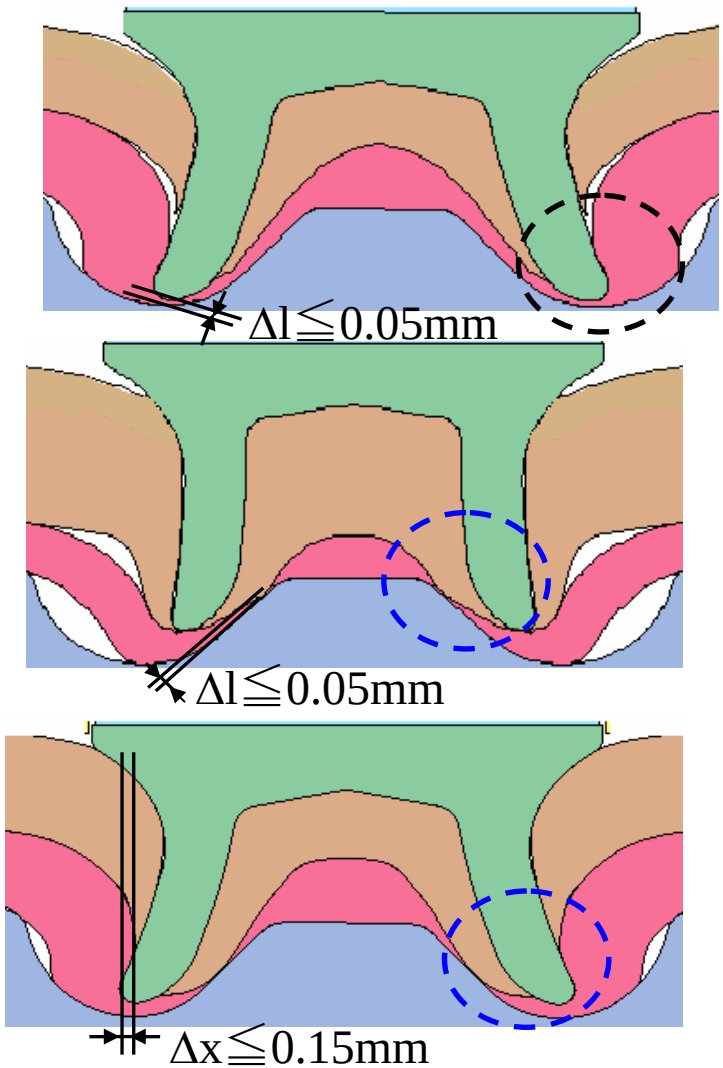
t_u=2.0mm

t_l=0.8mm

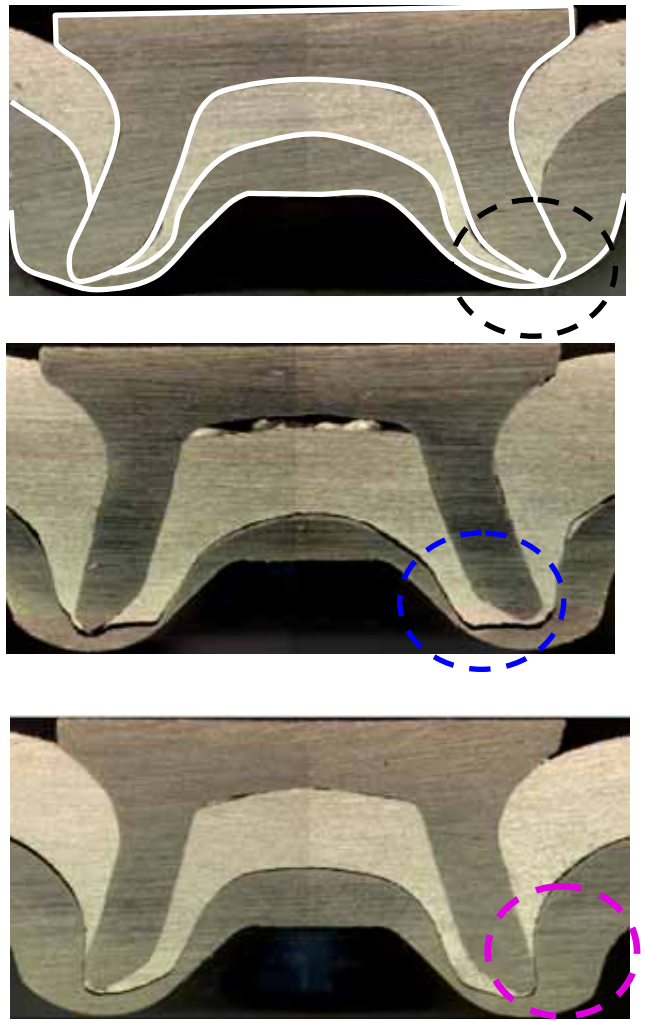
Separation

t_u=1.5mm

t_l=1.2mm

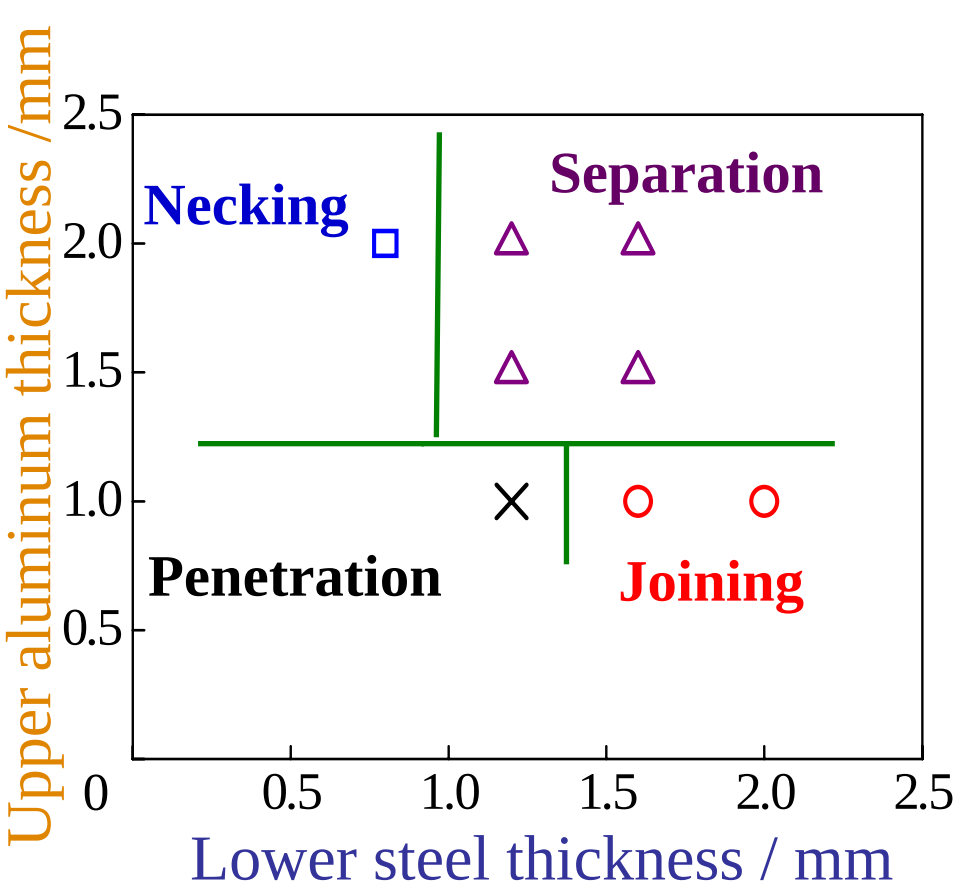


(a) Calculated

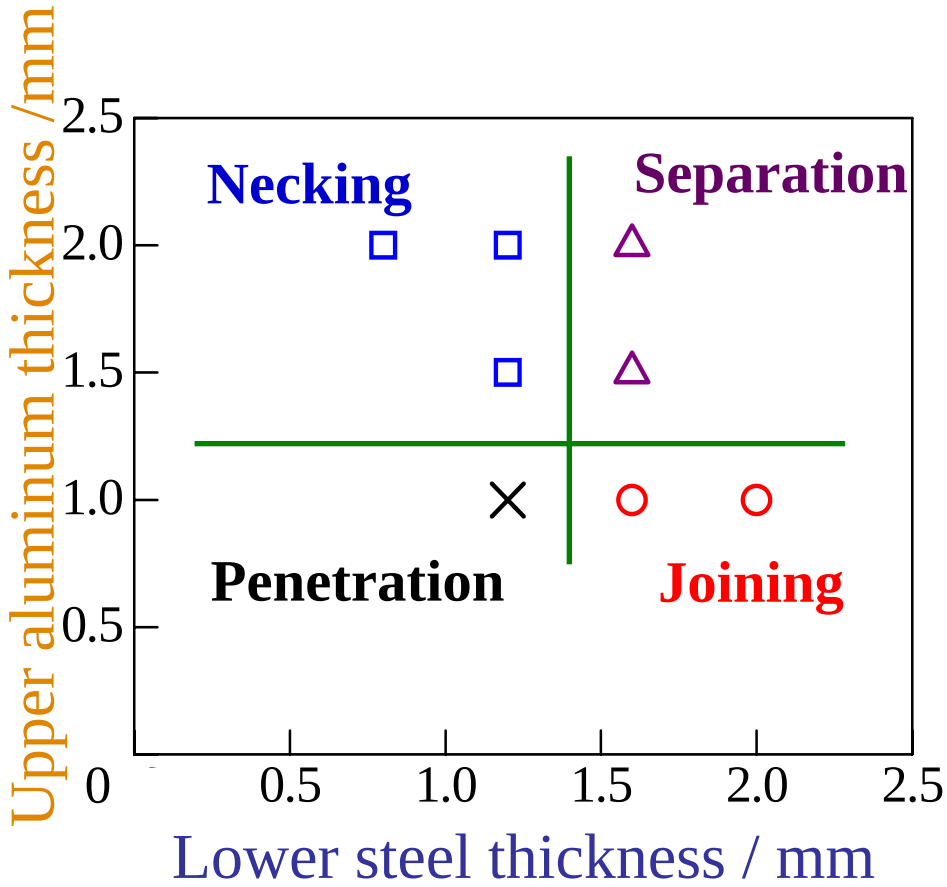


(b) Experimental

Joint performances for aluminum-steel

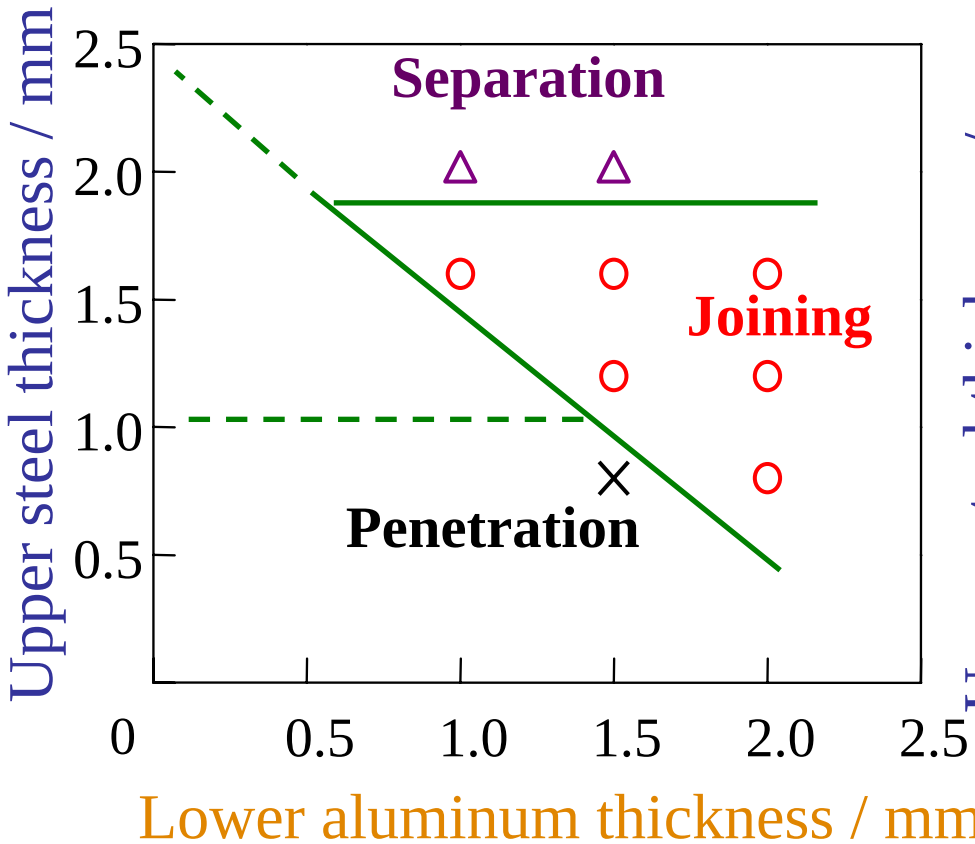


(a) Experimental

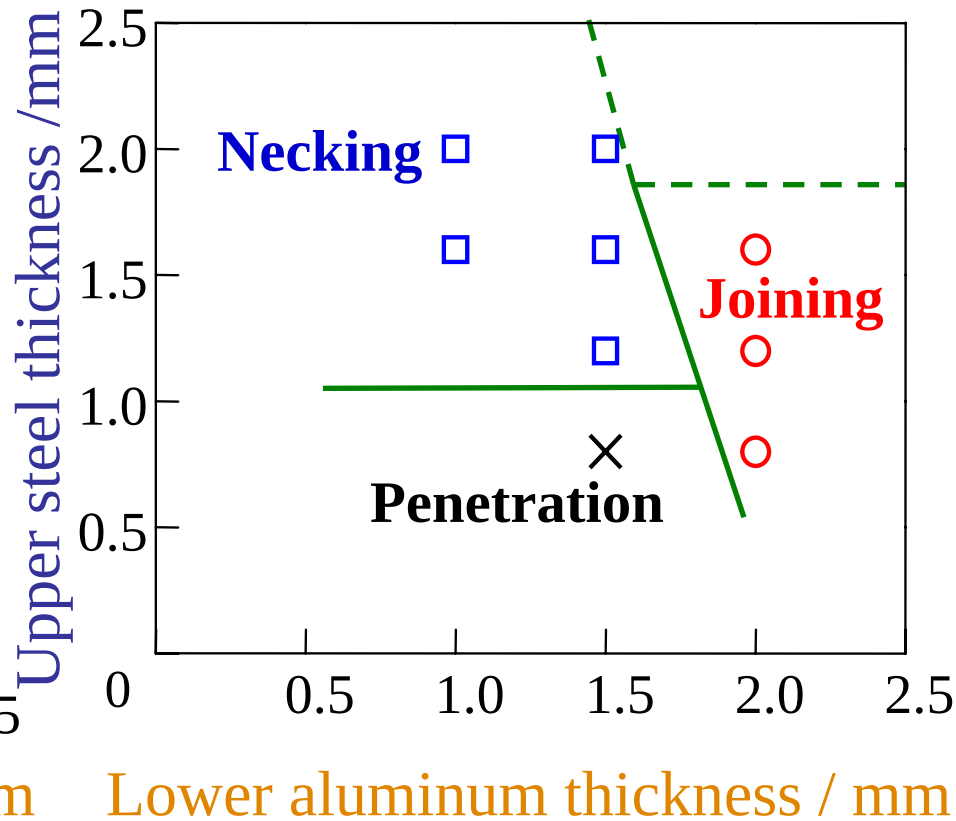


(b) Calculated

Joint performances for steel-aluminum

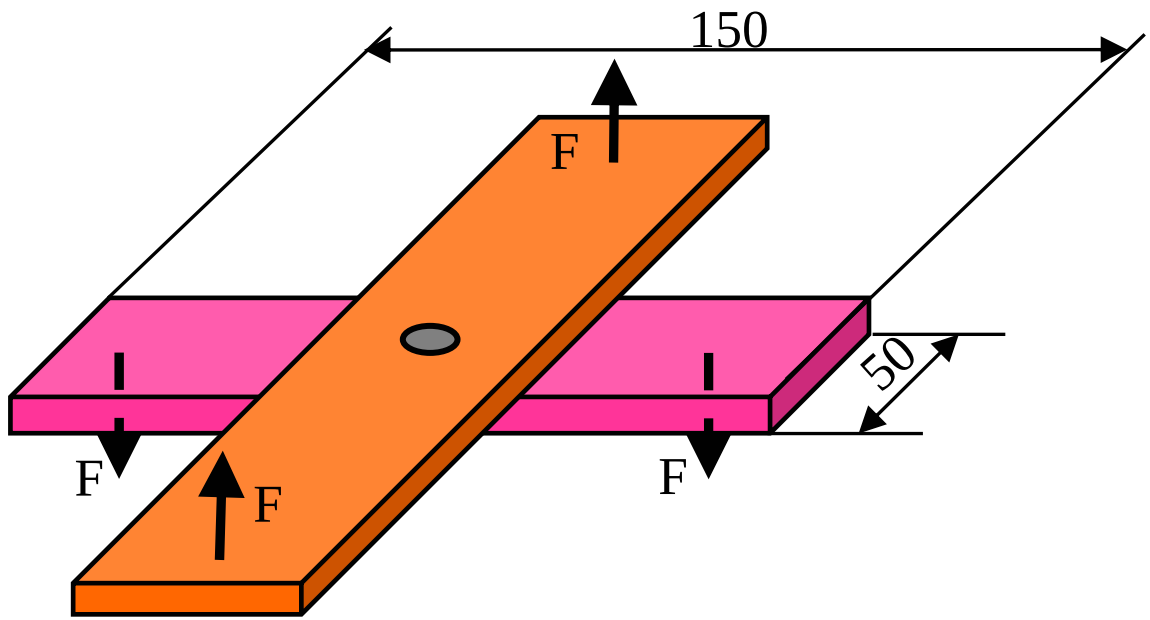


(a) Experimental

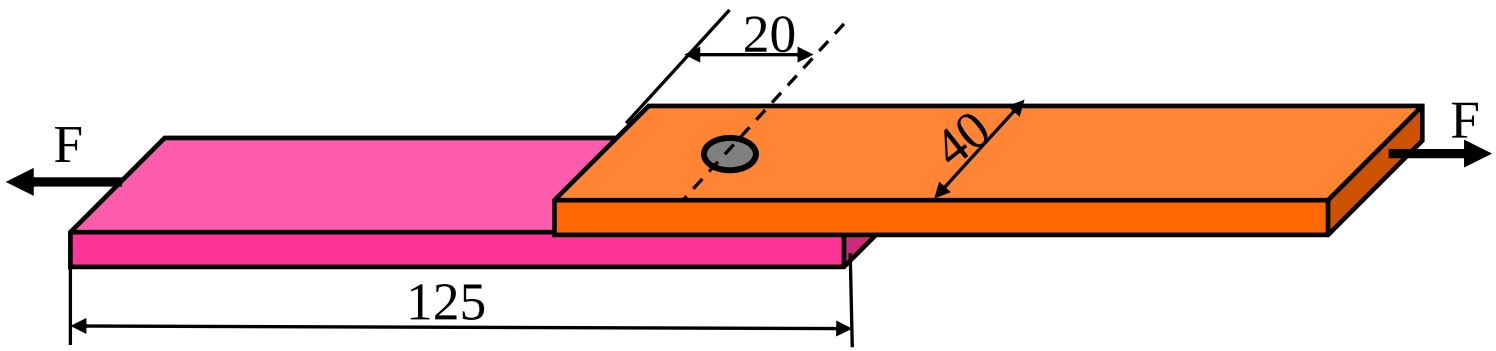


(b) Calculated

Evaluation of joint strength

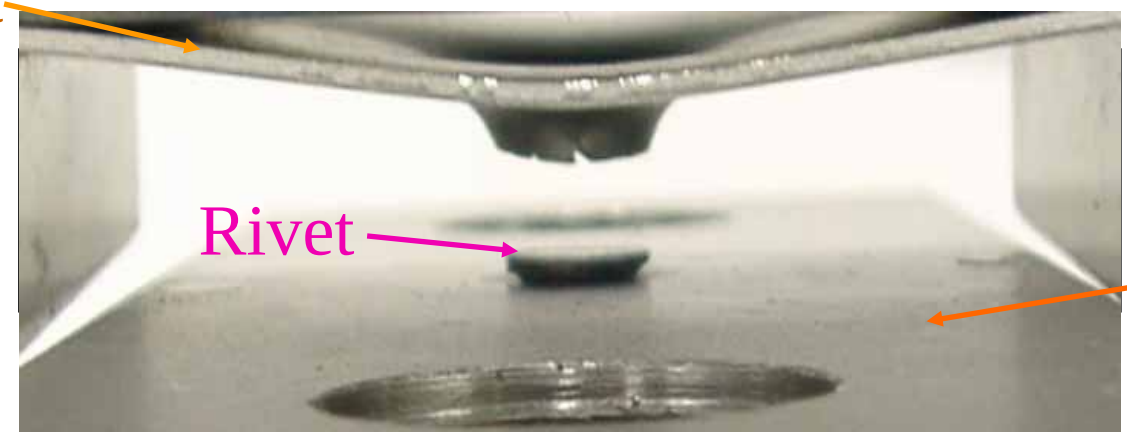


(a) Tensile test



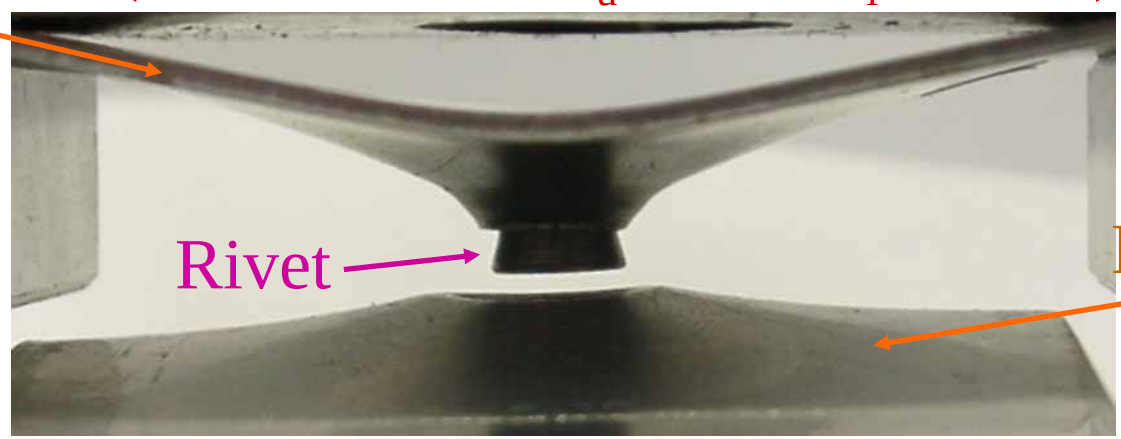
(b) Shearing test

Fractures observed in tensile test



(a) Fracture of upper sheet

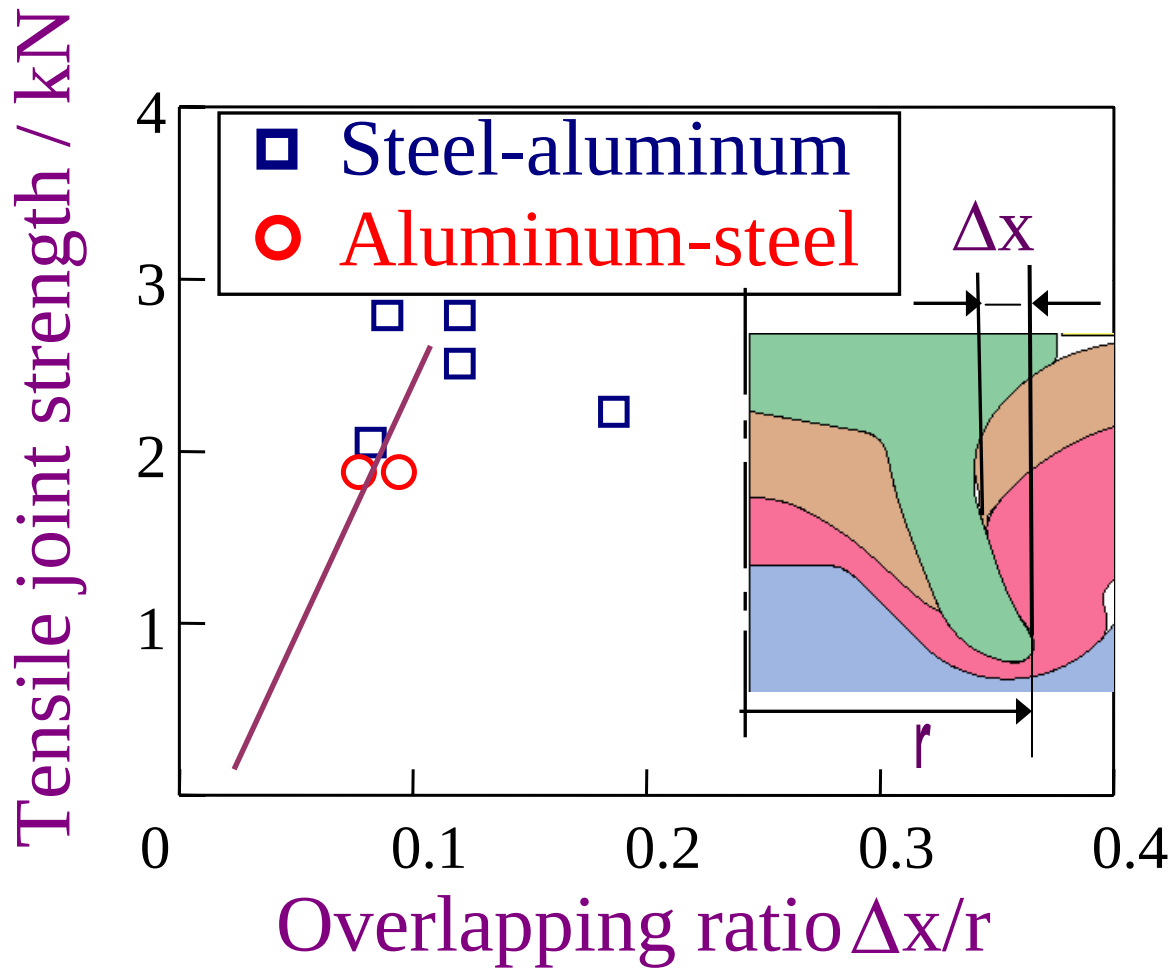
(Steel-aluminum, t_u=0.8mm,t_l=2.0mm)



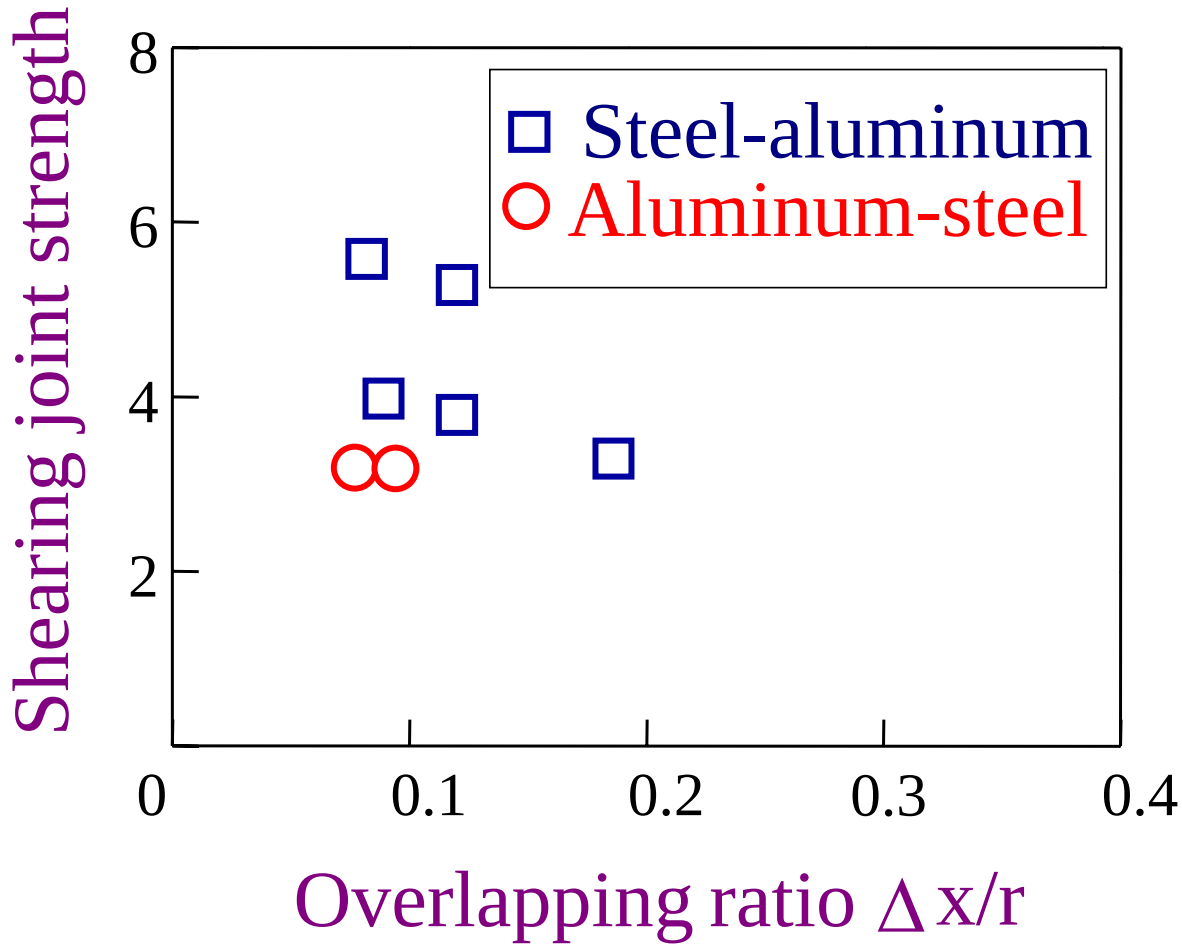
(b) Fracture of lower sheet

(Steel-aluminum, t_u=1.2mm,t_l=2.0mm)

Variation of tensile joint strength with overlapping ratio



Variation of shearing joint strength with overlapping ratio



Conclusions

1. The self piercing riveting is investigated by the finite element simulation, and the necking, penetration and separation can be predicted.
2. The combination and thicknesses of the sheets have large influences on the joint performance.
3. The aluminum and steel sheets can be joined by the self piercing riveting.