

Accelerating environmental ageing of adhesive aluminium joints by changing the specimen geometry

S. Golob^{1,2,3}, J. Holtmannspötter¹, M. Johlitz², M. Frauenhofer³, A. Lion²

¹WIWeB, Erding, Institutsweg 1, 85435, GER.

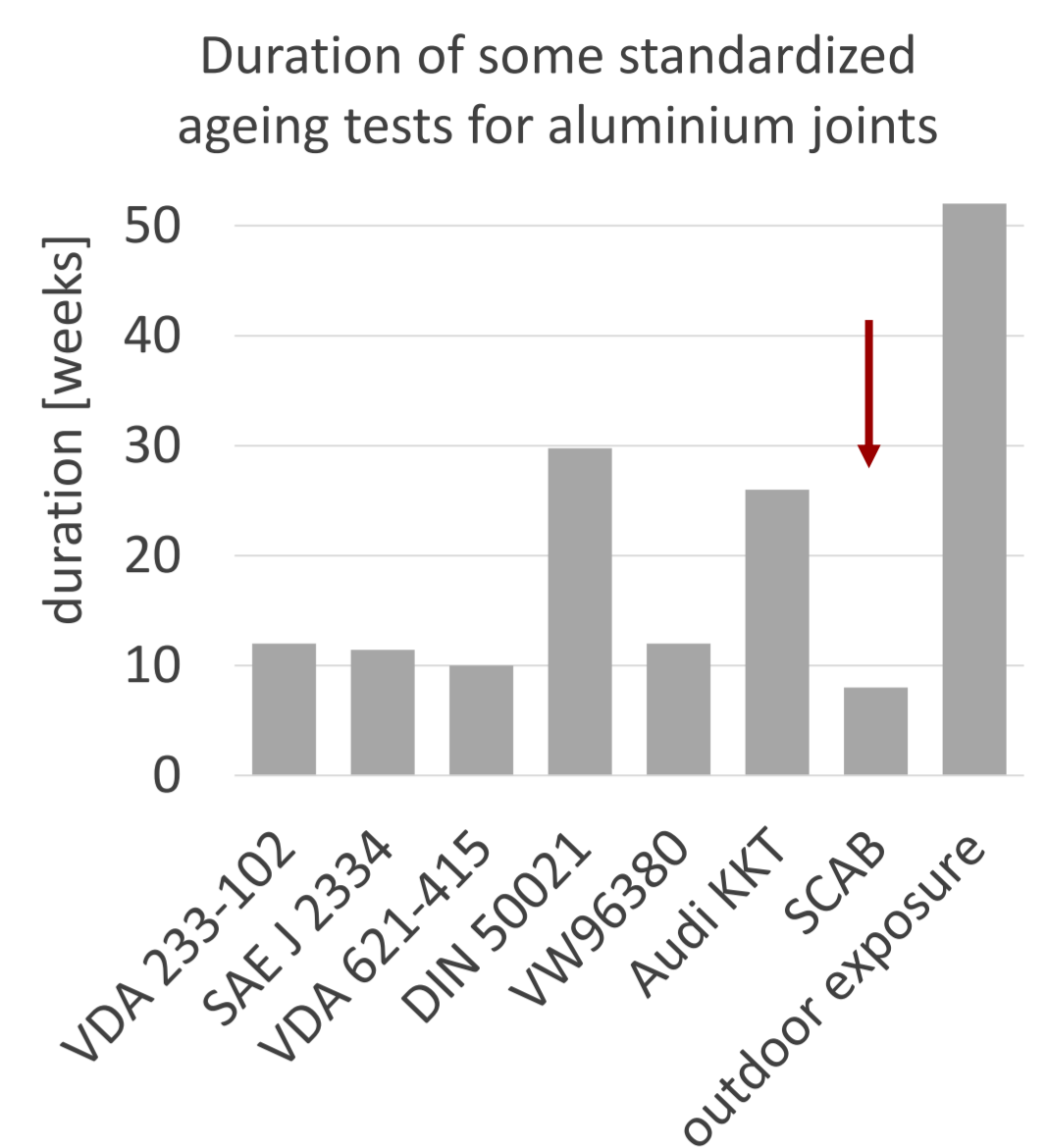
²Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, Neubiberg, 85577, GER.

³Audi AG, Ingolstadt, 85045, GER.

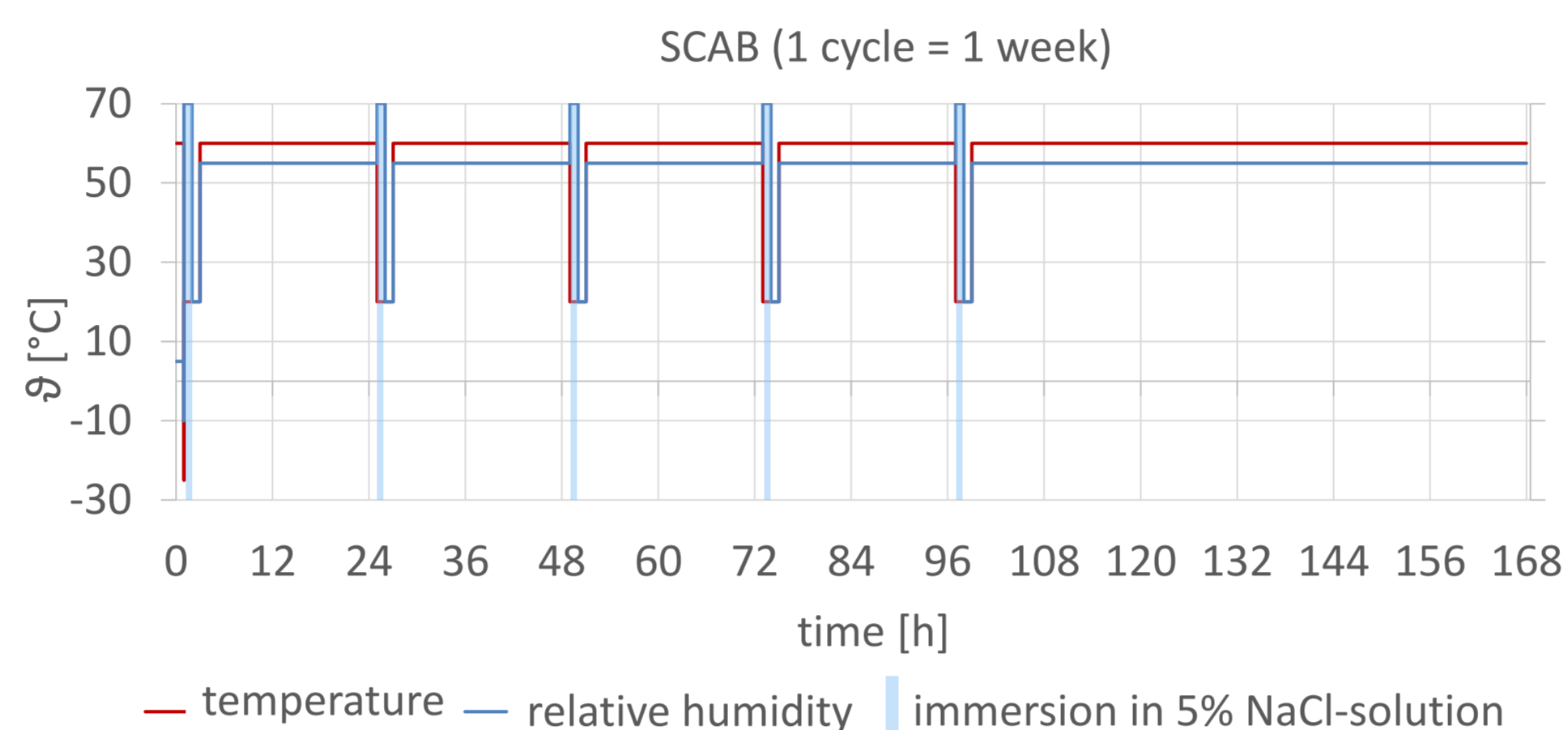
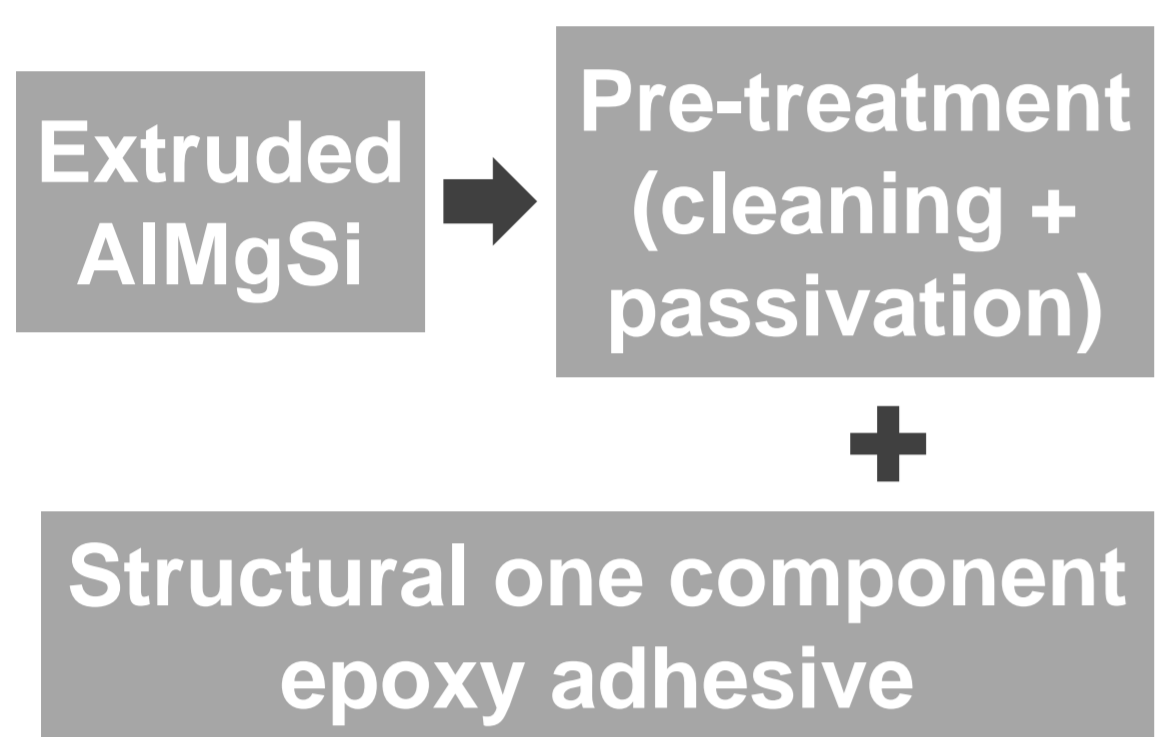
Motivation / General Approach

Adhesive joints in any application are exposed to environmental influences. Especially on metallic substrates, degradation processes such as corrosion can significantly weaken the bond. Therefore, their durability must be confirmed before use. Since degradation processes occur very slowly in reality, accelerated ageing tests have been developed that shorten the duration by intensifying environmental conditions in the laboratory. However, these accelerated ageing tests are still time-consuming and further intensifying of the environmental parameters would lead to results that are far from reality.

In this work, the influence of an adapted specimen geometry of the commonly used single lap joints (SLJ) on the ageing processes is investigated. SLJs with different widths, overlap lengths and adhesive layer thicknesses as well as an open-faced variant are aged and the degradation processes are evaluated. From this, an optimized geometry is developed and examined in more detail.



Experimental process



Destructive testing

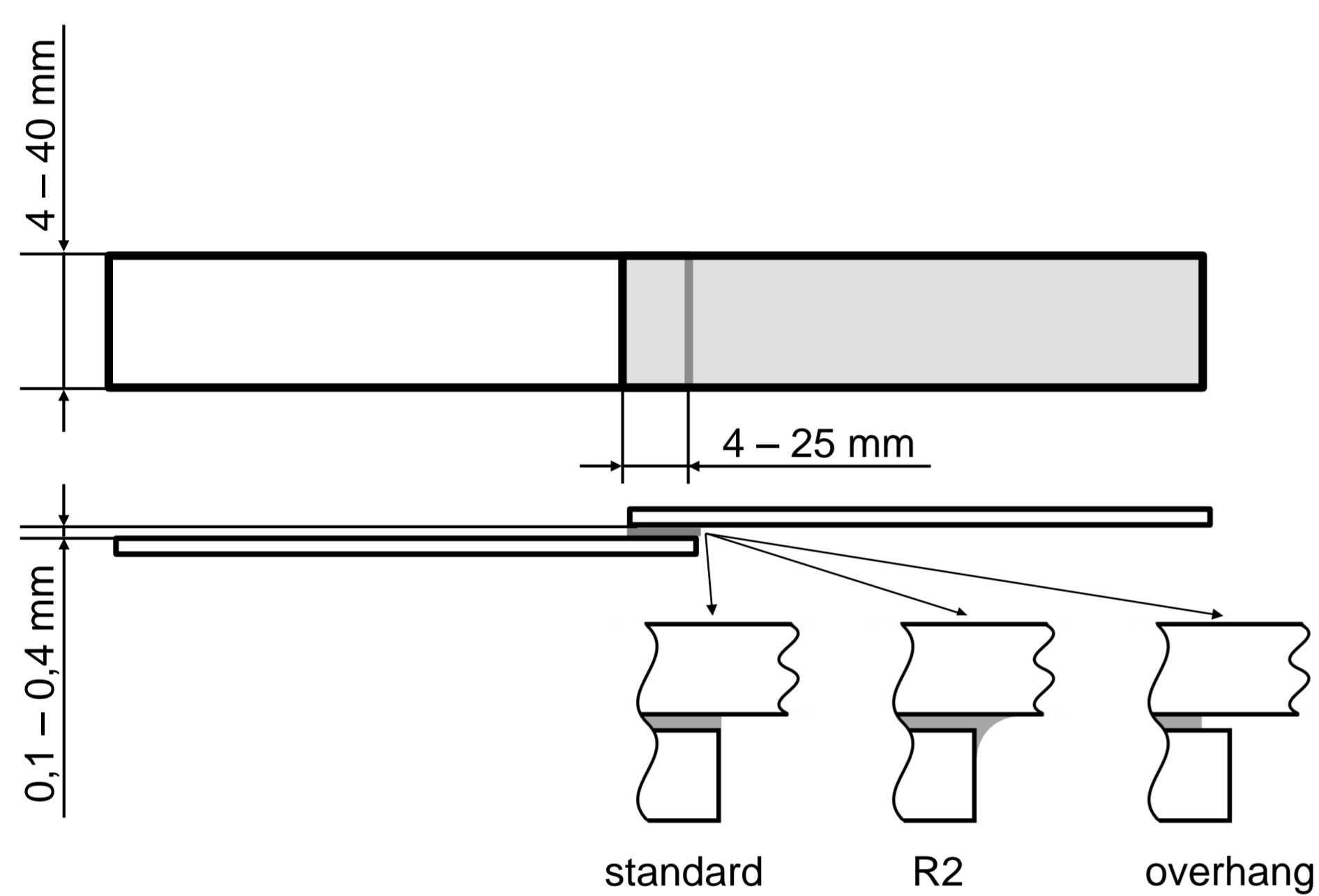


Fracture pattern evaluation

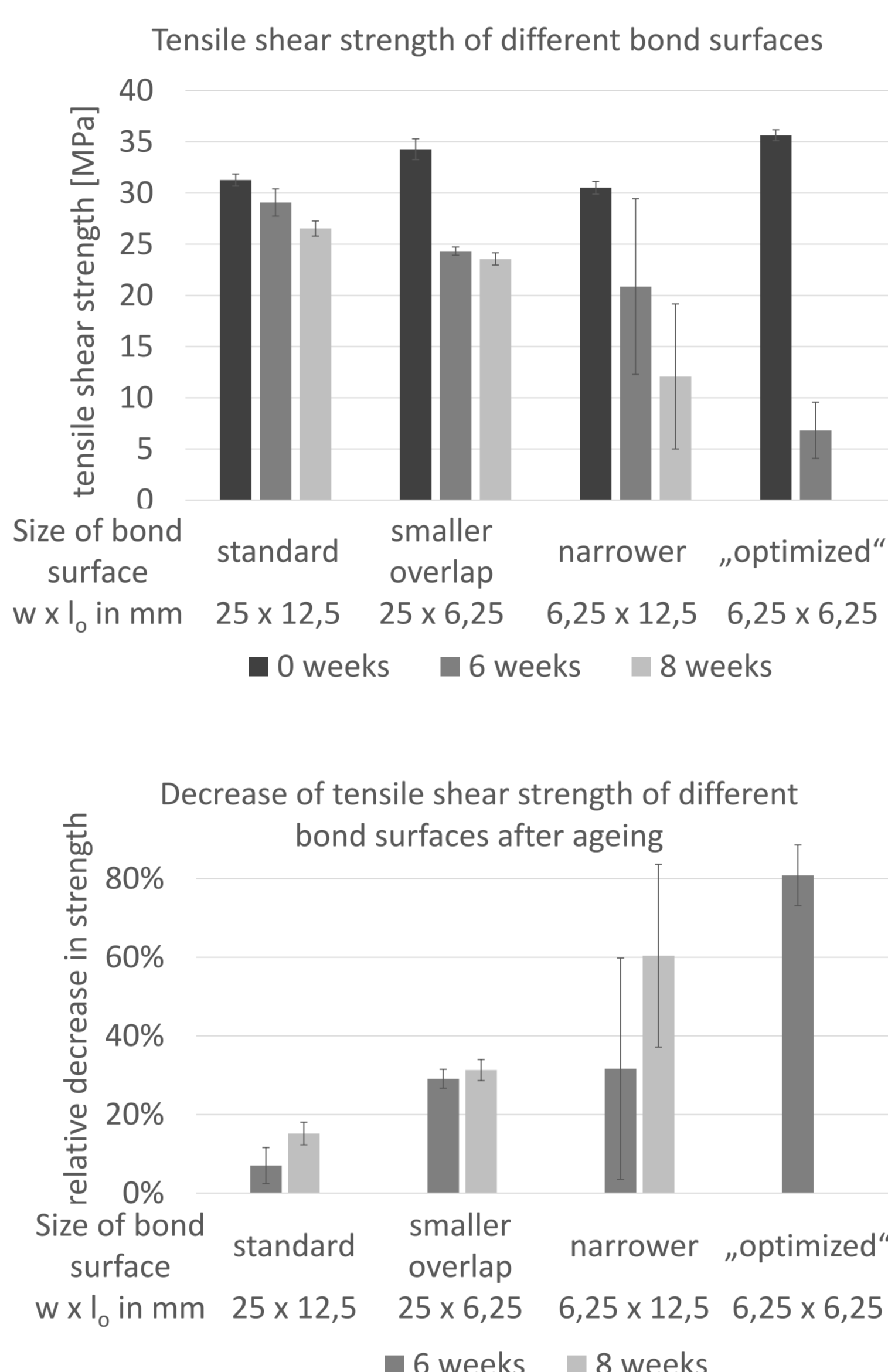
Preparation single lap joint (SLJ)

6/ 8 weeks ageing

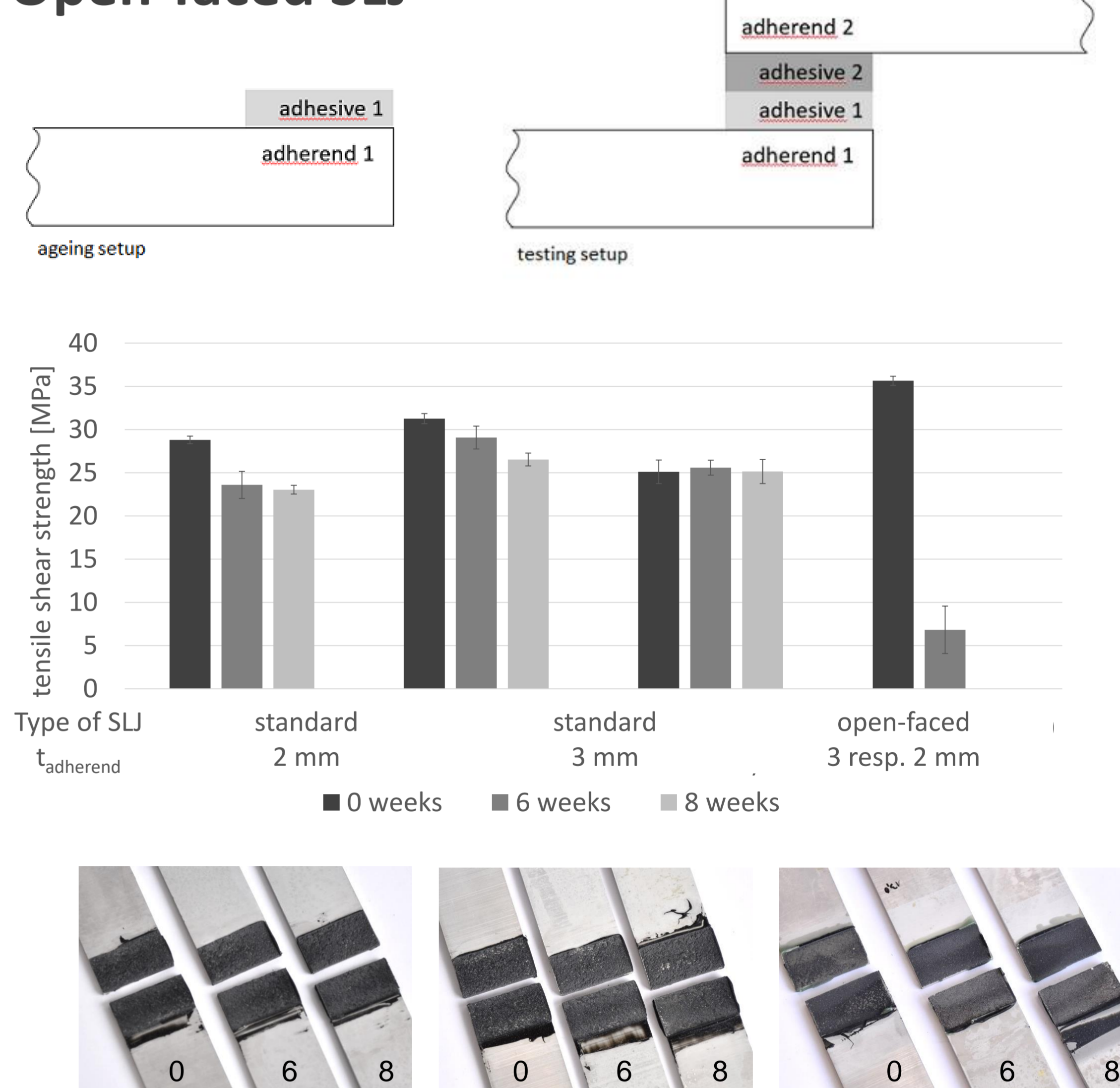
Varied SLJ geometry



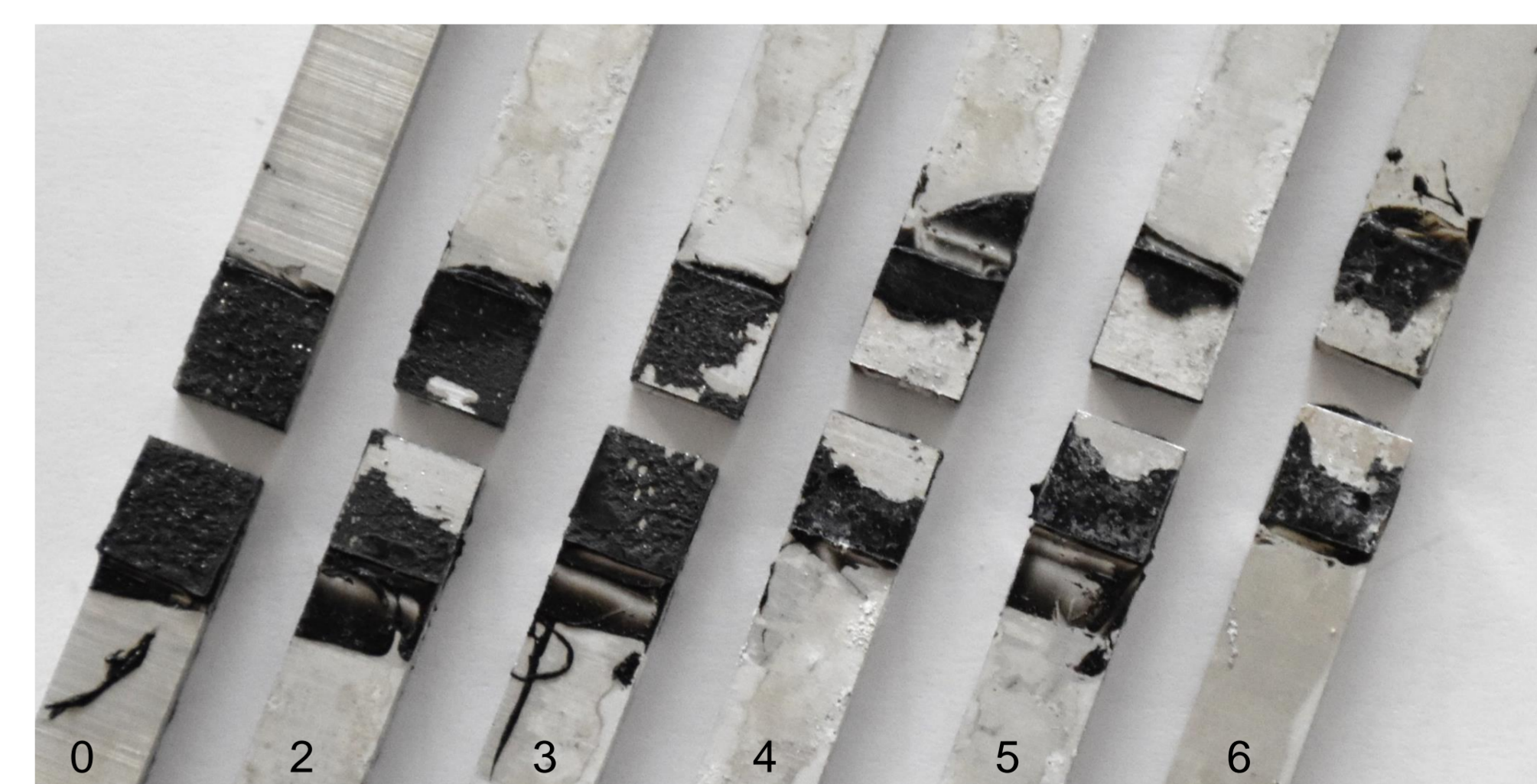
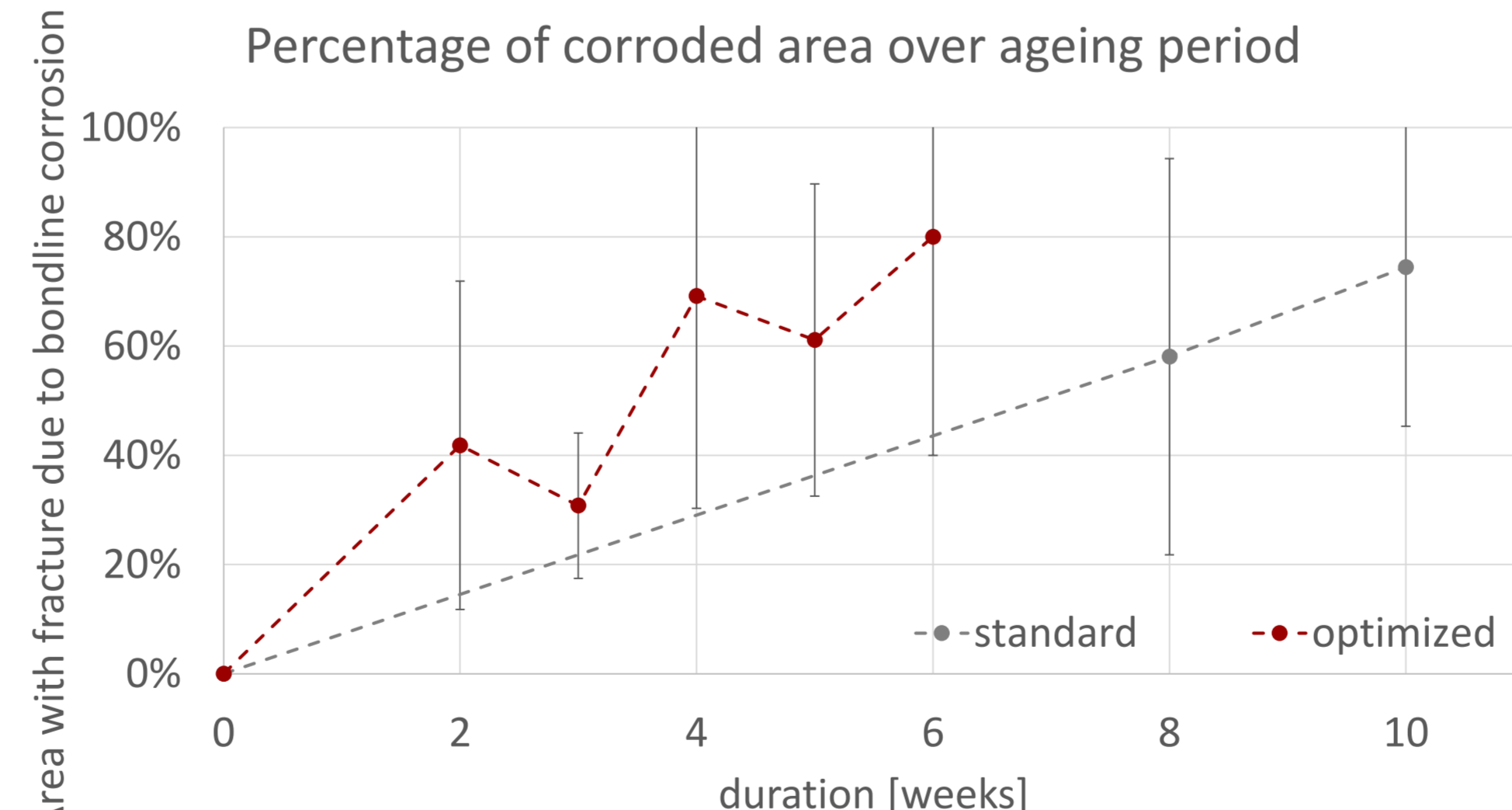
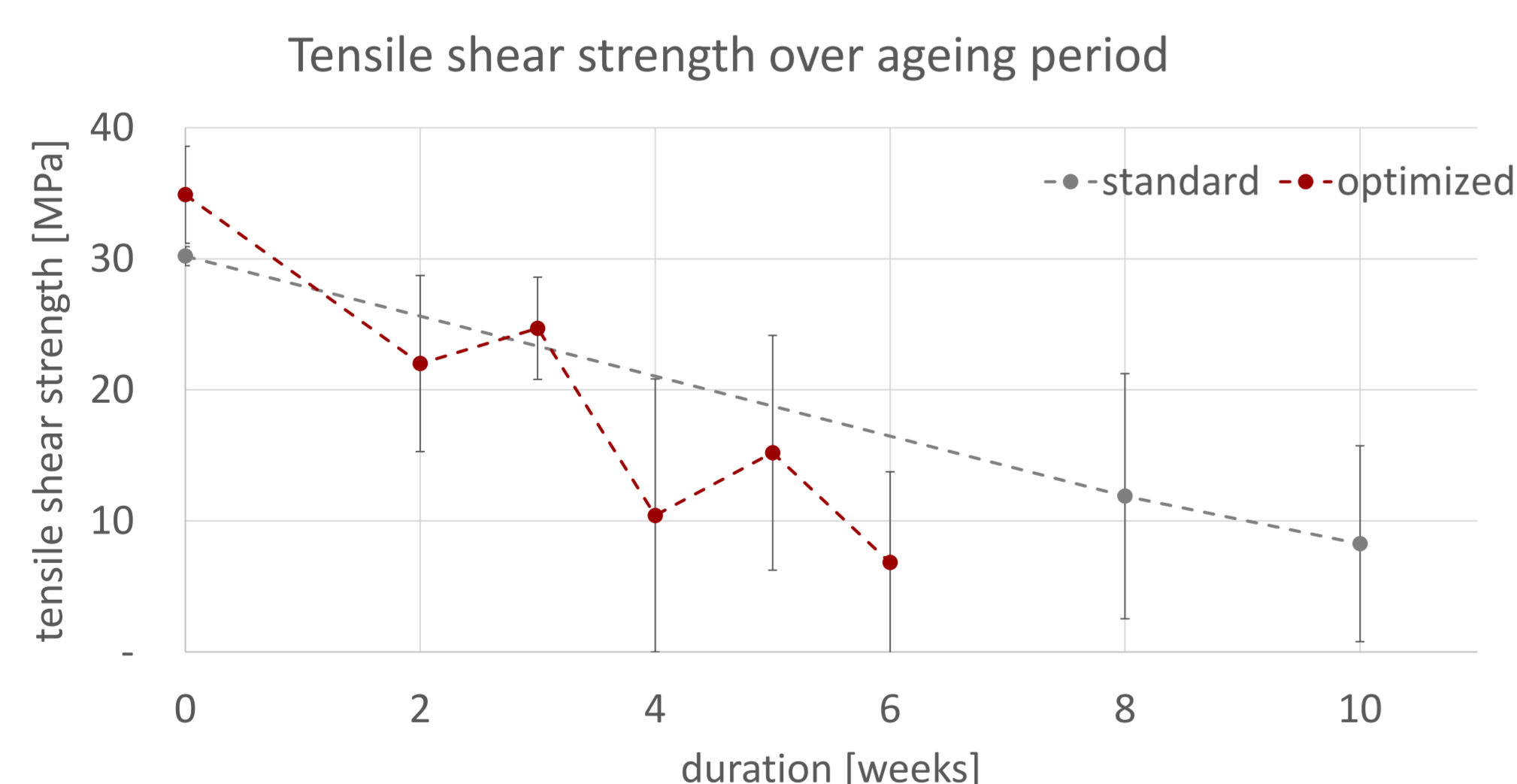
Results	After ageing	
	Decrease in tensile shear strength	(bondline) corrosion
Varied parameter		
Width (w)	↓ ↗	↗
Overlap length (l_o)	↓ ↗	○
Adhesive thickness	↓ ○	○
Spew geometry	○ resp. ↗	○



Open-faced SLJ



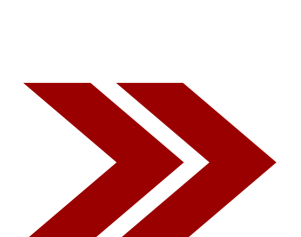
"Optimized" geometry



Fracture pattern of „optimized“ SLJs after 0/ 2/ 3/ 4/ 5/ 6 weeks of ageing

Conclusion

- A change in the SLJ geometry to narrower specimens with a smaller overlap length leads to more severe or faster signs of ageing.
- A change in the adhesive layer thickness or the geometry of the spew has no effect or changes the dominant degradation process.
- The open-faced variant does not indicate any increased ageing effect. This shows that diffusion through the adhesive bulk plays only a small role in the corrosive processes.
- As a test geometry optimized for ageing, a significantly downsized SLJ was tested, which has a more than twice as large ratio of edges to area in the adhesive surface.
- The tensile shear strength of the "optimized" SLJs drops and the area with bondline corrosion increases significantly in a short time. The fracture pattern as well as the tensile shear strength shows a wide variation.
- Further investigations will be carried out with other materials and a different ageing test (VDA233-102).



The relevant degradation processes occur and migrate along the interface, diffusion through the bulk plays a minor role. Due to the smaller adhesive surface and the larger edges to area ratio, the optimized SLJs show strong signs of ageing much earlier. The small adhesive surface and demanding manual sample preparation lead to a larger variance in the results.

