GREAT DESIGNS IN STEEL

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GREAT DESIGNS IN STEEL

AHSS REPAIRABILITY

AUTO/STEEL PARTNERSHIP

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PROJECT TEAM MEMBERS

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- Ted Coon, Ford Motor Company
- Mike Palko, Ford Motor Company
- David Rigg, General Motors Co.
- Rob Kaminski, Nucor Corporation
- Dean Kanelos, Nucor Corporation
- Weiping Sun, Nucor Corporation
- Hokook Lee, POSCO America

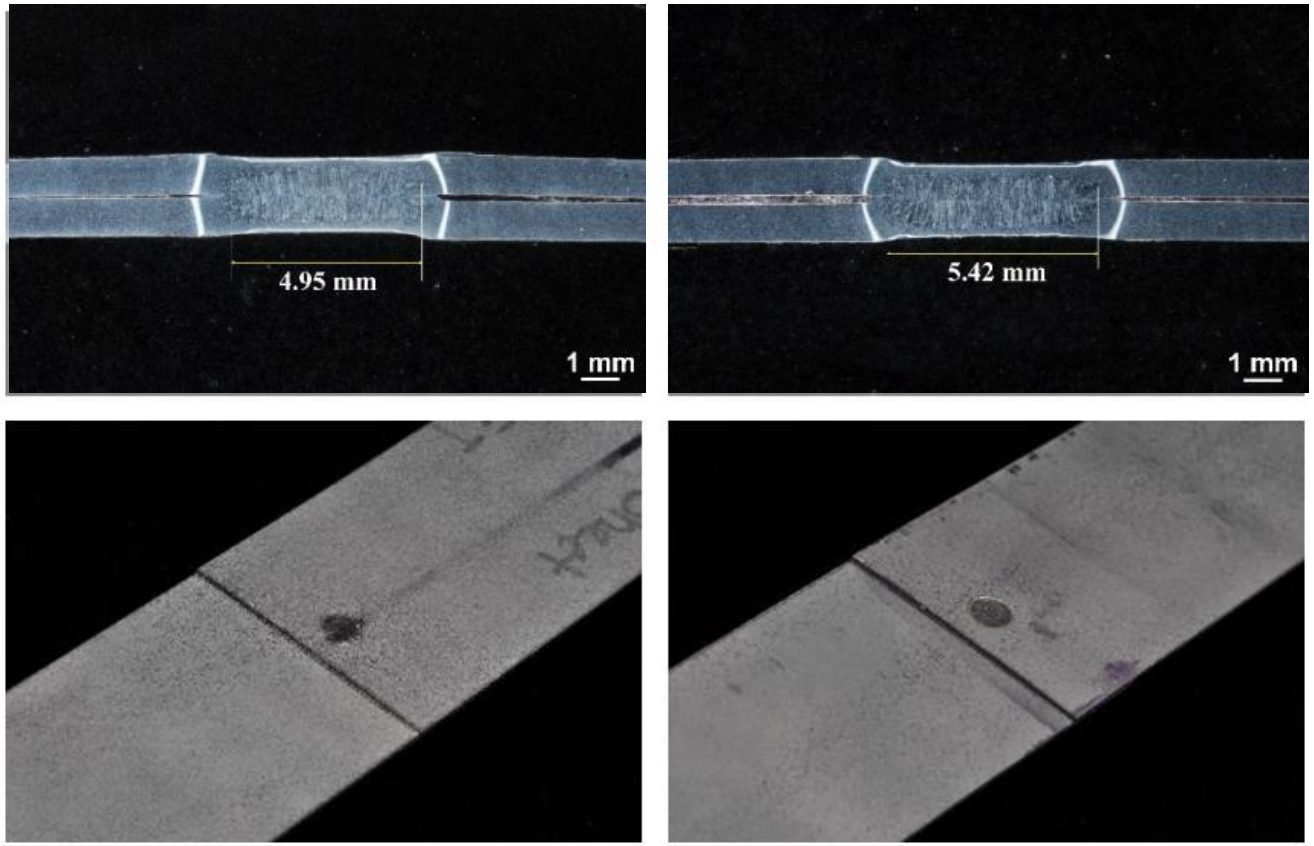
PROJECT GOALS

The purpose of this project was to evaluate various weld repair processes and to provide joint test data for use by OEMs

PROJECT APPROACH

- Using coupon test assemblies fabricated from various grades of AHSS, a variety of repair process joints were destructively tested. The resulting data can be used by OEMs to update repair process strategies
- MS1500, MS1700, and PHS1500 (heat treated) were tested
- Repair processes investigated include: resistance spot welding (RSW), gas metal arc welding (GMAW), gas metal arc brazing (GMAB), and mechanical fastening
- Production and service adhesives were also tested
- Tests include shear tension and cross tension quasi-static, shear tension fatigue, and cross-sections

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

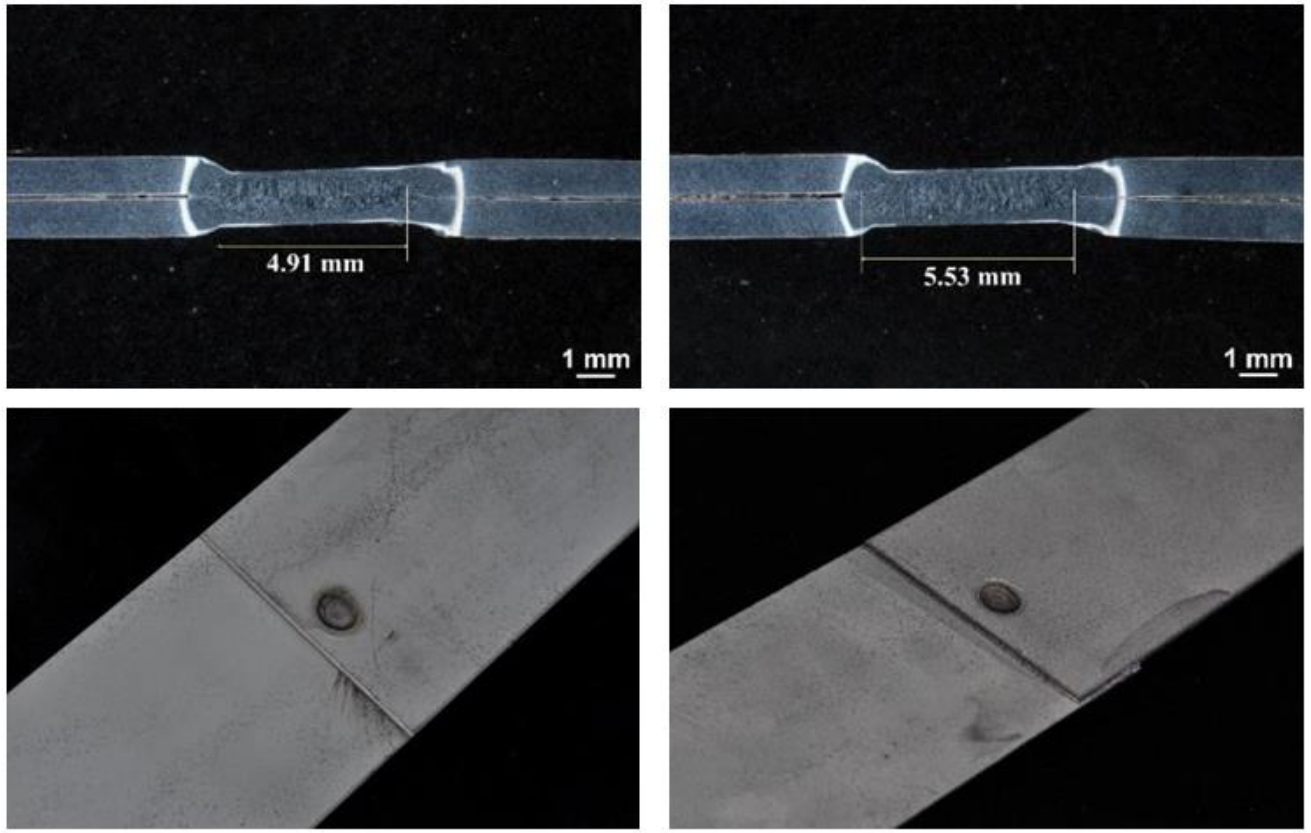


a) RSW (Production)

b) RSW (Production) with production adhesive

Figure A1 (a-b). 1.0 mm MS1500 EG RSW (Production) typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

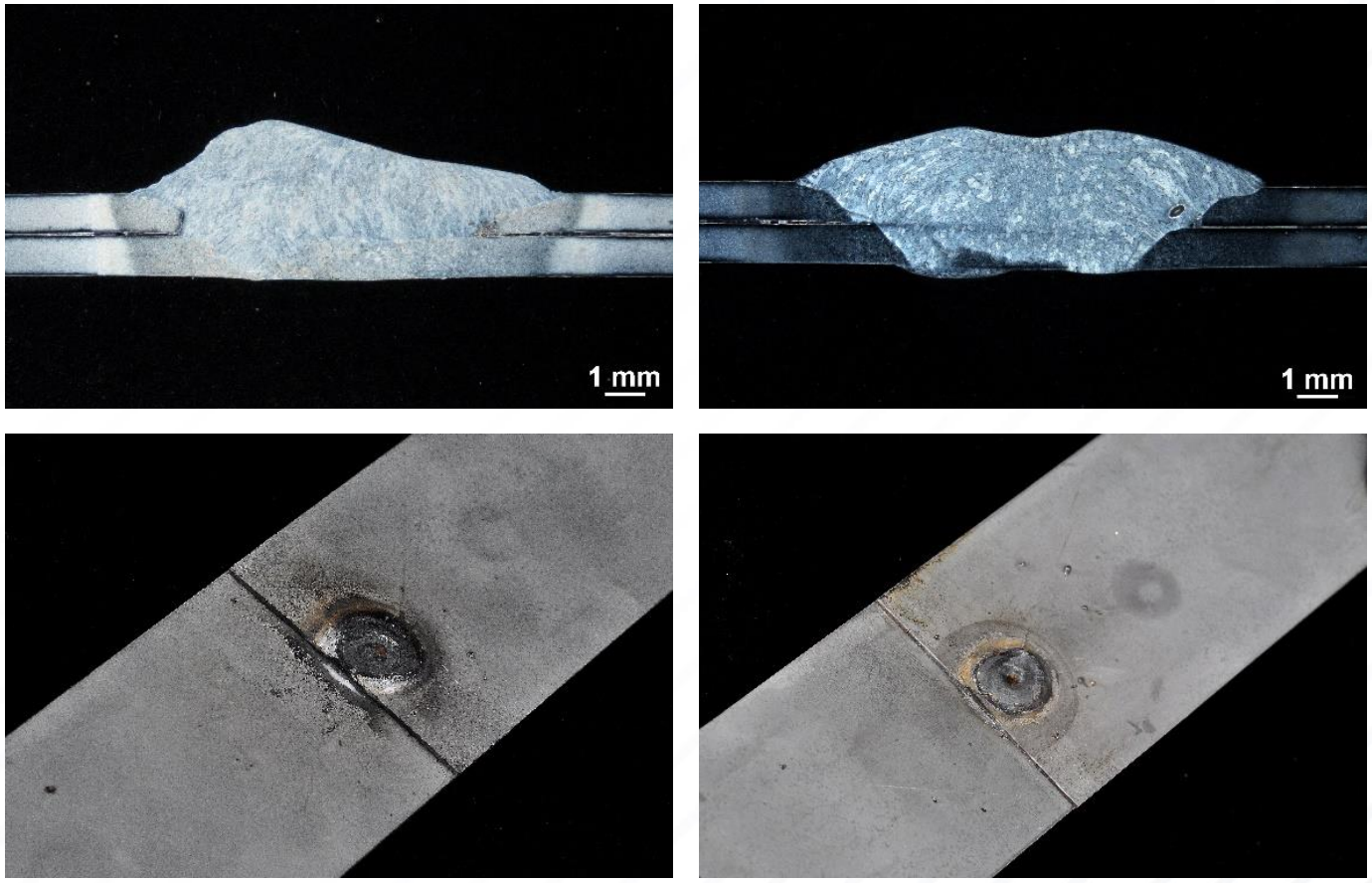


a) RSW (Service)

b) RSW (Service) with service adhesive

Figure A2 (a-b). 1.0 mm MS1500 EG RSW (Service) typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

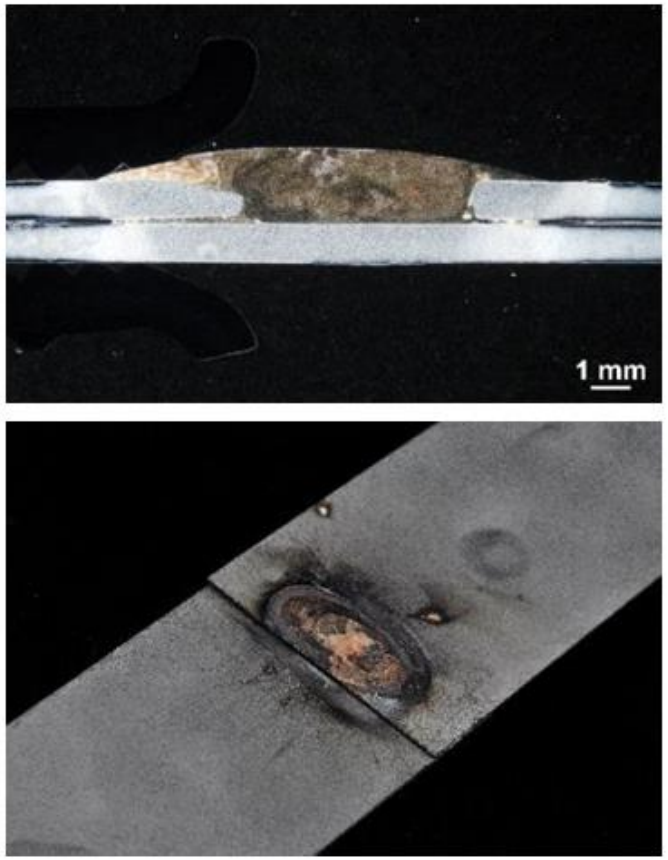


a) GMAW plug –
Bohler Union x96 filler

b) GMAW plug –
ER70S-6 filler

Figure A3 (a-b). 1.0 mm MS1500 EG GMAW plug typical joint and cross-section photos

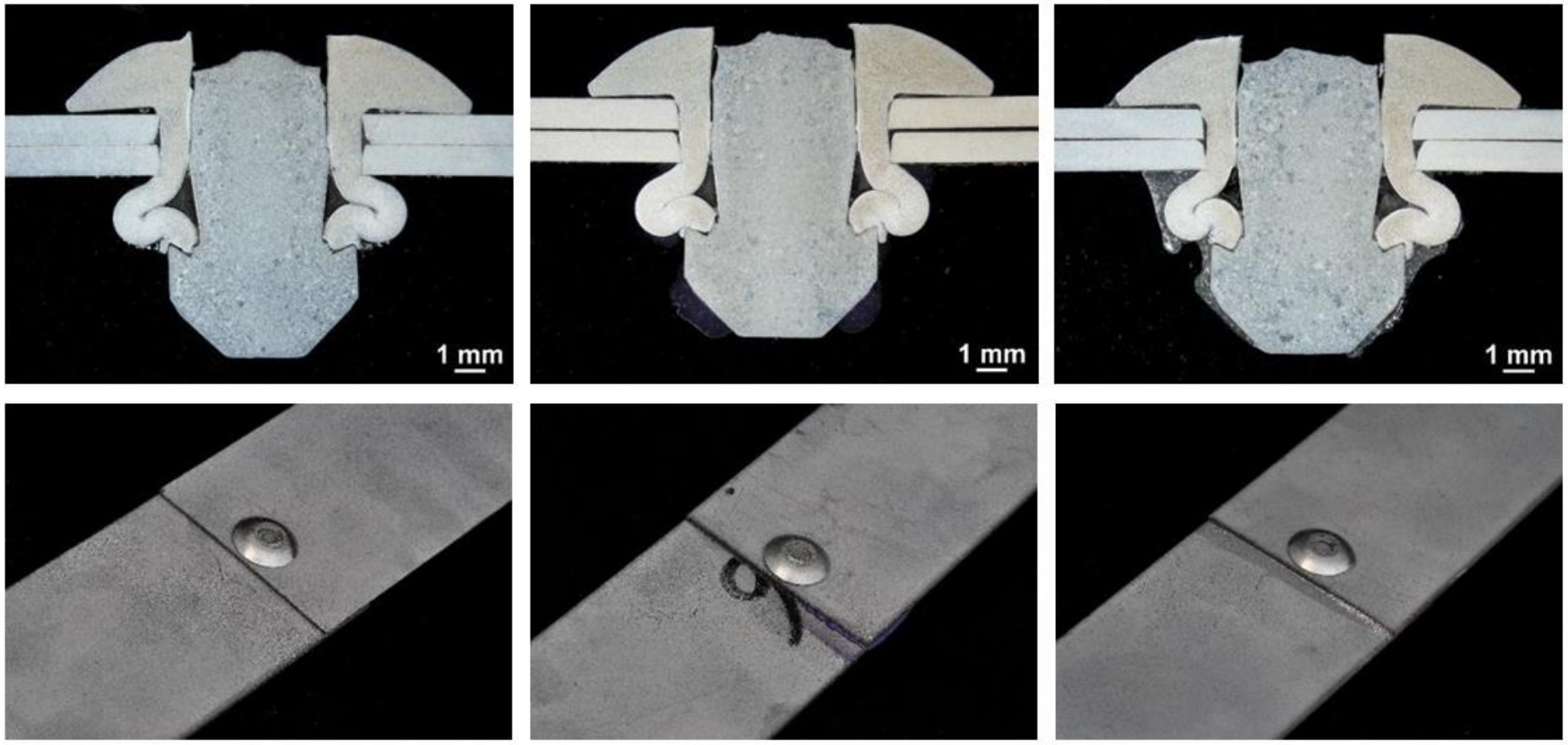
PROJECT RESULTS – SAMPLE CROSS-SECTIONS



GMAB slot braze

Figure A4. 1.0 mm MS1500 EG GMAB slot braze typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS



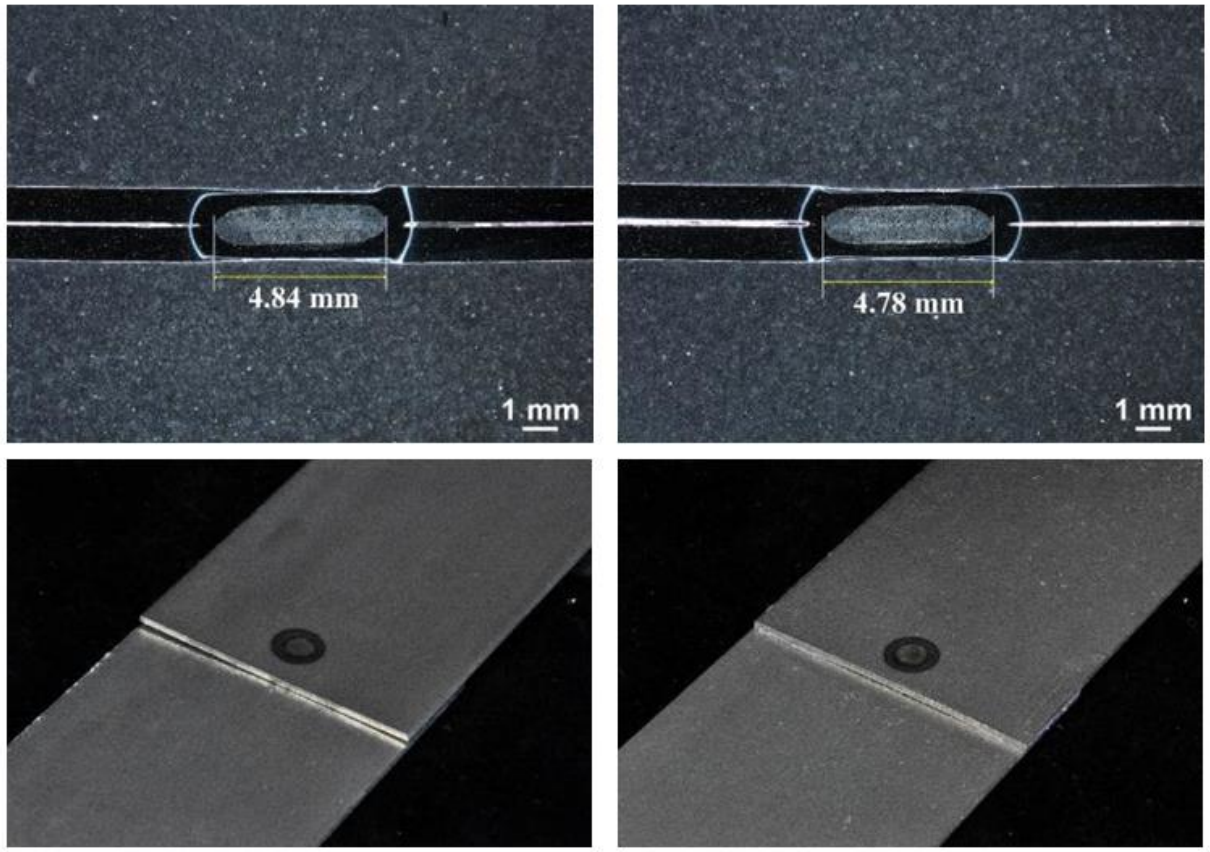
a) Structural blind rivet

b) Structural blind rivet with production adhesive

c) Structural blind rivet with service adhesive

Figure A5 (a-c). 1.0 mm MS1500 EG structural blind rivet typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

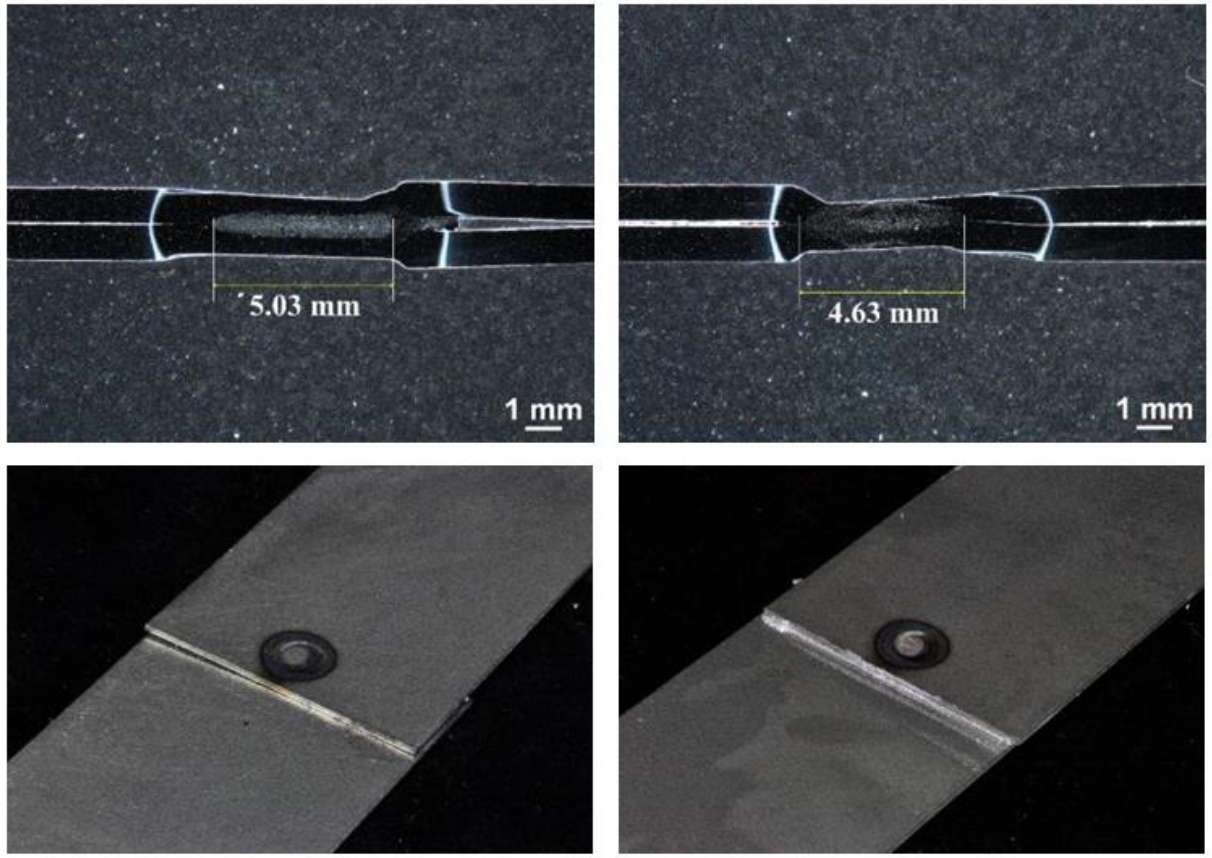


a) RSW (Production)

b) RSW (Production) with production adhesive

Figure A6 (a-b). 1.0 mm MS1700 uncoated RSW (Production) typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

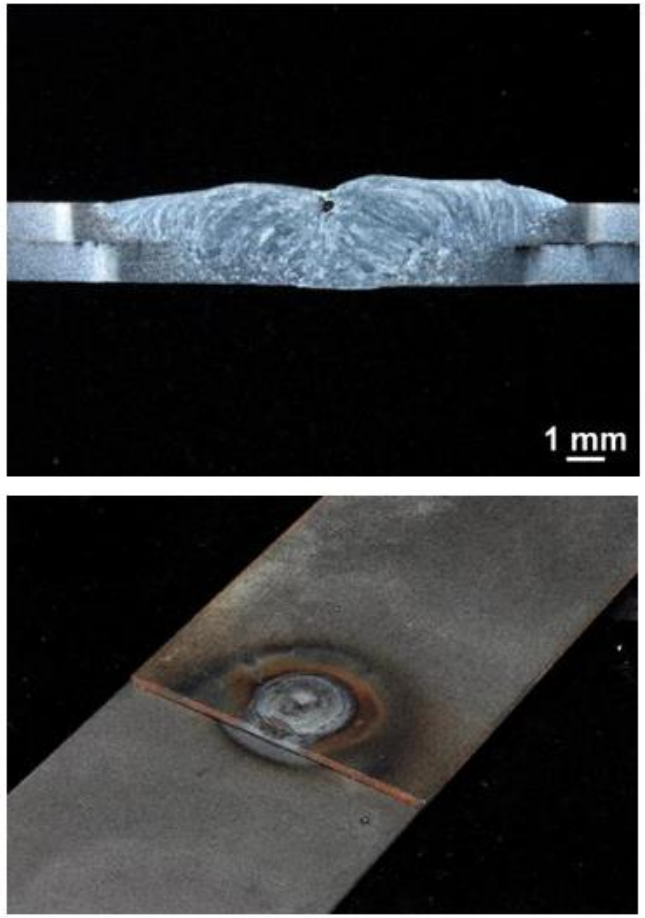


a) RSW (Service)

b) RSW (Service) with service adhesive

Figure A7 (a-b). 1.0 mm MS1700 uncoated RSW (Service) typical joint and cross-section photos

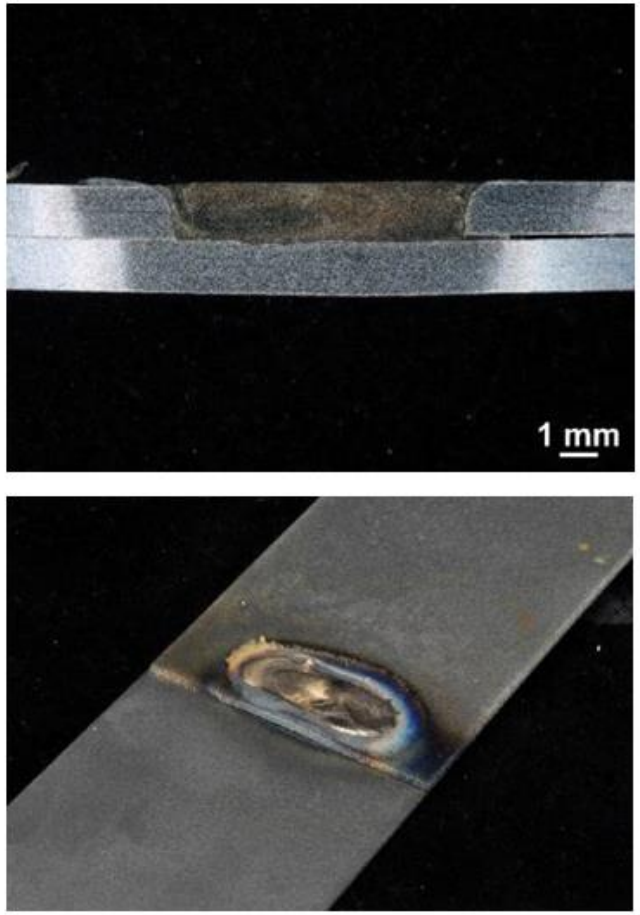
PROJECT RESULTS – SAMPLE CROSS-SECTIONS



GMAW plug

Figure A8. 1.0 mm MS1700 uncoated GMAW plug typical joint and cross-section photos

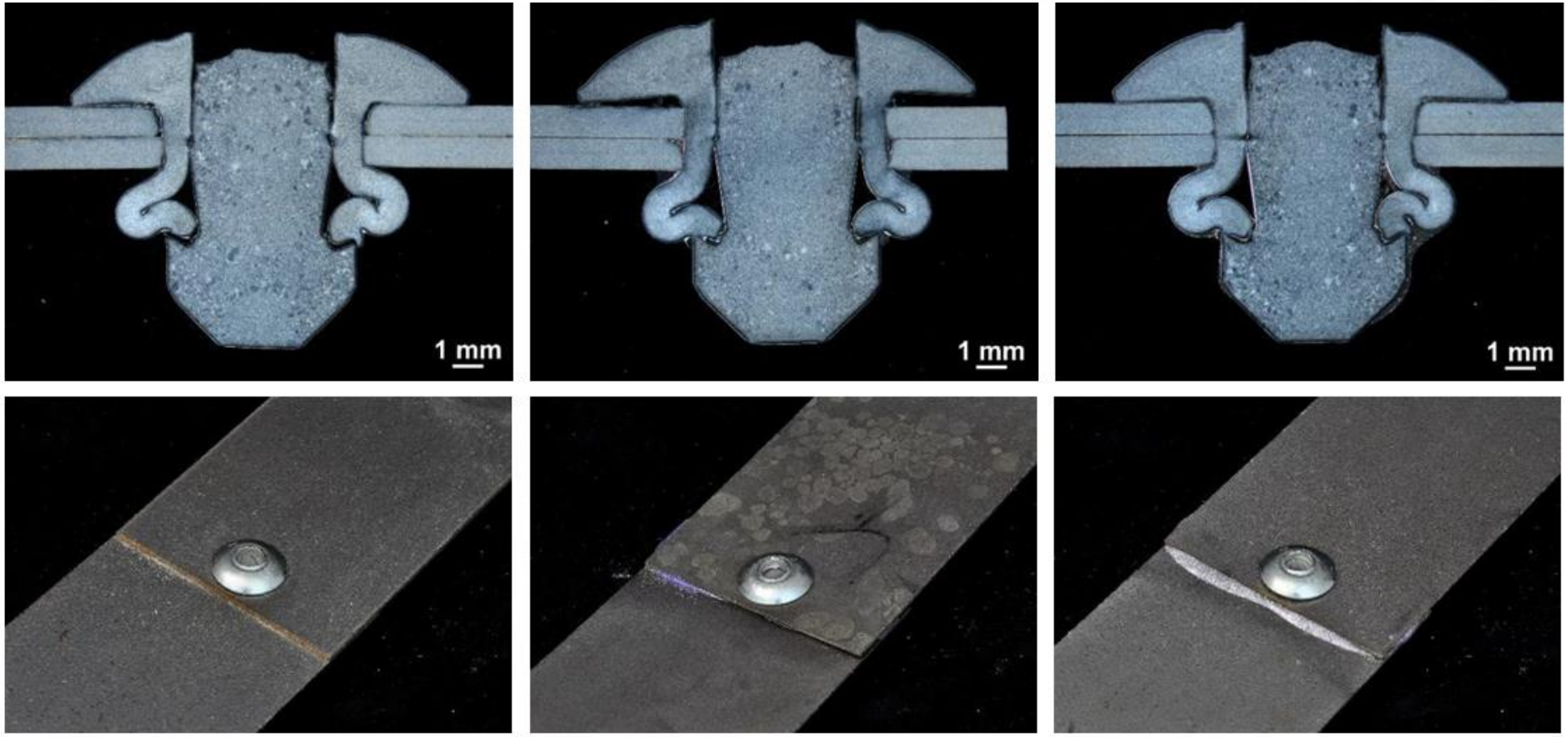
PROJECT RESULTS – SAMPLE CROSS-SECTIONS



GMAB Slot Braze

Figure A9. 1.0 mm MS1700 uncoated GMAB slot braze typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS



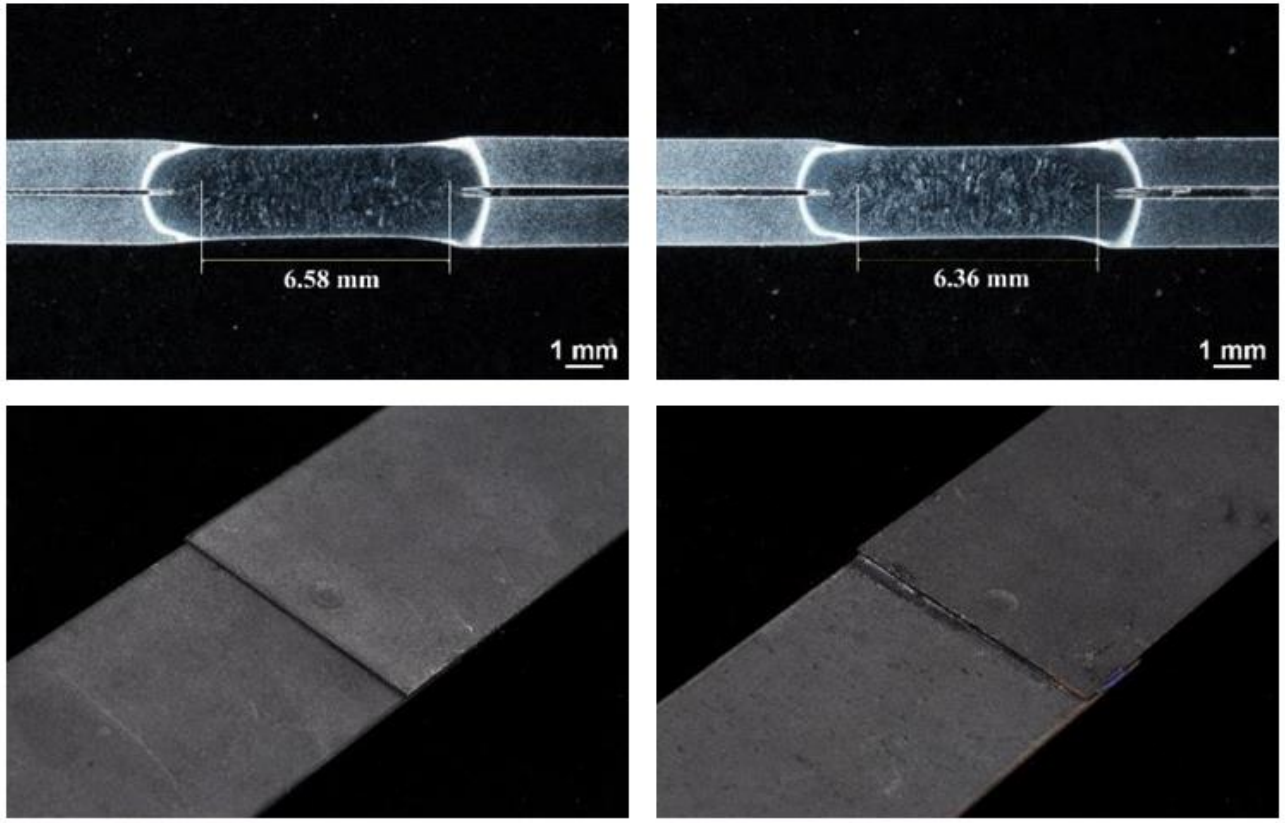
a) Structural blind rivet

b) Structural blind rivet with production adhesive

c) Structural blind rivet with service adhesive

Figure A10 (a-c). 1.0 mm MS1700 uncoated structural blind rivet typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

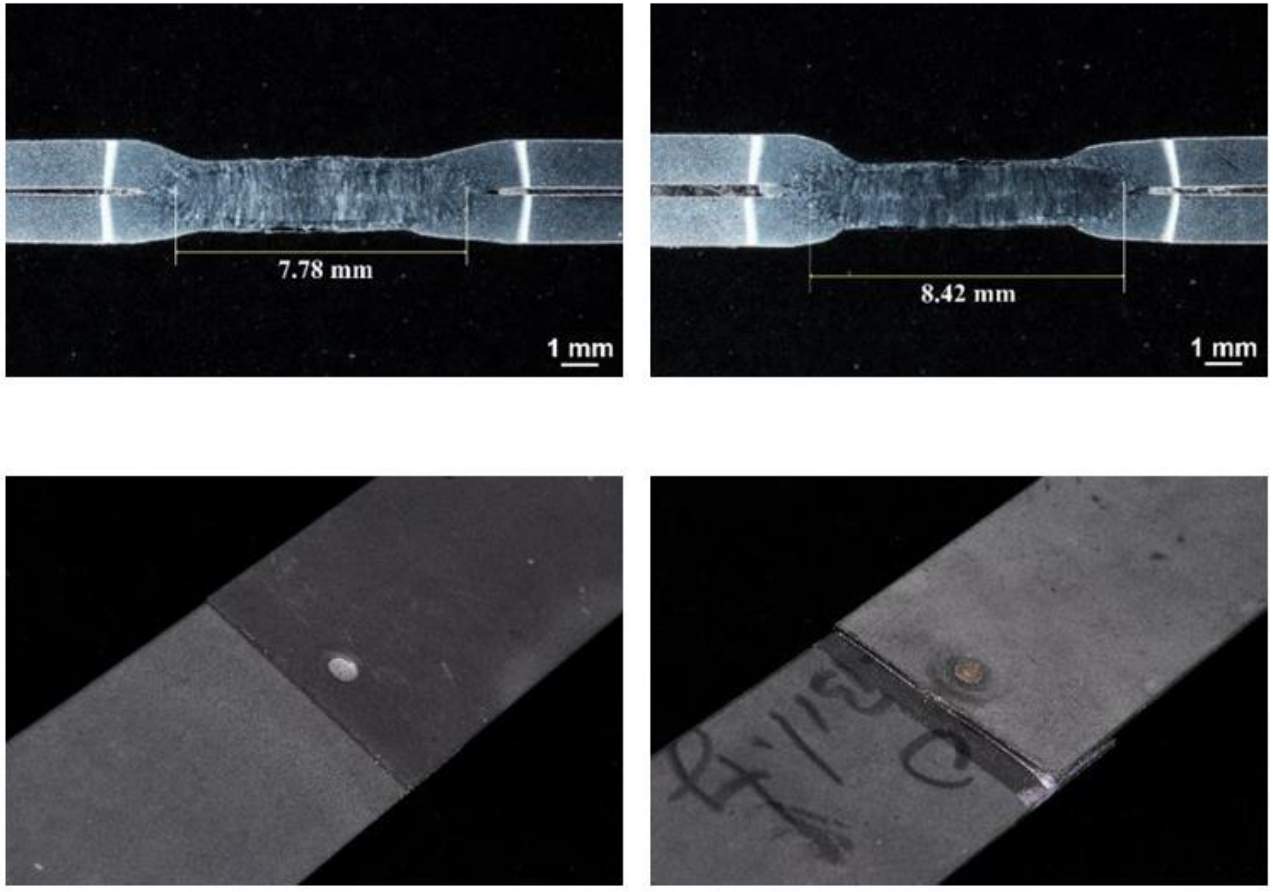


a) RSW (Production)

b) RSW (Production) with production adhesive

Figure A11 (a-b). 1.0 mm PHS1500 AlSi RSW (Production) typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

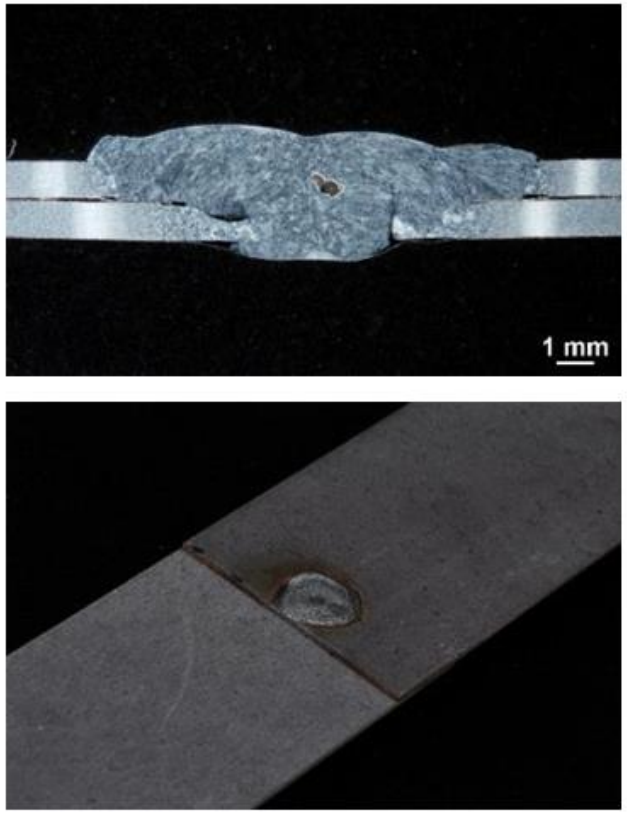


a) RSW (Service)

b) RSW (Service) with service adhesive

Figure A12 (a-b). 1.0 mm PHS1500 AlSi RSW (Service) typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS



GMAW plug

Figure A13. 1.0 mm PHS1500 AlSi GMAW plug typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS

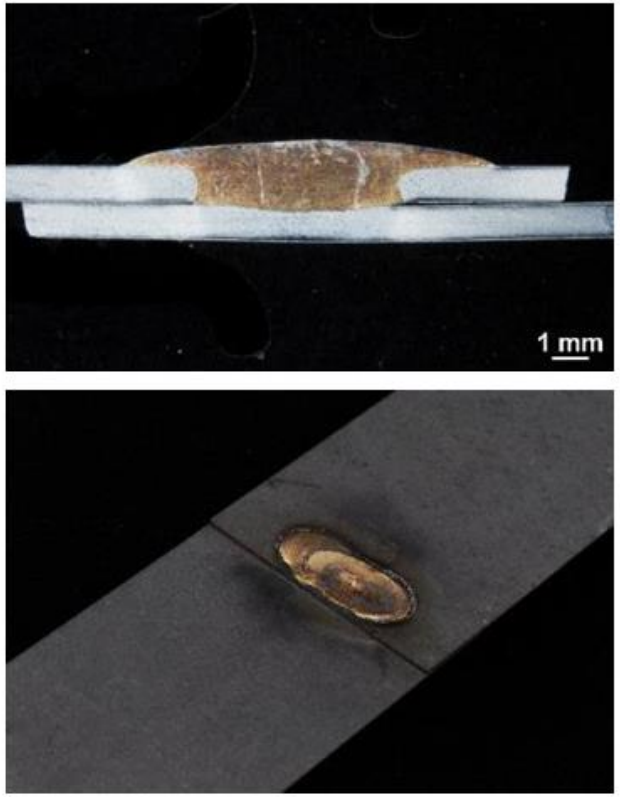
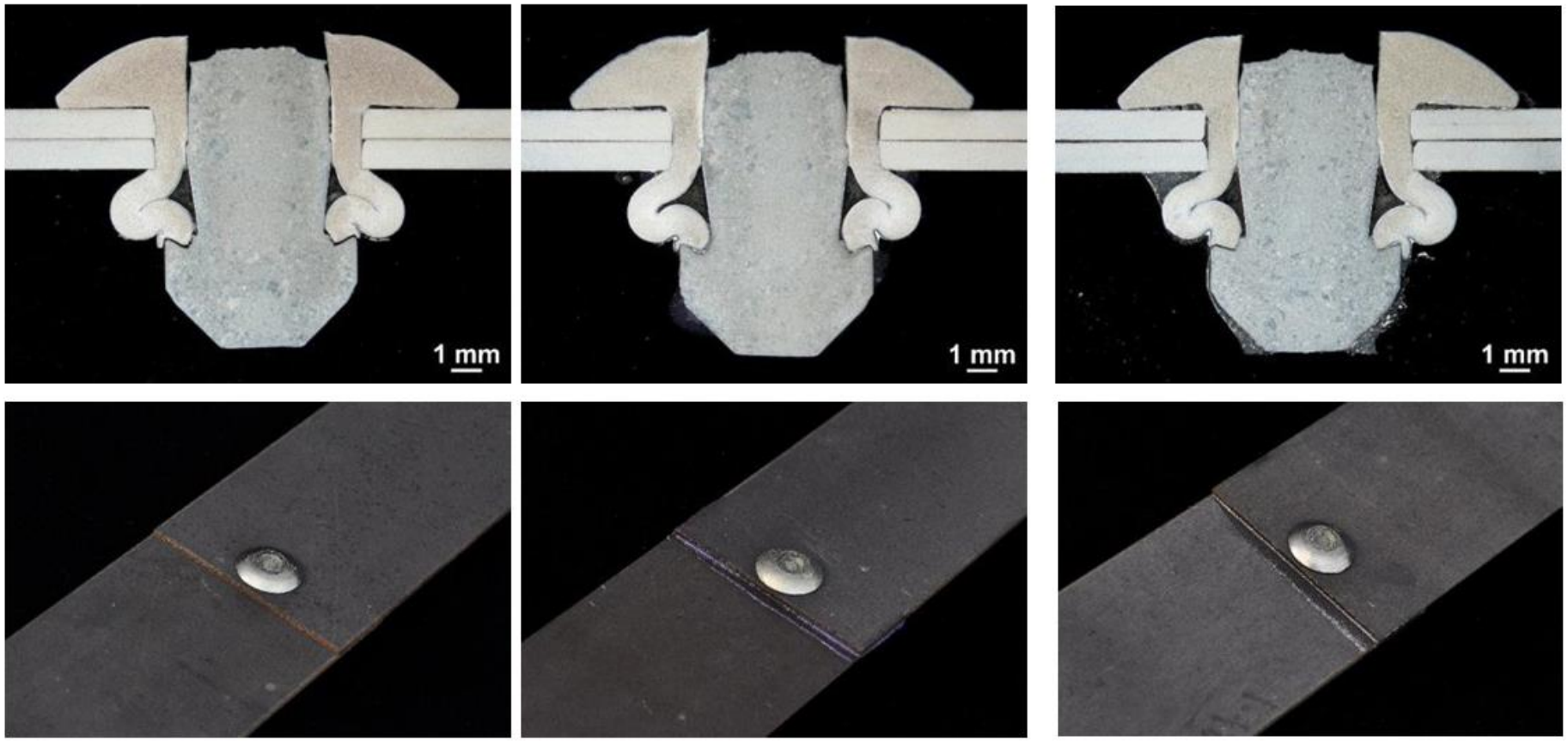


Figure A14. 1.0 mm PHS1500 AlSi GMAB slot braze plug typical joint and cross-section photos

PROJECT RESULTS – SAMPLE CROSS-SECTIONS



a) Structural blind rivet

b) Structural blind rivet with production adhesive

c) Structural blind rivet with service adhesive

Figure A15 (a-c). 1.0 mm PHS1500 AlSi structural blind rivet typical joint and cross-section photos

PROJECT RESULTS – SHEAR TENSION FORCE

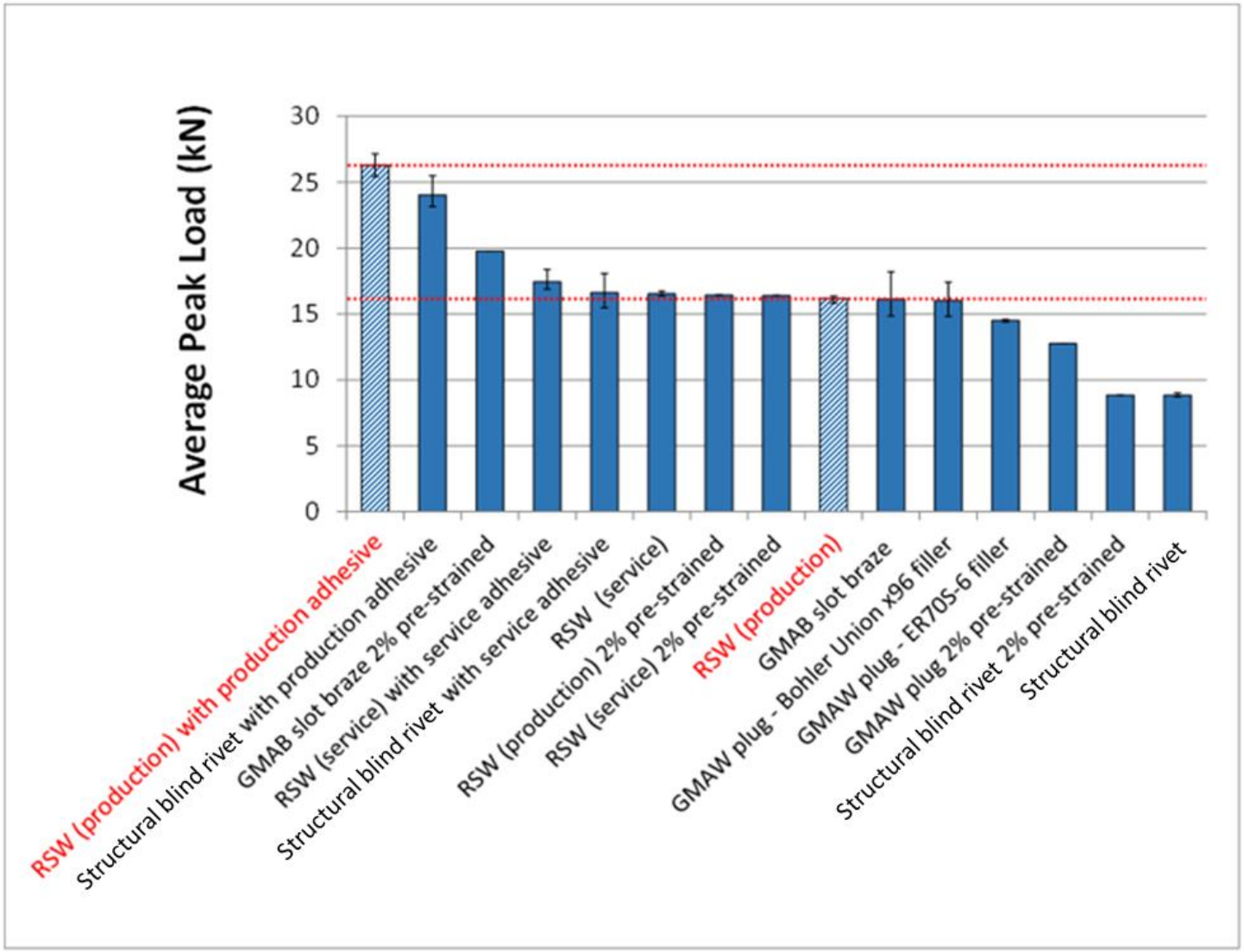


Figure B1. 1.0 mm MS1500 EG shear tension quasi-static peak load chart

PROJECT RESULTS – SHEAR TENSION FORCE

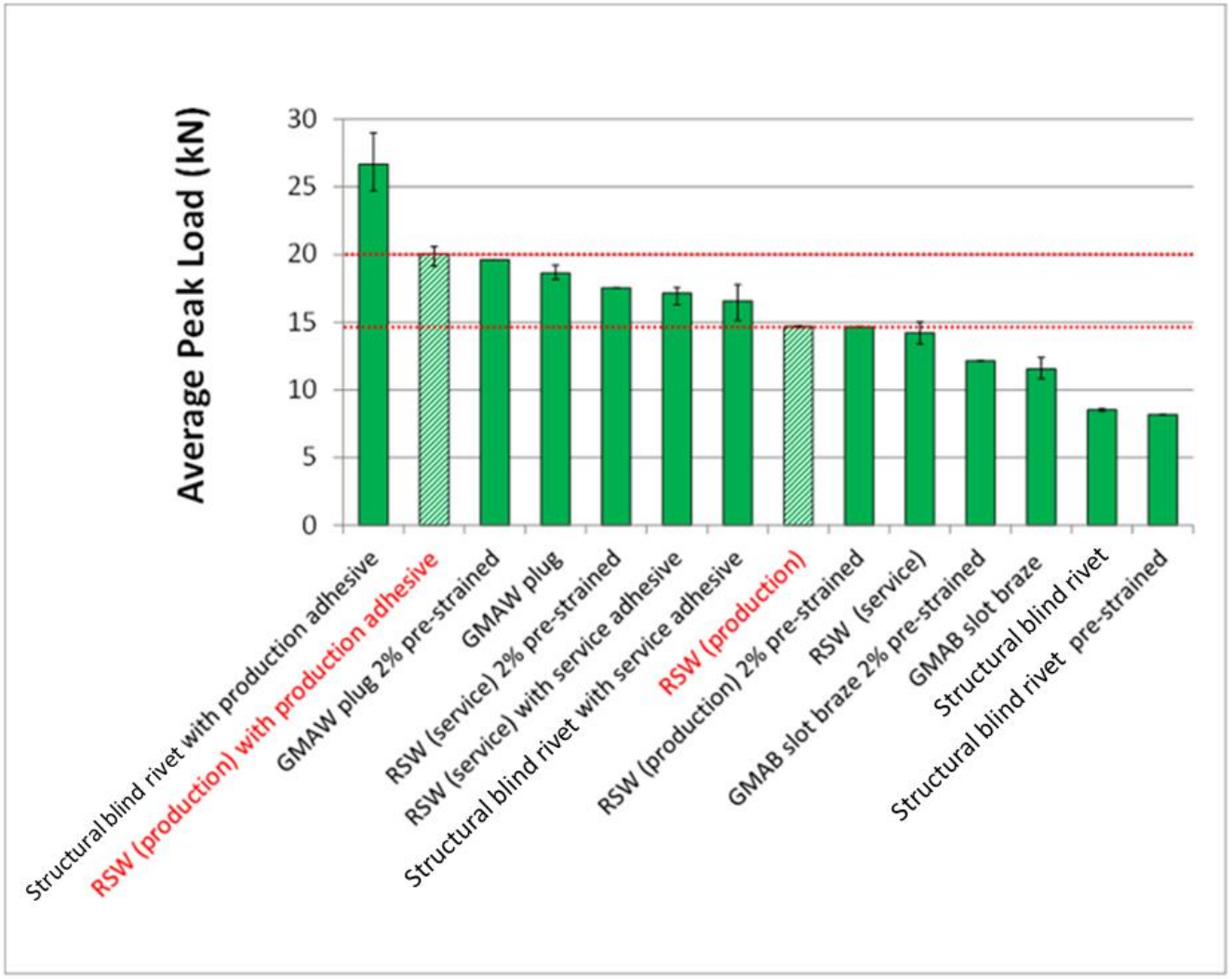


Figure B3. 1.0 mm PHS1500 AlSi shear tension quasi-static peak load chart

PROJECT RESULTS – SHEAR TENSION FORCE

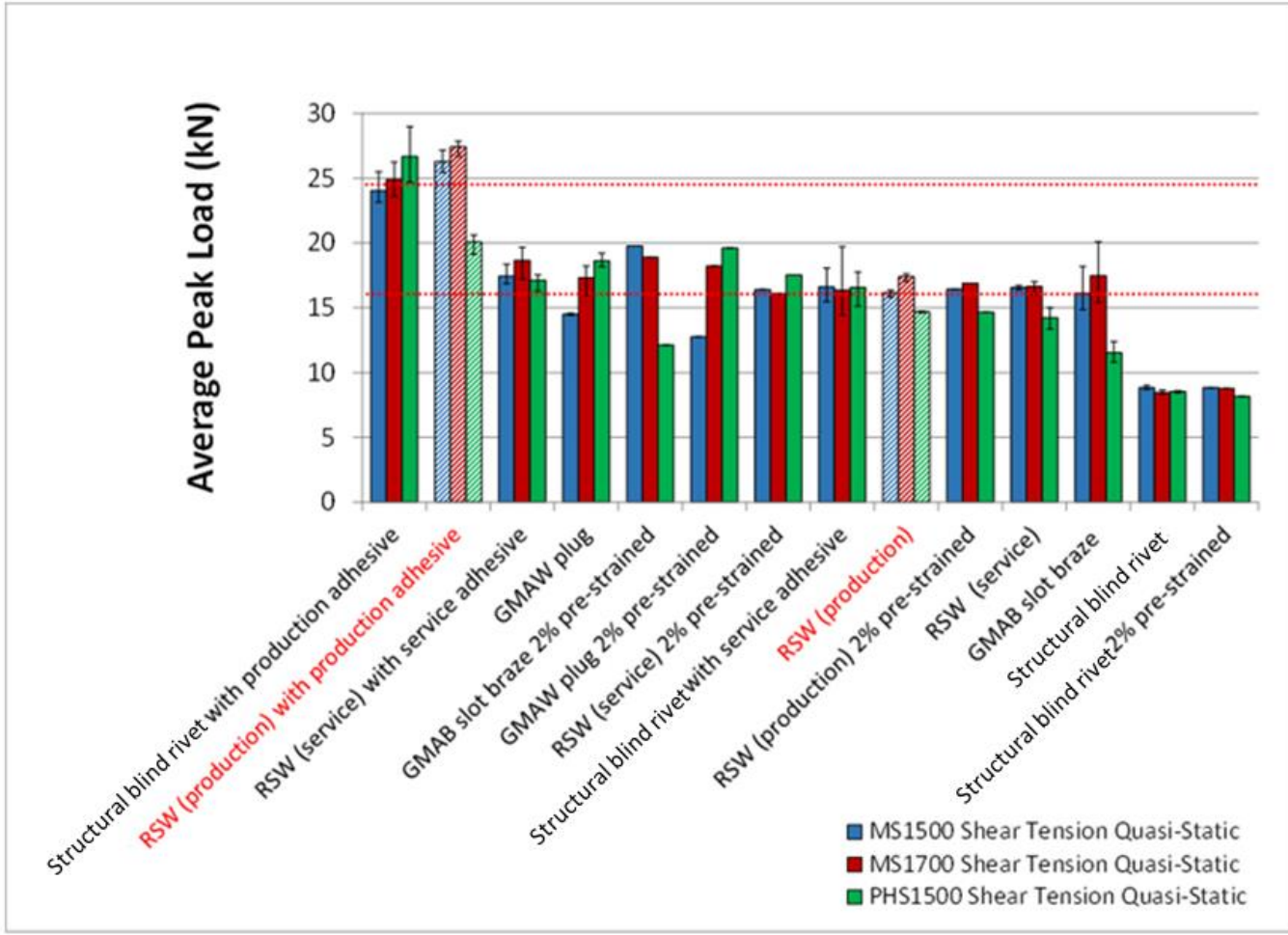


Figure B4. 1.0 mm MS1500 EG, 1.0 mm MS1700 uncoated, and 1.0 mm PHS1500 AlSi shear tension quasi-static peak load chart. Hatched bars show RSW (production) and RSW (production) with production adhesive average peak loads for each material. Dashed lines show the average peak load of all materials for RSW (production) and RSW (production) with production adhesive.

PROJECT RESULTS – CROSS TENSION FORCE

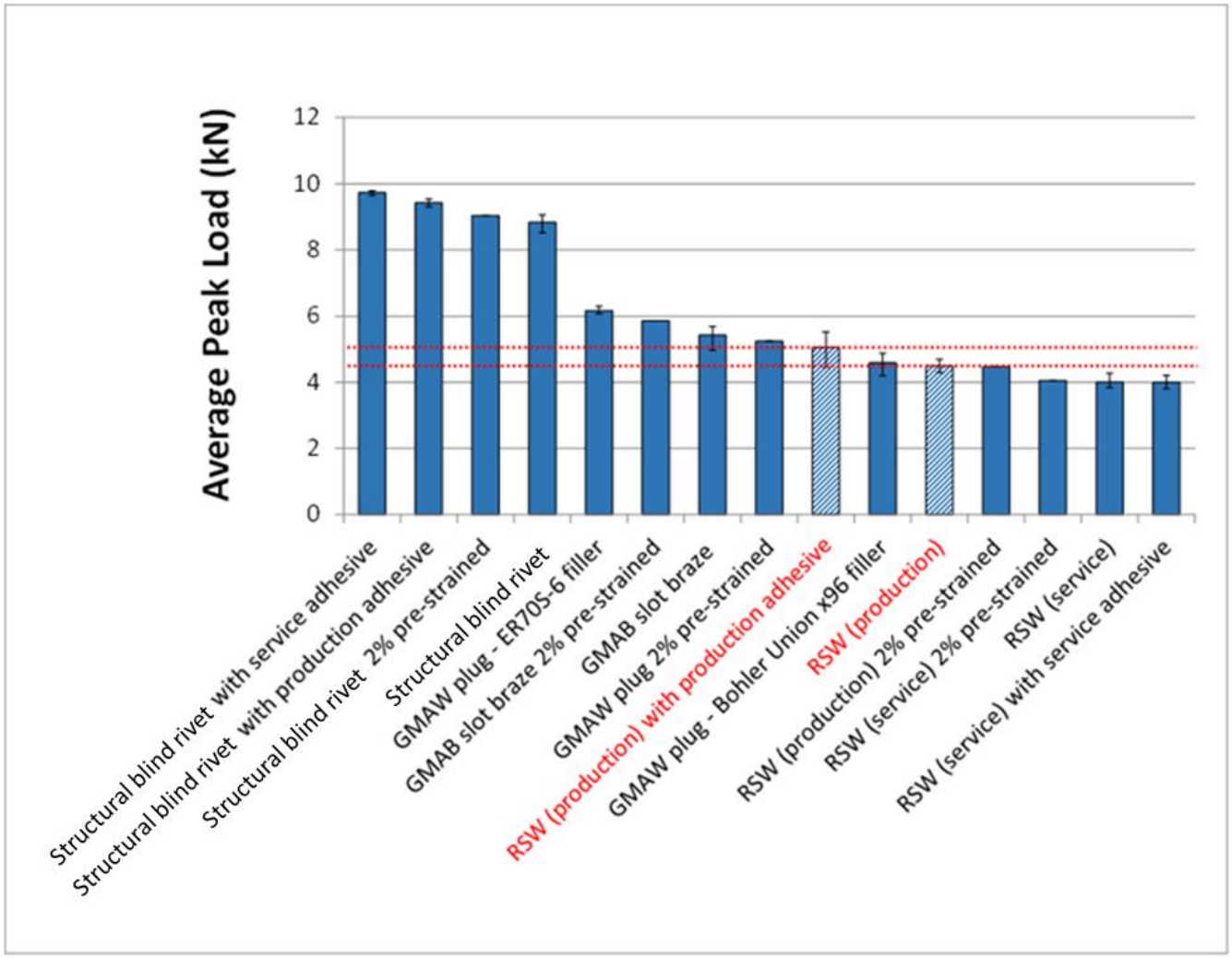


Figure B5. 1.0 mm MS1500 EG cross tension quasi-static peak load chart

PROJECT RESULTS – CROSS TENSION FORCE

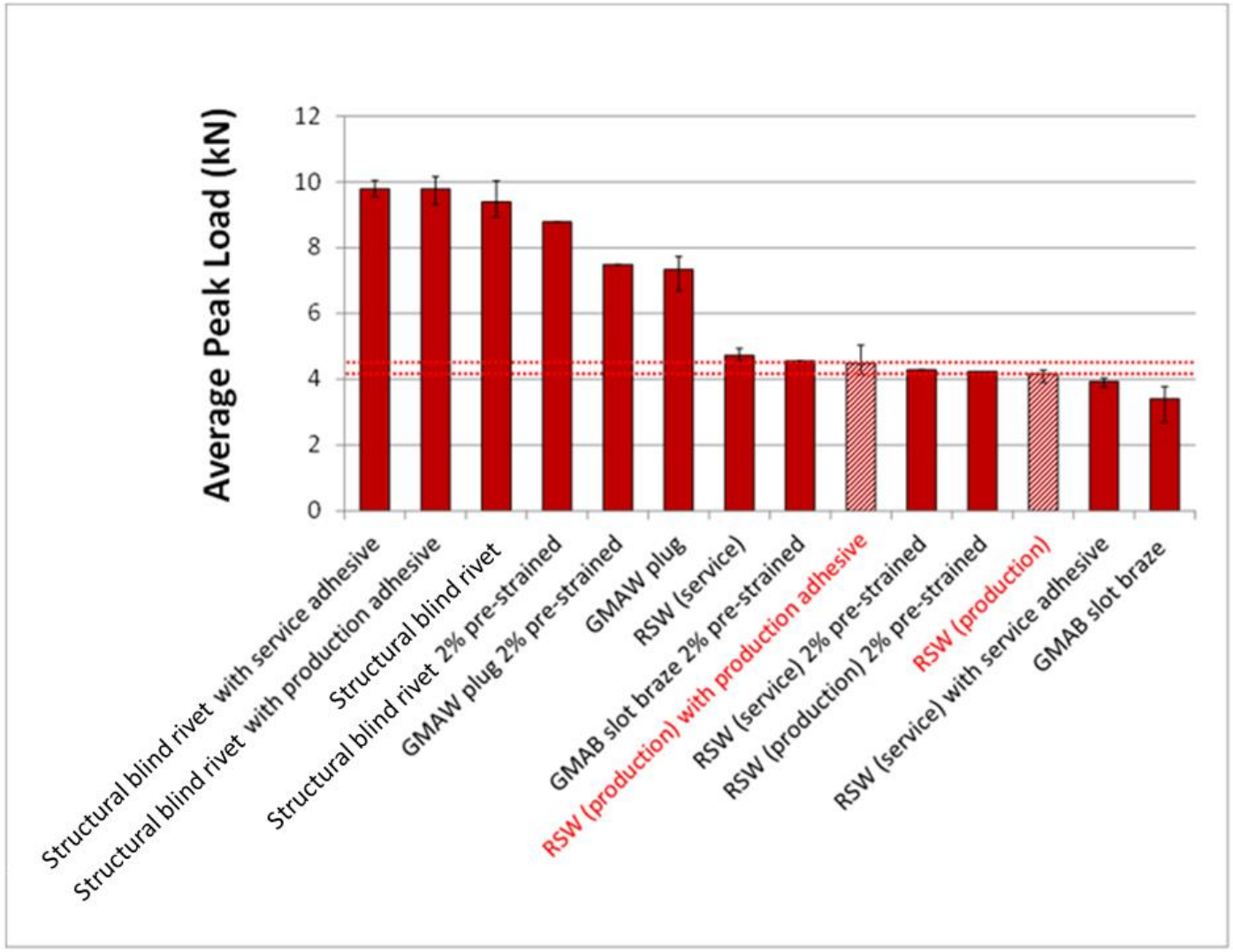


Figure B6. 1.0 mm MS1700 uncoated cross tension quasi-static peak load chart

PROJECT RESULTS – CROSS TENSION FORCE

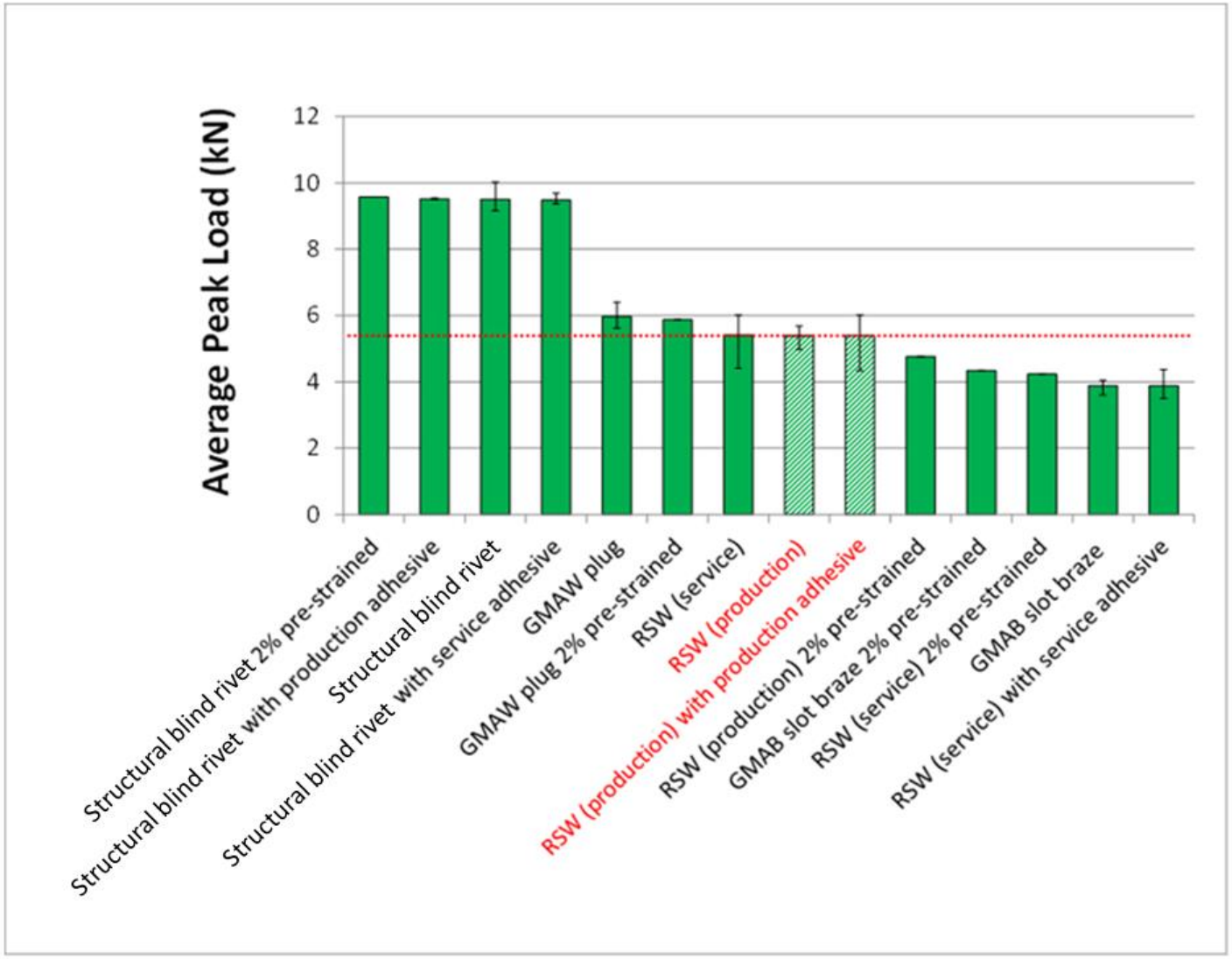


Figure B7. 1.0 mm PHS1500 AlSi cross tension quasi-static peak load chart

PROJECT RESULTS – CROSS TENSION FORCE

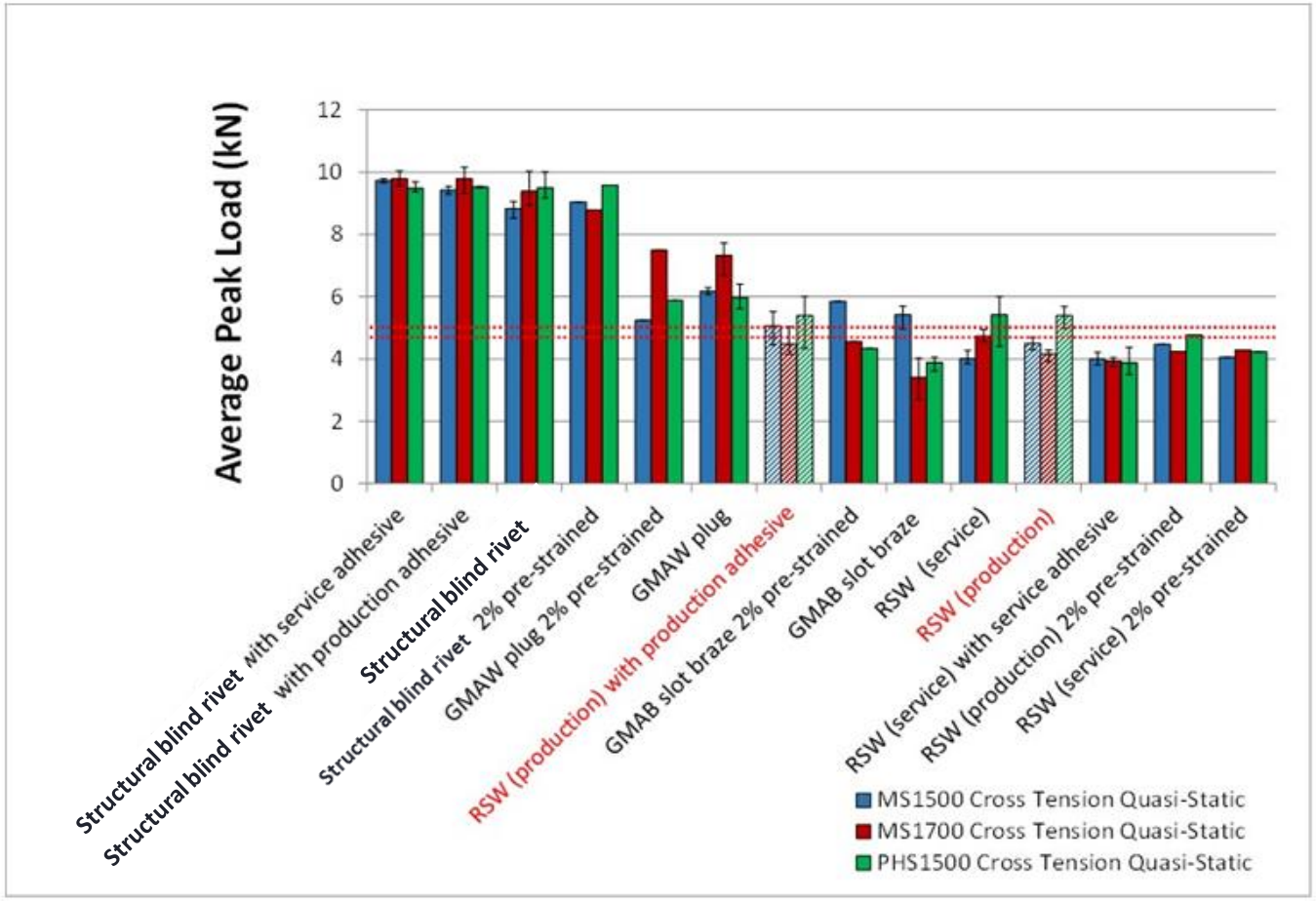


Figure B8. 1.0 mm MS1500 EG, 1.0 mm MS1700 uncoated, and 1.0 mm PHS1500 AlSi cross tension quasi-static peak load chart. Hatched bars show RSW (production) and RSW (production) with production adhesive average peak loads for each material. Dashed lines show the average peak load of all materials for RSW (production) and RSW (production) with production adhesive.

PROJECT RESULTS – SHEAR TENSION FATIGUE

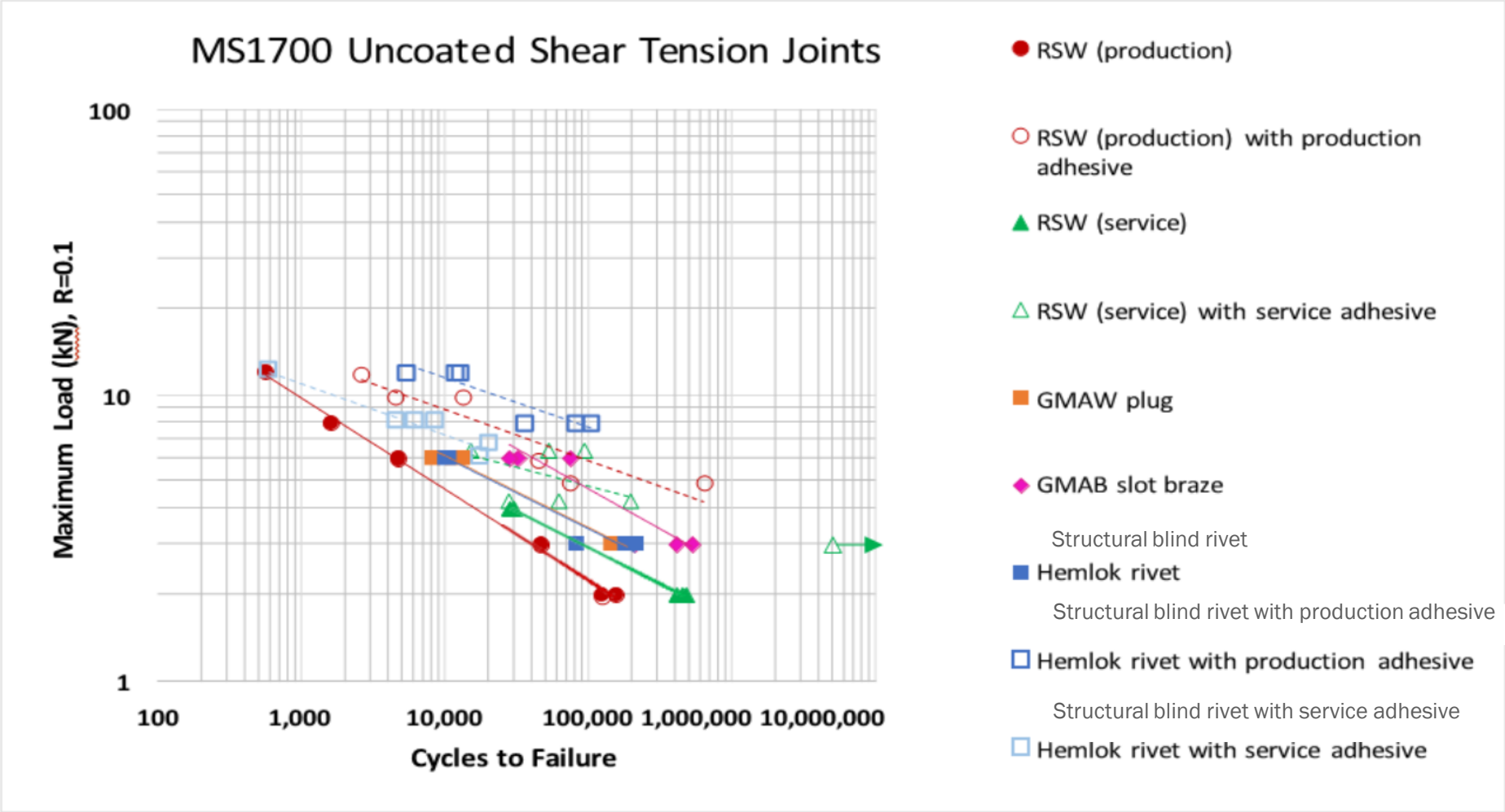


Figure C2. 1.0 mm MS1700 uncoated joints fatigue curves

PROJECT RESULTS – SHEAR TENSION FATIGUE

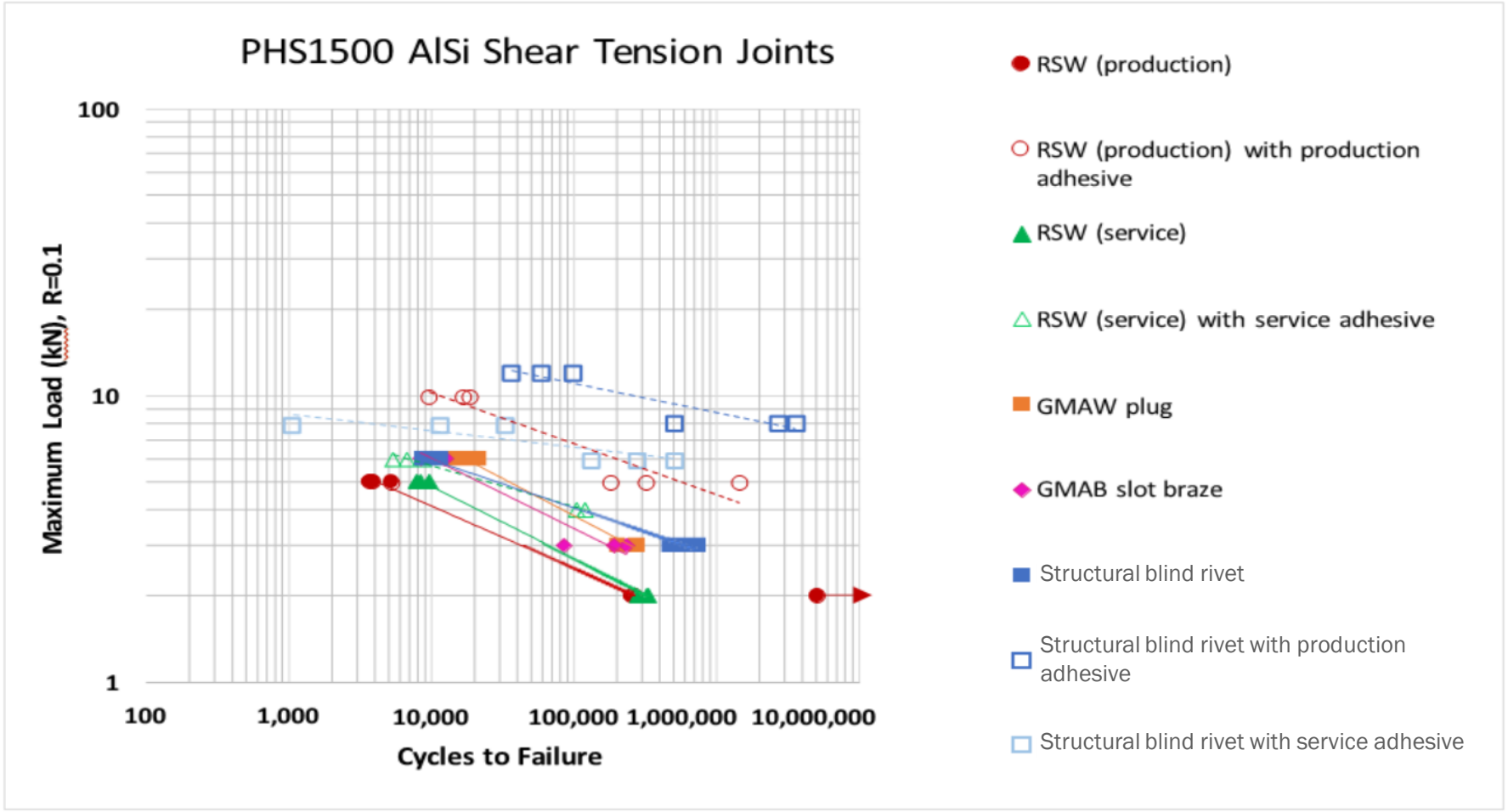


Figure C3. 1.0 mm PHS1500 AlSi joints fatigue curves

PROJECT CONCLUSIONS & RECOMMENDATIONS

- For the stack-ups and materials studied, it appears that appropriate repair methods can be selected from those evaluated in this project to meet joint strength requirements
- Adhesive increased shear tension quasi-static peak loads, but had little effect on cross-tension quasi-static peak loads
- Production adhesive joints generally had higher quasi-static shear tension peak loads than service adhesive joints
- Adhesive improved the fatigue performance of shear tension joints
- Joints with service adhesive showed decreased fatigue performance compared to joints with production adhesive
- All repair process joints showed similar or improved fatigue performance compared to RSW production joints

PROJECT CONCLUSIONS & RECOMMENDATIONS

- Through A/SP's collaborative efforts between automakers and the steel industry, this repairability project offers the repair community AHSS repair strategies valuable data about potential repair joining strategies on UHSS and Martensitic grade steel to apply in today's vehicles
- This information is offered to the OEMs for their service groups to use in developing collision repair strategies for their various vehicle designs

FOR MORE INFORMATION

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