Damage detection and mechanical performance of self-piercing riveting joint of CFRP and Aluminium 5754

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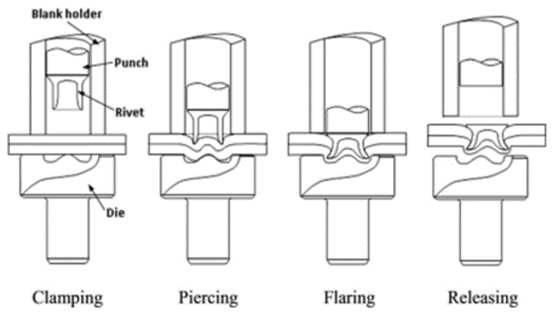


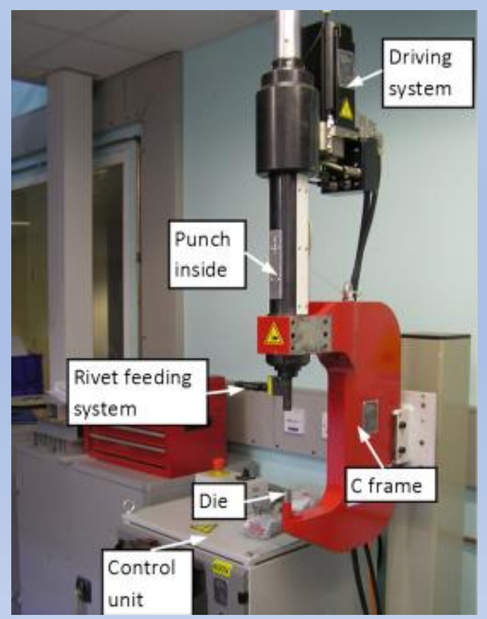
Background

Project Aim

To examine if SPR joint is suitable for composite material

Objective

- To investigate the mechanical performance of SPR joint of CFRP and Aluminium 5754 with tensile testing
- To damage detect and analyse the damage of SPR joints through NDT testing
- To examine if the SPR joint can be used in an industry standard



Experimental Method

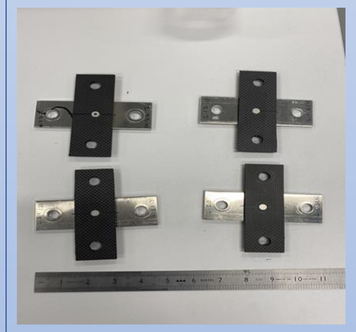
Damage detection

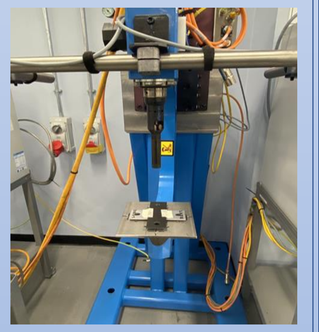
- 2.7mm CFRP as top layer and 3mm Aluminium 5754 as bottom layer used as sheet material
- 40x40mm coupon
- Different combinations process parameter used such as die and setting velocity

Tensile testing

- 40x120mm coupon

Material	Elastic Modulus (GPa)	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Elongation (%)
Aluminium 5754	70	215	260	14
CFRP	165	1315	55	2.15





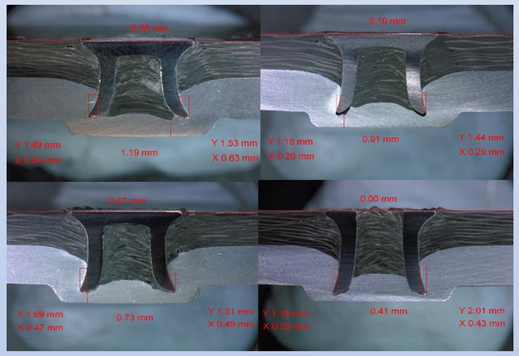
Joint Number	Rivet Type	Die	Velocity (mm/s)	Force (kN)	Head Height (mm)
1	A	DG10-120	300	59.4	-0.07
2	C	DG10-120	280	54.6	0.03
3	K	DG10-140	300	58.5	-0.04
4	T	DG10-120	280	58.3	0.13
5	Custom	DG10-160	220	45.4	0.21

Results & Discussion

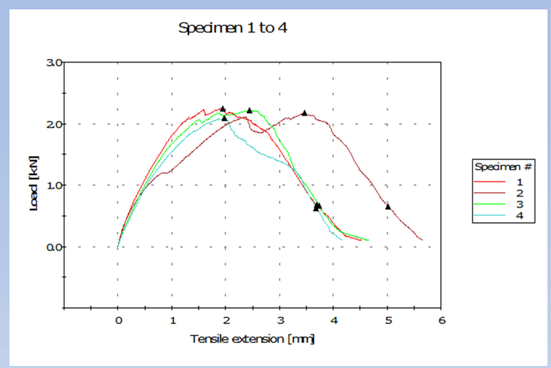
SPR Joint Quality Criteria

To determine a good quality joint, the joint criteria was determined using three factors:

1) Head height: In between 0.3 to -0.5
2) Interlock distance: Minimum 0.4
3) Remaining bottom material thickness: Minimum 0.1

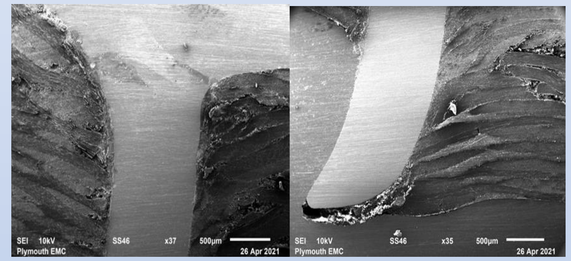


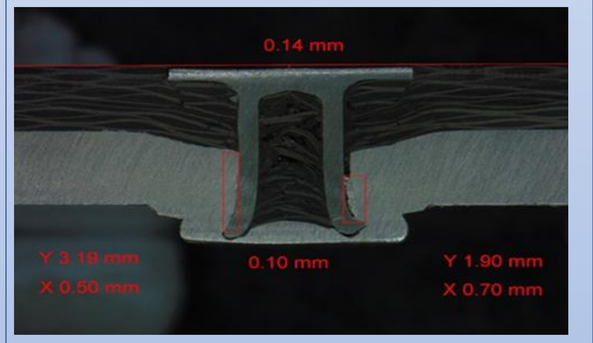
Joint number	Head height	Interlock distance (Average)	Remaining bottom material thickness	Status
1 (A)	-0.06	0.635	1.19	PASS
2 (C)	0.1	0.275	0.91	FAIL
3 (K)	0.07	0.48	0.73	PASS
4 (T)	0	0.435	0.41	PASS
5 (Custom)	-0.04	0.6	0.1	PASS



Conclusion

- SPR method is suitable for composite materials
- Changing rivet geometry by keeping the process parameters same can improve joint quality
- Bearing failure caused in tensile test can be overcome by increasing the head diameter of the rivet





Future Work

- Carry out NDT testing such as infrared technology, ultrasonic testing and digital shearography to evaluate the damages seen from electron microscopy
- Evaluate damages by changing rivet geometry

Reference

1) Li, D. et al. (2017) 'Self-piercing riveting-a review', The International Journal of Advanced Manufacturing Technology, Available at: https://www.researchgate.net/publication/315467318_Self-piercing_riveting-a_review (Accessed: 10/03/2021)