



Investigation into different joining technologies for CFRP components

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Introduction

Lentus Composites are looking at different joining technologies to join CFRP components. The following joining methods were investigated:

- Riveting.
- Hybrid of Riveting and Bonding.
- Bonding.

Also different surface treatment methods were used as followed:

- Shot Blasting.
- Vapour Blasting.
- Plasma Treatment (Blown ion)

A more in-depth investigation was done for plasma as it is a relatively new technology used on CFRP.

Methodology

Two standard methods were used for the design of the testing specimens:

- Riveted Specimens: ASTM D5961 [1]
- Bonded Specimens: ASTM D5868 [2]

Standard Operating Procedures were made and conducted systematically to assure the standardisation of all testing undertaken.

Surface Energy

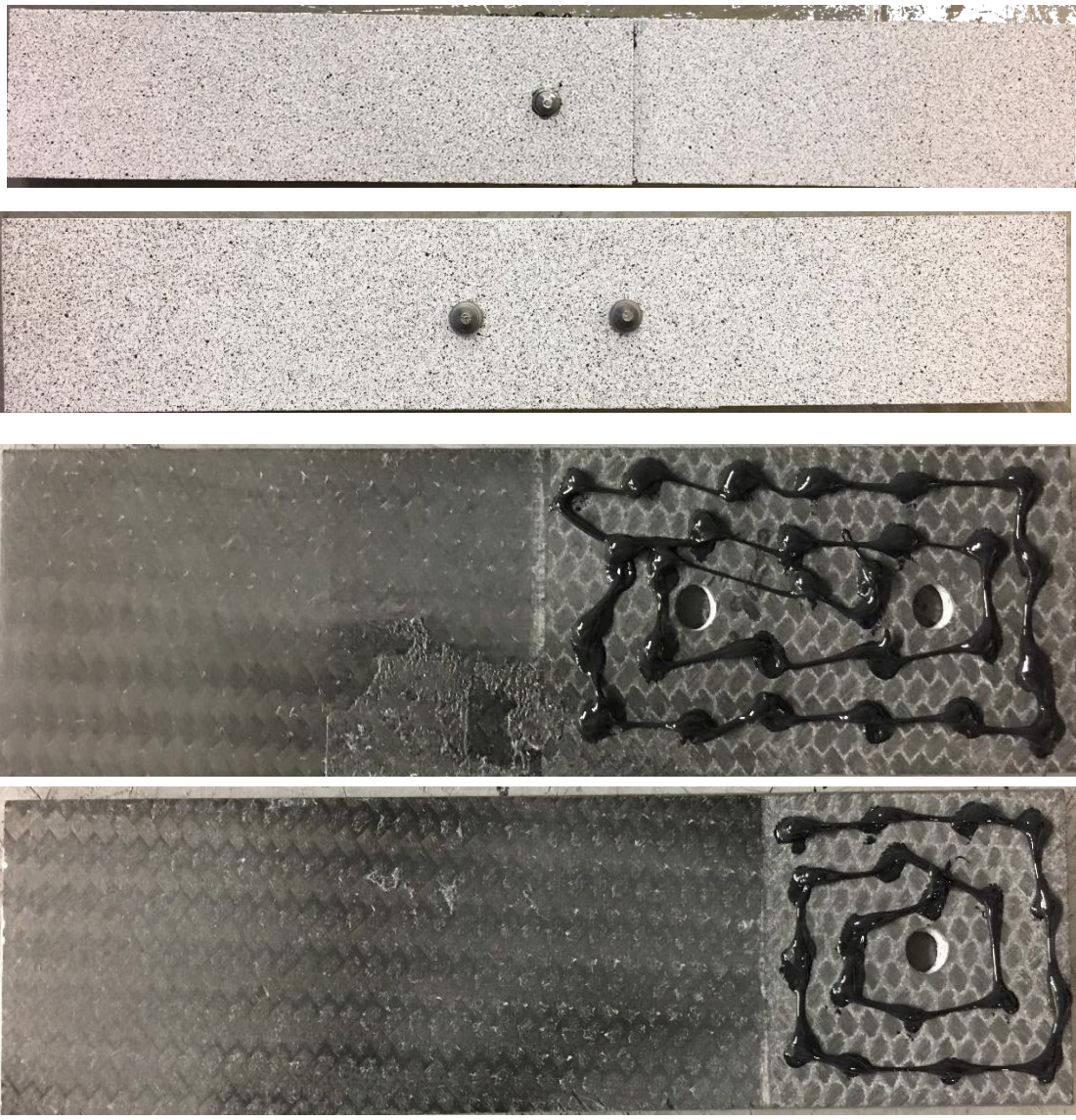
The surface energy was calculated using two methods:

- Dyne Pens
- Contact Angle Measurement

The roughness of the vapour blasted and shot blasted specimens were calculated with a roughness gage.

Line Speed (m/min)	Distance (mm)	Dyne Level (mN/m)
6	12	71
12	12	69
18	12	71
24	12	67
27.5	12	69
6	14	63
12	14	52
18	14	48
24	14	48
6	17	52
12	17	48
18	17	46
24	17	46

Surface Free Energy can be seen above for the different plasma configurations.



Examples of coupons, riveted and bonded.



Plasma treatment of coupons, multiport blown ion plasma

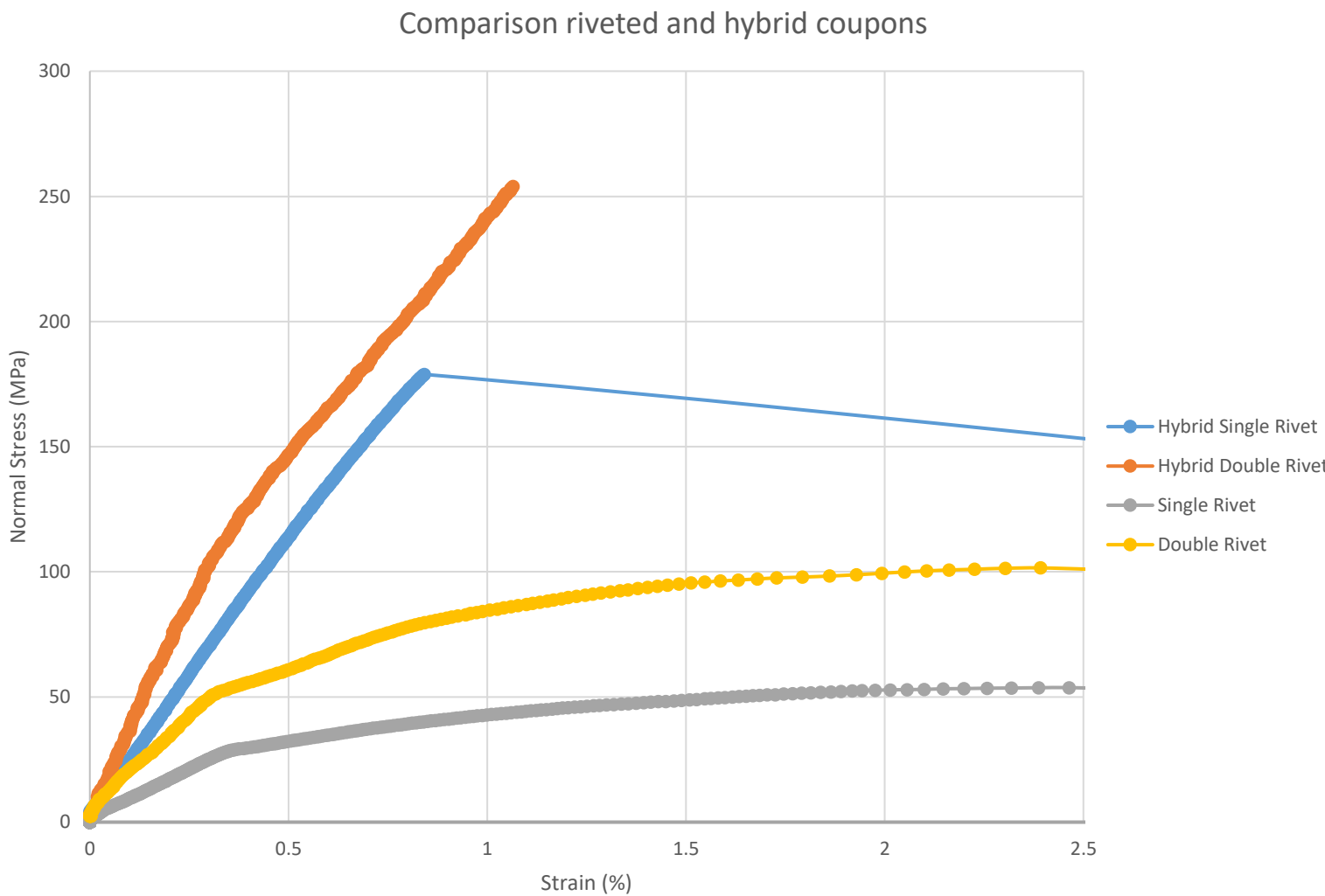


Top left shows a tear out of the material where the rivet was originally, top right is a structural failure of the coupon along the hole line.

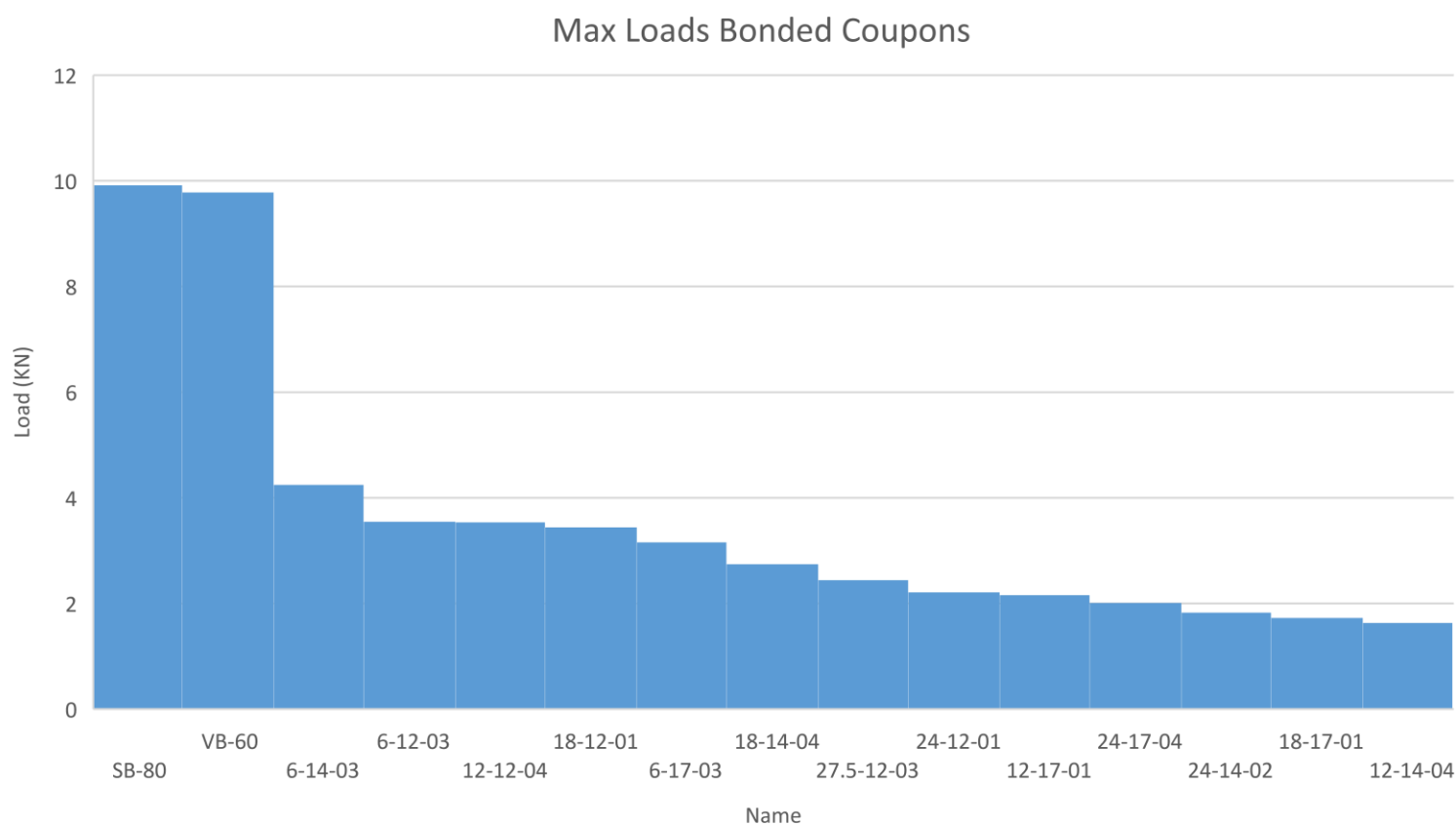


Top left shows a failure of the first ply of the coupon, top right is an adhesive failure between the glue and the carbon fibre, this kind of failure happens when the treatment of the material beforehand is not enough.

Results



The above graph, compares the difference of riveted joints and hybrid joints. The hybrid joints, orange and blue, are the strongest.



The above graph, compares the difference of max load for each surface treatment. The highest loads are achieved with shot blasting and vapour blasting.



The above graph, compares the difference of adhesive shear stresses between all the different joining technologies, the best joining technology was bonded coupons with a vapour blasted treatment.

Conclusion

Bonded specimens require a careful and systematic procedure to achieve the desired strengths, if done correctly it is the best option. On the other hand, hybrid specimens combine the easy assembly of riveting with the strength of bonding.

References

[1] ASTM, "D5961-Standard Test Method for Bearing Response of Polymer Matrix Composite Laminates," ASTM International, USA, 2013.

[2] ASTM, "D5868-Standard Test Method for Lap Shear Adhesion for Fiber Reinforced Plastic (FRP) Bonding," ASTM International, USA, 2014.