13th INTERNATIONAL CONFERENCE ON THE MECHANICAL BEHAVIOUR OF MATERIALS, MELBOURNE, AUSTRALIA, 2019

Mechanical Performance of Splice Connection for Hollow Section GFRP Members

Chengyu Qiu, PhD student, Department of Civil Engineering, Monash University, Australia

Yu Bai, Professor, corresponding author yu.bai@monash.edu, Department of Civil Engineering, Monash University, Australia

1. Background: Hollow section GFRP members

Features:

- GFRPs (glass fibre reinforced polymer) from the pultrusion process are corrosion-proof, lightweight, cost-effective in manufacturing, and available in different sections shapes
- Hollow section members are efficient in buckling resistance, but difficult to connect due to the closed section shape & material anisotropy and brittleness of the GFRP

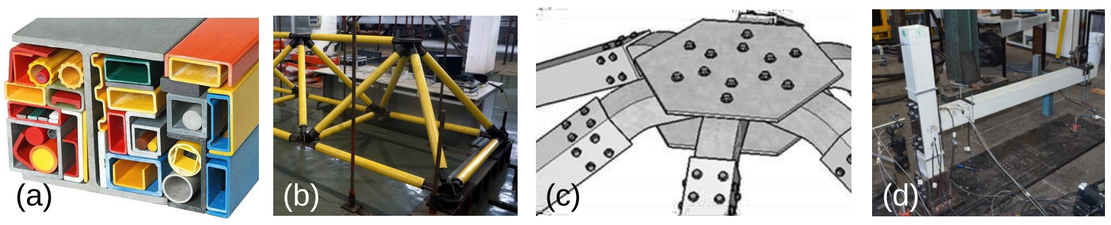


Figure: *(a) Pultruded FRP profiles; (b) nodal joint in FRP truss*[1]; (c) nodal joint in FRP latticed shell structure*[2]; (d) FRP beam-column connection*[3]*

Need for research:

- Connection designs exist for truss, shell structure, beam-column
- Splice connection for hollow section GFRP is yet to be developed

2. Conceptual design of splice connection

Comprised of two steel-GFRP BSJ (bonded sleeve joint) and a steel BFJ (bolted flange joint)

- Adhesive bond for high composite action & reduced stress concentration in GFRP
- Steel component for fast on-site installation via bolt-fastening & system ductility via steel yielding
- Performance under various loadings to be investigated

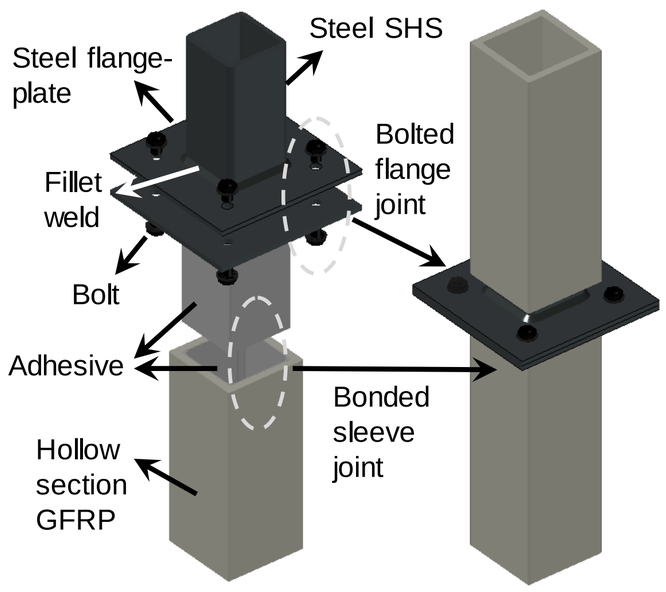
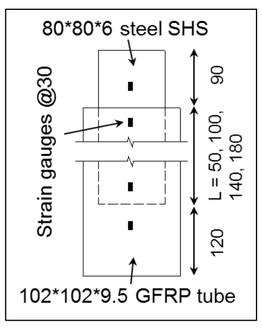


Figure: *Proposed splice connection for hollow section GFRP members*

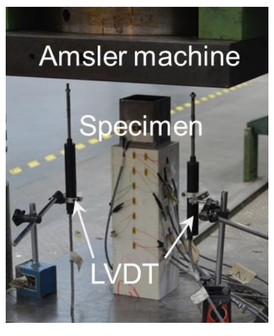
3. Performance of the splice connection under axial loadings

Individual performance of BSJ and BFJ: experiment and FE modelling

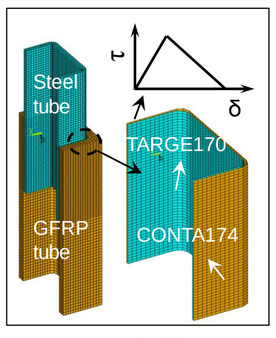
BSJ-50,100,140,180



Dimensions

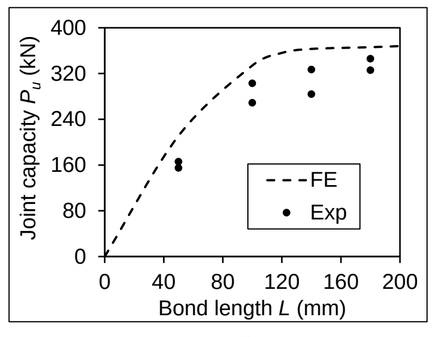


Test setup



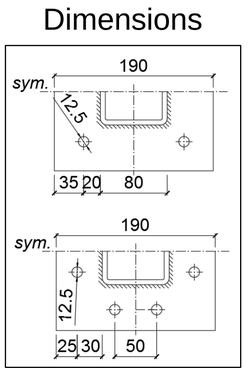
FE modelling

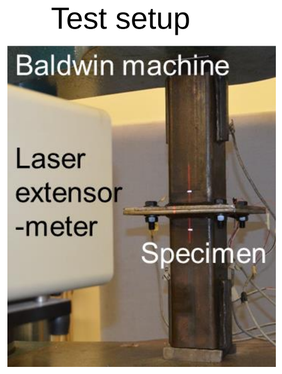
Failures

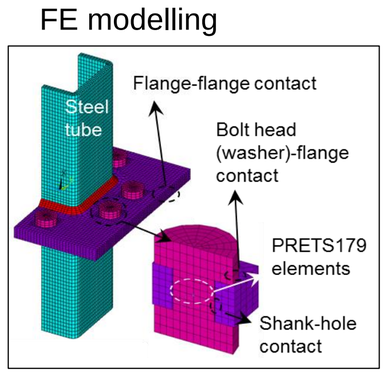


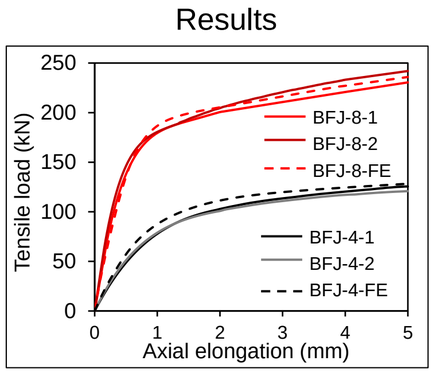
Results

BFJ-4 or 8



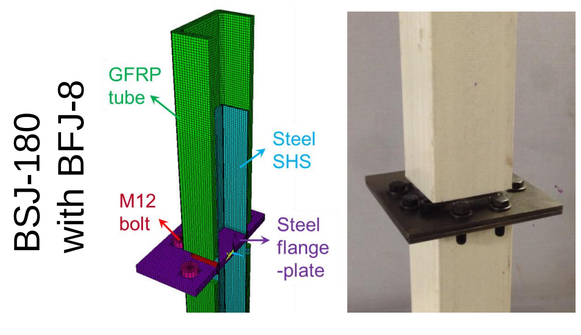


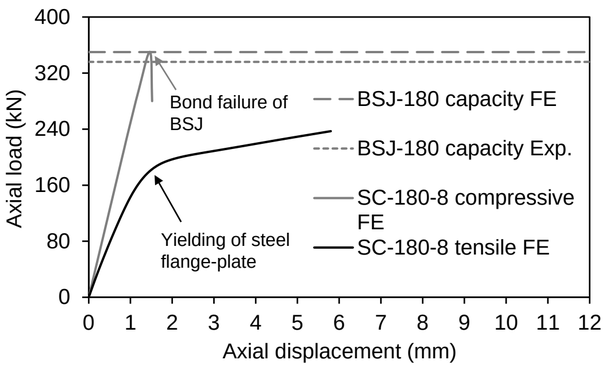




Integrated performance by modelling

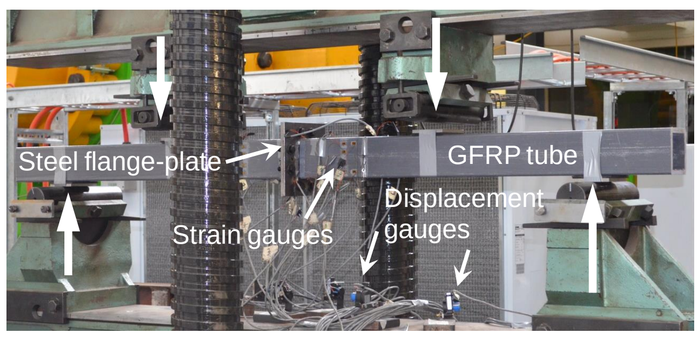
BSJ-180 with BFJ-8

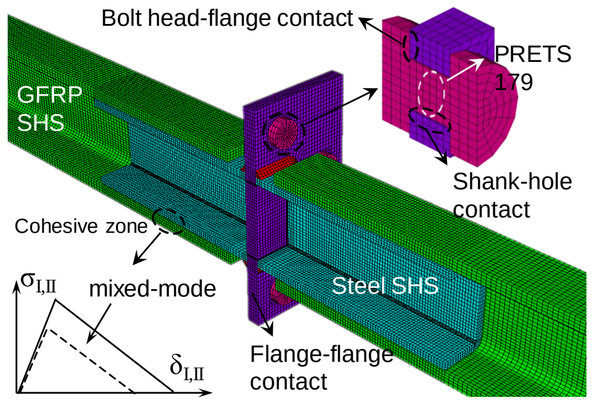




4. Performance of the splice connection under flexural loading

Four-point bending test & FE modelling

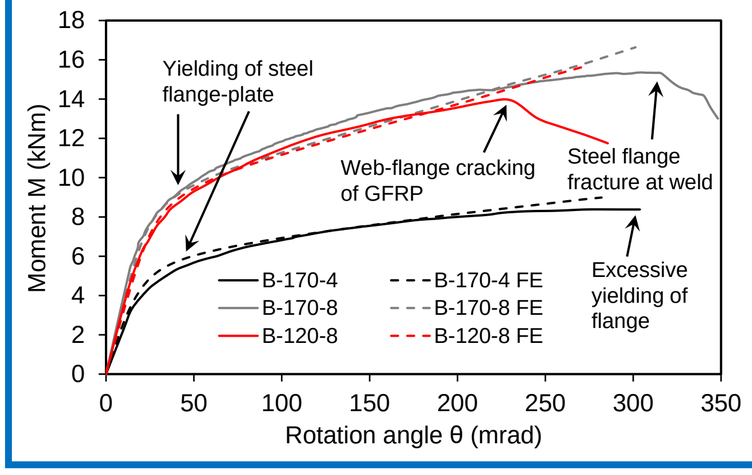




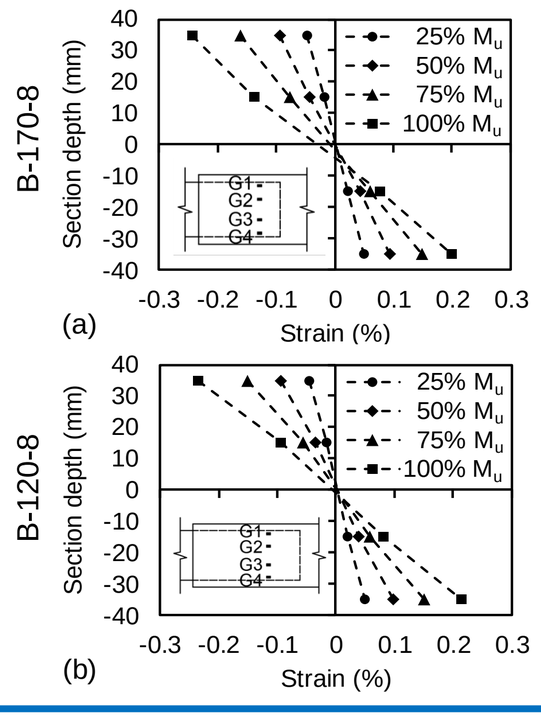
Specimens

Index	GFRP-steel bond length	NO. of bolts
B-120-8	120 mm	8
B-170-8	170 mm	8
B-170-4	170 mm	4

Moment-rotation behaviour

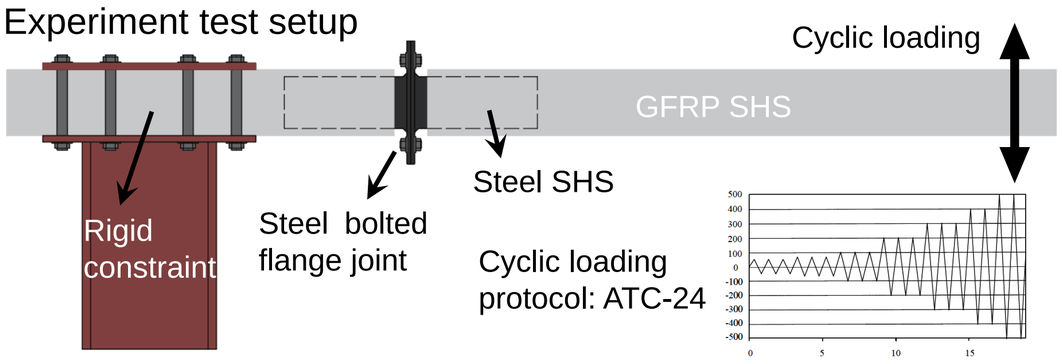


GFRP-steel Composite action

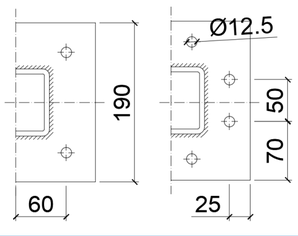


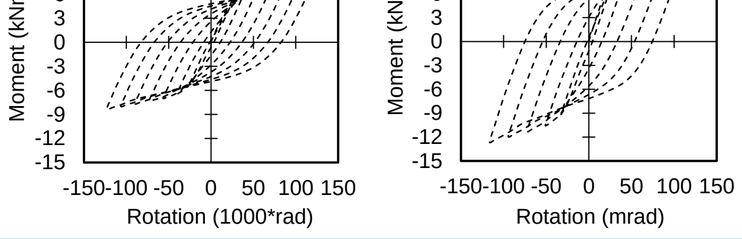
5. Performance under cyclic loading (in-progress)

Experiment test setup



Modelling results with 4 or 8 bolts





6. Main conclusions

- With satisfactory stiffness and strength, the splice connection can achieve ductile failure by yielding of the steel flange before failure in the bonded joint region
- Under axial loading, the capacity of the BSJ component exhibits nonlinear relation with bond length, showing effective bond length of about 120 mm
- Under flexural loading, the BSJ can maintain high composite action and high strength between the steel and GFRP SHS

References: 1. *Yang X et al*. Fiber-reinforced polymer composite members with adhesive bonded sleeve joints for space frame structures; 2. *Luo F*. Joining pultruded GFRP tubular components into space latticed shell structure; 3. *Zhang Z et al*. Bonded Sleeve Connections for Joining Tubular Glass Fiber–Reinforced Polymer Beams and Columns Experimental and Numerical Studies