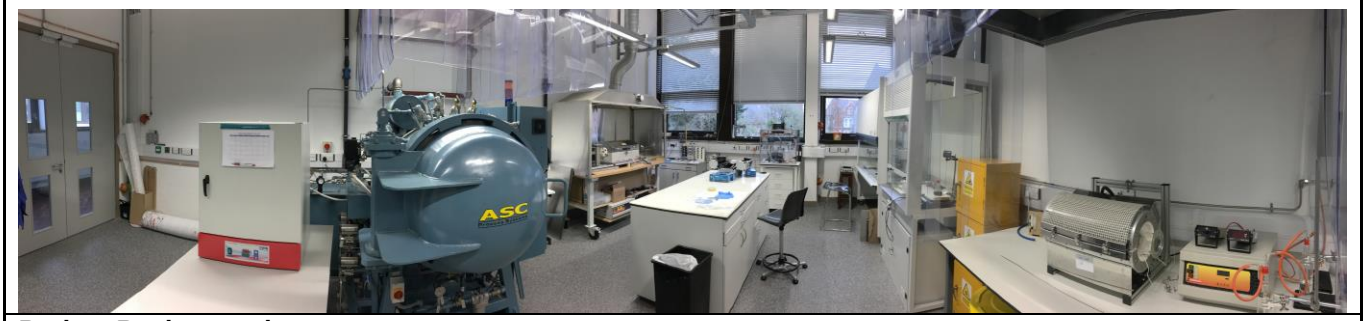
QUB- Mechanical and Aerospace Engineering

PhD Project 2021-22

Novel Layup Optimisation Methods in Design and Manufacture of Advanced Fibre Rienforced Laminated Composites



Project Background:

Fibre reinforced polymer (FRP) composite laminates are rapidly replacing traditionally metallic structural components in various areas, especially in aerospace industry where light weighting has become one of the most important design priorities. Advanced FRP composites, exhibiting the highest specific stiffness and strength among other materials, are ideal candidates to address such a grave need. This explains how the latest commercial and military aircrafts involve a high percentage of composite materials as part of their structural weight, and this has only been increasing consistently since appearance of the first advanced FRP composites. Despite their outstanding design versatility, especially in terms of layup design, the principals of layup selection and configuration have barely changed since the 1960's, where quad-axial laminates made from strict combinations of four main ply angles, namely, 0°, 90°, +45°, and -45°, are still used extensively (even exclusively) in composite design. This approach is mostly based on the so called "10 % rule", often leading to overly conservative designs with relatively thick repeated units, or "sublaminates". Suboptimal designs as such, not only underutilise the true potentials of carbon fibre composites, they make them costly and difficult to manufacture, and repair. The past few years have witnessed incredibly promising progress in the area of composite design, in particular laminate architecture where a number of advanced layup optimisation methods, tailored to specific applications have been introduced. In close collaboration with leading Aerospace OEMs including Spirit Aerosystems (Belfast), and Collins Aerospace UK, the supervisory team have already established the foundations of a new composite design methodology, based on the recent findings of Prof. Tsai's team, who has kindly supported the projects, to facilitate material screening and preliminary structural analysis of the load-bearing composite components. The current focus of the team is on further developing the invariant based design concepts through manufacture and characterisation of the optimised layup designs.

Project Description:

The proposed project, aims at employing a series of novel layup optimisation methods including invariant based approaches and the so called "Double/Double" alternatives to provide the most optimum laminate configurations, based on the given structural requirements. The optimisations are applied on the existing traditional designs in consideration of specific loading scenarios, based on real-life Aerospace applications. Prototypes will then be manufactured and tested for experimental validation in a comparative manner. This includes characterisation of a range of mechanical and damage properties.

The successful candidate will have the opportunity of being involved in technical meetings with Spirit Aerosystems, the industry partner of the project to discuss design ideas. This will be followed up by manufacture and testing the optimised composite laminates in the factory premises.

Key skills required for the post:
Applicants should hold or expect to hold a 2.1 Hons (or equivalent) degree in a relevant discipline such as Mechanical and/or Aerospace, or Polymer Composite Engineering, or in a related field. Students who have a 2.2 honours degree and a Master's degree may also be considered, but the School reserves the right to shortlist for interview only those applicants who have demonstrated high academic attainment to date.

It is essential that the candidate has an enthusiastic attitude towards undertaking research in the field of the mechanics of composite materials and is willing to travel to both academic and industrial collaborators for placements, training courses and dissemination activities.

Key transferable skills that will be developed during the PhD:
These will include an ability to effectively communicate research outcomes to academic peers and industry, independent analytical thinking and problem solving, time management, and leadership.

Lead supervisor:	Dr M. Ali Aravand School of Mechanical & Aerospace Engineering, Queen's University Belfast, m.aravand@qub.ac.uk, 028 9097 4113
Co-supervisors:	Prof Brian G. Falzon School of Mechanical & Aerospace Engineering, Queen's University Belfast Dr. Zafer Kazanci School of Mechanical & Aerospace Engineering, Queen's University Belfast
Funding mechanism:	UK nationals only.
Application closing date:	31st July 2021
Guaranteed stipend	£15,285 tax free. PhD students in the School may have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.