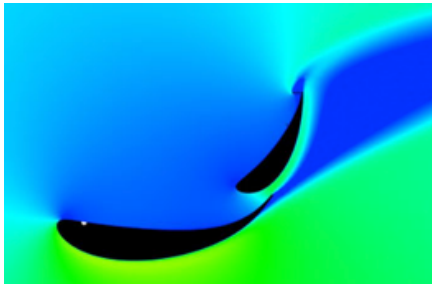


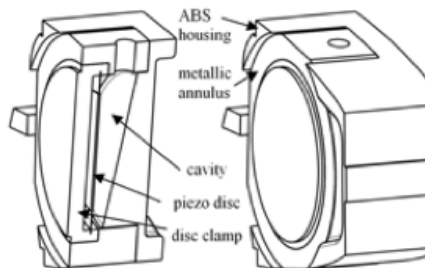
## Vehicle Aerodynamics

Aerodynamic flow control has been of significant interest since 1968 when Lotus experimented with wings fitted to Formula 1 cars. At Surrey we have been working on modifying the flow in the boundary layer on an aerodynamic surface to change the behaviour of the flow to either cause a wing to stall or, conversely, cause a separated (stalled) flow to reattach allowing the lift and drag to be controlled at the push of a button without moving the wing surface. To examine this flow we use advanced Computational Fluid Dynamics (see below) and wind-tunnel experiments to study the flow on a NACA 0015.



CFD image of flow around a rear wing with Gurney flap.

The devices we have developed are known as synthetic jets. Our design uses piezo-electric discs to drive the pulsing flow in a cavity generating the expanding jet which is powered by the vortex flow. Below is a diagram of the synthetic jet assembly used in the wing.



The experimental work was carried out in the 40m/s closed-return wind tunnel on a 2D wing. Future work will examine the effects of operating the wing in close proximity to the ground using the rolling-road facility.

## Lightweight Chassis Structures

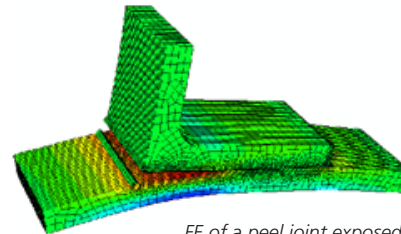
Expertise in this area has two complementary themes; adhesively bonded structures and fibre reinforced polymer (FRP) composites. Work in both areas is supported using advanced FE modelling software, a mechanical testing lab with seven state of the art electro-mechanical and servo-hydraulic testing machines, composite and adhesive bonding labs and a full range of micro-structural and surface analysis facilities.



Fatigue testing of an bonded composite sandwich panel

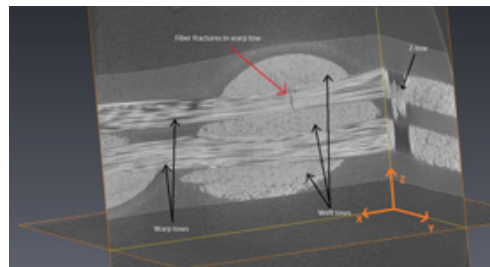
In this area the research of AERG focuses on:

- Design allowables and service lifetime predictions for adhesively bonded structures



FE of a peel joint exposed to a hot-wet environment

- Structural performance, damage micro-mechanisms and structural health monitoring of FRP composite systems



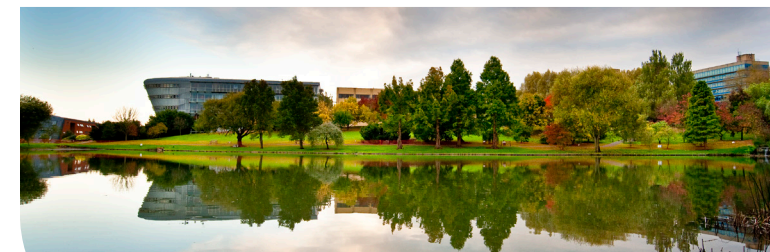
Fractures in a 3D woven composite using micro-CT

# Automotive Engineering Research Group

[surrey.ac.uk/mes/research/automotive](http://surrey.ac.uk/mes/research/automotive)

Surrey's Automotive Engineering Research Group (AERG) aims to provide world class technical research for vehicle analysis in the following key areas: all electric and hybrid powertrains, vehicle dynamics simulation, tyre dynamics simulation, design and simulation of vehicle subsystems (brakes, steering, suspension, chassis control systems design), design of experimental test benches, lightweight chassis design and vehicle aerodynamics.

*AERG has extensive research links with vehicle manufacturers such as Jaguar Land Rover, Skoda, Fiat, McLaren Automotive, Williams and Gordon Murray Design and with OEMs such as Lucas Varity, Inverto, and Oerlikon Graziano*



## Electric and Hybrid Vehicles

A significant variety of hardware layouts is possible for electric propulsion systems for BEVs, in terms of number of electric motor drives, centrally located or individually controlled (and in this case in-wheel or on-board variants are possible), and mechanical transmission system configurations (e.g. single-speed or multiple-speed). The number of possible architectures is even larger in the case of HEVs and PHEVs, where the interaction between the internal combustion engine and the electric motor drive is the focus of current research.



Vehicle demonstrator with yaw controller

**In this area the research of AERG focuses on:**

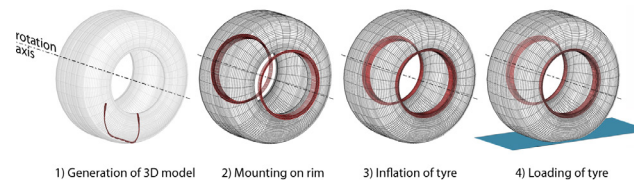
- Vehicle dynamics control of PHEVs and BEVs with torque-vectoring functionality
- Novel seamless multiple-speed transmission systems for PHEVs and BEVs and their control
- Energy management and regeneration in braking
- Hybrid energy storage systems, consisting of a battery and a supercapacitor.



Hardware-in-the-Loop (HiL) drivetrain testing facility

## Tyre Dynamics

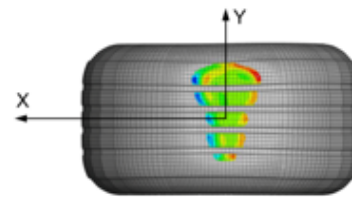
Tyres are at the heart of the dynamic qualities of vehicles and have an impact on the vehicle energy consumption (up to 7% of the total vehicle energy consumption is caused by tyre rolling resistance). Hence, there is a clear interest and need by automotive engineers and researchers to thoroughly understand the behaviour of tyres. To achieve this goal under all possible driving and road conditions, a detailed understanding of the physics of the rolling tyre is required. Yet, this aspect is not fully understood as the two components that meet in the contact patch (the tyre and the road surface) yield complex, interrelated physical-processes.



Virtual tyre testing approach

**In this area the research of AERG focuses on:**

- Virtual testing of static and rolling tyres using advanced FE models
- Development of rubber friction models based on physical mechanisms
- Creation of tyre models for bespoke vehicle dynamics simulations and high fidelity simulation tools such as full vehicle simulators.



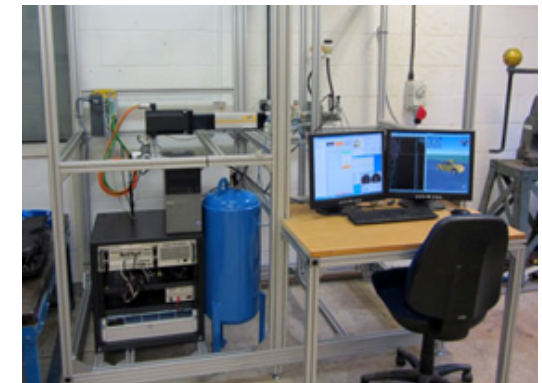
Contact patch on a cambered tyre

## Intelligent Transportation and Vehicle Control

With the emergence of electric and hybrid electric vehicles, the adoption of advanced stability and safety control technologies such as torque-vectoring, control allocation, active cruise control, collision avoidance and emergency braking is much easier because of the electric drive motors in such vehicles. However, precise actuation of these controllers requires accurate information of the vehicle dynamics which can be obtained by sophisticated estimation algorithms. Hence, developing a method of accurately estimating the vehicle states using cost-effective configurations of on-board vehicle sensors and extra information sources is of great importance for automotive industries.

**In this area the research of AERG focuses on:**

- Development of advanced stability and safety control techniques in order to improve significantly the performance of modern vehicles in terms of safety, comfort, drivability and other important characteristics.
- Development of advanced fault-tolerant vehicle estimation algorithms in order to improve the real-time performance of embedded vehicle controllers
- Hardware-in-the-loop and experimental verification of control and estimation algorithms



A state-of-the-art hardware-in-the-loop (HiL) system to analyse and develop modern brake systems with vehicle dynamics control functions such as ABS and ESP