

## Tim Gilbert, PhD student

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PhD Student in High-Speed Train Aerodynamics

Welcome to my personal page, where you can find out about the research I am doing for the University of Birmingham [School of Civil Engineering \(/schools/civil-engineering/index.aspx\)](#) and [Birmingham Centre for Railway Research and Education \(/research/activity/railway/index.aspx\)](#).



### Research interests

My research explores the flow field around a train passing a stationary observer, more specifically, when the train is passing through a semi-confined space. The confinement concentrates the airflow, which can lead to gust-forces severe enough to knock people off their feet or cause early fatigue failure of trackside structures.

I am proud to work with supervisors [Professor Chris Baker \(/staff/profiles/civil/baker-chris.aspx\)](#) and [Dr Andrew Quinn \(/staff/profiles/civil/quinn-andrew.aspx\)](#), who are at the forefront of international research on the aerodynamic effects of trains.

I conduct experiments at the [TRAIN Rig \(/research/activity/railway/research/train-rig.aspx\)](#) in Derby, a unique moving-model facility owned by the University of Birmingham. As well as academic research I provide technical assistance on commercial projects. A [demonstrational video \(http://www.youtube.com/watch?v=8dqh936Bp-I\)](http://www.youtube.com/watch?v=8dqh936Bp-I) is available.

### Research undertaken:

The flow field surrounding a high speed train causes many aerodynamic problems. My research focuses on transient aerodynamic loads including: pressure-induced loading on trackside structures; and airflow-induced loading on trackside objects. The loads contribute to the early fatigue failure of structural components, as well as hazards associated with the displacement of humans or objects, and discomfort caused by rapid pressure changes or sustained winds. The load magnitudes increase proportionally to the square or cube of the train speed. Consequently, aerodynamic effects impose significant design constraints on high speed routes.

A confined space is generally defined as a location where the flow field around the train is disturbed by a surface parallel to the tracks. Examples include noise barriers, train stations, tunnels or partially-enclosed spaces.

Past research on flow fields has focused predominantly on long tunnels and the open air, but little work has been carried out examining how the flow field changes for spaces which fall between these two extremes. Advancements in this area will facilitate the optimisation of codes of practice and test specifications for R&D studies, for the benefit of both infrastructure managers and rolling stock manufacturers. The potential benefits of this could include improved safety for passengers and railway workers, as well as significant reductions in expenditure, journey times and service disruptions.

I conducted moving-model tests at the TRAIN Rig facility. I fired a reduced-scale model train past simple structures. Stationary airflow sensors recorded the flow field around the train. The structures included vertical walls, partially-enclosed tunnels, short tunnels of varying lengths, and finally a long tunnel.

I performed more than twelve experimental studies using more than twenty structures, as well as one CFD study. Each study relates a geometric variable to a type of transient aerodynamic load. I consulted the relevant fluid dynamics theory in the interpretation of my results.

### Skills developed:

In the process of conducting this research I have developed a varied and versatile skill set which would be of great benefit for careers in academia, commercial research, and careers relating to engineering and environmental physics.

The University of Birmingham has provided me with access to cutting edge facilities, including the TRAIN Rig and three different wind tunnels. I was also given access to CFD packages including OpenFOAM, and the BlueBEAR computer cluster. I developed detailed knowledge in best practice for both CFD and experimental studies, and learnt to interpret OpenFOAM's C++ source code.

I made significant contributions to two commercial research projects, in addition to my academic research. My role included agreeing test specifications with new clients in person, conducting tests and processing the data using MATLAB, attending project meetings to update clients on the progress of the tests, and communicating our research results to the clients. I developed good professional relationships with suppliers, tradesmen, administrators, academics and clients of all levels during my PhD.

My research has provided me with regular opportunities to attend conferences and network with other experts in my field. Consequently I am now planning a collaborative CFD study with a PhD student from the Eindhoven University of Technology relating to the behaviour of train-induced airflows entering underground stations. Due to my participation in UK Wind Engineering Society conferences, I was also able to work as their webmaster; this allowed me to develop my Java and HTML skills.

I developed valuable interpersonal skills through teaching, and even organising two careers conferences for a total of 300 people. My teaching responsibilities included a lecturing post in the 'Electrical, Electronic and Computer Systems' module, and demonstrating responsibilities in 'Fluid Flow, Thermodynamics and Heat Transfer', 'Modelling Concepts and Tools', and 'Environmental Fluid Mechanics' modules.

#### **Publications:**

- Conference paper: Gilbert, T., Baker, C., Quinn, A. and Sterling, M. (2012) Aerodynamics of high-speed trains in confined spaces. BBAA7 conference, 2-6 September, Shanghai, China.
- Conference paper: Gilbert, T. (2012) The flow around high speed trains in partially-enclosed spaces. WES Conference, 10-12 September, Bristol, UK.
- Journal article: Baker, C. Jordan, S. Gilbert, T. Quinn, A. Sterling, M. and Lane, J. Transient aerodynamic pressures and forces on trackside and overhead structures due to passing trains. Part 1 Model scale experiments Part 2 Standards applications. Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit. DOI: 10.1177/0954409712464859

#### **Manuscripts:**

- Journal article: Gilbert, T., Baker, C.J. and Quinn, A. (2013) Gusts caused by high speed trains in confined spaces and tunnels. Manuscript submitted for publication.
- Journal article: Gilbert, T., Baker, C.J. and Quinn, A. (2013) Aerodynamic pressures around high speed trains: the transition from unconfined to enclosed spaces. Manuscript submitted for publication.
- Conference paper: Gilbert, T. (2013) The effects of confinement on high-speed train wake velocities. 6th European and African Conference on Wind Engineering, 7-11 July, Cambridge, UK.
- Conference paper: Gilbert, T., Baker, C. and Quinn, A. (2013) Aerodynamic effects of high speed trains in confined spaces. International Workshop on Railway Aerodynamics, 8-10 April, Birmingham, UK.
- PhD Thesis: 'Aerodynamic effects of high speed trains in confined spaces' - will be submitted by September 2013.