Building the safety case

Professor Luke Bisby is a structural engineer who is working to understand the impact of fires and elevated temperatures on materials and large-scale building structures. His studies strongly suggest that in many cases the current design provisions concerning fire in buildings are not fit for purpose. He and his colleagues are collecting the data necessary to build models and develop design tools to improve that.

ROYAL ACADEMY OF **ENGINEERING**

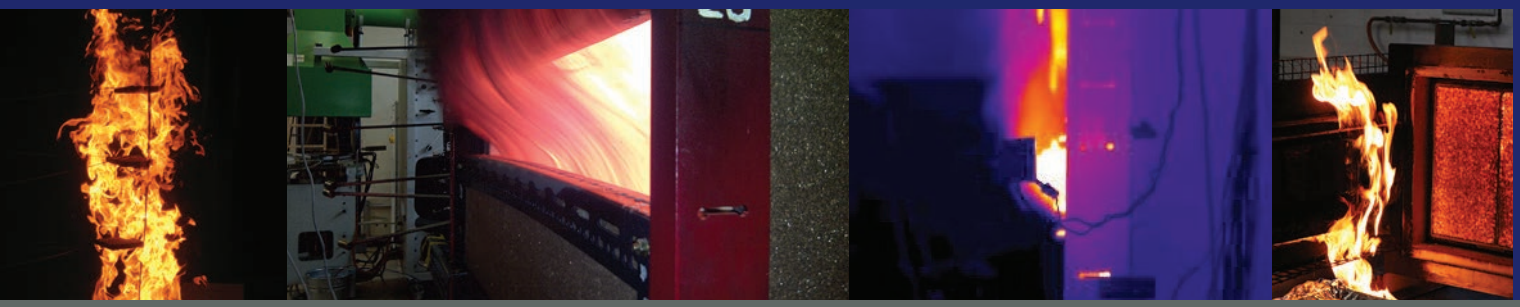
Research area

Luke Bisby is The Arup Professor of Fire and Structures at the BRE Centre for Fire Safety Engineering at Edinburgh University. He graduated originally in structural engineering and his PhD research looked into the use of advanced polymer composites as new materials for strengthening reinforced concrete in buildings. Part of this research entailed investigation into the fire performance of new materials and the bond that fixes them to existing structures. Fire research was only part of his work at that early stage.

Professor Bisby said that the terrorist attacks on the Twin Towers on 11 September 2001 were not a mainstream or typical fire event in terms of structural engineering, but that it rightly raised the subject of structural performance in fire up the research agenda at the same time. His own postdoctoral research focused on the issues raised, "As a structural engineer, I was trying to figure out if we could have – or should have – prevented what happened, and how structural engineers should think about fire and design for different scenarios as part of their duty of care." With his emphasis gradually moving away from composite materials, and, keen to back his structural fire engineering research with data from realistic tests, he moved to the Edinburgh centre. Here, he started working alongside subject specialists in fire science and engineering, and broadened his research into real fire events and analysing their effects on real structures.

The fundamental aim of his research is to be able to model fire in buildings (and vice versa), and to be able to derive and validate computer models which can be applied to the structural and fire safety design of buildings. The models will look into various factors, ie the dynamics of the fire itself, other ignition sources, the effects of other elements such as glazing and heat transfer into the structure, all as a dynamic transient event where the heat generated by the fire affects the response of the building structure.

The work has profound implications for international building design codes and the ways that fire is treated in structural engineering, and Professor Bisby said that norms that have been accepted for more than a century are now being exposed as inefficient or inadequate in some cases. As a result, the top structural fire engineers now operate in a design space where the building codes are simply used as tools within a performance-based framework, rather than as static, prescriptive requirements.



Academy support

Professor Bisby is currently supported by an RAEng Research Chair. "The Academy's support has made a fundamental difference to me professionally", he said. "More importantly, the support of the Academy has given me independence to develop my research career which will help society at large".

The Academy is also sponsoring further sociological research at Edinburgh that will investigate how the university can make its technology important in 'a regulatory and practical enactment sense' – Professor Bisby said this is fundamentally important, since his work is intended to lead to new design codes, but these will be of limited value unless enacted.

Other support

Arup's Fire Engineering practice currently co-sponsors the work of Professor Bisby and his team, and Arup is a principal collaborator in the overall project. Professor Bisby spends time each year in Arup's offices and Arup engineers collaborate with Edinburgh in both education and research contexts, to the benefit of both parties.

Research impact

Luke Bisby's work is redefining the way fire is treated in the structural design of buildings. He said, "Fire should be considered as a design load in the same way that wind, gravity, and seismic effects are treated. Current codes for new buildings are based on data collated more than a century ago and, even if they were state-of-the-art then, they take little account of the many advances since."

The research he and his colleagues at Edinburgh have done so far indicates that the current definition of a credible worst-case design fire leads in many cases to a significant over-estimation of risk and effects – although in some cases it produces under-estimation. "It means that there is a massive opportunity to optimise buildings for fire and in many cases to make structures lighter, more beautiful and sustainable," he said. Over-design implies higher cost in terms of initial construction and of the building lifecycle. And in those fewer cases where the current codes under-estimate the negative impacts of fire, there may be safety issues.

In order to be able to treat fire as a design load, "you need to be able to model a specific building, the specific construction techniques, the materials and then design for that load", he said. "So that means you need computational tools to do that and you need to validate those computation tools with experimental data. That is essentially what we are doing."

Future challenges

A big challenge for the future, Professor Bisby said, will be to persuade regulators that design codes and regulatory processes for significant buildings should be changed. "Often when we try to take an innovative approach to fire safety we come up against a regulatory process that doesn't want to hear it," he said. "The current methodologies are a century old and the numbers they're based on are decades old as well. There is a lot of inertia in practice, and we know that it will take time to affect real and lasting change."

"Our research can be used to great advantage to safely optimise buildings, and in most cases it can save clients' money and allow architects to do more interesting things, all while preserving or even enhancing safety."

Professor Luke Bisby

Biography/ Career Progression

1993-1997 Undergraduate degree in Civil Engineering and Applied Mechanics, McGill University, Montreal, Québec

1997-1999 Master of Science degree in Structural Engineering, Queen's University, Kingston, Ontario

1999-2003 PhD in Structural Engineering, focusing on structural and fire performance of polymer composite structural strengthening materials, Queen's University, Kingston, Ontario

2003-2008 Assistant Professor and Undergraduate Chair, Queen's University, Kingston, Ontario

2008-2013 The Ove Arup Foundation/ RAEng Senior Research Fellow in Structures and Fire, School of Engineering, Edinburgh University

2013-Present Arup /RAEng Research Chair in Structures and Fire, School of Engineering, Edinburgh University

Key achievements

Professor Bisby believes his research will continue to achieve 'slow but steady' outcomes rather than headline-making breakthroughs. He said, however, that his work has planted seeds that are fundamentally changing the perception of how structural engineering is done in the UK and elsewhere. This has been initiated with the direct involvement of The Ove Arup Foundation and Arup's Fire Engineering consultancy (former and current co-sponsors respectively) and through the continuing spread of Edinburgh-trained engineers into the profession worldwide.