



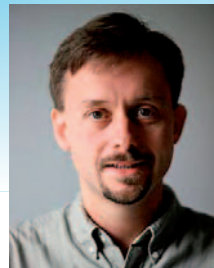
The Royal Academy
of Engineering

Distinguished Visiting Fellowship Scheme Case Study

Mechanical and Thermal Analysis of Composite and Sandwich Structures



Host:
University of Southampton
Professor Janice Barton
Professor of Experimental Mechanics



Distinguished Visitor:
Professor Ole Thybo Thomsen
Professor of Mechanical Engineering,
Head of Department
Aalborg University
DENMARK



The University of Southampton and Aalborg University have shared research interests in the mechanics of composite and sandwich structures. The expertise of the visiting fellow complements that of the host as the thrust of the host's work is in experimental mechanics and the visiting fellow's major interest is in developing analytical and numerical models to predict the structural response.



Professor Janice Barton with colleagues at a conference banquet

Professor Ole Thybo Thomsen is the Head of the Department of Mechanical Engineering and Professor of Solid Mechanics and Mechanics of Lightweight Structures at Aalborg University. He is an internationally leading researcher with numerous papers in ISI indexed journals and other publications. He has led numerous research projects funded by EU, European Space Agency, US Navy – Office of Naval Research, Danish Council for Technology and Production Sciences (FTP), and by industry and charitable foundations. He is a fellow of the Danish Academy of the Technical Sciences.

Professor Janice Barton is Professor of Experimental Mechanics in the School of Engineering Sciences at University of Southampton. She has published numerous papers in archival journals and conferences. She has been principal investigator on numerous research projects funded by the research councils, UK Government, charities and industry. To date she has supervised a number of successful PhDs and numerous masters projects.

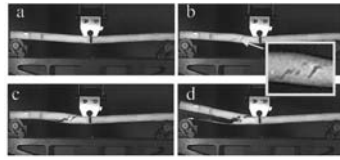
The visit combined the expertise at both institutions to study thermal degradation in polymeric foam cored sandwich structures, as well as nonlinear interactions between mechanical and thermal loads in such structures.

Statement from the Host

'I am impressed with the plan of activities and the way that the plan draws on the strengths in our School in experimental mechanics and on the strength at Aalborg University in modeling. The design and development of the test rig will bring a unique facility to our School and will provide opportunities for new research and new research collaborations with industry. Professor Thomsen's visit has provided great benefits to our research efforts and brought a new dimension to the work conducted within our School.

I hope that we will be able to build on this exchange and that there will be many other opportunities for ongoing collaboration.'

Professor W G Price FREng FRS
Head of School



Core shear failure of a sandwich beam loaded in three-point bending

Why a visit?

The purpose of this visit was to design an experimental approach that will provide a detailed validation of the numerical model at Aalborg University, as well as to further develop and refine the modelling capabilities with a special focus on their adaptation for engineering design purposes.

The visit underpinned collaborative research in three areas:

- Thermal degradation in polymeric foam sandwich structures.
- Analysis of the stresses at discontinuities in sandwich structures.
- Stress analysis in joints in pultruded composite materials.

Visit outcomes

- The visit resulted in a research proposal on thermal degradation in polymeric foam sandwich structures.
- An experimental rig was conceptually designed.
- A further strand of research is an in-parallel funding application to further develop the modelling capabilities. This will include the expansion of the present panel/beam model, based on a so-called high-order sandwich theory approach that includes the transverse flexibility of the core, geometrical nonlinearity as well as temperature dependent material properties, to allow for the analysis of general sandwich plate or shell structures. A number of design studies will be carried out supported and validated by the experimental results. The end result of the research will be a unique facility, comprising numerical/predictive and experimental capabilities, which enable an in-depth evaluation of the performance of composite sandwich materials subject to thermal and mechanical loading.
- Outline proposals for funding have been prepared and were sent to Airbus (UK and Germany), GE Aviation, RNLI and E-on.
- Professor Barton and Professor Thomsen visited and made a presentation at E-on.

Statement from the Distinguished Visitor:

The RAE distinguished visiting fellowship has been very helpful in strengthening the collaboration between Southampton and Aalborg University. The basic idea and motivation behind the collaboration is to combine and further develop the expertise of both institutions, and I envisage that our combined efforts on the topic of thermal degradation effects in advanced foam cored sandwich structures will lead to a world leading position in this area of research and industrial application. In addition to this particular research project that we have engaged in, it is my hope and expectation that this will lead to increased collaboration on student exchange as well as future research projects. The visit has been invaluable to me as it enabled close links to be built with one of the leading UK Engineering universities and with UK industry, all of which will help future research prospects and widen the scope of the collaborative research at Aalborg.

Professor Ole Thybo Thomson
Aalborg University

Statement from E-on

'The research project of Professor Thomsen and Professor Barton has immediate applications for wind turbines, and from our perspective will provide greater understanding of degradation mechanisms, which will stimulate the research and development of appropriate counter measures, thereby maximising plant availability. The proposed validation and development of computational methods used to predict the evolution of 'damage' in these structures during service is considered essential. We strongly support the project and would be prepared to contribute by participating in technical meetings and technical correspondence as appropriate, thereby providing an end-user's perspective. As the project develops we would also consider opportunities to sponsor aspects of the research via PhD studentships.'

Andrew Morris
E-on UK

- A presentation was made at University of Southampton to representatives of GE Aviation Systems, and Aerostructures Hamble Ltd.
- A presentation was given at Airbus UK in Filton to a delegation of representatives.
- A journal paper "Characterisation of local effects at core junctions in sandwich structures using thermoelastic stress analysis", has been accepted for publication in the Journal of Strain Analysis for Engineering Design.
- A journal paper "Development of a finite element model for analysis of pultruded structures using thermoelastic data" has been finalized and was accepted for publication. The fellowship has allowed the continuation of work with a French internship as well as the finalisation of the paper.
- Professor Thomsen was invited to present his work entitled "Control of delamination in sandwich structures" at a British Society for Strain Measurement seminar on Core Materials and Sandwich Structures that took place in Liverpool.
- Professor Thomsen was appointed as Visiting Professor at University of Southampton with unlimited access to computational and experimental facilities.
- The visit has enabled the fellow to build close links with one of the leading UK engineering universities and with UK industry, all of which will help future research prospects and widen the scope of the collaborative research.



Professor Janice Barton in an autoclave to be used for the manufacture of some of the materials used in the thermal degradation project

Future links and collaboration

In order to maximise the benefits from the visit plans have been put in place to continue the collaboration between the host and Professor Thomsen and his Centre of Excellence. The best possible route for this is initially through the success of the research proposals and access to much larger funds to support the work.

For further information please contact

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The scheme application form and guidance notes for applicants are available to download from The Academy's website:

<http://www.raeng.org.uk/research/researcher/dvfs/apply.htm>