



## Summary Report on the Proceedings and Outcomes of the Facilitated Activity during the DURACOMP Event on 28 April 2016

The activity lasted 135 minutes and was focused on targeted and realizable deliverables. **Appendix I** lists the 38 participants who organized themselves in five discussion groups. The participants comprised of 18 from industry, one from a trade organisation, one from NCC and 18 for HEIs, which because of the mix of expertise helped to make the activity a success.

The groups discussed a wide range of engineering issues, facilitated by Peter Gosling. The activity was concluded by developing a number of priority topics. These topics are important to the development of composites in construction and had to have outcomes from targeted research work that would be beneficial to academia and industry. The word 'composite' is used to mean a material of Fibre Reinforced Polymer (FRP) from which a structural engineering component or structure can be fabricated.

The five groups proposed a number of questions or topics for further work (not listed in any order of priority), and they are:

1. Do we need standardised testing procedures and can standardized testing be beneficial?
2. Do we need specific test methods for thick composites? (from two groups)
3. Designers require data to be reported in specified format.
4. What is the minimum number of data set(s) and how do we qualify their sources?
5. We need to define performance classes of composite materials for applications.
6. Can predictive modelling give assurances to clients on long-term behaviour of composite structures?
7. We need reliable and relevant failure criteria (for service and failure design).
8. We need to have better understanding to use adhesive bonding as a method of connection in primary structural joints.
9. Do we know and understand enough about composites degradation mechanisms?
10. Can accelerated aging be a useful test methodology to determine long-term mechanical properties?
11. For the durability of composites why can't we learn from other industries, such as from the Aerospace sector?
12. Should the trigger points for durability be included in a future structural FRP Eurocode (standard for the design of structures of composite materials)?



13. We need simple rules to show that durability is not an engineering problem or can be avoided. When can we provide definite advice and certain back-up technical/engineering information to our clients?
14. How do we know we have robust specifications for composite processing methods?
15. There is need to develop the UK supply chain for composites in construction.
16. What can be done for long-term structural assessment and asset management in terms of inspection, Non-Destructive Testing (NDT) and monitoring?
17. What data are we to collect from monitoring 'live' structures that can be input data for academic research work to deliver reliable and relevant design parameters for the preparation of a structural FRP Eurocode?
18. Designers need a specification for patch repairs.

In summary, the 18 topics scope the determination of mechanical properties for design (1-5), computational modelling and evaluation (6-7), adhesively bonded connections (8), durability and 'degradation' mechanisms (9-13), robustness of composite processing (14), inspection and monitoring (16-17) and patch repairs (18). The need to have standard test methods for thick composites received a priority from two groups.

The Composite Leadership Forum has prepared *The 2016 UK Composites Strategy* ([https://compositesuk.co.uk/system/files/documents/Strategy%20final%20version\\_0.pdf](https://compositesuk.co.uk/system/files/documents/Strategy%20final%20version_0.pdf)) for delivering UK growth through the multi-sector application of composites. Within the recommendations is a section on **Regulations Codes and Standards** states that "One of the major inhibitors to the uptake of composites in new sectors is that regulations, codes and standards are often inappropriate for composites. This is because they are both explicitly and implicitly based on named materials, such as steel, and do not permit consideration of composites applications despite the strengths and benefits of the materials in many cases. We recommend that the sector:

- Work with regulators and standards bodies to adapt regulations to enable use of composites.
- Establish composites materials test and database capability.
- Develop standards for key topics such as process related measurements, fire, smoke and toxicity.
- Develop non-destructive methods for thick sections and large scale manufacture.
- Implement design codes for structural applications."



The DURACOMP partners, led by Peter Gosling, are using the priority topics from the Facilitated Activity, recommendations from the *The 2016 UK Composites Strategy*, and knowledge and understanding gained from the DURACOMP project to develop a continuation programme of research. The underlying aim of this project is to transform the basis of design for long-life infrastructure composite structures. In 2016 we shall be making an application to EPSRC for funding.

For composites subjected to long-term environmental exposure, the following research questions will be answered by the proposed research project:

1. What are the key indicators of loss of performance at each of these scales, how should they be measured, and what test protocols may be required?
2. What are the underlying micro- to macro-scale deterioration processes?
3. What insights can ontology provide into understanding the underlying micro- to macro-scale deterioration processes?
4. What is the quantitative inferred deterioration?
5. How should the quantitative inferred deterioration be represented?
6. How can the data and understanding from a range of scales and sources be integrated to describe long-term mechanical behaviour?
7. What contribution can Bayesian inference make in understanding the impact of and accounting for small or incomplete data sets describing long-term performance?
8. Can the perturbation-based stochastic finite element method estimate the long-term structural performance of composite components?
9. Can the stochastic long-term performance of composite components be predicted?
10. What values of partial (or conversion) factors can be proposed to represent long-term structural performance for design and be accepted for an FRP structural Eurocode?

#### **Appendix I. List of participants (in surname order)**

<b>Name</b>	<b>Position and organisation/company</b>
Edward Blackett	Construction & Innovation Manager, iLECSYS Ltd
Lee Canning	Principal Engineer, Jacobs
Robert Davies	Research Associate, Cardiff University
Marco Dona	KTP Research Associate, Newtecnic Ltd. and Cambridge University
Mark Evernden	Senior Lecturer, Bath University



Simon Eves	Technical Director, Pipex ps
Fengge Gao	Reader in Nanotechnology, Nottingham Trent University
Peter Gosling	Professor, Newcastle University
Sotirios Grammatikos	Research Fellow, Civil and Environmental Engineering/ University of Chalmers, Sweden
Sue Halliwell	Operations Manager, Composites UK
Martin Halpin	Director, CI & C Consult Ltd.
Stephen Heaney	Senior Engineer, WSP   Parsons Brinckerhoff,
James Henderson	Technical Authority, Transportation Atkins
Mike Johnson	Structures Manager, South Gloucestershire Council
Lukas Kaczmarczyk	Senior Lecturer, University of Glasgow
Antonis Kanellopoulos	Research Associate, Cambridge University
Kunal Kansara	Principal Engineer (Assessment & Design), XEAD Ltd.
Nigel Keen	Business Development Engineer, National Composites Centre
David Kendall	Consultant, Optima Projects Ltd.
Kaloyana Kostova	Principal Engineer, Tony Gee & Partners
Matthew Langhorne	Engineer, WSP   Parsons Brinckerhoff
Dimitrios Mamalis	Research Associate/PhD Candidate, EireComposites/University of Edinburgh
Alexander Meilton	Graduate Engineer, WSP   Parsons Brinckerhoff
Toby Mottram	Professor, Warwick University
Kieran O'Leary	PhD Student, University College Dublin
Isabelle-Denise Paparo	PhD Student, Cambridge University
Chris Pearce	Professor, Glasgow University
Alvaro Pizzaro	Graduate Engineer, South Gloucestershire Council
Muhammad Imran Rafiq	Principal Lecturer (Environment and Technology), University of Brighton
Rusi Rusev	Senior Engineer, Mott MacDonald
Wendel Sebastian	Reader in Structural Engineering, Bristol University
Jon Shave	Technical Director, WSP   Parsons Brinckerhoff
Wei Sun	Research Assistant, Bristol University
Simon Walley	Business Development Manager, Magma Structures Ltd.
Xiaojun Wei	Research Fellow, Warwick University
Suzanne Wood	Managing Director, Construction Composites Ltd.
Behrouz Zafari	Lecturer in Civil Engineering Structures, Kingston University
Xiaoyi Zhou	Research Associate, Newcastle University