Providing Confidence in Durable Composites

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LimesNet

FORMAX MULTIAXIAL REINFORCEMENTS

PARSONS BRINCKERHOFF

HIGHWAYS AGENCY

AQUAMARINE POWER

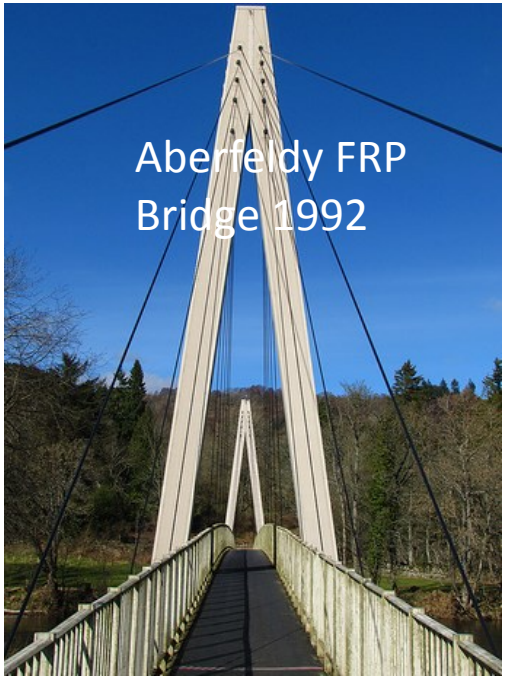
Introduction

Composites represent an enabling technology for a resilient, adaptable, low-carbon **UK infrastructure**

Revolutionising the Aerospace industry

Can now do same for **Infrastructure**

Durability is the main hurdle for composites in a 50+ years infrastructure environment



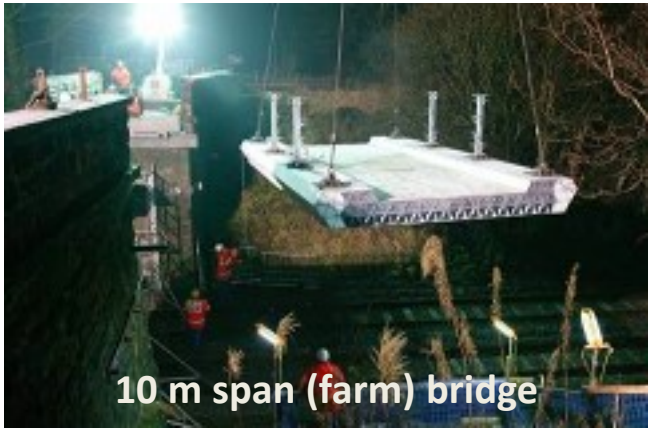
Composites in Infrastructure (current and future)

Bridges

- Manufactured under factory conditions
- Lightweight
  - Fast erection
  - No need to strengthen foundations
  - Small cranes for installation
- Easily fabricated off-site
- What about long term performance?

Innovative structural forms

- Lightweight → large-span structures
- Dramatic new forms enabled


10 m span (farm) bridge


National Grid – security fence


School of the future

Composites in Infrastructure (current and future)

Wind/wave/tidal turbines

- Larger blades require materials with high strength-to-weight and stiffness-to-weight ratios

  Only composites can achieve this

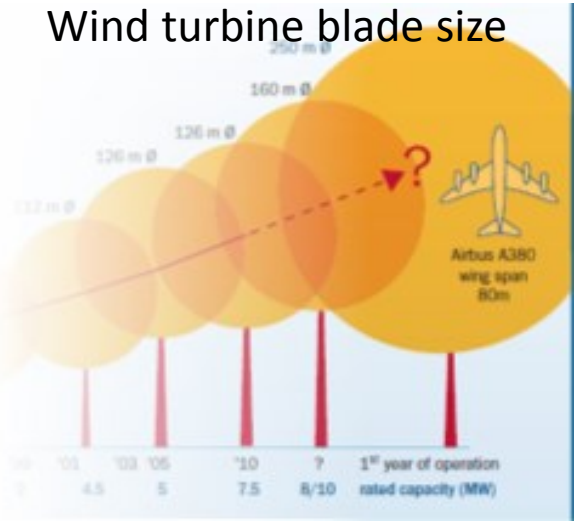
Structural repair & adaptation

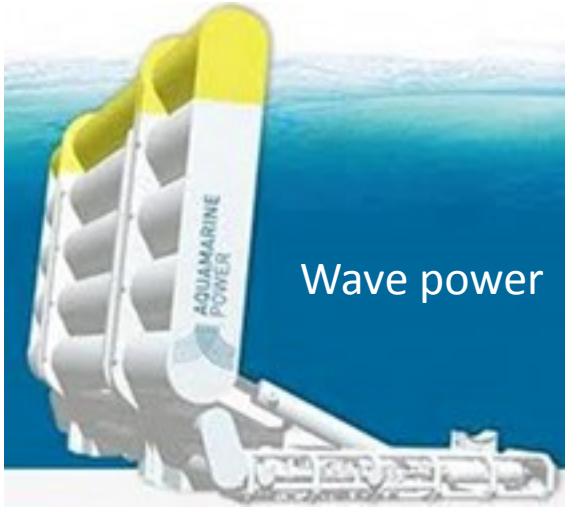
(e.g. bridge repair)

- Increasingly prevalent in ageing infrastructure
- Avoid unnecessary use of primary resources
- Providing infrastructure resilience

  Composites offer unique solutions

Many other examples of use: Transport, communications, energy, water services, …





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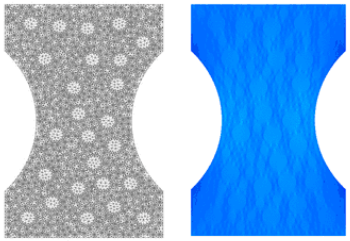


WP1: Multiscale modelling

Modelling

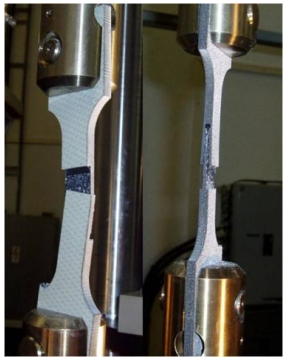
WP2: Material characterisation

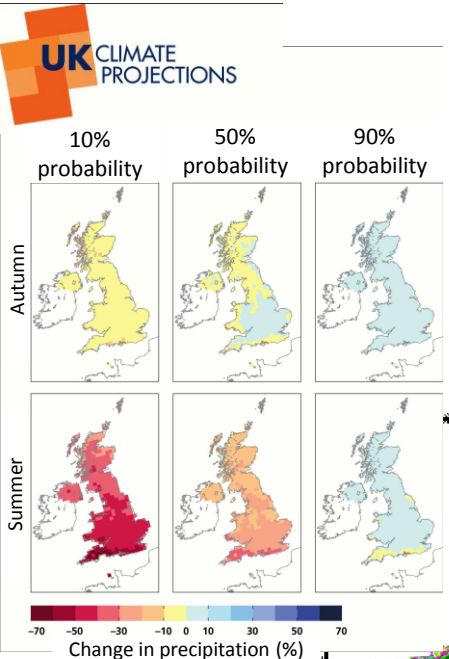
WP5: dissemination/ management/ national importance

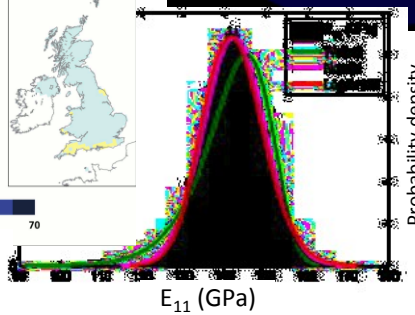
Testing

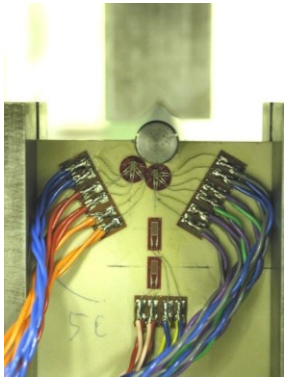
WP3: Stochastic reliability analysis

WP4: Structural component testing









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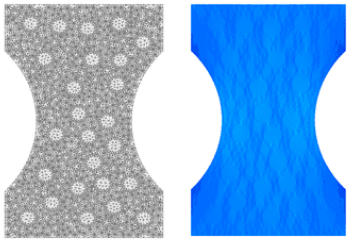
WP Linkages



WP1: Multiscale modelling

WP2: Material characterisation

WP3: Stochastic reliability analysis

WP4: Structural component testing

Modelling

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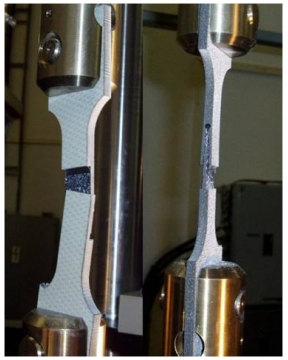

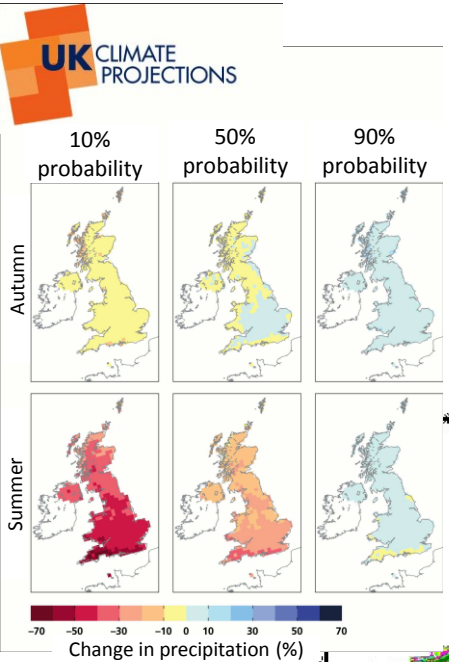

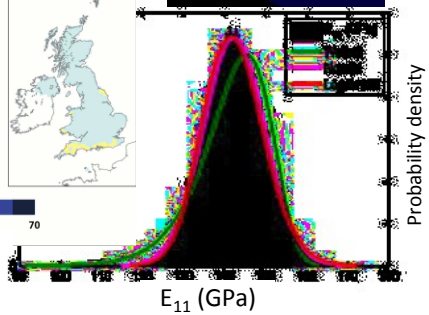

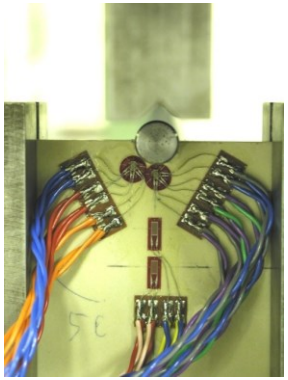

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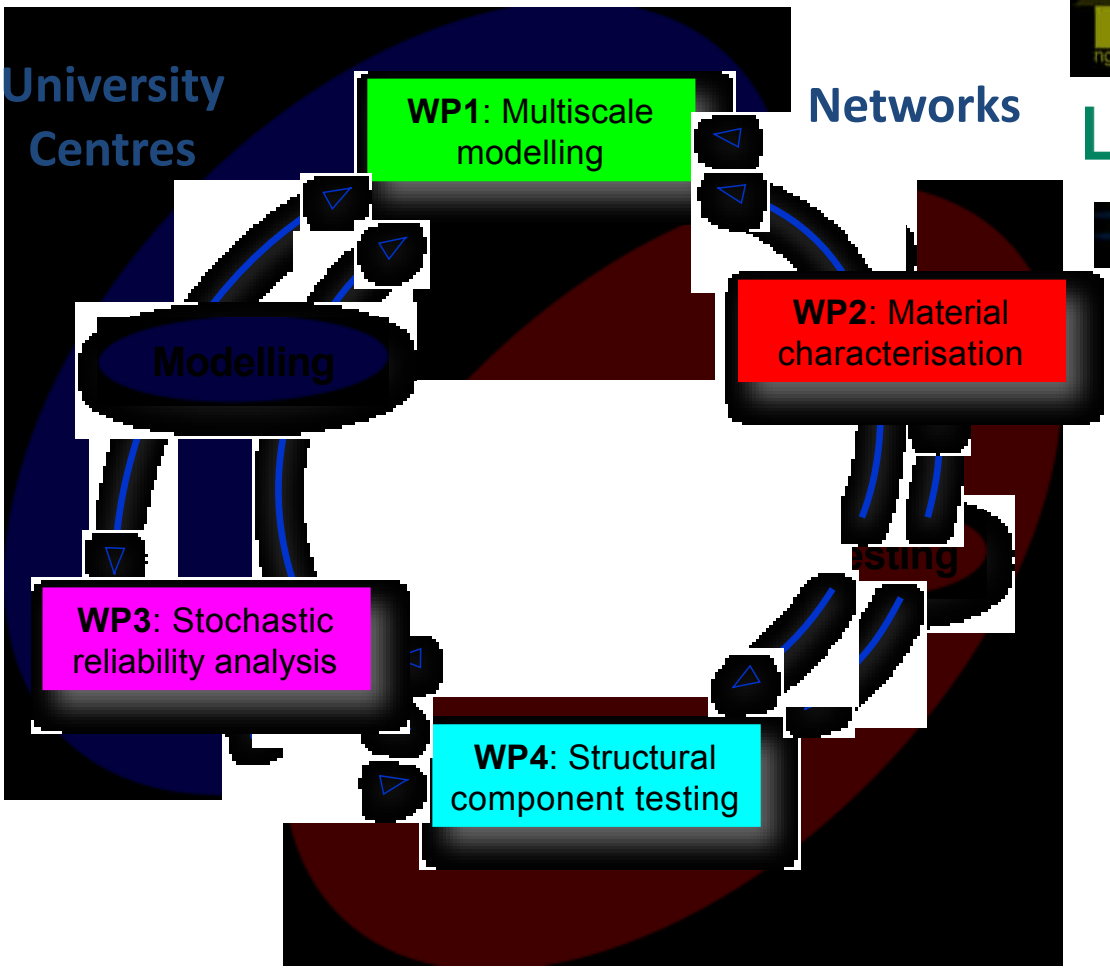
CESER
Centre for Earth Systems Engineering Research

bre Centre for Innovative Construction Materials

Institute for Resilient Infrastructure, Leeds

GRPE
GLASGOW RESEARCH PARTNERSHIP IN ENGINEERING



network group for composites in construction
ngcc

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Project Partners

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METAL REINFORCEMENTS

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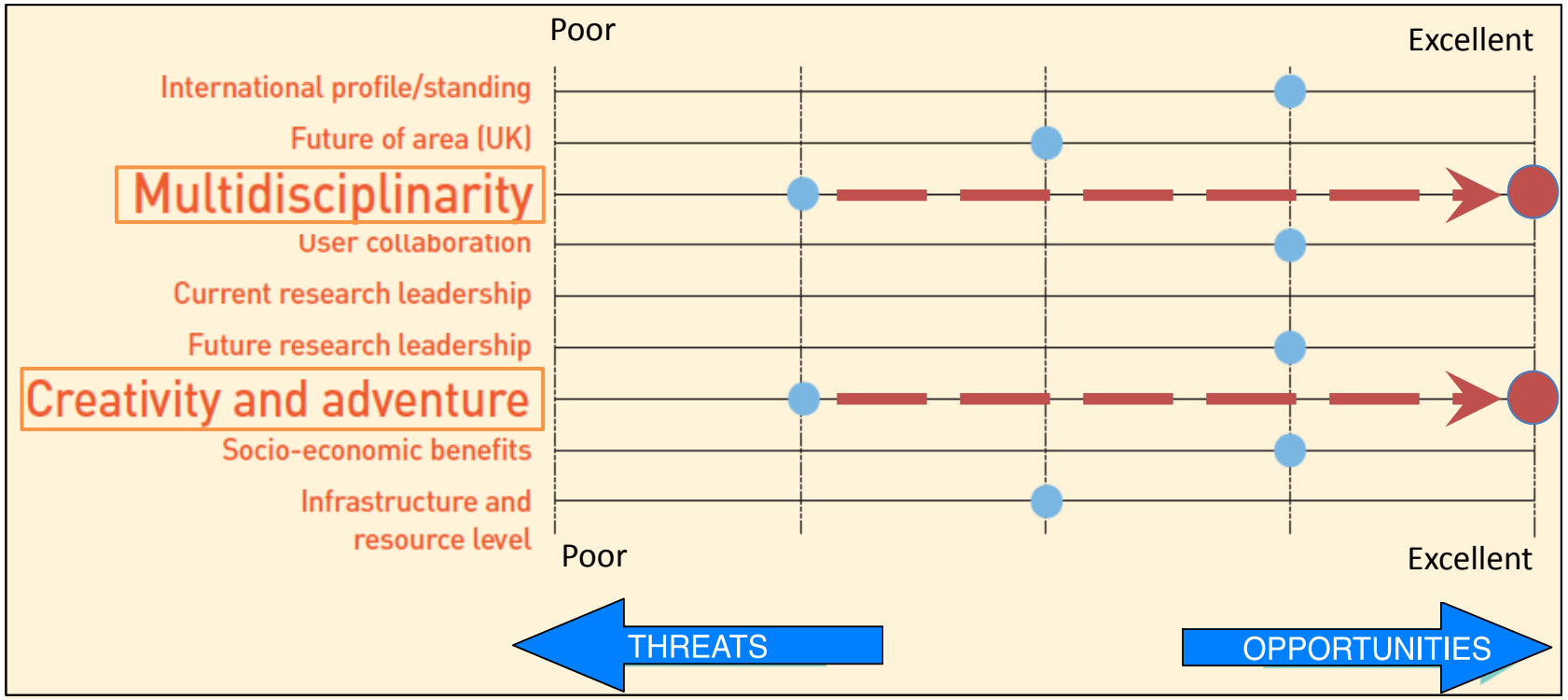
EPSRC Review of Ground & Structural Engineering identified **TWO challenges:**

- Novel Materials and Novel Use of Materials in the Built Environment
- Resilient and Sustainable Infrastructure



Aims of Call:

- Stimulate revolutionary cross-disciplinary thinking
- Generate new ideas in the research challenge areas

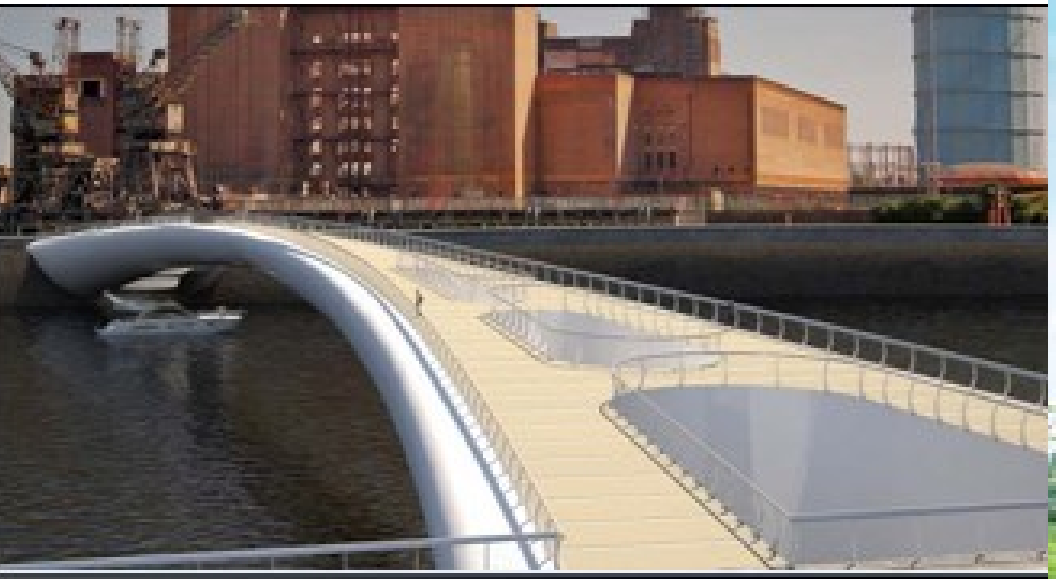
How does our Proposal Fit the Call?

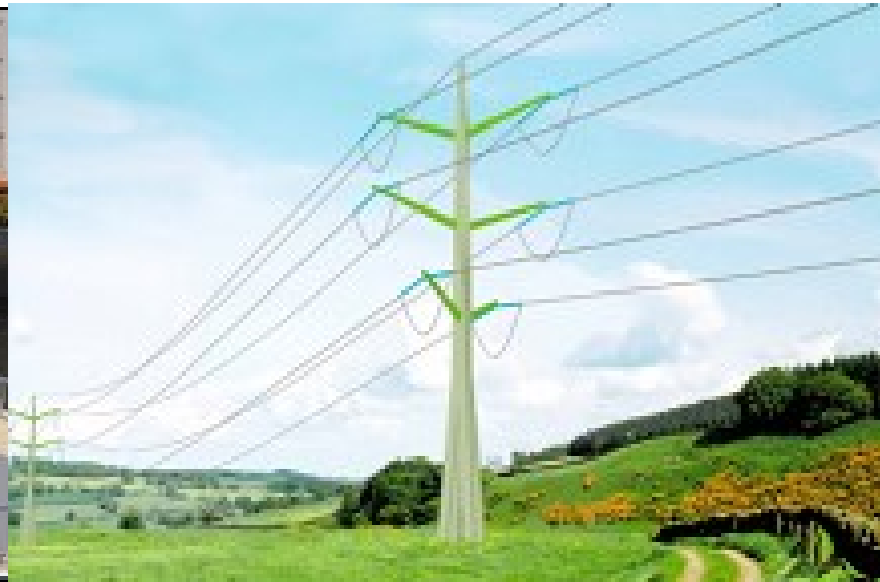
Stimulate revolutionary cross-disciplinary thinking

- Materials science, computational mechanics, reliability analysis, environmental science and structural engineering
- Composite specialists, experience academics and ECRs

Generate new ideas in the research challenge areas

- Confidence in Durability will enable new, innovative, complex and unusual structural solutions that exploit properties of composites.





National Importance

- Sustainable and resilient infrastructure

  UK 2010 National Infrastructure Plan

- Low carbon and low energy agenda

  UK Government 2011 commitment for mid 2020s

- Position UK as world-leader in design and specification of composite materials for infrastructure - a rapidly expanding market.

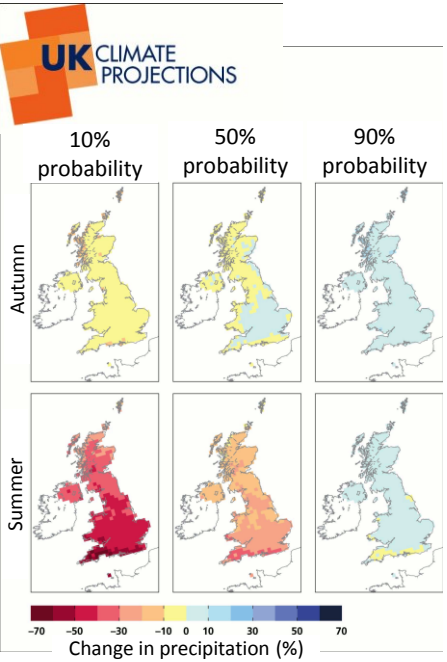
- Agenda setting in developing international standards, in particular EC10

Climate Change

- Designing composite materials and structures to be resilient to climate change is a key tenet of the project

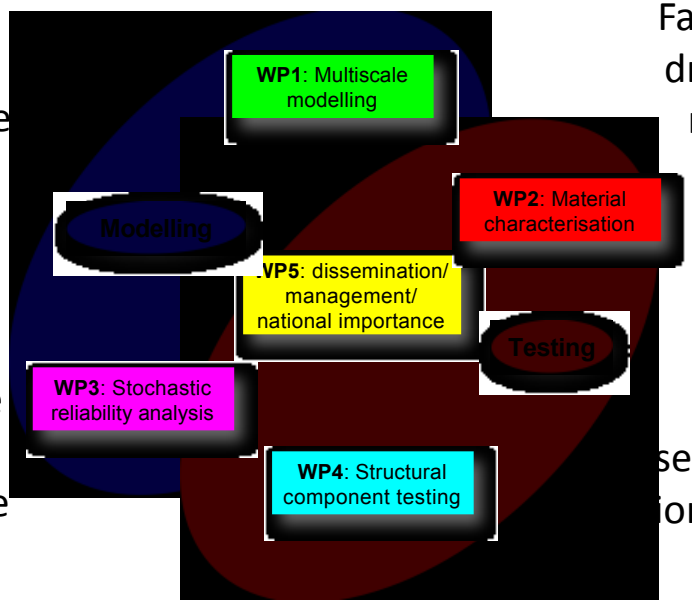
  To cope with inherently unpredictable changes in future physical and environmental loadings

- Chris Kilsby is Professor of Hydrology and Climate Change
- Embedded in all WPs:



Degradation processes explored computationally stochastic prope

UKCP09 Weather Generator to define probabilistic-based projections of future weather scenarios.



Factors and mechanisms driving the processes of material degradation quantified

Specimens sed to environmental ions that simulate field conditions

Adapting Technologies between Sectors

- We will utilise knowledge from other sectors, e.g. aerospace
- Aerospace industry has investigated areas such as fatigue
- Fundamental differences between Aerospace and Infrastructure
- WS is core member of Bristol's Advanced Composites Centre for Innovation and Science, with a focus on Aerospace.

  $\rightarrow$ share experience and knowledge in testing and analysis

- Our multiscale modelling techniques originally developed for metal matrix composites and applied to textiles & cementitious materials

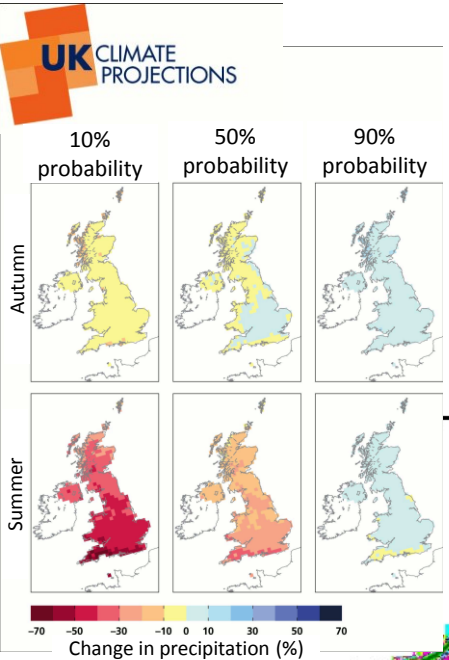
In Conclusion

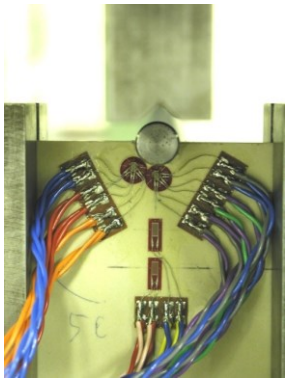
We will, for the first time, integrate:

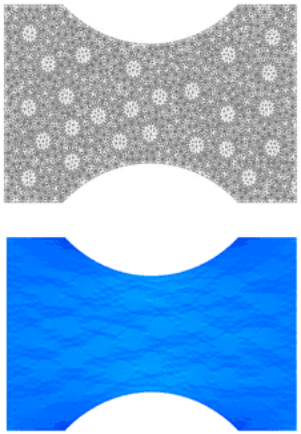
- Material and component testing,
- Multiscale predictive modelling and
- Probabilistic analysis

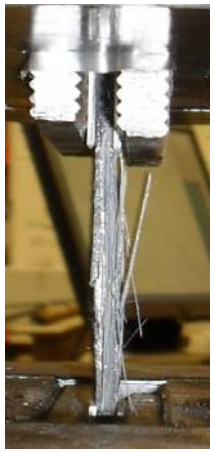
} Creating a new and unique stochastic modelling framework for infrastructure composites

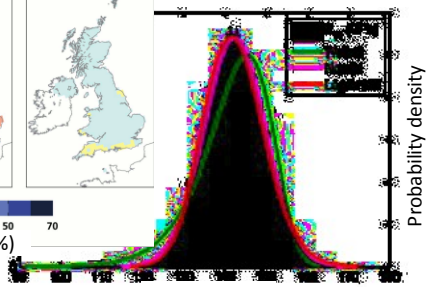
Leading to establishment of Centre of Excellence in durability performance

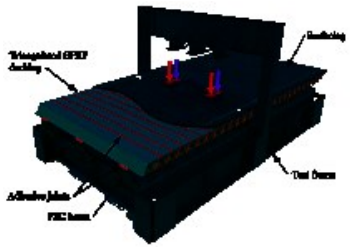


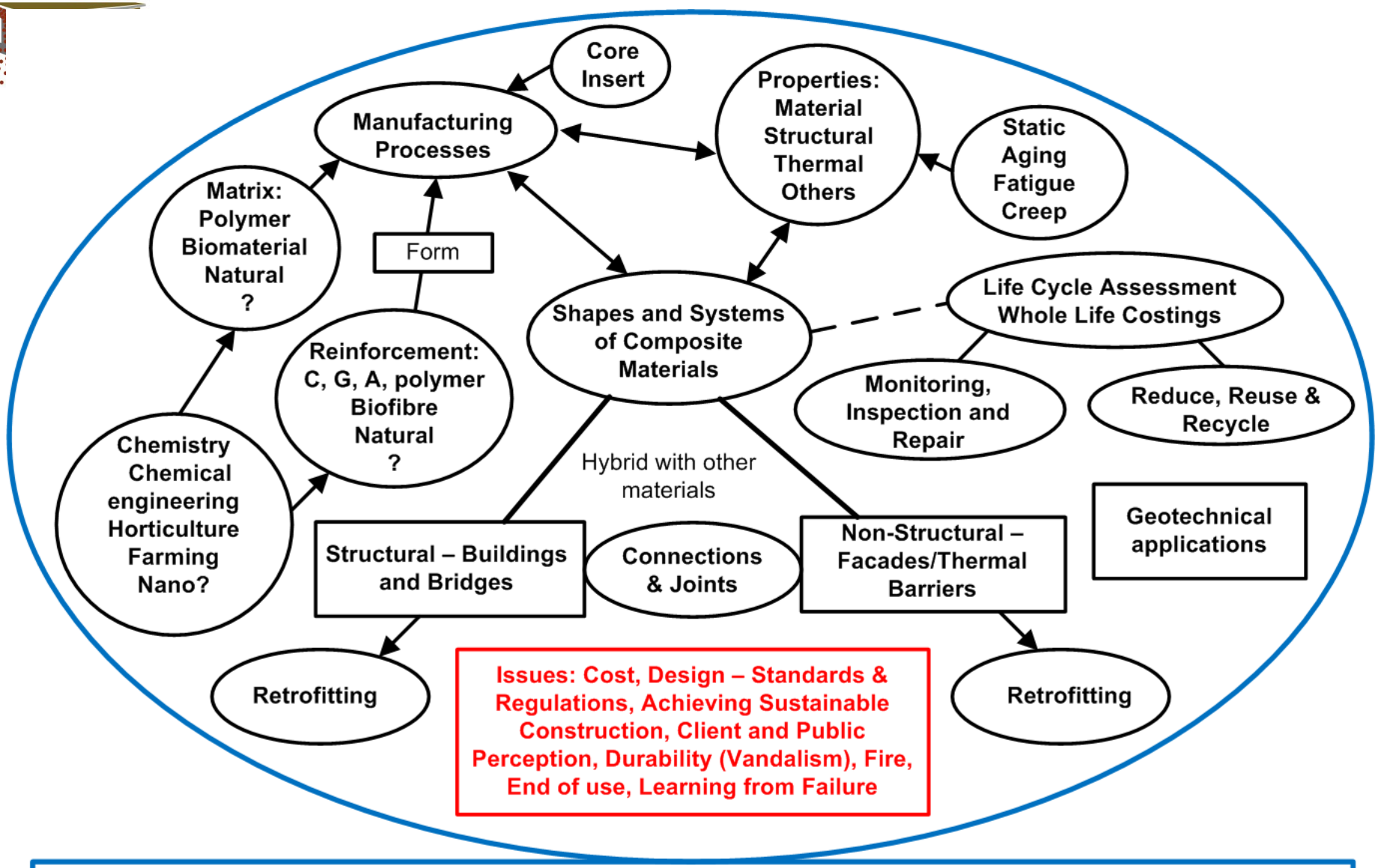












What are the challenges, gaps in knowledge and/or components and/or end uses?


Foryd Harbour FRP Bridge,
Rhyl 2013


Dawlish Station 2012


Dawlish Station 2013

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Cooling towers


What could the future look like
over the River Thames?