



Future Infrastructure Forum

University of Nottingham

Department of Civil Engineering



Infrastructure research at Nottingham

Structures

- Centre for Structural Engineering and Construction (CSEC)

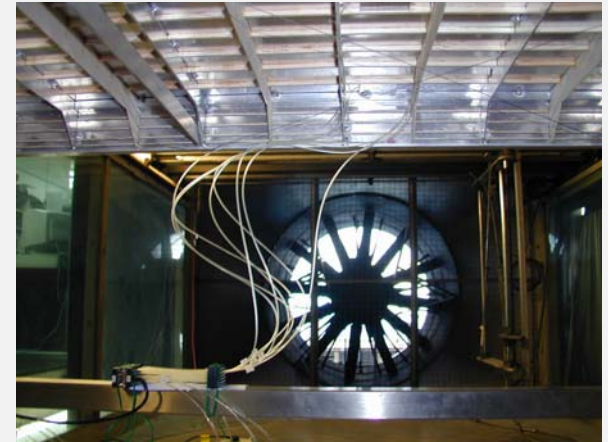
Ground Engineering

- Nottingham Centre for Geomechanics (NCG)
- Nottingham Transportation Engineering Centre (NTEC)



Centre for Structural Engineering and Construction

- Research across the key disciplines of structural engineering
- Excellent laboratory facilities including a new servo controlled actuator system
- State of the art measurement systems





An holistic approach to SHM

Multi mechanistic damage models

- Chemical mechanisms
- Environmental mechanisms
- Structural mechanisms

Improved monitoring systems

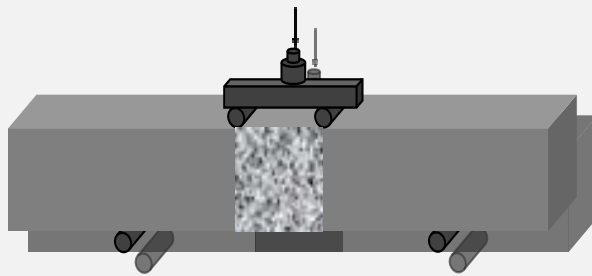
- Parametric based
- Model based

Simulation of whole-life behaviour

- Accelerated laboratory testing
- Validation of probabilistic models



Flexural crack modelling for SHM of RC structures



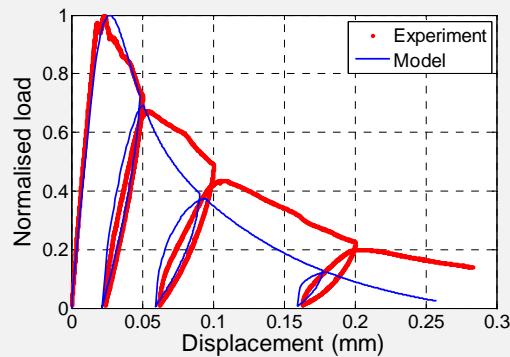
4-point bending on PC prisms



Cameras for DIC



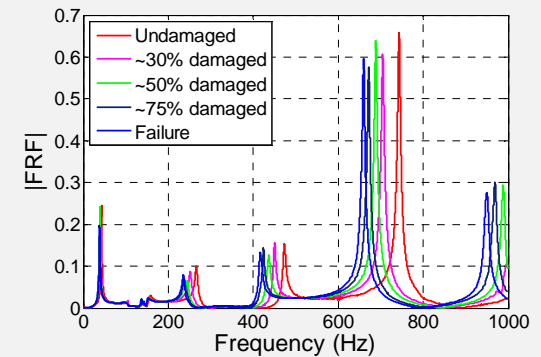
A crack captured by DIC



Crack modelling verification



Cyclic loading experiments



Degradation in vibration data

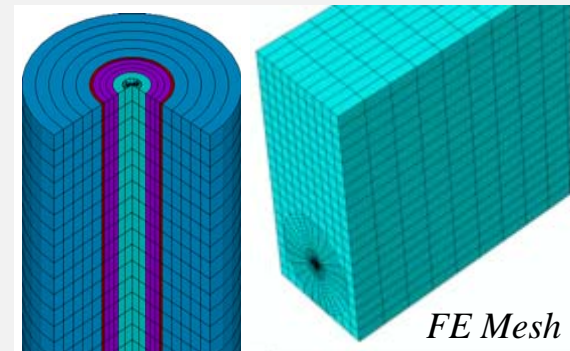
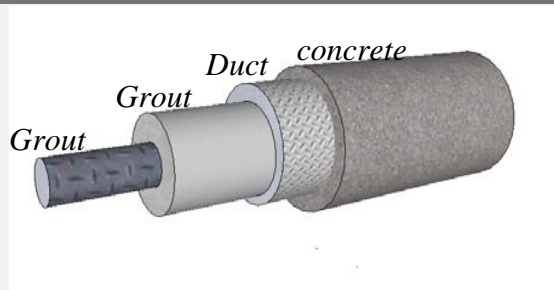
Aim: to understand the non-linear dynamic behaviour of flexurally-cracked RC beams



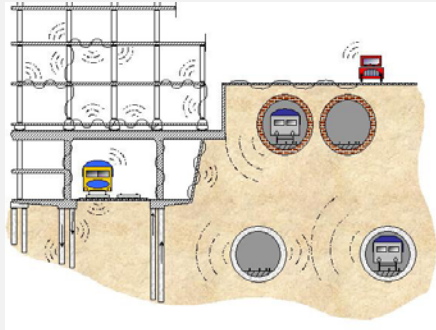
Assessment of post-tensioned concrete beams with ruptured tendons



Aim: to model the re-anchorage of ruptured tendons and develop accurate calculations for residual structural capacity

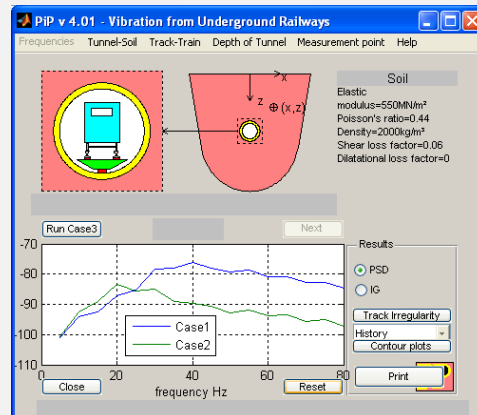


Numerical modelling of ground-borne vibration



Aim: to develop validated computationally efficient tools for the design of railway infrastructure to reduce ground-borne vibration

Work in
collaboration
with
**Cambridge
University**



www.pipmodel.com



The Centrifuge Machine at the University of Nottingham

Validation using physical modelling



An holistic approach for the design and assessment of railway tracks



Aim: to develop innovative new models to optimise the design for conventional railway tracks, considering both civil and mechanical engineering design criteria simultaneously.



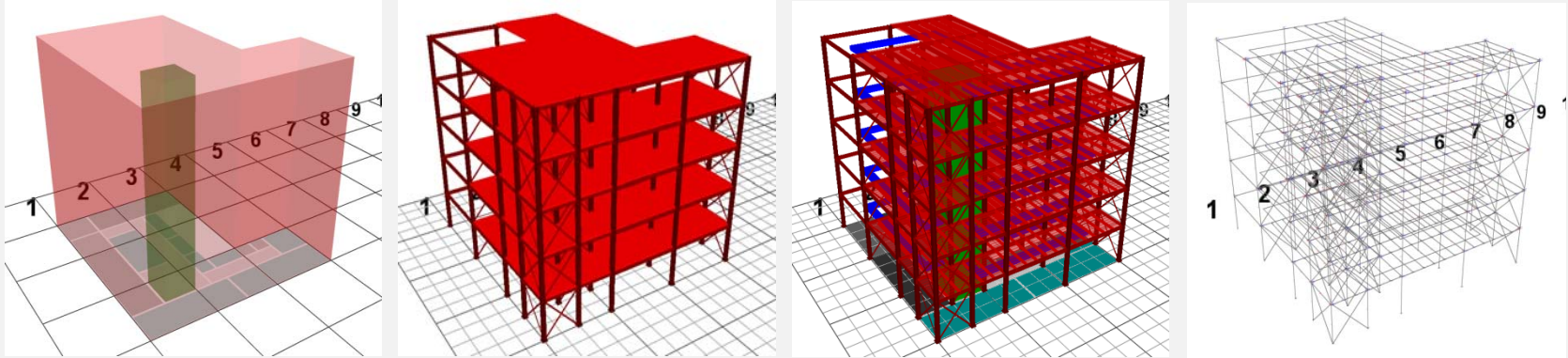
Using FRP Composites in Construction

- **FRP internal reinforcement**
- **FRP externally bonded reinforcement**

Aim: To study the behaviour of RC elements with FRP composites (as internal or external reinforcement) and applications of Basalt Fiber Reinforced Polymer (BFRP).



Support for Engineering Design



The use of information technology to support design and construction decisions, e.g:

- AEC process integration
- Building Information Modelling (BIM)
- Virtual prototyping – digital buildings
- Appraisal: cost modelling, sustainability, ...



Nottingham Centre for Geomechanics (NCG)

- Constitutive and numerical modelling
 - Prof H S Yu, Prof G McDowell, Dr X Li
- Physical and numerical/analytical modelling
 - Dr A Marshall
- Materials, Laboratory testing
 - Dr D Wanatowski, Dr M Hall



Railway track improvement

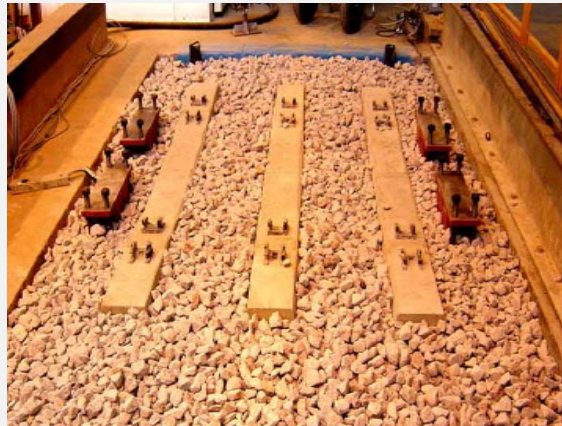
Prof Glenn McDowell and Dr J F Ferellec

- Aim: Improve ballasted railway track to make it more sustainable (reduce maintenance and cost) by analysing behaviour under different types of loading and with different possible types of reinforcement



Railway track improvement

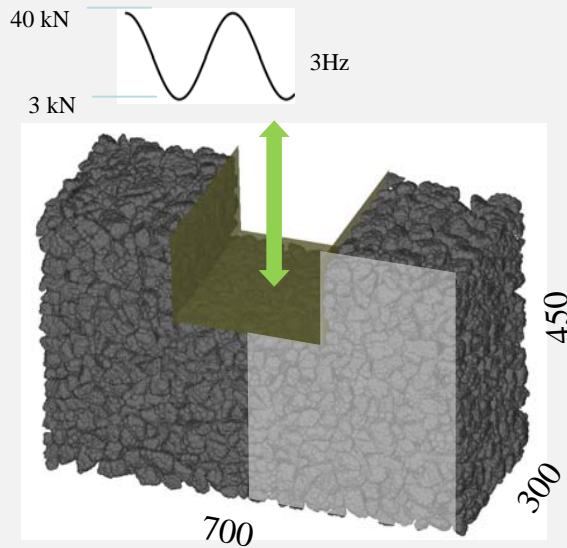
- Experimental
 - Cyclic vertical loading to simulate passage of trains before and after maintenance operations



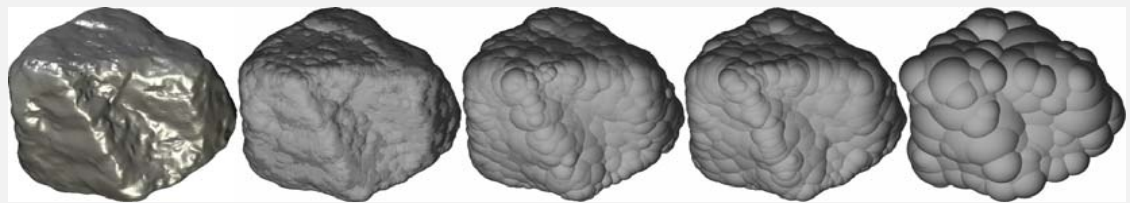
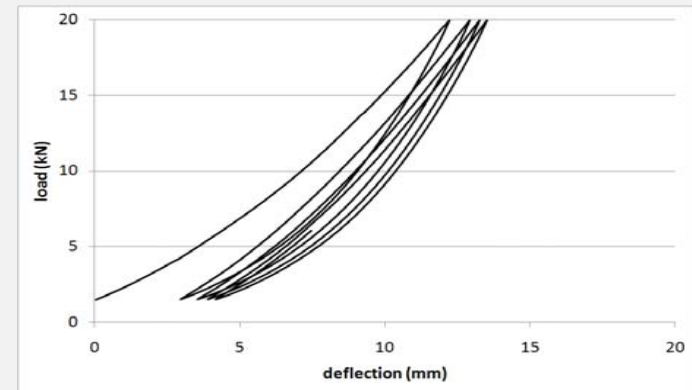
Railway track improvement

Numerical

- Box test simulations using realistic DEM code



Different
shapes of
sleeper are
analysed





Materials

Dr Matthew Hall

- porous materials
 - transport phenomena, hygro-thermal behaviour, micro/macro-structural characterisation of thermo-physical properties and pore networks.
 - cement and concrete composites, cement/lime stabilised soils, soils and aggregates, ash & by-products, desiccants, gas sorbents, and phase change materials.



Dr Matthew Hall

- Expertise
 - Scanning electron microscopy (SEM)
 - Transmission electron microscopy (TEM)
 - Energy Dispersive X-Ray Spectroscopy (EDS)
 - X-Ray computed Tomography (XRCT)
 - X-Ray diffraction (XRD)
 - Differential Scanning Calorimetry (DSC)
 - Heat Flow Meter (HFM)
 - Modified Transient Plane Source (MTPS)
 - Environmental simulation chambers



Dr Matthew Hall

- Potential sustainability research avenues:
 - Using stabilised soils for construction materials
 - Passively regulate temperature and humidity
 - Improve indoor air quality and thermal comfort
 - Reduce/eliminate issues with condensation/mould
 - Use of by-products (e.g. slag) and recycled aggregates for carbon capture and storage
 - High performance cementitious grouts and borehole design for geological CO₂ injection



Centrifuge/numerical/analytical modelling

Dr Alec Marshall

- 2m radius, 50g-Tonne geotechnical centrifuge
- Soil-structure interactions between infrastructure systems
 - Effect of tunnel construction on
 - Pipelines
 - Piled foundations
 - Improving soil-structure interaction modelling by incorporating sub-structuring methods within centrifuge
 - coupling centrifuge and numerical modelling to achieve a global geotechnical-structural analysis





Others projects

- Compressed air storage in disused mine shafts
- Security of mine shafts (failure)
- Vulnerability of structures within mining basins
- Application of fibre optics strain measurement systems within mines
- Waste management from coal mines



Nottingham Transportation Engineering Centre (NTEC)

- Prof Gordon Airey
- Dr Tony Parry
- Mr Andrew Dawson
- Dr Nick Thom



U.S. Department of Transportation
Federal Highway Administration



NTEC
Nottingham Transportation
Engineering Centre



Nottingham Transportation Engineering Centre (NTEC)

Environmental Life Cycle Assessment – Dr Tony Parry

- Relevance to pavement engineering
 - Life cycle definitions (Product Category Rules (PCRs))
 - Allocation of impacts to recyclates and byproducts
 - Decision making (design, specification, procurement, asset management)



Sustainable Trench

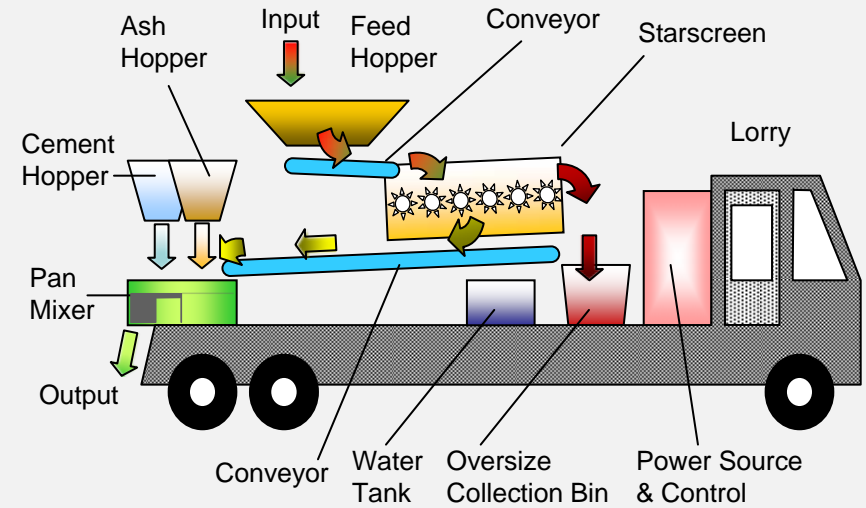
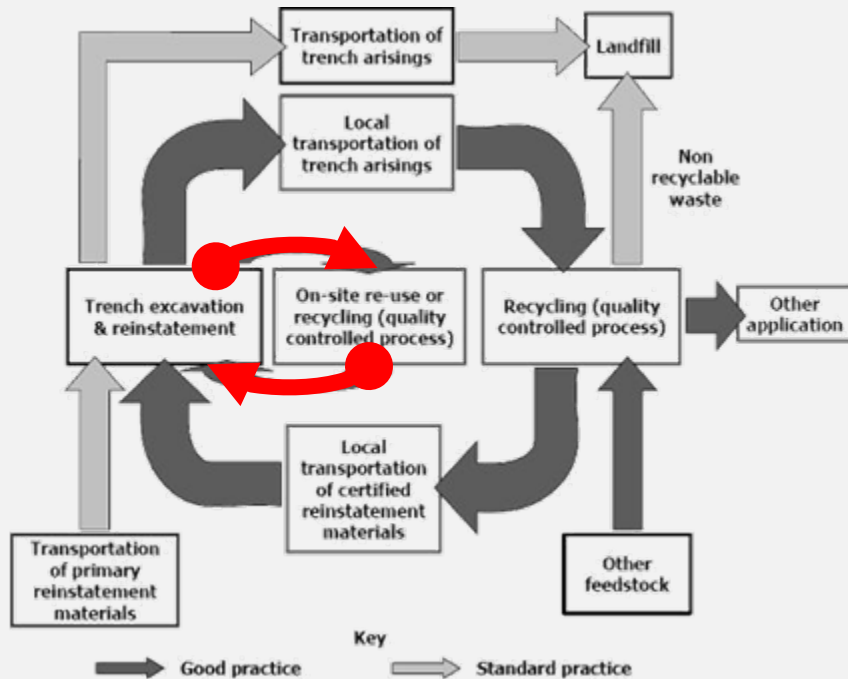
Reinstatement – Andrew Dawson

- Research on physical and physio-chemical studies of wide range of soils, including recycled and treated materials
- Also looking at secondary and recycled materials use for pavements





Short-circuiting the recycling loop



Pro-Star



Pavement Performance & Remediation Requirements following Climate Change

- A Road ERA-NET project
- Direct impacts
 - Temperatures, precipitation, freeze/thaw cycles
- Indirect impacts
 - Demographic shifts due to climate change





Sustainable Concrete Subjected to Extreme Loading: Microstructural Approach – Dr. N Thom

- Substituting natural aggregates with recycled aggregates from industrial by- products
 - To develop hybrid simulation systems through the microstructural study for improving the resiliency of the infrastructures to the extremes of load...
 - Development of high performance and long-life concrete products through the integration of microstructural processing and nanotechnology based materials...