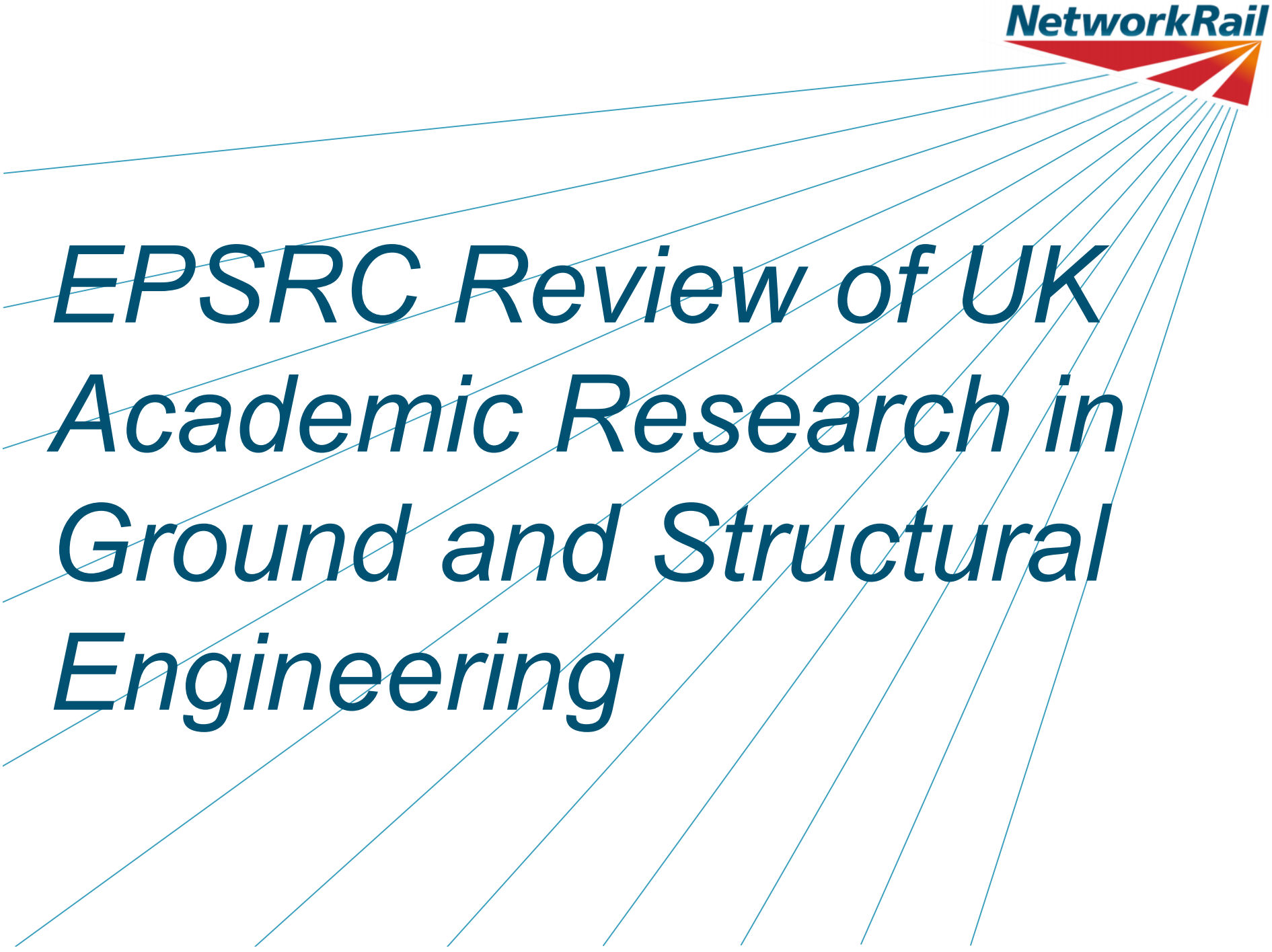
Future Infrastructure Forum – Meeting 2

Some thoughts

Brian Bell

Contents

- EPSRC review of ground and structural engineering
- Future Infrastructure Forum mission
- What do we mean by infrastructure?
- Future priorities
- Research



EPSRC Review of UK Academic Research in Ground and Structural Engineering

Recommendation 2

EPSRC, the academic community and other stakeholders should look to identify and invest in the key research challenges in ground and structural engineering, formulate a shared vision for these challenges, and communicate this vision strongly

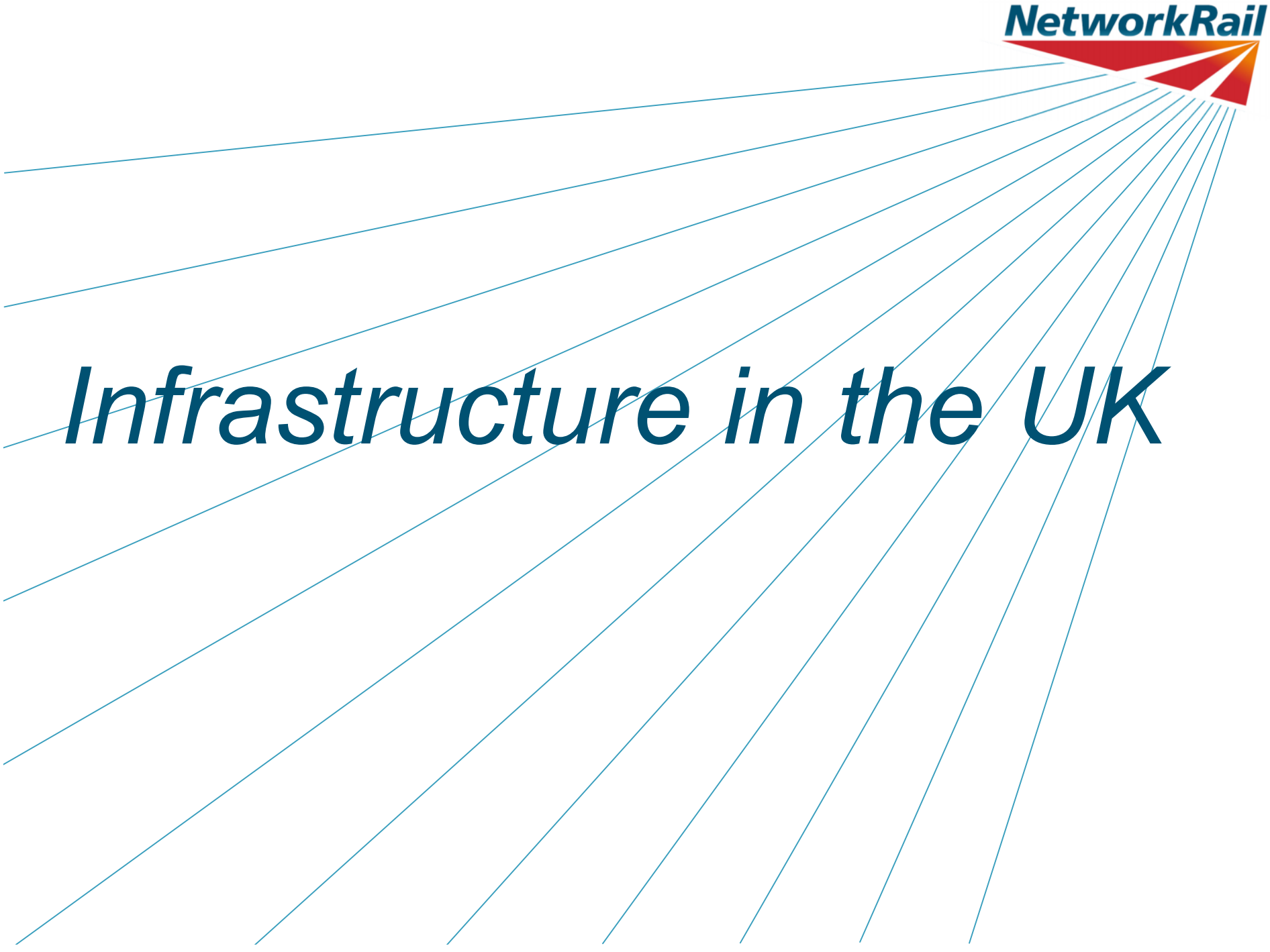
Reported research challenges

- Adaptation to Climate Change
- Codes and Standards
- Carbon and Resource Reduction
- Design Against Blast and Impact
- Energy Generation and Supply
- Environmental Hazard Engineering
- Flood Risk Management
- Investigation
- Improved Construction Process
- International Development
- Improvement of Safety
- Improved Simulation and Design of Structures
- Mechanics and Fracture
- Maintenance, Repair and Retrofit
- New Durable Infrastructure
- Novel Materials
- People and Structures
- Sustainable Construction and Infrastructure
- Sensors and Structural Health Monitoring
- Smart Structures
- Urban Systems and Design
- Vibration Engineering
- Waste and Recycling

FIF mission

FIF mission

- To generate a new vision of the shape of tomorrow's construction industry by providing a roadmap of research priorities in the ground and structural engineering sectors which will lead to firm proposals for innovative research aimed at revolutionizing how we procure, design and deliver major infrastructure projects.
- A core function will be to identify specific areas of focus and research projects which could be instigated immediately to precipitate this transformation. It will promote a total rethink of the fundamental approach to design, challenge established norms and stimulate innovation in construction.



Infrastructure in the UK

What do we mean by infrastructure?

- Simply – “Anything man made that is necessary to sustain society as we now know it today.”
  - Utilities
    - Water, electricity, gas, sewerage, telephone, district heating
  - Transport
    - Roads, railways, airports, ports, commercial waterways
  - Buildings
    - Housing, shops, offices, factories

Infrastructure networks

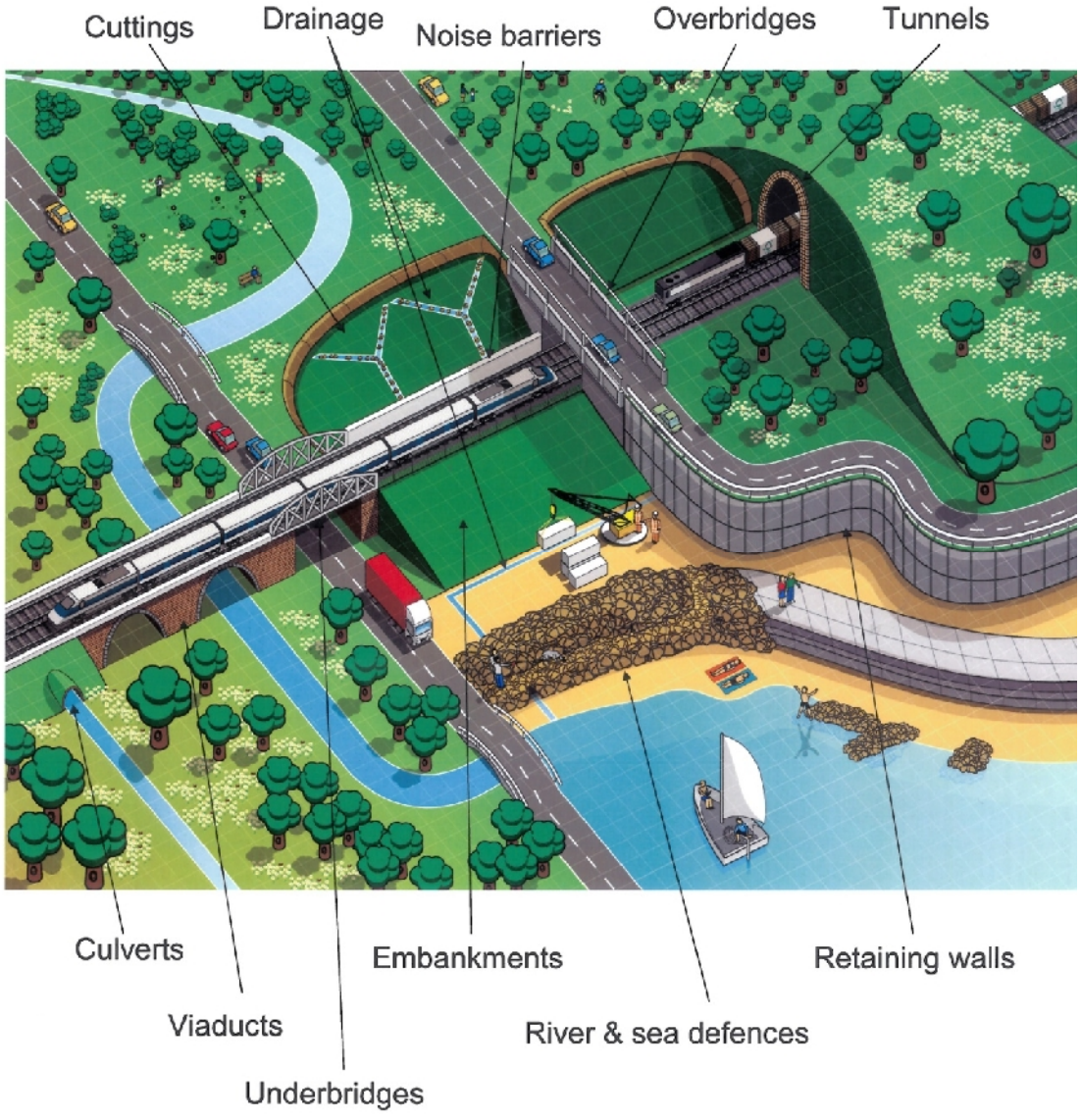
- Infrastructure networks are complex and bring together diverse disciplines and components
  - Ground and structural
    - Earthworks, bridges, tunnels, retaining walls, pavements/track, drainage, gantries, locks, pipelines, transmission towers, dams
  - Building
    - Stations, depots, signal boxes, treatment works, sub stations
  - Mechanical
    - Pumps, lifts, escalators, emergency generators
  - Electrical
    - Signals, power supplies, lighting
  - Telecommunication
    - Emergency telephones, microwave links

UK infrastructure networks

Network Rail (Great Britain)	16,000km of railway with 40,000 bridges, 17,000 retaining walls, 700 tunnels and 2,500 stations
London Underground (London)	400km of railway with 270 stations and 180km of tunnels
Highways Agency (England)	7,754km of trunk road and motorway with 17,000 structures including 8,800 bridges
Local roads (Great Britain)	380,000km of roads with around 80,000 bridges
British Waterways (Great Britain)	3,540km of canal with 1,654 locks, 54 tunnels, 3,115 bridges, 417 aqueducts and 91 reservoirs
Water supply & waste water (Great Britain)	700,000km of mains and sewers with 1,000 reservoirs and 11,500 sewage and water treatment works
National Grid - electricity transmission (E&W)	7,206km of overhead lines with 21,863 towers 713km of underground cables, 338 Substations
National Grid - gas (GB)	7,671 km transmission & 132,000 km distribution pipelines; 23 Compressor & 3 LNG sites, 15,475 PRPs

PLUS - Over 60 main airports and around 120 large ports

Typical rail infrastructure ground and structural components



Existing infrastructure in generally old

Bridging materials – rough timeline

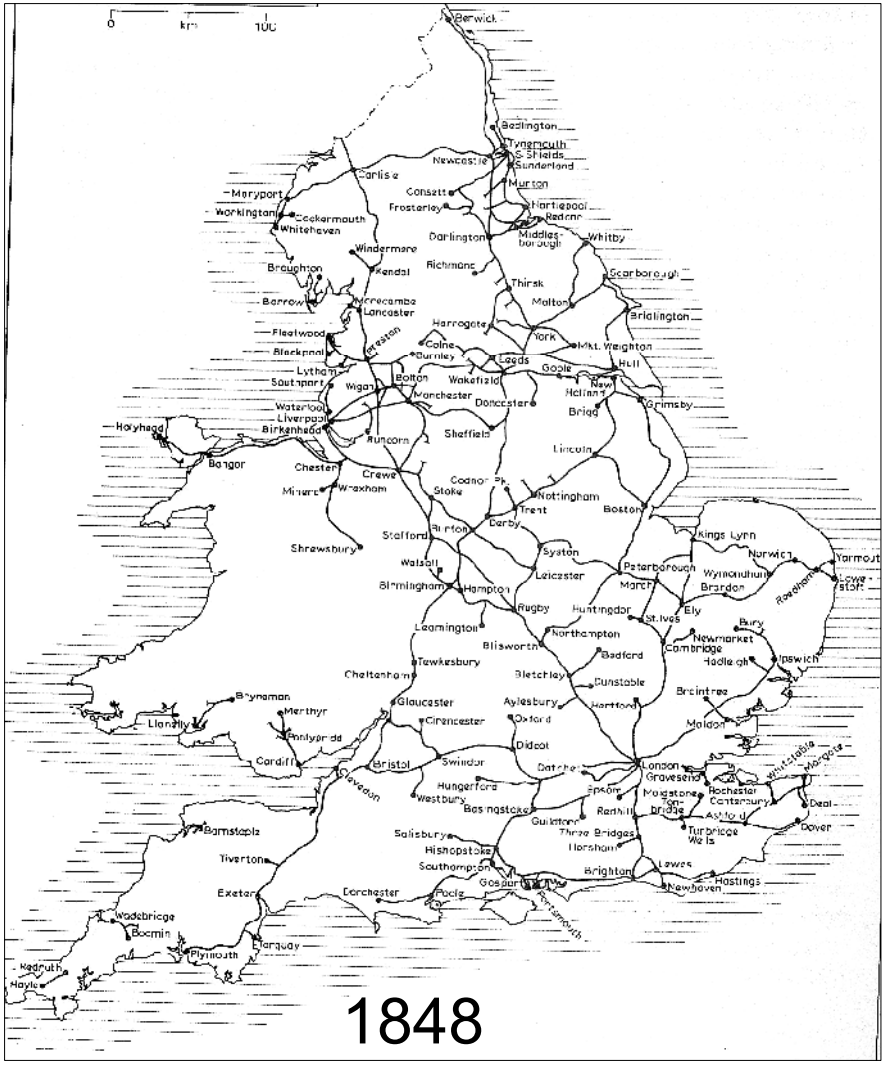
Masonry	from Roman times
Cast iron	pre 1800 to 1850
Wrought iron	1840 to 1900
Steel	from 1890
Reinforced concrete	from 1920
Prestressed/post tensioned concrete	from 1960
Fibre reinforced polymers	from 2000

The growth of railways in the UK

1832	166 miles
1842	1839 miles
1852	6913 miles
1862	8300 miles
1872	11300 miles
1882	14050 miles
1892	14550 miles
1902	15000 miles

England & Wales

1840



1848

The growth of UK motorways

1958	8 miles
1968	623 miles
1978	1579 miles
1988	1908 miles
1998	2112 miles

Network Rail's bridges

70% over 100yrs old

13% 50 - 100 yrs old

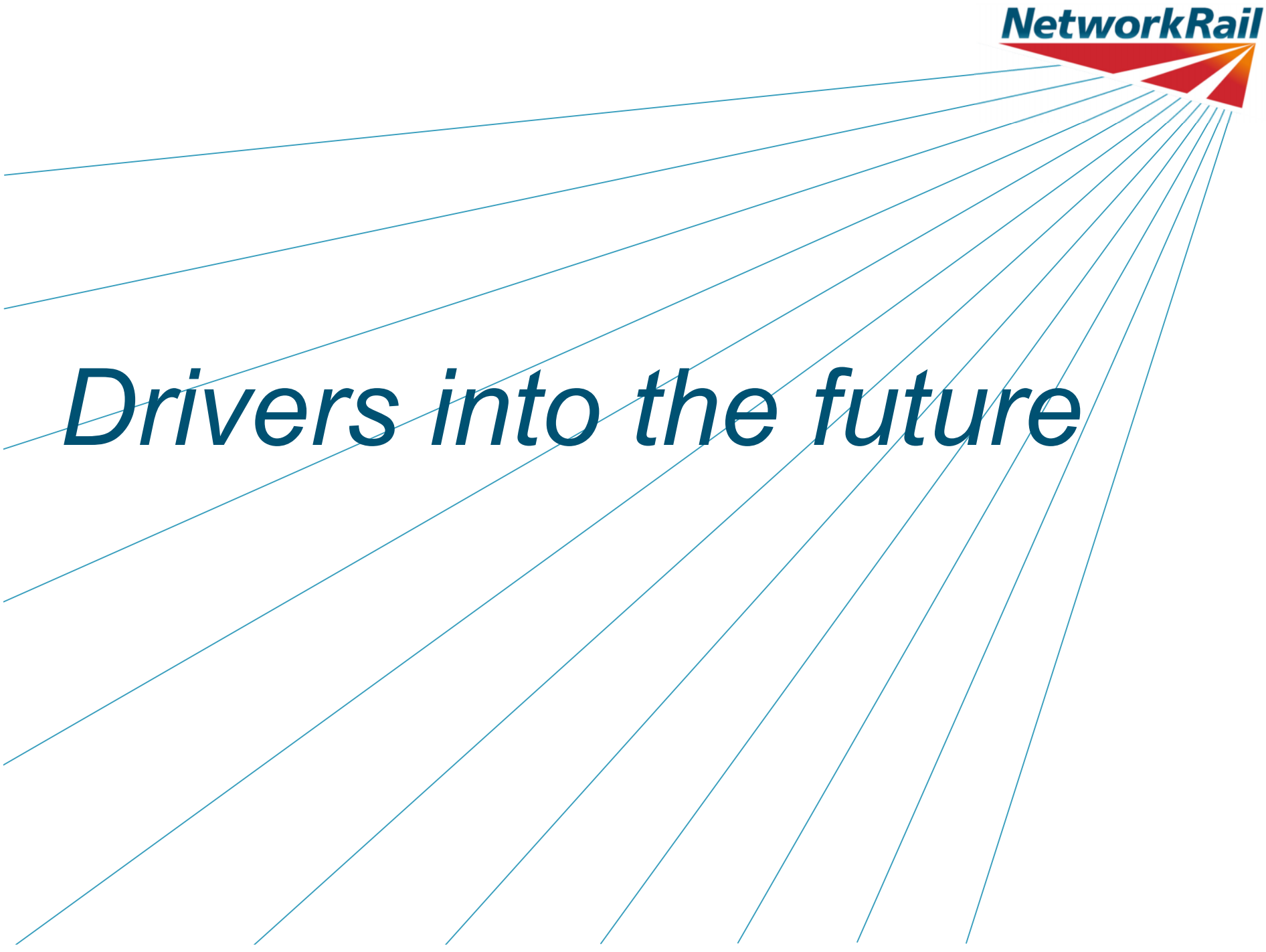
10% 20 - 50 yrs old

7% less than 20 yrs old

50% masonry arches

40% steel or wrought iron

10% concrete

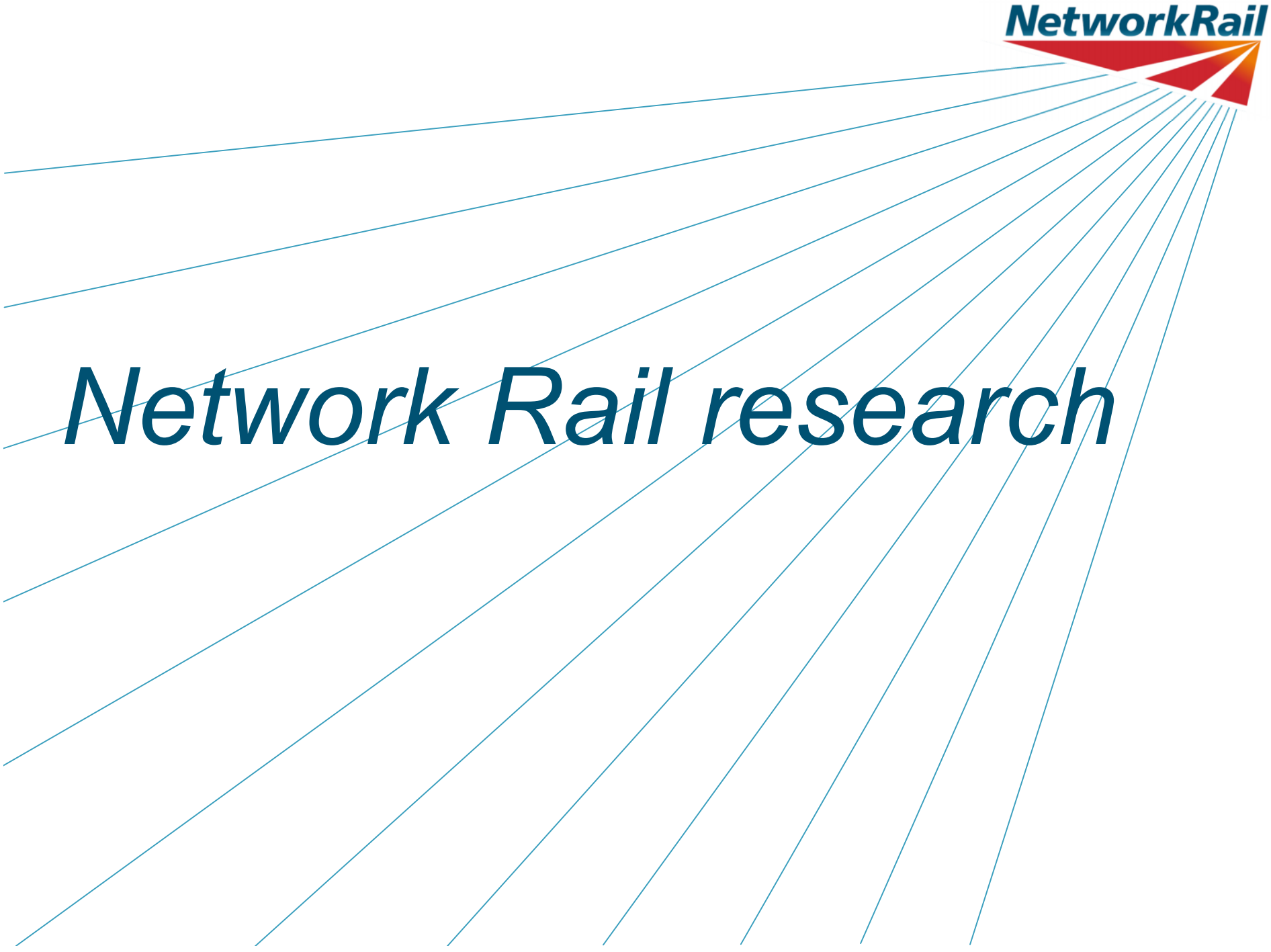

NetworkRail
Drivers into the future

Political drivers

- Sustainability
  - Carbon agenda
- Resilience
  - Climate change

Client/owner drivers

- New build will be overshadowed by maintenance.
- Maintaining safety is paramount
- Transport infrastructure assets such as embankments, tunnels, major bridges need to be treated as if they have an infinite life.
- For other assets, replacement will be the least favoured option
  - Disruption to users
  - Conservation of natural resources
  - Cost
  - Selective monitoring



Network Rail research

Examples of NR supported research

- Directly funded
  - Spandrel wall deterioration
  - Automated tunnel inspections

- Collaborative
  - Partner organisations
    - European Commission
    - Technology Strategy Board
    - Universities
    - Research Bodies
    - Industry Bodies

Support funding

- EC Supported
  - BriFag
  - CoPatch
  - SmartEN
  - MAINLINE

- TSB supported
  - ACTS (Advanced composite truss structures)
  - Lightweight low energy concrete
  - IMAJINE (Innovative Multi-Materials Jointing Integrity Engineering)

University projects

- Birminham – FUTURENET
- Bristol - Fatigue Testing of Bridge with Fibre Reinforced Polymer (FRP) Deck
- City - Fibre optic sensors for PH and chloride levels and rebar rusting
- Newcastle - Modelling the collapse of shallow mine workings
- Plymouth – Impact of rising sea levels on London-Penzance railway
- Oxford – ITRC
- Sheffield and Salford - Ultimate and permissible limit state behaviour of soil-filled masonry arch bridges
- Surrey - Bridge reliability under the influence of changing environmental and demand conditions
- Surrey - Corrosion of metallic structures
- West of England - Fatigue behaviour and remaining service life of masonry arch bridges

- LIMES.Net
- Future Infrastructure Forum
- SIMoNET

Research & industry body projects

- Concrete Society
  - TR55 issue 3
- Department for Transport (on behalf of RLG/Bridges Board)
  - The design, assessment and strengthening of masonry parapets
  - Use of FRP for shear strengthening metallic beams
- National Physical Laboratory
  - Concrete monitoring demonstration project
- Network Group for Composites in Construction
  - Design guidance for FRP bridges
- Rail Safety and Standards Board
  - TRaCCA

Under review/development

- FP7
  - Robust Rail
  - NDE & cloud computing
- TSB
  - ACCESS (ACTS phase 2)
  - Satellite monitoring of earthworks

How could £3m be spent?

- Do
  - Focus on traditional materials
  - Think about whole structures
  - Talk to clients during proposal development
    - Being presented with a “fait accompli” is very off putting, if not demeaning
  - Research into:
    - Better understanding of traditional materials and structural systems
    - Improved assessment methods
    - Improvements to existing maintenance techniques
    - Develop new maintenance techniques
- Don’t
  - Concentrate on monitoring techniques

Thank you