Joint Bridge Researchers' and Owners' Forum

King's College, Cambridge

27-28th October 2003

MASONRY AND BRICK ARCH BRIDGES:

CONDITION APPRAISAL AND REMEDIAL TREATMENT

May Gurney

THE UNIVERSITY OF SALFORD

CIRIA
sharing knowledge
building best practice

Mott MacDonald

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CONDITION APPRAISAL AND REMEDIAL TREATMENT

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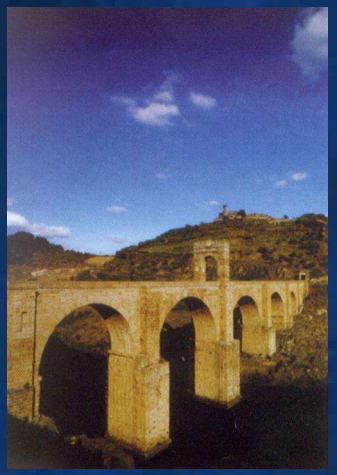
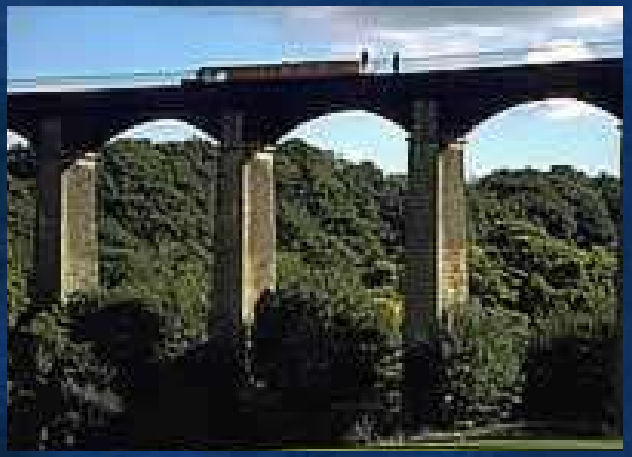
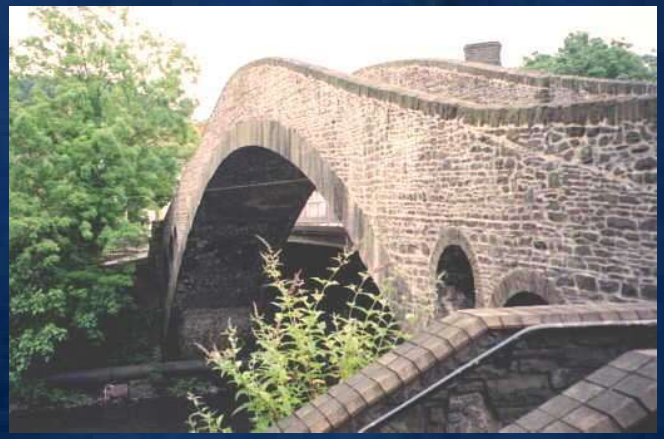
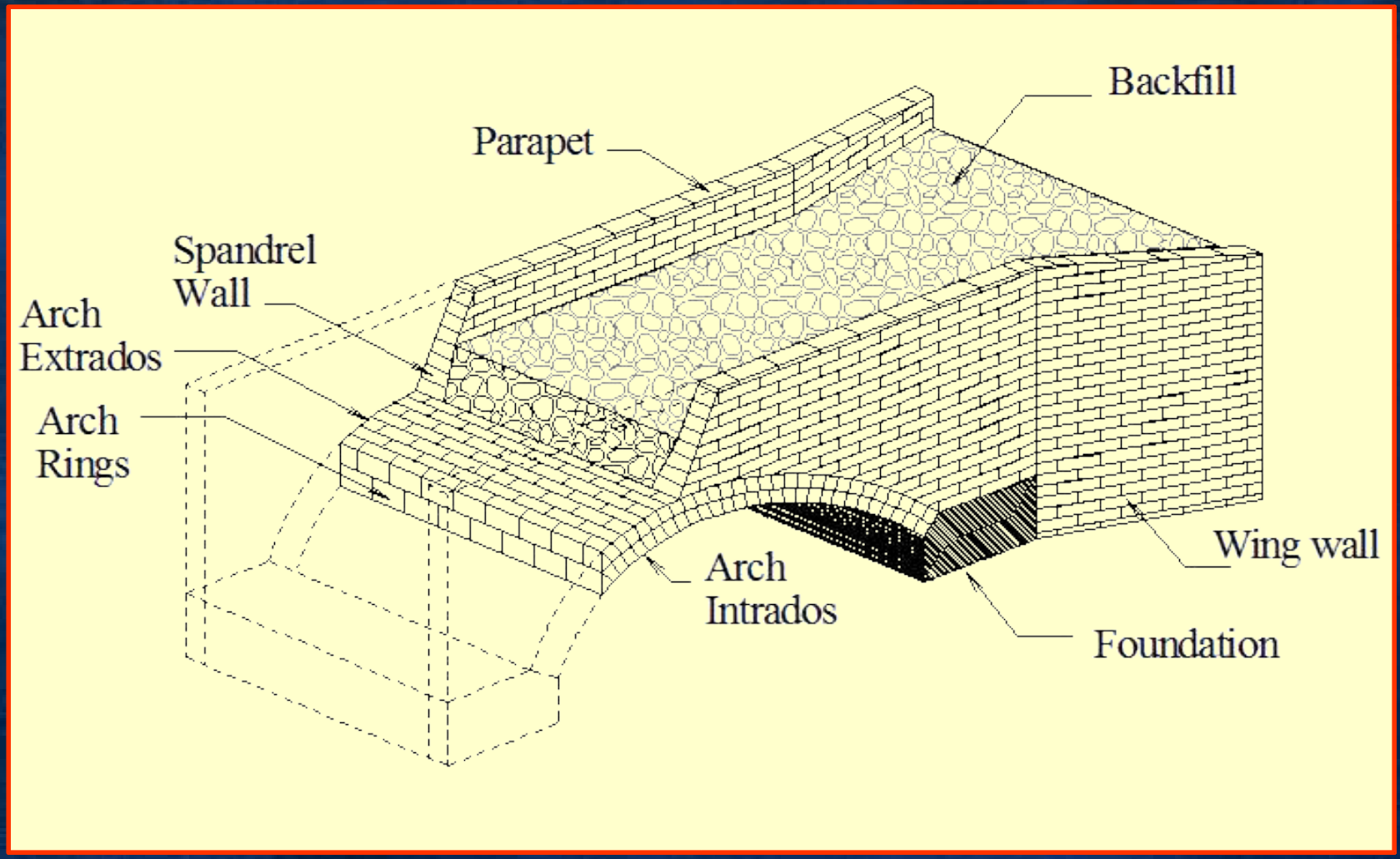








Masonry and Brick Arch Bridge



The Problem

- Construction of Masonry Arch Bridges has long been Abandoned in the UK
- However, Bridges of the UK Networks of Transport are still Primarily Masonry and Brick Arches
- Subjected to ever Increasing Traffic Levels, Speeds and Loads
- At least 100 years old
- Some of them Damaged or Simply Gradually Deteriorating

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NEED FOR MAINTENANCE, REPAIR AND STRENGTHENING

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NEED FOR BEST PRACTICE GUIDANCE

Difficulties of the Problem

- Inelastic Materials
  - Masonry: Composite, Anisotropic, No tension, Creeps, Variability
  - Soil
- Structurally Complex System:
  - Gravity Pre-Stressed Structures
  - Arch + Spandrels Weight + Arch-Spandrels Interaction
  - Gradual Separation of its Elements
  - Three-Dimensional Structures (Skewed Arches)
- Magnitude of the Problem

Magnitude of the Problem

- Largest Single Group of Bridges in the UK
- 40% of the UK Bridge Stock are Masonry or Brick Arches
- 40 000 Arch Highway Bridges
- 33 000 Railway Arch Spans
- Very High Proportion on British Waterways Network

Purpose of the CIRIA Project

- Present Best Practice
- Facilitate Knowledge Sharing
- Provide an Enabling Document
- Have National Application
- Recommend a Maintenance Strategy for Best Value for Money for Different Infrastructures
- Provide an Independent Assessment

Main User Groups

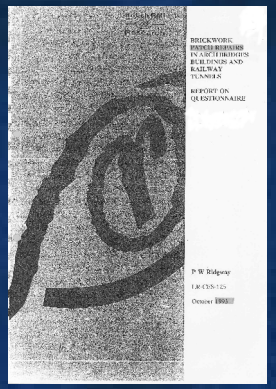
- Clients (Asset Owners and Operators) in Railway, Road and Canal infrastructures
- Engineers (Consultants and Contractors)
- Maintenance Managers

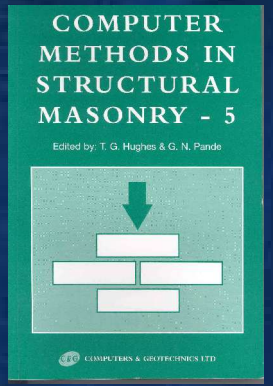
Approach

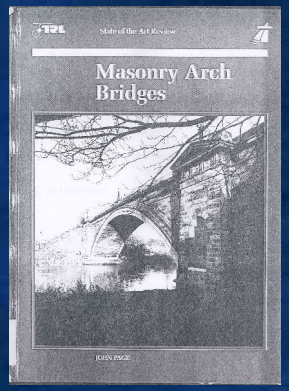
- Asset Management
- Structural Behaviour of Masonry and Brick Arch Bridges
- Loss of Bridge Performance
- Condition Appraisal (Materials and Structures) and Assessment of Capacity
- Preventative, Remedial and Strengthening Measures
- Monitoring
- Environmental and Heritage Considerations
- New Masonry Arch Bridges
- Future Research

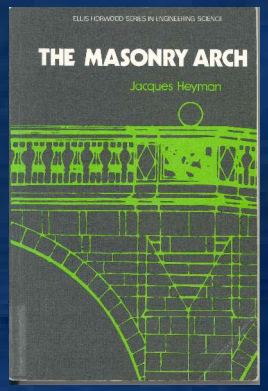
Method

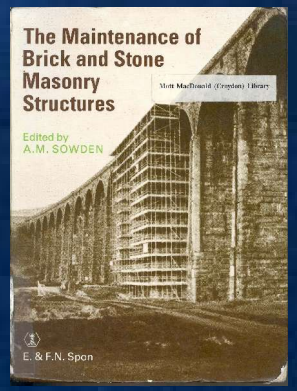
- Literature Review
- Consultation
  - Interviews
    - Owners and Asset Maintainers
    - National and International Experts
    - IStructE Arch Bridge Study Group
    - European Network on Sustainable Masonry Arch Technologies
  - Workshops
  - Web Site (Questionnaires)
- Case histories
- Assessment of Information
- Reporting and Conclusions



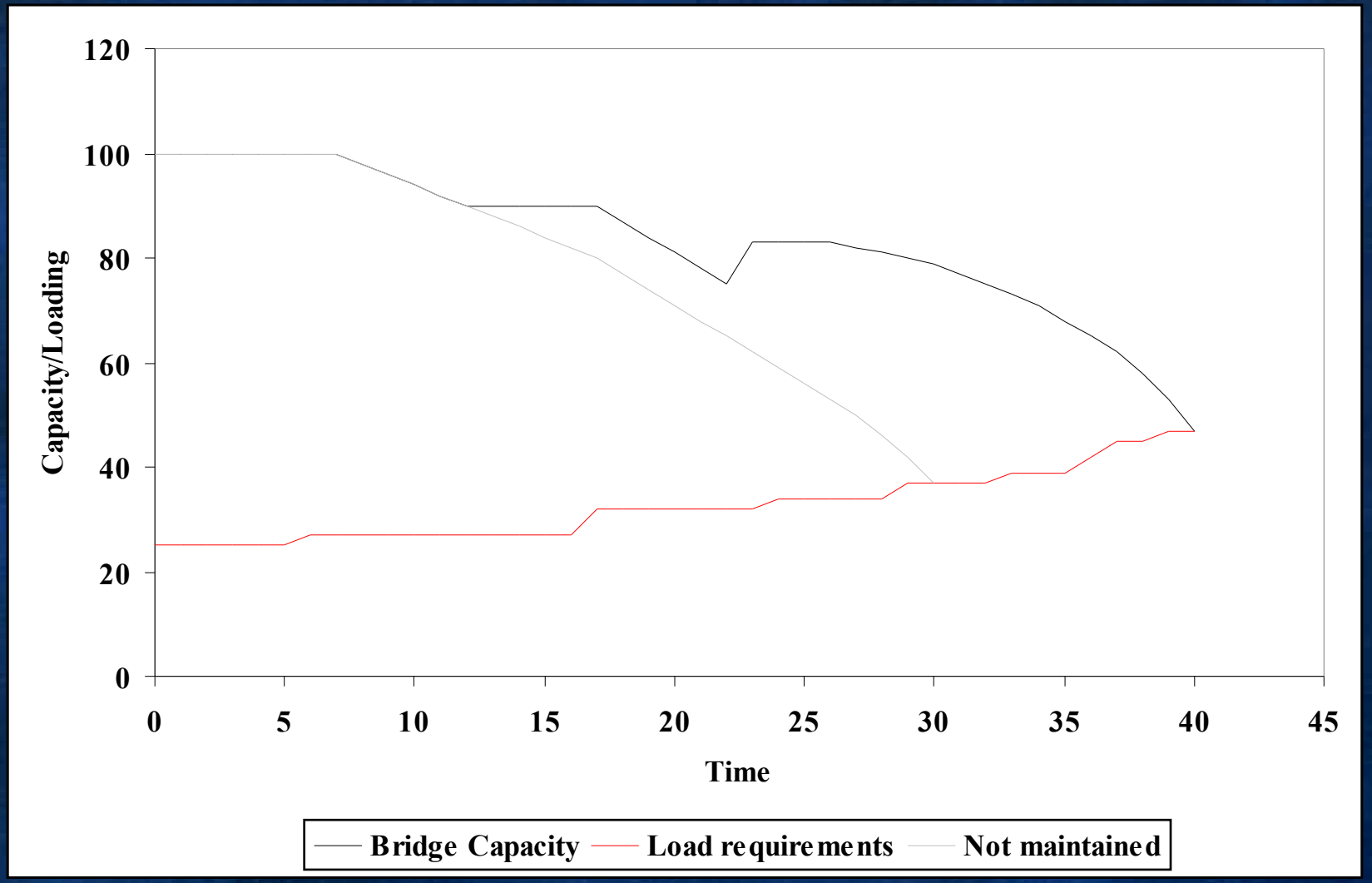








Bridge Safety



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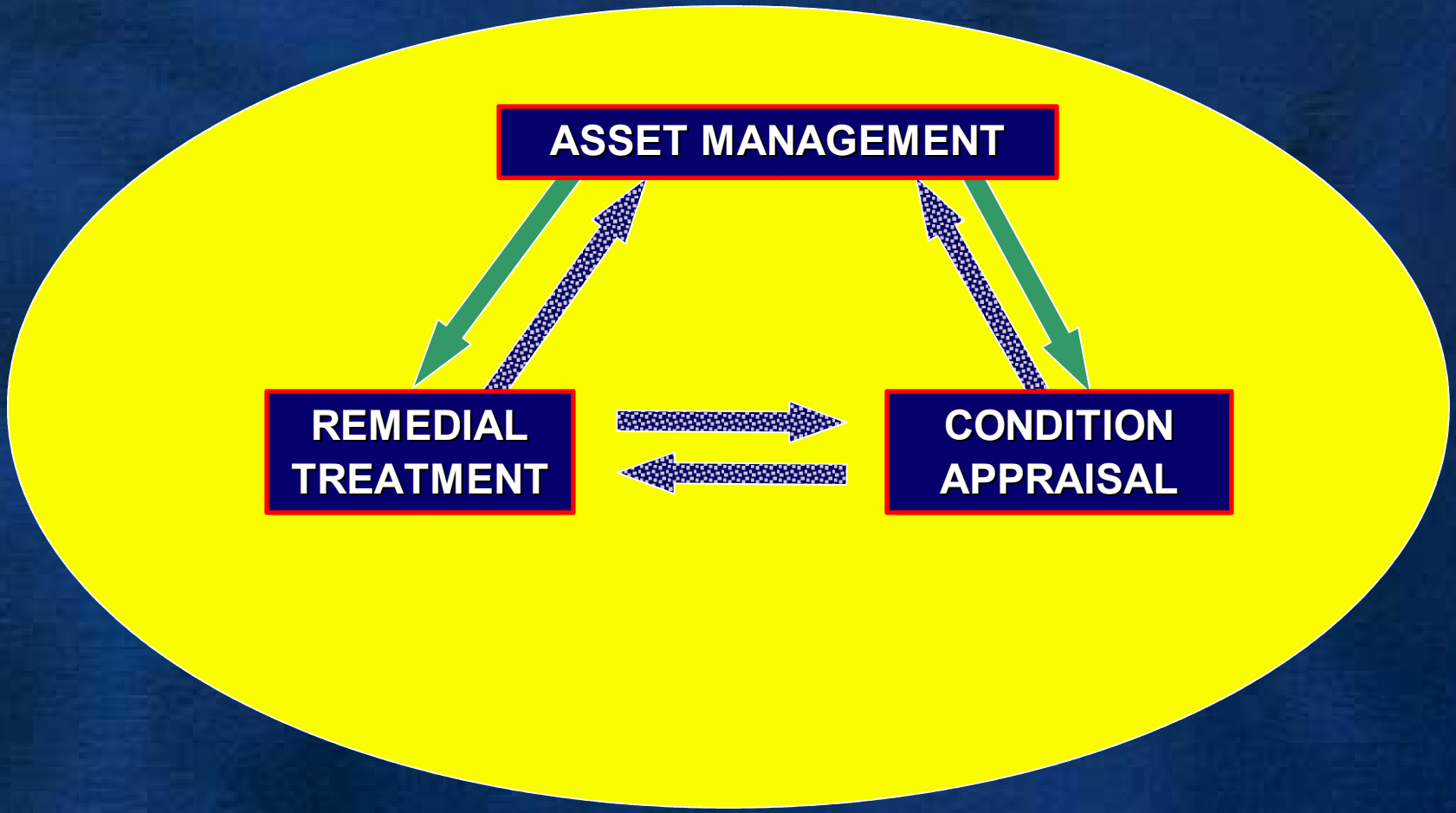


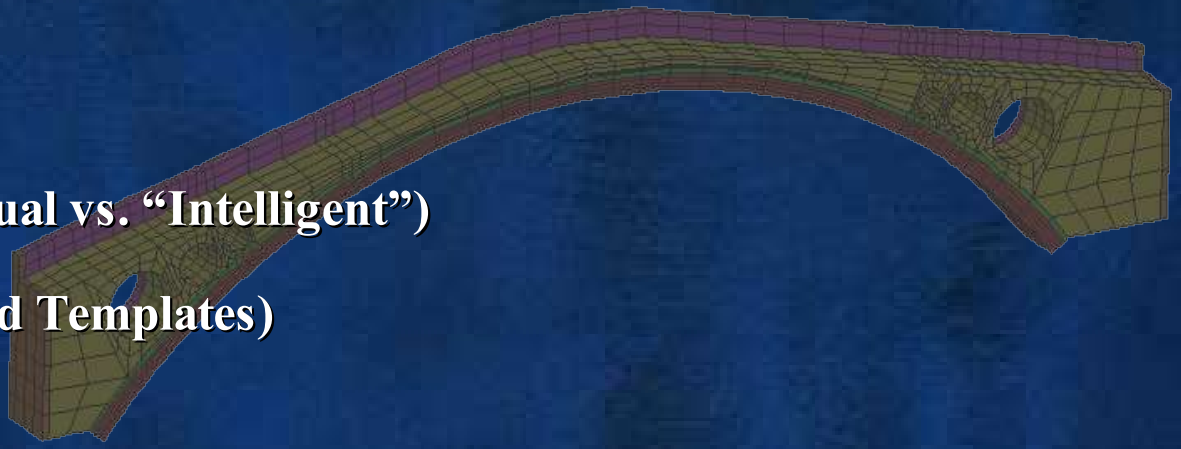
Asset management

- Data Collection and Storage
- Regular Inspection Regimes
- Triggers for Condition Appraisal and/or Abnormal Monitoring Regime
- Prioritisation (Risk Management)
- Cost Effectiveness (Whole Life Costing)

  Do Nothing – Repair – Complex Analysis - Strengthen – Replace
- Post-works Monitoring
- Feedback - Constant Improvement

Condition appraisal and Studies

Inspection and assessment



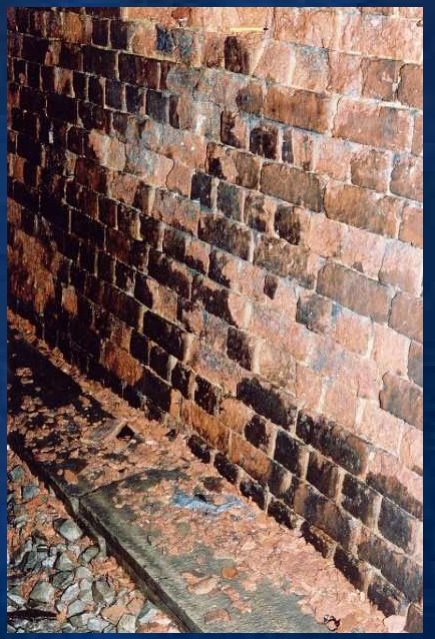
- Inspection
  - Types of Inspection (Visual vs. “Intelligent”)
  - Objectives (Guidance and Templates)
- Assessment/Analysis
  - Code (Ultimate/Service)
  - Method (Empirical – Limit State – FEM/DEM)

    Available tools in order of complexity (Suggest Sequence of Use)
  - Applicability/Expectation/Reliability of Assessment Tools
  - Critical Parameters and Sensitivity
  - Stochastic Approaches

Typical problems

- Foundation
- Structure
  - Distortion – Transverse Cracks
  - Spandrel Wall Separation
  - Ring Separation
  - Backfill (Saturated Backfill)
- Materials
  - Effects of Water (Freeze – Thaw, Leaching)
  - Chemical Attacks (Mainly Various Types of Sulphate)
  - Physical Erosion
  - Vegetation

Typical problems



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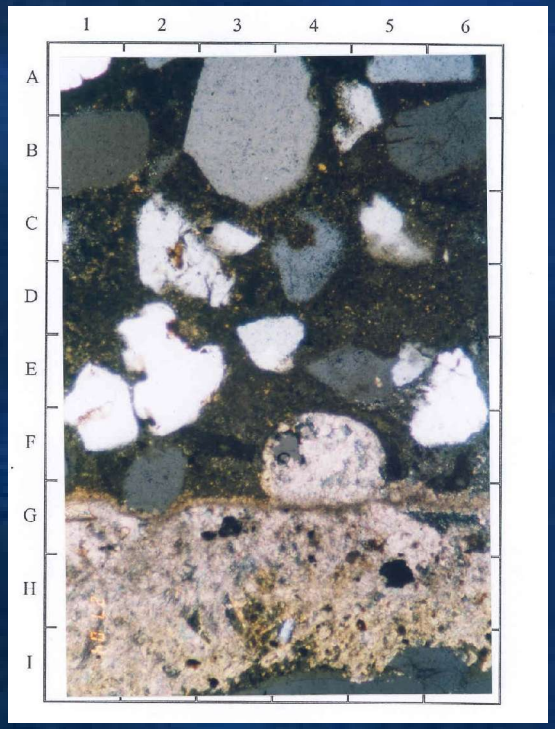
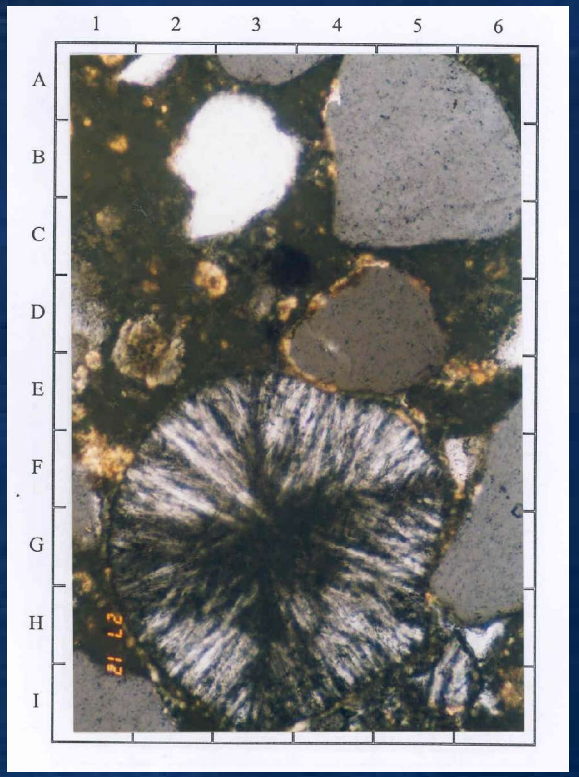




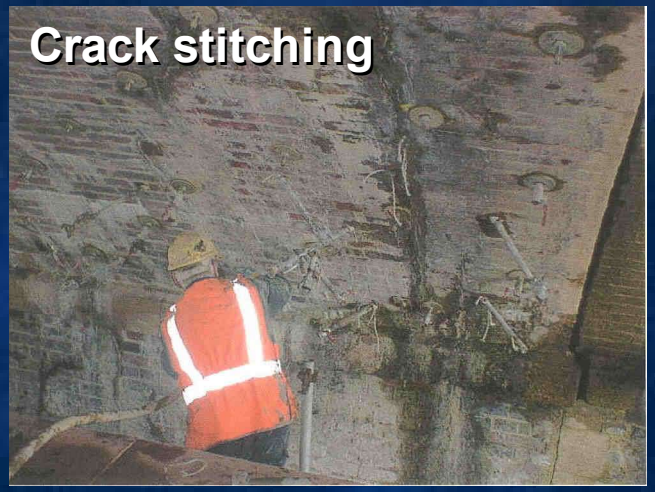
Physical measures (I)

Maintenance, Repair and strengthening

- Repointing
- Patch repairs
- Arch grouting
- Underpinning
- Tie bars
- Stitching
- Waterproofing and/or drainage improvements
- Replacing backfill with concrete or reinforced fill
- Saddling
- Sprayed concrete
- Retro-reinforcing
- Prefabricated liners

Physical measures (I)

Maintenance, Repair and strengthening



Physical measures (I)

Maintenance, Repair and strengthening


Arch grouting


Patch Repair

Physical measures (I)

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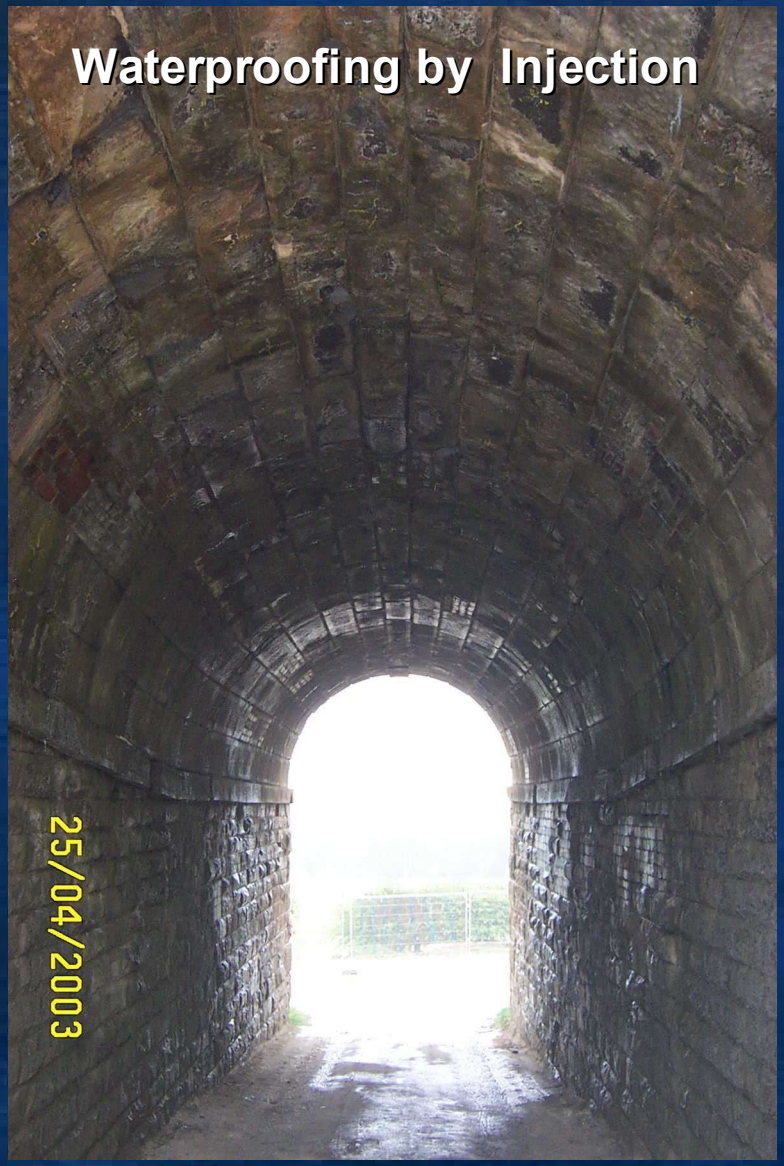
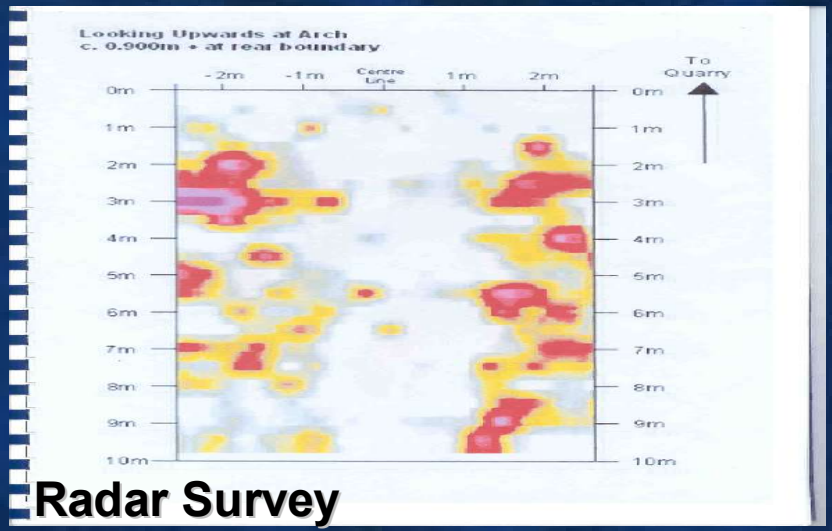
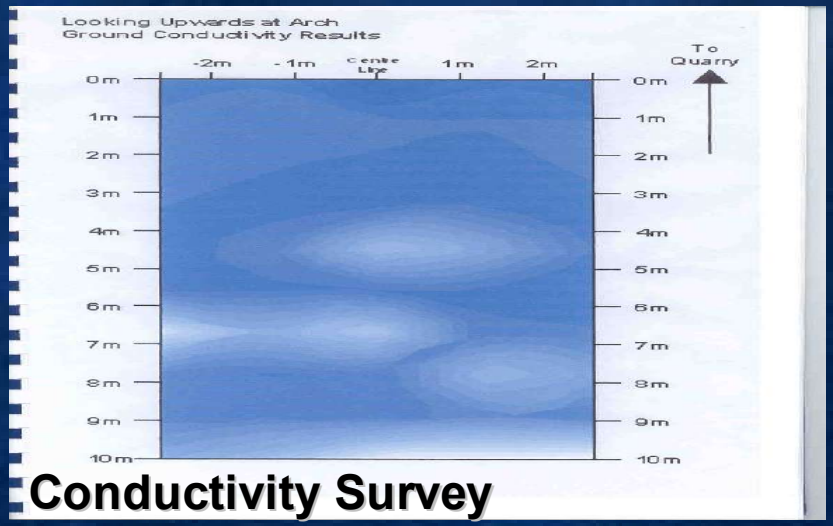




Radar Survey



Conductivity Survey

Physical measures (I)

Maintenance, Repair and strengthening

Physical measures (I)

Maintenance, Repair and strengthening

Physical measures (I)

Maintenance, Repair and strengthening

Piling

Concluding Remarks

- The Programme has just Started
- Experienced Team
  - Knowledge
  - Practical Experience
  - Best Practice
- HELP !
  - Owners
  - Experts

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?