MASONRY AND BRICK ARCH BRIDGES: CONDITION APPRAISAL AND REMEDIAL TREATMENT

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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

**NEED FOR MAINTENANCE, REPAIR AND STRENGTHENING**

**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

ASSET MANAGEMENT

REMEDIAL TREATMENT

CONDITION APPRAISAL
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)
    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
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

Stitching

Voussoir stitching

Patch repair

Crack stitching

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Physical measures (I)
Maintenance, Repair and strengthening

Arch grouting

Patch Repair
Physical measures (I)

Maintenance, Repair and strengthening

Corrugated steel liner

2003
Physical measures (I)
Maintenance, Repair and strengthening

Waterproofing by Injection

Radar Survey

Conductivity Survey
Physical measures (I)
Maintenance, Repair and strengthening

Emergency Works

25/09/2003

30/09/2003
Physical measures (I)

Maintenance, Repair and strengthening

Stainless steel reinforcement anchored to structure

Wingwall block to be rep
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?