



# GOLDHAWK

Bridge Restoration

Sustainable **rehabilitation** and **strengthening**  
of masonry arches, bridges and tunnels





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## Services provided

- Structural surveys, assessment and design using in house computer programs ASSARC and MARSYS backed by Professional Indemnity Insurance.
- Rehabilitation and strengthening of masonry arches, bridges and tunnels.
- Strengthening of masonry arches and parapets.
- Masonry construction and restoration using lime mortars and traditional materials and techniques.
- Structural repairs and strengthening using carbon fibre and FRP materials.
- Installation of proprietary ground anchoring and micro piling systems for support and retaining structures.
- Overall project management.



Goldhawk Bridge Restoration undertakes structural repairs and refurbishment, specialising in the sympathetic rehabilitation and strengthening of masonry arch bridges.

We use established and highly regarded computer analysis and design programs. Coupled with well proven repair products and non-disruptive concealed installation techniques, we provide high quality, environmentally friendly, economical and reliable solutions.

We offer turnkey packages that cater for the concealed cost-effective repair of all structural faults together with the necessary reinforcement to upgrade bridges and enable them to meet modern load bearing requirements. Our innovative systems both repair and enhance bridging and retaining structures, with minimal effect to their visual appearance, while causing minimal inconvenience to the public or disruption to road and rail traffic.

The company brings together considerable bridge engineering experience and expertise, state of the art software for assessment and design, proven repair products and techniques and high standards of professional installation.

# Comprehensive customer service

Goldhawk Bridge Restoration Ltd is committed to providing a first class service and developing a close working relationship with our clients which allows both parties to achieve mutual benefits through effective collaboration.

Through a policy of trust, openness and collaboration, Goldhawk aims to deliver best value solutions that meet clients' needs, aims and objectives.

To achieve these goals we offer clients a full service that includes advice and technical support, designed repairs, quality installation and on-site back-up, all designed to ensure customer peace of mind.

Over 250 arches in the United Kingdom have been rehabilitated using the Masonry Arch Repair and Strengthening (MARS) system.



...an example of the very best  
in British ingenuity'  
Knight of Garter Tony Blair. 1999



## Our method

- Fostering close relationships.
- Understanding clients' aims and objectives.
- Working together to achieve pre-agreed goals.
- Establishing clear lines of communication.
- Providing cost-effective reliable solutions.
- Adopting an open, honest, flexible approach.
- Supplying complete turnkey packages.



## Advantages of Goldhawk's systems

Our masonry repair and strengthening systems offer a number of important benefits compared with more traditional repair methods.

Advanced computer programs provide accurate assessment and optimised designs while the lightweight stainless steel repair and reinforcement systems combine exceptional tensile strength with structural flexibility. No additional stresses are therefore introduced, normal structural movement is accommodated and there is minimal disturbance to the retained original masonry.

The concealed repairs leave the bridge virtually unchanged but with its structural integrity restored and at a fraction of the cost of full bridge replacement. The system enables weak bridges that have had weight restrictions imposed to be sympathetically strengthened to accept full highway loadings and comply with EU regulations.



“Very impressed on all aspects of the site such as safety, cleanliness of the site, friendly staff and the knowledge of the staff to mention a few. Well-done to all and keep up the good work.

Gopal Pirathapan  
Essex County Council.



Arch barrel reprofiling



iGap injection process

- Minimal disruption to road and rail traffic - no closures necessary.
- Environmentally friendly with minimal carbon footprint.
- Economical, effective and durable.
- Increased strength with no excessive stiffness.
- Improved structural behaviour.
- Allows normal structural movement.

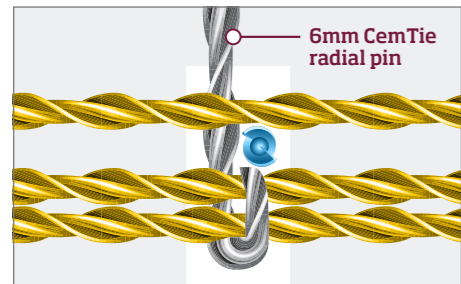
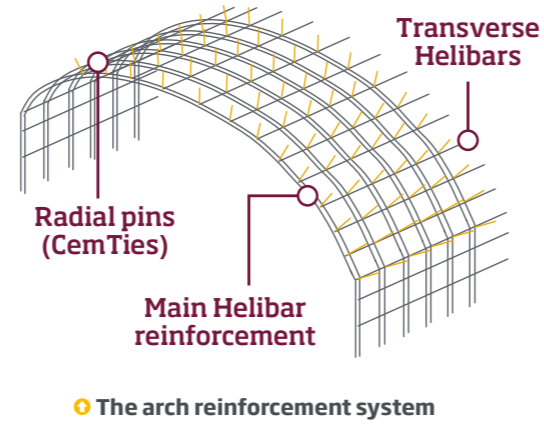
### Accurate structural computer analysis.

- Optimised software engineering design.
- Rapid, concealed, sympathetic installation.
- Allows staged, sequential, installation.
- Minimal disturbance to bridge fabric.
- The System gives users confidence in the integrity of the bridge.

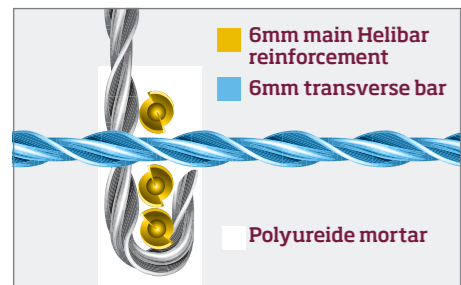
- Significant loading enhancement.
- No disruption to Statutory Undertakers mains and cables.
- Independently tested by the TRL.
- Fully proven and widely used.
- Ideal for historic and listed structures.
- Features Helifix helical high quality reinforcement and Marflex structural adhesive.

# How our **arch strengthening** system works

A full structural survey and assessment of each bridge is carried out using the ASSARC computer software. Appropriate repair and strengthening is designed, using the proven MARSYS software, to suit the individual needs of the bridge and the client. For bridges that are being upgraded beyond their original design capacity the increase in soil pressure under abutments is checked to determine that it is within acceptable limits.



Longitudinal view of a node on the grid



Transverse view of a node on the grid

## Load capacity checked and approved

For the temporary condition, when the slots have been cut, the load capacity of the bridge is checked using ASSARC.

The required grid pattern is marked out on the bridge soffit. Narrow slots are cut just 12mm wide and up to 40mm deep.

Services are avoided and environmental issues observed.

Radial stainless steel Helifix CemTies are installed throughout the grid.

Stainless steel Helifix HeliBars are installed into the slots.

## Weather proof and durable

The reinforcement is encapsulated with structural adhesive – a durable polyureide resin with high bond strength, particularly to damp substrates.

This is elastic and can be colour matched or coated with a layer of masonry dust taken from the slot cutting machine.

## Tested at the Transport Research Laboratory

The MARS System was tested on a 5m span brick arch. The unreinforced arch failed at 20 tonnes giving an equivalent traffic weight restriction of 7 tonnes.

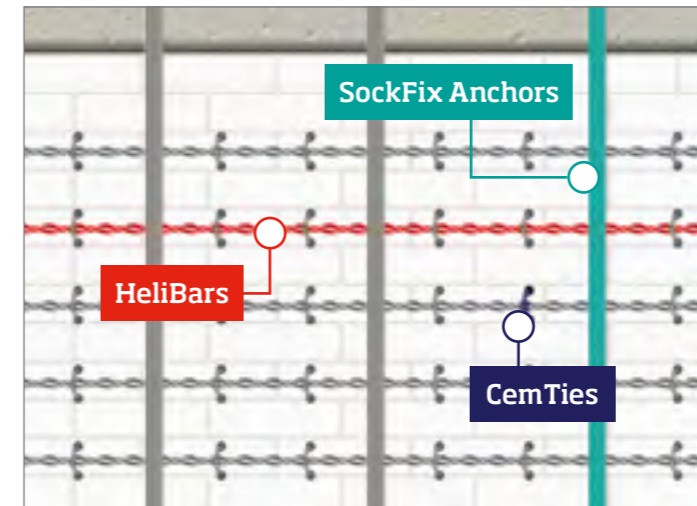
A designed amount of reinforcement was inserted and the barrel failed at 34.5 tonnes. This was equivalent to a 40 tonne traffic capacity.

The MARSYS program run before the test predicted a failure load of 34.9 tonnes. As the barrel was slightly weakened as the loading jack had to be replaced near the end of the test.

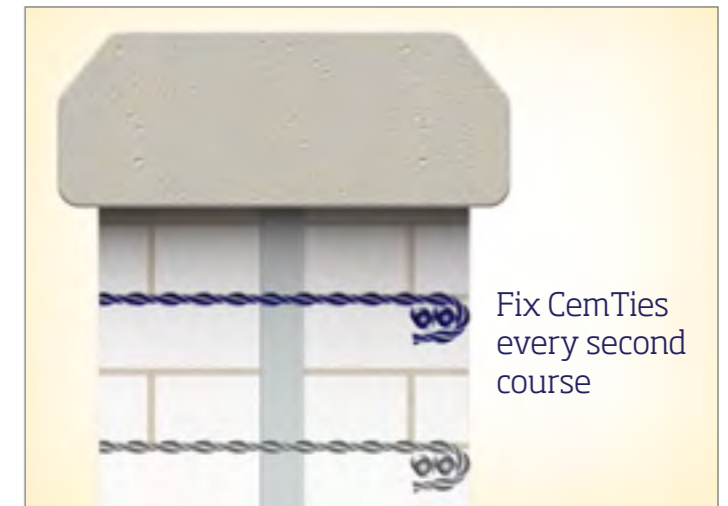
The test verified the efficacy of the MARS System and the accuracy of the design program, MARSYS. The reinforced barrel also failed in a controlled manner compared to the uncontrolled collapse of the unreinforced barrel.



# How the **parapet strengthening** system works



Helifix reinforcement system



Cross section of reinforced parapet

A full structural survey of the masonry parapet is carried out detailing the critical dimensions, type and condition of the brick or stone, type and condition of the mortar and defects.

The appropriate strengthening measures are designed to meet the requirements of the Department of Transport.

The installation will commence with the setting out of the positions of the vertical anchors, longitudinal bed joint reinforcement and the transverse ties.

A temporary works platform will be installed to protect the workforce and prevent objects and debris falling from the workface to the area beneath the bridge.

Vertical holes are drilled through the masonry parapet into the spandrels in order to accommodate the Helifix SockFix anchors. After installation of the vertical anchors horizontal longitudinal rebates are cut into the bed joints at the prescribed spacings.

After drilling transverse holes in the masonry at the prescribed locations Helifix CemTies are installed and grouted.

Longitudinal HeliBars are then inserted in the rebates and the ends of the CemTies are bent around the HeliBars.

The whole is encapsulated with structural adhesive. At the completion of the installation the surface of the masonry is cleaned and the temporary works removed.

The longitudinal HeliBars provide lateral continuity and distribute the stresses induced by impact throughout the masonry, the CemTies enhance the transverse resistance by maintaining the mass of masonry thus preventing bricks or stones dislodging from the parapet.

The Helifix SockFix anchors act as vertical restraints providing stiffness and resistance to the stresses transferred by the longitudinal HeliBars.

## Notes

- All work is undertaken from the carriageway face of the bridge.
- No requirement for external safety/access platforms.
- No disruption for users of the thoroughfare below the bridge span.
- Easy and rapid installation and removal of safety platforms.

I and clearly everyone at the demonstration of the PARS system were impressed with this new system of strengthening the parapets, especially due to the sophistication with which the rebar was embedded into the parapet.

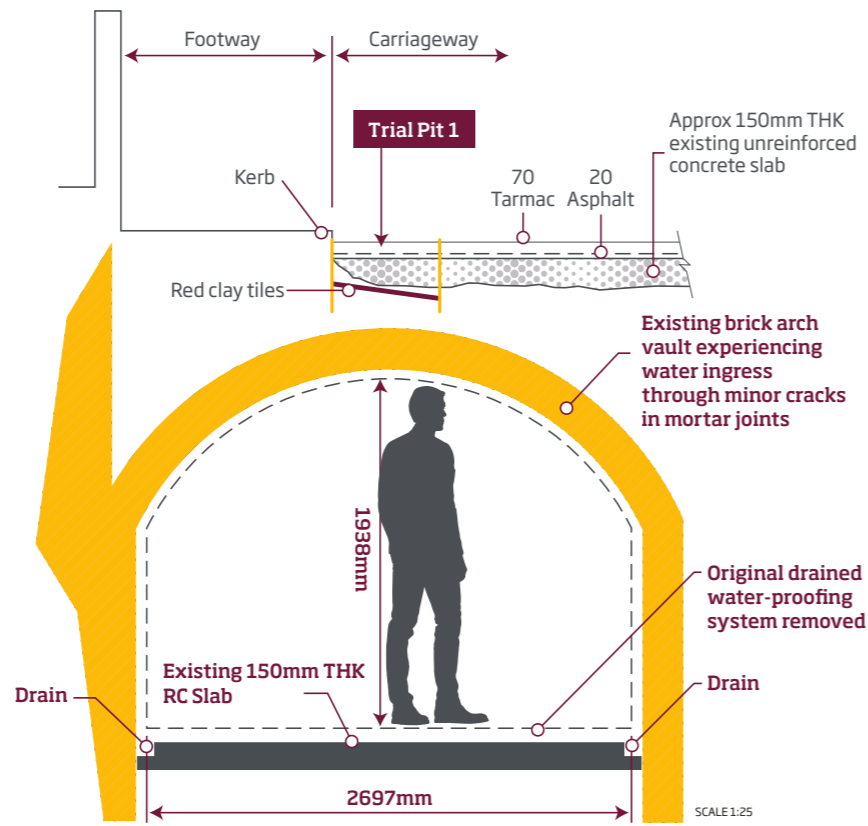
**Bhavya Rajagopal**  
Senior Structural Engineer,  
London Borough of Merton

# Vault strengthening

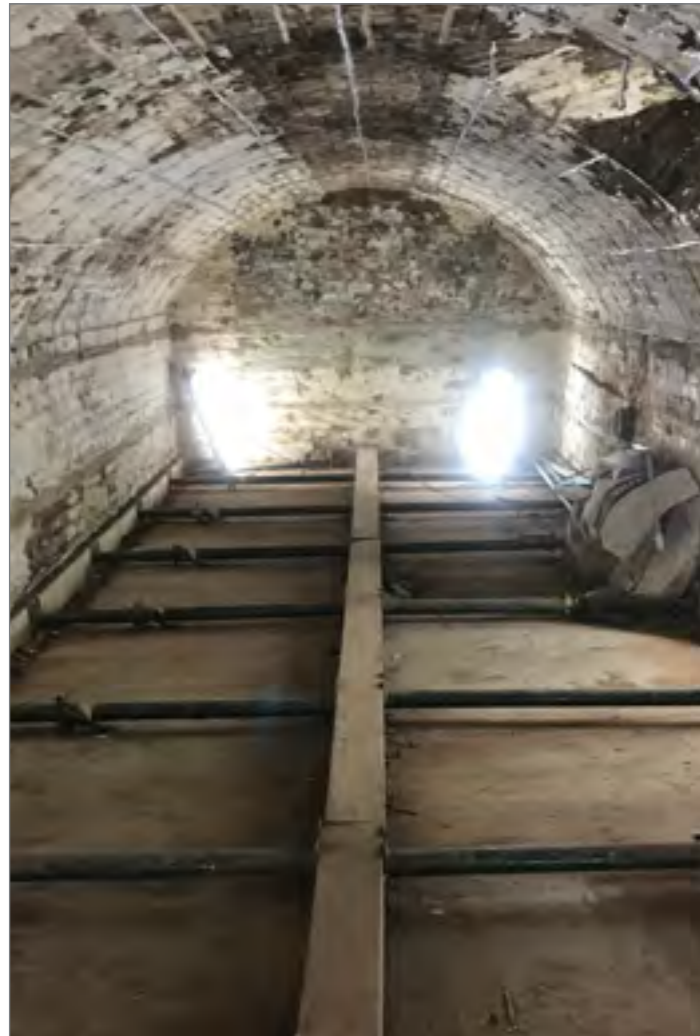
Barrel arched vaults are a historic feature of most British towns and cities having previously been used for non-perishable goods storage such as coal and timber.

Often vaults are located beneath pavements and roads which rely on their integrity for support. Any defect through age or damage risks collapse of the arch and roadway above.

The MARS system is ideally suited to provide the necessary cost-effective strengthening to overcome defects and increase the arch capacity to take required highway loadings.



Long room existing section



# Case study Briscoes underbridge, Reading

Client: Network Rail



The bridge is a classic Brunel brick construction allowing access beneath the twin rail line.

## The problem

The arch could be seen to flex under train loading. Vertical deflections of up to 10mm could be measured.

The excessive movement required correction and the bridge strengthened to level RA10 which would enable it to carry heavy freight loading.



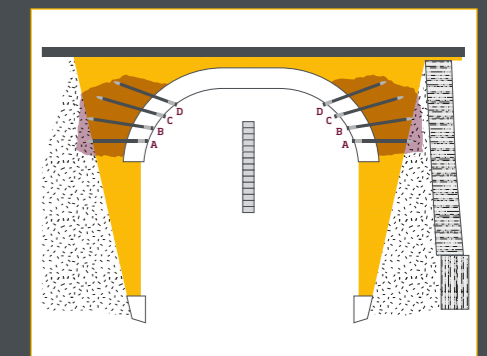
## The solution

Use the MARS system to increase the capacity, correct the arch ring separation and combine this with increasing the stiffness of the haunching backfill to resist the arch forces exerted by the flexing barrel. This was provided by Goldhawk's sister company STRESS using their unique patented ReFORCE system for ground injection.



## The result

Reducing the arch deflection by over 90% and increasing the strength to level RA10 without the need for any engineering possessions or disruption to rail timetables saving Network Rail considerable sums.



ReFORCE 3 lance setting out tables

Ref.	Length	Set angle	Horizontal centres	Vert centres
A	1000	0°	900mm	300mm
B	1200	10°	900mm	300mm
C	1300	15°	900mm	300mm
D	1000	20°	900mm	300mm

Installation of the ReFORCE 3 lances

The project was delivered on time and within budget.

## Case study Oundle North Bridge, Northampton



Delivered to schedule and to budget.



### The solution

Goldhawk used a pontoon system to provide safe access to the arches so that the MARS system could be installed efficiently from beneath to all understrength barrels.

### The result

A historic masonry multi-arch bridge capable of taking full 44-tonne loading, strengthened without needing to close the road above.



**Client:** Northamptonshire CC  
-Kier-WSP

The structure is a thirteen arch historical bridge providing access to Oundle over the River Nene.

### The problem

Arch assessment had shown a number of arches to be understrength resulting in a three tonne weight limit. This caused considerable lorry congestion on the other route into Oundle and required the north bridge to remain open during strengthening.

## Case study Thrapston Nine Arch Bridge, Northampton

**Client:** Northamptonshire CC  
-Kier-WSP

The bridge is a nine arch historic and listed masonry structure providing direct access to the centre of Thrapston over the River Nene.



### The problem

Significant defects, particularly in one arch, causing a weight limit and restricted vehicle use.

### The solution

Goldhawk designed individual bespoke MARS schemes for each damaged and understrength arch. Use of a flexible pontoon and floating scaffold system allowed safe and efficient access to the underside of each span.

### The result

A strengthened historic bridge, future-proofed to provide decades of maintenance free service. A full 44-tonne capacity for traffic whilst complying with Historic England restrictions and requirements of the Environment Agency.



Delivered to schedule and to budget.



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