Sustainable rehabilitation and strengthening of masonry arches, bridges and tunnels
Scope of work

• 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, they 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.

Goldhawk Bridge Restoration works in partnership with Helifix, market leaders in the design and manufacture of stainless steel helical reinforcement and fixings.
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.

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.
- Accepting responsibility by supplying complete turnkey packages.

“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.

…an example of the very best in British ingenuity’

Rt Hon Tony Blair. 1999
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.

• 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.
• Lines of the System give 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.

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 Marflex 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

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 the structural adhesive ‘Marflex’. 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
Parapet strengthening works at Holybush Hill bridge in the London Borough of Redbridge

CemTie installation
Hooked Helifx CemTies are installed to form a mechanical connection with the longitudinal reinforcement.

Main Rebar installation
Twin HelifBars are inserted into horizontal slots cut into the face of the parapet every two courses.

Encapsulating the reinforcement
The installed rebars are encapsulated in MARFLEX, a solvent free thixotropic epoxy/urethane resin that bonds it to the masonry.

Finishing
The MARFLEX is over-pointed with lime mortar to provide a matching finish to the parapet.
Case study Nant Mafon, Treharris, Merthyr Tydfil, Wales

Client: Merthyr Tydfil County Borough Council

The bridge is a single span segmental stone arch with a clear square span of 3.5m. It comprises a natural stone arch and abutments on spread foundations and carries the unclassified Pentwyn Deintyr road over the Nant Mafon Brook.

The problem
The bridge had suffered from severe flood damage. The spandrel walls had been severely damaged and a large bulge had formed in the barrel of the arch.

The solution
Following analysis using ASSARC assessment a repair scheme was devised using MARSYS.

The fill over the barrel was removed and the bulging area of the barrel was jacked back into shape.

The MARS System was installed and stainless steel anchors were additionally installed through the barrel into a new reinforced concrete backing.

Works were completed within the scheduled five weeks, including repairs to the parapet walls.

The repairs and strengthening left the visual appearance virtually unaltered and allowed the bridge to be opened to unrestricted two way traffic.
**Case study** Unsliven Old Bridge, Stockbridge, near Sheffield

**Client:** Sheffield City Council

The 8.5m span Unsliven Old Bridge was originally built in 1730s as a narrow stone bridge for horses and pedestrians only. It was extended on both sides in 1796 to enable it to carry carts as well as horses.

**The problem**

In circa 1980, a strip of stonework on the crown of the west arch extension was cut-out to accommodate an electricity cable in a 75mm diameter plastic duct, thus weakening the arch. A reinforced concrete slab was cast on top of the west and centre arch to bridge a 40mm gap which had opened up between the west and centre sections of the arch. The slab also encased the electricity cable.

In 2013, the west and centre sections of the bridge were assessed as being understrength. It was proposed to replace the bridge but local residents were so outraged they successfully campaigned against this and Goldhawk was called in to install the MARS System to bring the bridge up to full capacity.

**The solution**

It was found that, as the centre section had a relatively thin barrel, it could not be brought up to full strength using the MARS System alone. However, when the MARS System was combined with a lightweight foamed concrete fill, the bridge was able to be upgraded to accommodate full highway loading.

In the end, the local residents were happy, the history and heritage of the area had been preserved and the council were given an unrestricted bridge at a fraction of the environmental and monetary cost of a replacement one.
Case study
Strengthening a 200 year old Grade II listed aqueduct

Client:
Neath and Port Talbot

Built 1824-7 by the iron-master John Reynolds to supply waterwheels at the Oakwood Ironworks, the Aqueduct located in Pontrhydyfen, spans the Afan valley and is now used as a public footpath and cycle path.

The problem
Goldhawk were engaged to assess the degradation and movement in the structure and put forward a strengthening and masonry repair scheme that would compliment an aesthetic and remedial repair overhaul being carried out by local contractor Ian Davies Plant.

The solution
Goldhawk carried out a visual structural assessment of the bridge, with particular interest paid to the bulging of the spandrel walls of each of the four arches and cracking of the arches between the voussoir and the soffit.

Goldhawk proposed inserting sock anchors, as used on the PARS (PArapet Repairs and Strengthening) System. In this case the stonework was cored to specified depths at regular centres and the sock anchors installed at offset right angles to bind the spandrel wall to the ring of the arch.

Additional information
Whilst undertaking the works, Goldhawk were asked to analyse the internal make-up of the aqueduct to better understand the impact on the spandrel walls. In undertaking the survey, Goldhawk were able to establish that the aqueduct had in fact been constructed using a lattice brick dwarf wall system, rather than a solid fill. From this investigation into the structure, of which the internals had not been seen for nearly 200 years, we were able to reduce the scope of works to suit the needs of the structure, saving the client a significant sum on the structural repair costs.

Goldhawk worked closely with the main contractor and client to accommodate the phased programme of works, whilst also reducing the client’s liability and providing a custom-fit solution which perfectly and cleanly rectified the structural issues identified. Goldhawk’s works were completed ahead of schedule and well within budget.