Sustainable Rehabilitation and Strengthening of Masonry Arches, Bridges and Tunnels
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 affect 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 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.

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 with our patented system.
- 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.
Advantages of the Goldhawk Systems

The 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 regulation.

- Minimal disruption to road and rail traffic – no closures necessary.
- Economical, effective and reliable.
- 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.
- Original characteristics retained.
- 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.
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.

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 40mm deep.

Services are avoided and environmental issues observed.

Radial stainless steel Helifix CemTies installed throughout the grid.

Stainless steel Helifix HeliBars are installed into the slots.

The reinforcement is encapsulated with Marflex structural adhesive, a durable polyureide resin with high bond strength, particularly to damp substrates, that is elastic and can be colour matched or coated with a layer of masonry dust taken from the slot cutting machine.

How the Arch Strengthening System\* works

\* The System is a patented (GB2304360) method of strengthening masonry arches and is solely installed by Goldhawk Bridge Restoration Ltd.
How the Parapet Strengthening System Works

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/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.

- 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.

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.

The 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 will be cut into the bed joints at the prescribed spacings. HeliBars will be inserted in the rebates and encapsulated with the structural adhesive ‘Marflex’.

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

At the completion of the installation the surface of the masonry will be cleaned and the temporary works removed.
A burst water main had caused movement of the spandrel and parapet walls together with separation between the arch barrel and the voussoirs. Fine material in the carriageway sub base had been washed out and continued vehicle use was causing settlement. Traffic was removed from the arch section of the bridge and restricted to using the newer southern section controlled by three way temporary traffic lights.

**SOLUTION**

- Following analysis using ASSARC assessment a repair scheme was devised using MARSYS.
- Stainless steel helical rebars were bonded into longitudinal radial and transverse rebates cut into the underside of the arch with interlocking stainless steel radial pins installed at right angles to the bars at the grid intersections. All bars are then encapsulated with a special structural adhesive.
- Works were completed within 28 days, including rebuilding part of the north spandrel and parapet walls and reconstruction of the north carriageway and footway.
- Repairs and strengthening left the visual appearance virtually unaltered and allowed the bridge to be opened to unrestricted two way traffic.

Projects

**Bridge: Brownhill Bridge, Dobcross, Oldham**

**Client:** Oldham Metropolitan Borough Council

A single 5m span bridge, carrying the A6052 over the Huddersfield Narrow Canal, Brownhill Bridge comprises a natural stone arch and abutments on spread foundations which had been widened, with the newer bridge being contiguous with the original stone structure.

**SOLUTION**

- Following an assessment the bridge had been restricted to a gross vehicle weight of 7.5 tonnes, so did not meet highway standards. The general structure was in a fairly good condition with some 20% of the mortar in the arch barrel spandrels and the parapets was loose or missing. Part of the structure was covered in ivy and leached calcite deposits, a temporary repair had been carried out to the abutment foundations following scour damage and the north west end of the spandrel and adjacent embankment had been eroded by water draining from the carriageway. The height of the parapets was too low and the south parapet had suffered impact damage.

**SOLUTION**

- Following ASSARC analysis a repair scheme was devised using the MARSYS computer package.
- All vegetation was removed and leached deposits blasted away using a fine glass powder.
- Stainless steel helical rebars were bonded into rebates cut in a grid pattern into the underside of the arch and, with its interlocking right-angled stainless steel radial pins, the system was encapsulated with a special structural adhesive. The height of the parapets was increased to meet regulations.
- Loose and missing mortar joints were raked out to a depth of 50mm and the whole structure re-pointed using an approved lime/sand mix. The temporary scour repairs were removed, the voids filled and a permanent stone/concrete apron formed to protect the foundations.
- The concealed repairs and strengthening left the bridge visually unaltered while increasing its load carrying capacity from 7.5 tonnes to 40 tonnes and allowing the weight restrictions to be lifted.
Bridge: West Lydford Bridge, Somerset  
Client: Somerset County Council

Carrying West Lydford High Street over the River Brue, this Grade II listed natural stone bridge is 22.1m long, 4.1m wide, has five arches with spans ranging from 2.0m to 2.72m and 2.36m wide parapets.

**PROBLEM**

A number of defects had been noted, following an inspection in 2006, which were severely weakening the bridge. Mortar in the joints was missing, loose or friable, some stones had become dislodged or dropped and others were missing, mainly from two of the arch soffits.

**SOLUTION**

- A full underwater dive survey of the structure and the riverbed, up and down stream, was undertaken. Spans were dewatered to access the pier columns.
- The dropped or dislodged stones were repositioned and missing stones replaced, secured with stainless steel radial pins and bonded with cementitious grout.
- As agreed with the client, specified sections of the bridge structure were repointed using Natural Hydraulic Lime mortar.
- The Goldhawk proprietary strengthening and rehabilitation techniques were reliable and cost-effective. Fully concealed, they caused minimal disturbance to this heritage structure and left the bridge virtually unaltered.

Bridge: Tintern Wire Works Bridge, Gloucestershire  
Client: Gloucestershire Highways

The listed twin masonry arch Tintern Wire Works Footbridge carries an unclassified accommodation route over the River Wye between the villages of Tintern Parva and Brockweir in Gloucestershire. The bridge comprises a steel lattice truss superstructure supported by masonry river piers with twin masonry arches at the eastern end, each with a span of 5.9m and a central rise of 2.95m. The arch barrel brickwork is 380mm thick with a 686mm cover and the abutments and spandrels are faced with ashlar stonework.

**PROBLEM**

An inspection revealed deterioration of the arch barrels’ masonry and concern about the integrity of the two spans as a whole. The outer ring of bricks in the west arch was severely damaged and cracking was evident in the barrel structure, particularly a shear crack at the junction with the spandrel / parapet wall.

**SOLUTION**

- As the former railway bridge is now only used for farm access the load carrying capacity of the main structure was retained at 3.5 tonnes.
- Following ASSARC analysis a repair scheme was devised using the MARSYS computer package.
- Single stainless steel helical rebars were installed at 450mm centres for both circumferential and transverse reinforcement with stainless steel radial pins inserted at every intersection of transverse and circumferential bars.
- The Goldhawk proprietary repair and rehabilitation techniques were reliable and cost-effective. Fully concealed, they caused minimal disturbance to this listed structure leaving it secured but virtually unaltered.
Goldhawk 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 Restoration UK 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.

- 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.

Comprehensive Customer Service

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

The Masonry Arch Repair and Strengthening (MARS) system is provided in association with Helifix, market leader in the design and manufacture of stainless steel helical reinforcement and fixings.

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