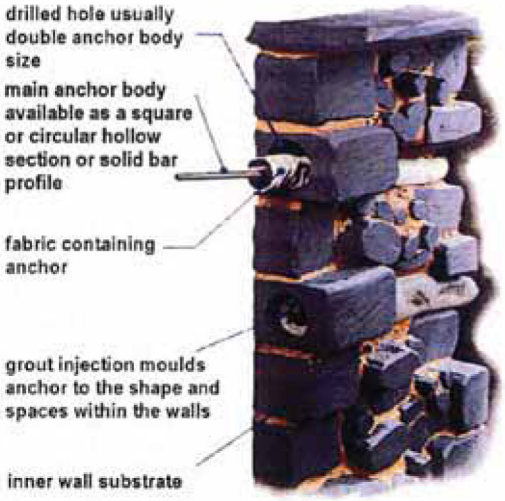
PARATEC

PARAPET WALL STRENGTHENING FROM CINTEC

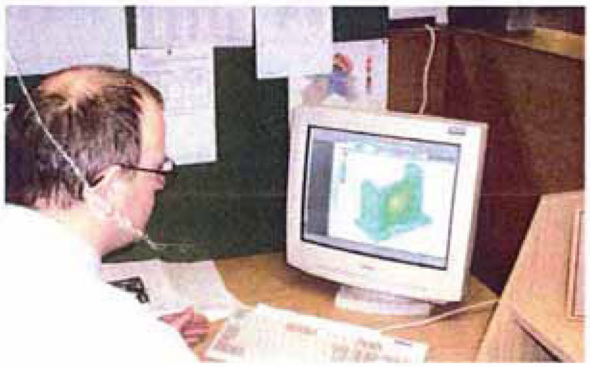
No two masonry arch bridges are the same, and this also applies to their parapet walls. The requirements specified for individual walls can differ considerably and must reconcile a variety of needs. These may include impact containment, vehicle redirection, the protection of others in the vicinity, compatibility with the masonry structure as a whole, as well as the visual appearance of the strengthening solution implemented.

The Cintec Anchor System provides a highly versatile method of internal structural reinforcement that is tailored to meet the specific requirements of each parapet wall. This service, known as Paratec is backed by extensive research and development, this includes advanced computer modelling, practical testing and also the experience built up from numerous strengthening projects. The Paratec system can strengthen a masonry wall while remaining sensitive to the original architecture and without any narrowing of the road way.

The Anchor: The system comprises a steel bar enclosed in a mesh fabric sleeve, into this a highly specialised grout is injected under low pressure. This is a Portland cement based product, containing graded aggregates and other constituents which, when mixed with water, produce a pumpable cementitious grout that exhibits good strength without shrinkage. Installation is by precisely drilled holes using wet or dry diamond coring technology. The flexible sleeve of woven polyester restrains the grout flow and expands up to twice its original diameter moulding itself into the shapes and spaces within the walls. This provides a strong mechanical bond along the entire length of the anchor dispensing with the need for external anchor plates.



The size and type of steel anchor, the strength of grout and the diameter of the hole can all be varied to the required design parameters, these will include providing the appropriate stiffness compatible with the masonry.



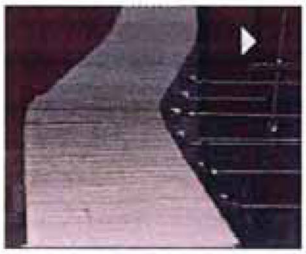
Research & Development

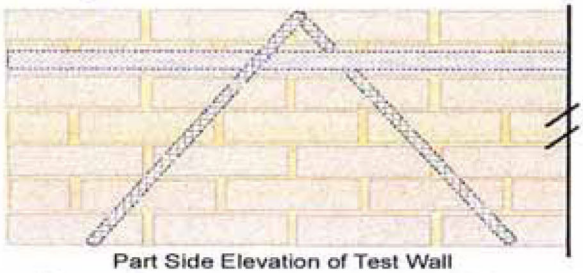
The comprehensive service offered by Paratec include advanced computer modelling techniques that simulate the effects of a vehicle impact upon a specified masonry wall. Working in conjunction with both software specialists and consulting engineers, Paratec utilises an advanced dynamic software incorporating a discrete element analysis technique that enables the behaviour of parapet walls to be accurately predicted under various circumstances.

Practical Testing: Tyne-Tees University

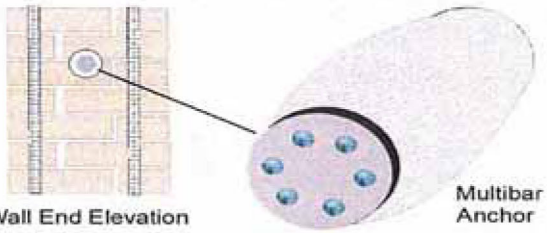
Dynamic full-scale parapet wall tests were undertaken in the heavy structures laboratory at Tyne-Tees University. The tests clearly demonstrate the robustness of parapet walls reinforced with Cintec masonry anchors. The walls were impact loaded using a falling weight test rig designed to generate the force/tme history of an actual vehicle impact test that had previously been recorded and analysed at MIRA.

In this test, the Cintec reinforcement used was a 19.5 metre high yield MS multibar anchor comprising six individual stainless steel bars of 8mm in diameter. This was installed 370mm below the top of the wall. Raking anchors were also installed in pairs at 30° to the vertical. These were 1 metre long 3 strand 8mm diameter multibar anchors encapsulated in a 40mm diameter sock and installed in a 50mm diameter hole.

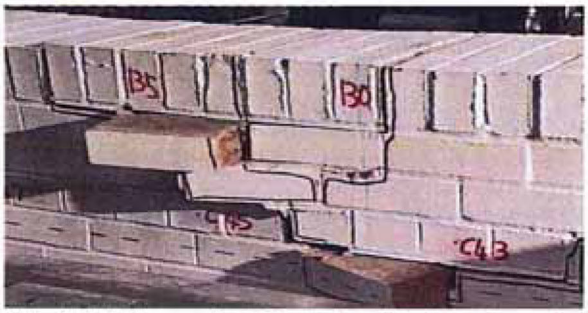




Part Side Elevation of Test Wall



Wall End Elevation



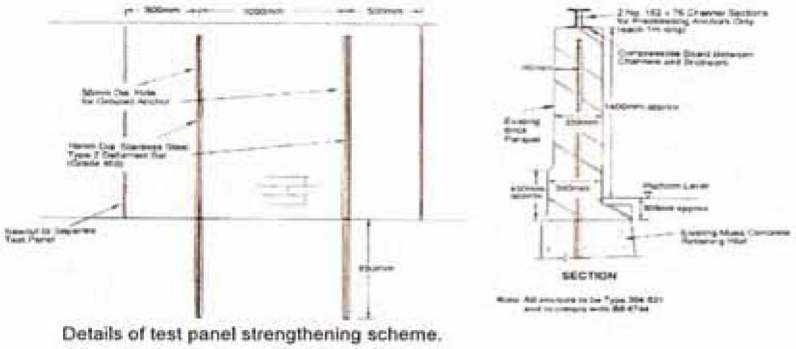
Although the bridge was shunted by the force of the impact, it remained intact with no significant spalling. The picture above shows the wall face opposite to the point of impact after two consecutive tests.

London Underground

Post-tensioning Cintec anchor in test panel.

Two 16mm diameter 2 stage anchors were installed vertically, the anchorage length within the supporting structure was then inflated and left to fully harden. The anchor was then tensioned and the second sock occupying the remaining space in the masonry wall was inflated.

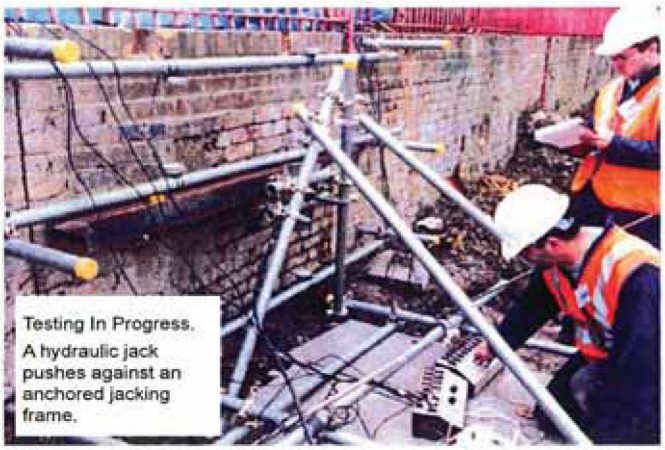
London Underground has a great many brick walls and parapets supported on elevated structures. As it is the world's oldest underground system, many of the walls are between 100 and 150 years old and are consequently suffering from a degradation of the mortar which is invariably lime based. An insitu load test was carried out in order to demonstrate the applicability of Cintec anchors for both stabilising these structures and for strengthening them against dynamic air pressure loading. The test was also used to confirm that the performance of the strengthened wall had been correctly calculated and thus provide assurance of the methodology.



Details of test panel strengthening scheme.

Once the anchors were cured, an applied wind loading was simulated by the application of a lateral point load on a horizontal spreader beam positioned at the walls centre. An incremental lateral load up to 3.5kN/m was applied by a hydraulic jack which demonstrated a linear elastic response.

The predicted response, calculated beforehand and based on assumed values for the material properties, was within 30% of the measured values. Bearing in mind the wide range of uncertainties in relation to the wall stiffness and strength, this demonstrated an adequately high level of accuracy. On completion of the test, no cracking or spalling was observed. It was concluded that the strengthening scheme presented both "an economic and aesthetic solution to the refurbishment of understrength and unstable masonry parapets".



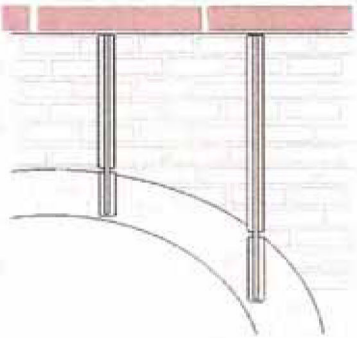
Testing In Progress. A hydraulic jack pushes against an anchored jacking frame.

CASE HISTORY - INCLINED PLANE BRIDGE, COALPORT

Spanning the river Severn at Coalport in Shropshire, the Inclined Plane bridge is a registered ancient monument and as such, any alteration to its appearance is unacceptable. The Archtec method of bridge reinforcement was chosen to increase the load bearing capacity of the structure, and a need was also recognised to strengthen its parapet walls.

A solution was achieved by the installation of Cintec 16mm studding anchors, of between 1.5 and 3 metres in length. These were designed with two individually inflated socks and were installed vertically at 1 metre intervals through the parapet walls and into the barrel of the arch. The lower (arch barrel) sock was then inflated and left to cure. The second sock was then inflated and placed under a tension of 10kN by using a tensioning plate. The grout was then cured and the tensioning plate removed.

Finally the sandstone parapet coping stones were replaced and two missing stones reproduced. The solution provided the necessary increase in wall strength without having any visible change to its appearance.



CASE HISTORY - WALCOT ROAD BRIDGE, TELFORD

Built in limestone and spanning the river Tern, Walcot Road bridge is an historic structure with a grade II listing. As it was constructed long before the development of motorised traffic, it is vulnerable to the modern demands placed upon it. The narrow roadway has led to numerous collisions and scrapes along its parapet walls for which Wrekin Council had correspondingly undertaken various stonework repairs. It was decided to pre-empt future repair work with a parapet reinforcement scheme. Cintec provided a solution that met both the engineering and aesthetic requirements.

With the use of non-percussive diamond core drilling, thirty-six prestressed Cintec anchors of between 1.4m and 2.8m in length were installed vertically through the parapet walls and into the arch barrel. Core drilled sections of the monolithic coping stones were then replaced and grouted into the entrance of the anchor holes to provide an almost invisible finish.

Current research is focusing on the development of articulated anchor reinforcements. These are designed to fail progressively in order to absorb the energy of a vehicle impact while at the same time reducing the structural damage incurred by the bridge.

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